Wastewater Needs Evaluation and Plan
for
Southern New Castle County

June 1992

Prepared for:
New Castle County
and
Delaware Department of Natural Resources and Environmental Control

C341

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EXECUTIVE SUMMARY

This Wastewater Needs Evaluation and Plan for Southern New Castle County was commissioned jointly by New Castle County and the Delaware Department of Natural Resources and Environmental Control. The primary purpose of this study was to update the Area Wide Wastewater Management Plan, originally drafted by New Castle County in 1975, for the southern New Castle County area. This Wastewater Needs Evaluation and Plan considers projected wastewater demands, evaluates treatment requirements, and identifies alternatives for meeting these requirements. The alternatives considered the continued use of on-site systems, expansion of existing facilities, and the construction of new facilities as methods by which to provide adequate wastewater treatment service over a 20-year planning period (1991 through 2010). The plan is based upon the environmental constraints of the area and is designed to protect the area's surface and groundwater resources from improper or inadequate wastewater management practices. Specific areas of New Castle County which were examined in this document include portions of the New Castle and Central Pencader Planning Districts, the Red Lion Planning District and the Middletown-Odessa-Townsend Planning District.

WASTEWATER MANAGEMENT NEEDS

In order to identify options for wastewater management in southern New Castle County, several assumptions were made in regard to the present direction of wastewater management. The following is a list of those assumptions.

- The present Wilmington collection and conveyance system will be extended south to accommodate flows generated in the Red Lion district. This expansion has been approved and is currently in the design stage. The capacity of this expansion (1.218 mgd) will be sufficient to handle the wastewater needs of the projected population. In addition, the Wilmington Wastewater Treatment Plant (WWTP) is scheduled to undergo a capital expansion by 1995. It is assumed that this expansion will result in sufficient reserve capacity to meet the wastewater treatment needs of the projected future population in the Red Lion district.

- Since population is projected to decline in the Delaware City area, it is assumed that the Delaware City WWTP has sufficient capacity to meet future needs.

- Based on the two aforementioned premises, it is concluded that future wastewater management needs for the portion of the study area located north of the C&D Canal have been adequately addressed in present wastewater management strategies.

- Wastewater treatment and disposal capacity in the M-O-T area will be expanded to a capacity of at least 1.5 mgd. A feasibility study (FS) is presently underway to determine the most desirable alternative by which to treat and dispose of present and near-future flows that will be generated in the M-O-T area. Based upon present conditions at the M-O-T regional WWTP and the forecast of projected needs for this area, it is likely that this expansion in total capacity will be accomplished by developing a combination of existing M-O-T facilities and new components.

- With the exception of the City of Wilmington WWTP, there is no reserve capacity at any other treatment facility located within a reasonable proximity to the study area. Therefore, any future public collection and treatment alternative will consist of the expansion of present treatment systems and/or construction of new facilities.

- Septage management for the study area will continue to employ transport of septage to the Wilmington WWTP via the transfer at the airport. This approach is consistent with the County's current intent. However, the viability of this approach may be affected by the wastewater management scenario selected by the County, since septage quantities may vary widely under different scenarios.

The range of feasible alternatives for meeting projected needs is normally framed by existing patterns of development and infrastructure. However, in the case of the southern New Castle County planning area, the historically rural development pattern does not define the configuration that the area may assume under continued development pressure in the future.

For this reason three potential wastewater management scenarios were defined for the study area. The scenarios are essentially "pictures" or "snapshots" of how the study area may look under different land development strategies. In each case, the scenarios dealt with the conflicting goals of providing water quality protection while allowing for continued economic and population growth in different ways. The scenarios are:

- CURRENT PLANNING - Presents a future development pattern that would most likely occur if existing trends continue (Scenario 1).
- EXPAND EXISTING WASTEWATER SERVICE AREAS - Concentrate new high-density development around existing wastewater management infrastructure (Scenario 2).
- PROVIDE NEW WASTEWATER SERVICE AREAS - Expand wastewater infrastructure by providing new public services to outlying areas via new Public Service Zones (PSZs) (Scenario 3).

Under Scenario 1, current development trends continue during the next 20 years. New facilities are constructed in the Middletown, Odessa, and Townsend (M-O-T) area to expand to 1.5 mgd (subject to NPDES permit issuance) to serve the towns of Middletown, Odessa, and Townsend, with minimal extended service outside their municipal boundaries. Development outside the M-O-T area (and other smaller sewer service areas) will be supported by on-site systems at prevailing densities and by privately owned and operated small community (e.g., spray irrigation) systems. The Boyd's Corner and Summit areas are expected to be the locations for continued scattered subdivision development. This scenario is illustrated in Figure ES-1.

Scenario 2 would concentrate new development around existing centralized wastewater management infrastructure. Of the existing centralized wastewater systems in the study area, the M-O-T service area is potentially expandable to 2.1 mgd through the construction of new facilities and extension of sewer lines beyond the current sewered service area. Development outside the expanded M-O-T service area would be supported by on-site systems. For those areas, new residential development densities (calling for larger minimum lot sizes) may be required. Where possible, cluster developments would be encouraged to maintain the open space, rural natural area of the M-O-T. Revised subdivision plat procedures would be implemented to provide for maximum control of on-site systems siting and design. Complementary land use planning and zoning would be needed to integrate wastewater systems decisions with land use management objectives. Scenario 2 is illustrated in Figure ES-2.

Figure ES-1

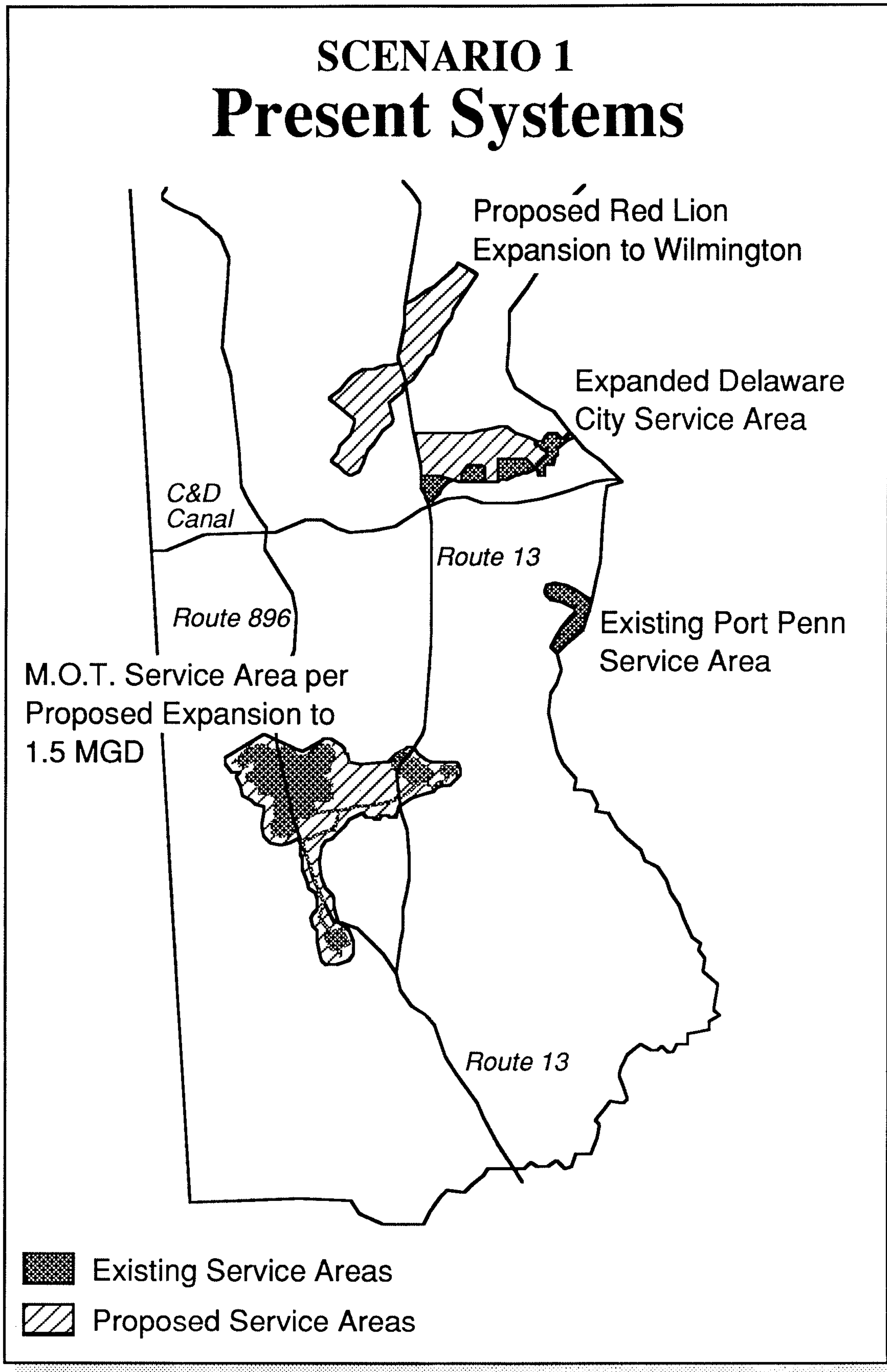

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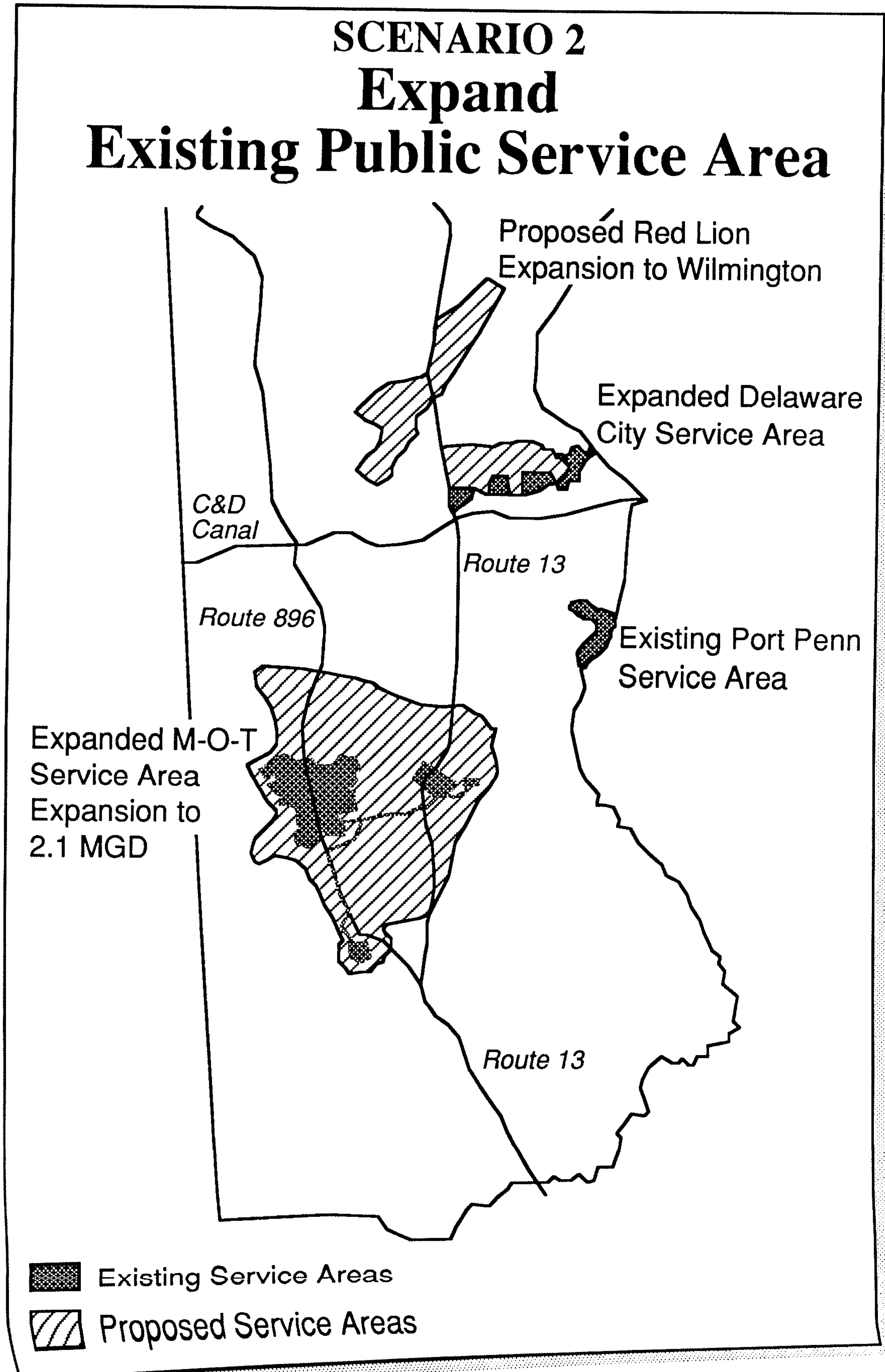
Figure ES-2



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Under Wastewater Management Scenario 3, as shown in Figure ES-3, new areas of concentrated development would be fostered as a matter of public planning in the Boyd's Corner and Summit areas. In such a case, additional public collection, treatment, and disposal systems would be required to serve the new service area. Areas outside of the new and existing service areas would be supported by on-site systems with larger lot sizes. To preserve the rural nature of the planning area, growth would be directed towards areas of public sewer service. To the extent that this system is not currently in place, there were a number of wastewater treatment alternatives that were evaluated.

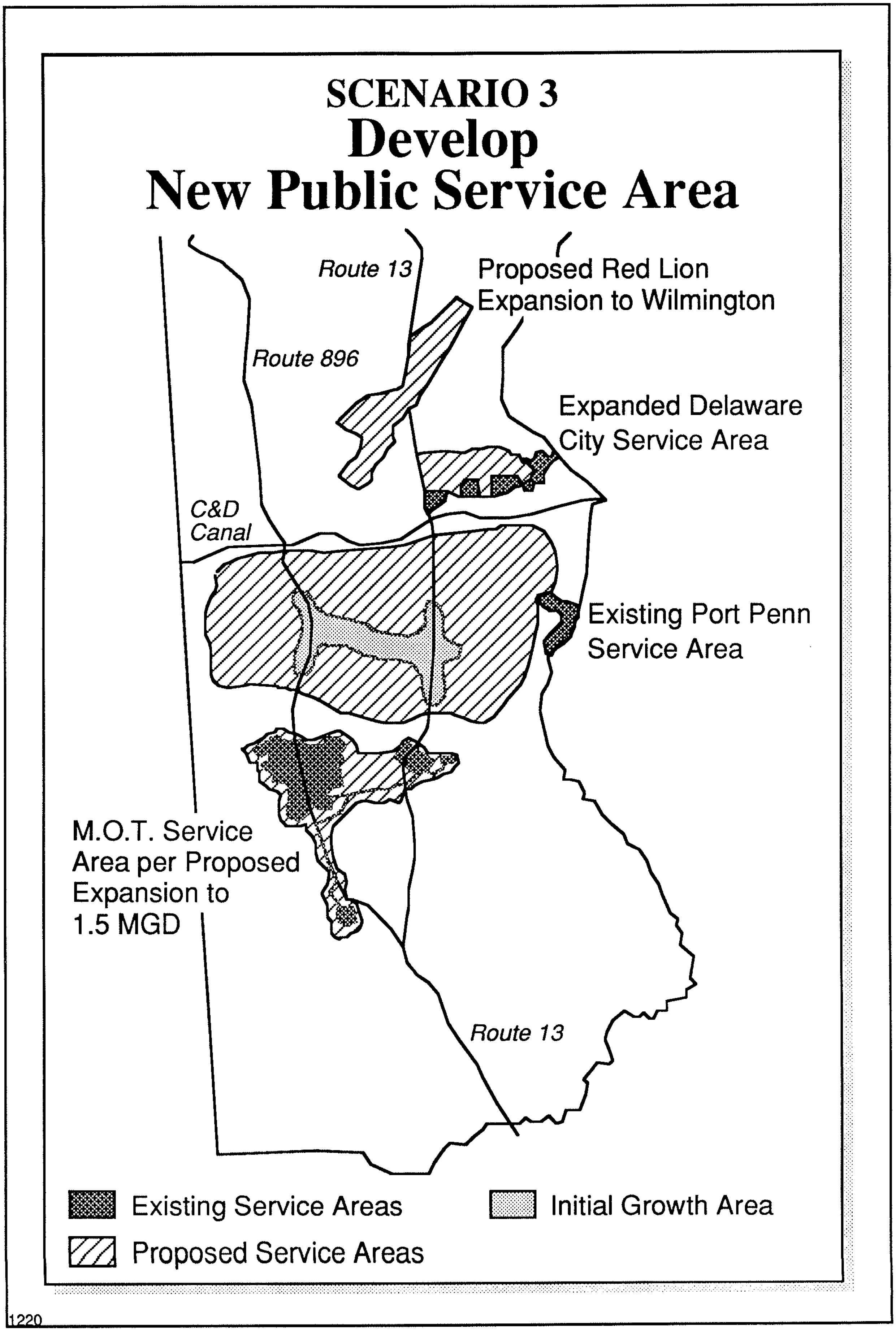
Alternatives that were evaluated for new treatment included:

- Centralized secondary treatment with surface water discharge.
- Centralized advanced nutrient treatment with surface water discharge.
- Centralized secondary treatment with land application.
- Decentralized secondary treatment with centralized land application.
- Centralized secondary treatment with constructed wetlands and surface water disposal.
- Centralized secondary treatment with constructed wetlands and land applications.
- Advanced nutrient treatment with land application.

WASTEWATER MANAGEMENT SCENARIOS EVALUATION

The wastewater management scenarios were evaluated to consider which scenario best met the projected future wastewater management needs of the southern New Castle County area. These alternatives were subjected to comparative analyses based upon environmental, technical, and economic considerations. Each of these major evaluation factors had a number of specific criteria that addressed a broad spectrum of wastewater management concerns. The specific criteria upon which this evaluation was conducted are as follows:

Figure ES-3


SCENARIO 3
Develop
New Public Service Area
Route 13
Proposed Red Lion
Expansion to Wilmington
Route 896
Expanded Delaware
City Service Area
C&D
Canal
Existing Port Penn
Service Area
M.O.T. Service
Area per Proposed
Expansion to
1.5 MGD
Route 13
Existing Service Areas
Initial Growth Area
Proposed Service Areas
1220

Environmental Criteria

- Impact to Groundwater.
- Impact to Surface Water.
- Preservation of Agricultural Lands/Rural Character.
- Protection of Public Health

Technical Criteria

- Implementation Requirements.
- Constructability.
- Ease of Operation and Maintenance.
- Reliability.
- Adaptability
- Public Perception
- Reliance on On-Site Systems

Economic Criteria

- Treatment and Disposal System Capital Costs.
- Conveyance System Capital Costs.
- Operation and Maintenance Costs.

Because the majority of these criteria are subjective, they have not been given numeric ratings or quantitative totals/rankings. Each alternative was subjected to evaluation under each criterion, and a judgment was made as to how well each alternative performs. The values that were used are as follows:

- Promotes/Favorable/Low Cost.
- Neutral/No Effect.
- Detracts/High Risk/High Cost.

The relative performance of each alternative was then compared and considered along with the economic evaluation of each alternative.

A matrix of the identified wastewater management alternatives and the evaluation criteria was prepared to illustrate how each alternative fared in the evaluation under each of the given criteria. This matrix is presented in Figure ES-4.

○ Promotes/Favorable/Low Cost
◍ Neutral/No Effect
● Detracts/High Risk/High Cost

Evaluation Criteria

Alternative	Environmental						Technical/Institutional									Economic		
	Groundwater Quality/Quantity	Surface Water Quality	Agricultural/Farm Resources	Public Health			Reliance on Onsite Systems	Implementability	Adaptability	Reliability	Ease of O & M	Constructability	Public Perception			T. P. Capital Costs	Convey Sys Capital Costs	O & M Costs
I Current Wastewater Management	●	○	●	◍			●	○	○	◍	○	○	◍			○	○	○
II Expand Existing Service Areas	○	○	○	○			◍	○	○	○	○	○	◍			○	○	○
III Create New Service Areas																		
A Secondary/Surface Disposal	◍	◍	○	○			○	◍	●	○	◍	◍	○			◍	◍	◍
B Advanced/Surface Disposal	◍	○	○	○			○	◍	●	○	●	◍	○			●	◍	●
C Secondary/Land Application	○	○	○	○			○	○	○	○	○	○	◍			◍	◍	○
D Decentralized/Land Application	○	○	○	○			○	◍	○	○	○	○	◍			○	◍	○
E Secondary/Constructed Wetlands	◍	○	○	○			○	●	◍	○	○	○	○			◍	◍	○
F Secondary/Const Wetland/Land Appl	○	○	○	○			○	●	◍	○	○	○	◍			◍	◍	○
G Advanced/Land Application	○	○	○	○			○	○	●	○	●	◍	◍			●	◍	●

Figure ES-4

Summary of Alternative Evaluation

Conceptual cost information for each alternative is presented in Table ES-1.

FINDINGS

This Wastewater Needs Evaluation and Plan analyzed potential wastewater service growth and development pressures in the southern New Castle County planning area. It also explored various ways in which the projected demand can be met by the agencies responsible for providing and managing such services. Key considerations in developing these options include not only reliability and cost-effectiveness, but also the protection of environmental resources in this area. The following findings have been drawn from this study:

- Based upon population projections originally developed by WILMAPCO, the total population within the planning area is expected to grow by 122.5% by the year 2010, from 25,097 to 55,840 persons. Associated with this population growth is likely to be a normal level of commercial development as necessary to provide goods and services to that population. Based upon current New Castle County planning projections, substantial industrial growth is not foreseen.

- This projected growth pattern would result in a substantial increase in the total daily wastewater generation from 2.5 million gallons per day (mgd) to approximately 6.0 mgd in 2010 (based upon sewered and unsewered populations and projected commercial flows). The characteristics of this wastewater are likely to be those typical of domestic wastewater and will not include significant industrial components.

- Current County plans provide for sufficient wastewater treatment capacity at the Wilmington and Delaware City sewage treatment plants to accommodate needs of the project area north of the Chesapeake and Delaware Canal. However, this is not the case in the project area south of the Canal.

- Current zoning and planning policies and ongoing land development south of the Canal appear to be leading towards dispersed residential development that is not conducive to service by centralized wastewater treatment facilities.

- While current wastewater management policy would foster accommodating the projected growth by reliance upon individual (on-site) wastewater disposal systems, this approach is questionable from the standpoint of environmental resource protection, high risks associated with future environmental problems, and in terms of other community goals as established by the New Castle

Table ES-1
Comparative Economic Evaluation of Wastewater Management Alternatives

Alternative	Capacity (mgd)	Capital Cost ($ million)				O & M Costs ($ million)			
		Pump Stations (Total)	Force Main (Total)	Treatment Plant (Total)	Treatment Plant ($/gpd)	Pump Stations (Annual)	Treatment Plant (Annual)	Pump Station ($/1,000 gal)	Treatment Plant ($/1,000 gal)
I A	NA	NA	NA	NA	NA	NA	NA	NA	NA
II A	0.6[a]	0.158	1.22	3.048	5.08	0.020	0.164	0.09	0.75
III A	0.8	0.308	2.21	4.49	5.61	0.051	0.344	0.17	1.17
III B	0.8	0.308	1.76	6.032	7.54	0.051	0.492	0.17	1.68
III C	0.8	0.308	1.76	4.065	5.08	0.051	0.219	0.17	0.75
III D	0.8	0.308	1.76	3.77	4.71	0.051	0.184	0.17	0.63
III E	0.8	0.308	1.76	0.795	0.99	0.051	0.083	0.17	0.28
III F	0.8	0.308	1.76	4.565	5.70	0.051	0.23	0.17	0.79
III G	0.8	0.308	1.76	9.80	12.25	0.051	0.535	0.17	1.83

[a] Additional service in the M-O-T area.

NA = Not applicable.

County Comprehensive Development Plan.

- Groundwater protection is of primary importance. Currently all water supply systems in the project area rely upon local groundwater sources. Although some public supply systems obtain water from deeper aquifers, private domestic wells in aquifers account for the largest portion of residential water supply. It appears that this area will continue to rely indefinitely on groundwater as its source of supply.

- While it may be possible to accommodate projected growth by extensive reliance upon individual (on-site) wastewater management systems, other approaches more protective of groundwater resources were evaluated. Three scenarios were identified that contrasted different development patterns in terms of methods that could be used to provide wastewater services. Scenario 1 presented the current wastewater management policy, which calls for the continued reliance on on-site systems to meet the demands outside of existing public wastewater service areas. Scenario 2 presented the expansion of the existing M-O-T public service area and treatment facilities to accommodate projected growth, while Scenario 3 presented the development of a new public service area in the Boyd's Corner/Summit areas. Both Scenario 2 and 3 recognize the continued use of on-site wastewater systems for outlying areas. However, an increase in the minimum lot size in such areas has been proposed to protect groundwater supplies.

- From the standpoint of wastewater management, the choice among these scenarios reflects a trade-off between concerns over potential environmental impacts of extensive use of private on-site wastewater management and disposal and the higher infrastructure requirements associated with public facilities. Based upon the analyses presented in this study, reliance upon extensive on-site systems in terms of groundwater protection is discouraged.

- Additional investigation into potential environmental impacts for on-site systems is warranted. Based upon present information, resource protection considerations indicate that stringent siting criteria, including the requirement for relatively large lot sizes, should be employed in areas where on-site systems will be employed. Consequently, reliance upon on-site systems as the primary wastewater management approach for the study area would result in relatively large areas of land being devoted to residential development. If this development pattern is determined to be unacceptable in terms of comprehensive planning goals, scenarios relying upon on-site systems should be rejected in favor of those employing centralized wastewater management.

- Projected growth using public wastewater management systems can be accommodated by expansion of the M-O-T regional system (Scenario 2) or development of new public service to serve development in the Boyd's Corner/Summit area (Scenario 3). It is likely that expansion of the M-O-T regional system would require the development of additional treatment capacity for discharge to land, since additional discharge through the existing treatment system and to the Appoquinimink River is not a viable option.

- Among treatment and disposal options for new public service systems in the study area, land application of treated wastewater is considered to be the most promising option at the strategic level based upon environmental, technical, and financial evaluations. Current plans underway by DPW for land application are consistent with this study's findings. Factors to be considered in the final selection of this approach at a particular site include: 1) verification of the groundwater quality protection criteria that will be applied to this discharge option; and 2) verification that sufficient areas of suitable land are available for discharge.

- Under the development assumptions and wastewater management scenarios used in this study, the permitted capacity of the existing M-O-T facility at .65 mgd will be exceeded by 1995. Sewered flow in the combined Boyd's Corner/Summit areas (if developed) may exceed 400,000 gpd by 1995. In order to allow for design, construction, and startup of facilities to meet these additional needs, determination of wastewater management and development strategies should be made as expeditiously as possible.

GENERAL PLANNING RECOMMENDATIONS

Based upon these findings the following recommendations are made:

Scenario 1 — Implementation of this wastewater development strategy is not recommended due to the potential impact on groundwater quality as a result of the cumulative impact of high density on-site wastewater management systems. Additionally, there is a high likelihood that the continued use of on-site systems at prevailing densities will result in costly remediation and a management burden for the County in the future. While some of the specific goals stipulated in the Comprehensive Development Plan (e.g., preservation of open areas, encourage growth in areas where capital facilities are provided, manage development so that infrastructure is not overloaded) can be accommodated under this scenario, specific County-level legislation for stringent adherence to future planning and zoning ordinances will be required to ensure growth within acceptable parameters. Other key criteria, namely protection of public health, control of public costs, and resource preservation, are not adequately addressed by this wastewater development plan and therefore result in the nonendorsement of this strategy.

Scenario 2 — Expansion of the existing M-O-T public service area is recommended under the following conditions:

- The County, in consideration of proposed public wastewater infrastructure, consider the location of new proposed uses on the future land use plan map, proposed development areas, and the potential for an expanded and/or additional 5-year growth areas (PDA's) around M-O-T.

- The County, adopt an interim larger minimum lot size requirement for on-site septic systems.

- The County, re-examine existing land use and revise the Comprehensive Plan and zoning ordinance to reflect implementation strategies for development in the M-O-T area.

- The County, implement complementary land use and development policies to direct new growth to the M-O-T service area through higher land use and zoning densities.

- The County, develop appropriate control mechanisms to address pollution potential from platted (but unbuilt) subdivisions with lot sizes less than the revised minimum lot size.

- The County, revise existing major subdivision and land development application processes to encourage usage of wastewater treatment systems that conform to adjusted minimum lot size requirements and availability of small community wastewater treatment systems outside the service area.

- The County, implement groundwater monitoring and modeling programs in the study area to identify potential groundwater pollution and support development of new regulations (County and State).

Scenario 3 — Implementation of a wastewater management strategy requiring the development of new PSZ in the Boyd's Corner/Summit area is recommended under the following conditions:

- The County, in consideration of proposed wastewater infrastructure, consider the creation of new proposed uses on the future land use map, proposed development areas (PDAs), and the potential for expanded and/or additional 5-year growth areas around the Boyd's Corner/Summit area.

- The County develop an infrastructure implementation plan to consider the staging requirements of wastewater collection and treatment systems with other planned expansion and maintenance programs, e.g., transportation, utilities, and access needed for planned commercial, industrial, and residential development areas within the PSZ.

- The County, evaluate financing alternatives and bond capacity to support public costs associated with development of a new PSZ.

- The County, develop and augment the wastewater planning and management process to accommodate the increased wastewater infrastructure management requirements.

- The County adopt an interim larger minimum lot size requirement for on-site septic systems.

- The County re-examine existing land use and revise the Comprehensive Plan and zoning ordinance to reflect the implementation strategies for the Boyd's Corner/Summit area.

- The County develop and adopt complementary land use and zoning controls growth to the Boyd's Corner/Summit area through higher land use and zoning densities and limit on-site septic systems in the PSZ.

- The County develop appropriate control mechanisms to address pollution potential from platted but unbuilt subdivisions with on-site disposal, and lots with less than the minimum lot size.

- The County revise the existing major subdivision application permitting process to require installation of provisional holding tanks pending the availability of sewerage connections within the PSZ: modify subdivision application process to conform to adjusted combined minimum lot size for permits outside PSZs.

- The County and State implement groundwater monitoring and modeling programs in the study area to identify potential groundwater pollution and support development of new regulations.

As this evaluation plan supports implementation of either Scenario 2 or 3, the decision for final selection will rest with further refinements to existing County planning and development forecasting. The decision between Scenario 2 and 3 will incorporate consideration of sequenced activities to obtain needed and presently unavailable planning information, evaluate project financing options, restructure existing regulations and ordinances, and ultimately address the specific programmatic requirements for the selected management system. These recommendations can be classified into two general groups relative to required actions to facilitate the County decision-making process for selection between the endorsed alternatives. Sequencing of the specific activities for the recommendations will be dependent upon final selection of a wastewater management alternative for southern New Castle County. The recommendation groups have been structured to combine the common activities required for either selection into an initial timeline of activities that are separate from specific situational activities that will be required for implementation of each wastewater scenario:

- General Activities:
  - Revise Comprehensive Plan.
  - Conduct economic/financing analysis.
  - County wastewater development decision.

- Scenarios 2 and 3:
  - Design wastewater treatment and collection systems.
  - County approval of wastewater treatment system and collection design.
  - Permit application and approval process.
  - Revise subdivision application process.
  - Review/revise on-site wastewater treatment regulations for:

    Holding tanks/dry sewer (and other interim facilities)
    Use of advanced/innovative technologies
    Minimum lot size

  - Implement interim regulations for subdivision and other development pending PSZ connection.
  - Develop and authorize service fees and rates for PSZ and/or County.
  - Implement NCC management authority for PSZ.

The grouping and activities are presented in Table ES-2 to identify relevant action leads and schedule considerations for sequencing of activities.

Table ES-2

Recommendations for Implementation of Wastewater Management Plan

Recommendation	Action Lead	Schedule
1) Change current wastewater management for the Southern Service area. a. Reject Scenario 1 - Existing Wastewater Management policy. b. Authorize County Staff to further evaluate Scenarios 2 and 3. c. Pursue upgrade of MOT capacity to meet current shortage.	New Castle County Council	Spring 1992
2) Modify Land Use Requirements and Comprehensive Plan to Accommodate Wastewater Management. a. Establish an interim larger minimum lot size in low-density residential areas relying on on-site wastewater systems. b. Designate higher density areas for public treatment and disposal. c. Amend Areawide Wastewater Management Plan for the Southern Service area (208 Plan)	New Castle County Planning Department, DNREC	Initiate immediately - modify comprehensive plan and unsewered zoning ordinance by January 1993.

Table ES-2

Recommendations for Implementation of Wastewater Management Plan (continued)

Recommendation	Action Lead	Schedule
3) Select Wastewater Management Scenario/Plan a. Complete current upgrade to MOT facilities b. Finalize plan for expansion of M-O-T service area (Scenario 2) or development of PSZ in Boyd's Corner/Summit area. (Scenario 3) c. Adopt final wastewater management plan and define public and private service functions. d. Develop contractual procedures and plan for design and construction services in accordance with DNREC regulations.	New Castle County DPW	Implement as soon as possible after conclusion of Recommendation 1 after allowing public comment period. Schedule release of design RFP for June 1993.
4) Identify Infrastructure Facilities Planning Area and Timing of Services a. Prepare financing study on services, development sequencing, cost allocations, etc. b. Recommend public investments in land and equipment for future service areas. c. Define private sector (i.e., developer) financial responsibilities for system construction, maintenance, and connection.	New Castle County Planning Department, DPW	Conduct concurrently with Recommendation 2 for task findings to be incorporated into wastewater management scenario selection.

Table ES-2

Recommendations for Implementation of Wastewater Management Plan (continued)

Recommendation	Action Lead	Schedule
5) Revise Subdivision Application Process a. Establish County Requirements for private wastewater treatment and collection systems. b. Incorporate analysis of alternatives. c. Establish O&M requirements for homeowners and developers.	New Castle County Council and Planning Department	Initiate at conclusion of Recommendations 3 and 4. Schedule completion for June 1994.
6) Reclassify Platted (Unbuilt) Subdivisions a. Examine each unbuilt subdivision and compare to revised requirements. b. Require revision and resubmittal of subdivisions which are not in compliance.	New Castle County Planning Department	Initiate at conclusion of Recommendation 5. Schedule for completion of approval process of January 1995.

Table ES-2

Recommendations for Implementation of Wastewater Management Plan (continued)

Recommendation	Action Lead	Schedule
7) Implement Comprehensive Groundwater Characterization Program a. Pursue cooperative arrangement with USGS/DGS to implement comprehensive groundwater monitoring program. b. Refine soils and geology data sufficient to support groundwater characterization. c. Redefine necessary minimum lot size to protect groundwater. d. Modify regulations (NC Co. and DNREC) to include necessary changes to requirements and approval procedures. e. Modify Comprehensive Plan based upon findings of investigations.	WRA of New Castle County, DNREC, USGS, and DGS	Implement groundwater monitoring program as soon as possible after the Wastewater Needs Evaluation and Plan has been approved.

SECTION 1
PURPOSE AND OBJECTIVES

1.1 INTRODUCTION

New Castle County is experiencing significant development pressure, reflecting the economic prosperity and high quality of life that characterizes the State of Delaware and the region in general. The overall purpose of this Wastewater Needs Evaluation and Plan is to serve as an updated version of the areawide wastewater management plan and in doing so perform a comprehensive evaluation of wastewater management issues and options for southern New Castle County. The County is addressing these development pressures in a pro-active fashion through such measures as the recently published Comprehensive Development Plan for New Castle County. The County also has recognized the need for additional wastewater management planning, particularly for the southern portion of the County.

New Castle County is highly diverse, ranging from industrial, urban, and suburban areas in the north to largely rural areas in the south. This diversity arises in large part from the County's unique geographical setting. At the same time, however, the various regions of the County are interdependent with respect to population and, therefore, infrastructure development. Consequently, wastewater planning for particular regions of the County must consider the projected development of the County as a whole.

This study is based upon existing plans and documents, including, but not limited to, the Comprehensive Development Plan and the New Castle County Annual Profile. The study examines future wastewater management needs and the potential applicability of alternative management options that may provide for reliable, cost-effective wastewater treatment and disposal. The study encompasses a 20-year planning period, from 1991 through 2010.

1.2 PURPOSE

As previously stated, the primary purpose of this Wastewater Needs Evaluation and Plan is to perform a comprehensive evaluation of wastewater management issues and options for southern New Castle County. As a result of this evaluation, this plan will act as a tool for the County's decision-makers by which informed and educated decisions will be made in regard to such issues as the level of public service that must be provided to ensure proper wastewater treatment and disposal, what technologies may best serve the County in the future to provide these services, and how wastewater management may play a role in shaping the future development pattern of the County.

In light of these trends, it should be recognized that the purpose of the southern New Castle County's wastewater management plan is to prepare a long-term wastewater management strategy that is based upon the area's geology, soil characteristics, water conditions, topography, and existing and projected wastewater generation. As such, the plan must be based upon the environmental constraints of the area and be designed to protect the area's surface and groundwater resources from improper or inadequate wastewater management practices. As it currently stands, the area is groundwater dependent for its water supply and is likely to remain so. Therefore, it is imperative that groundwater quality and quantity be protected.

It should be kept in mind that this plan was developed based on the most recent information available. Given the variability of such factors as economic climate, social values, projected rates of socioeconomic growth, and the impact of emerging technologies, the premises upon which this evaluation is based may change within the 20-year planning period. Therefore, this Wastewater Needs Evaluation and Plan is meant to be a living document; that is, a document that may be subject to revision as the information upon which it is based changes.

1.3 OBJECTIVES

The objectives of this Wastewater Needs Evaluation and Plan have been generally based upon the goals of the New Castle County Comprehensive Plan. Objectives from that plan that are germane to wastewater management planning are as follows:

- To ensure that new development is managed in such a way that the infrastructure serving the County is not overloaded and adversely affecting the quality of life in the County.
- To ensure quality growth and development by encouraging development in areas where the County and State are providing capital facilities.
- To discourage growth in areas where development would require the unplanned extension or expansion of capital facilities.
- To preserve and enhance the quality of natural resources.
- To protect natural resources and other features that are important in their own rights and for their value in protecting water quality.
- To quantitatively preserve selected critical natural site classes, while conserving the use, consumption, and/or conversion of other natural resource site classes.
- To manage growth and change to: achieve a pattern, scale, and intensity of development in harmony with existing communities; protect environmental quality; and ensure the required services and facilities.
- To reduce and guide the conversion of prime agricultural lands to suburban and urban uses so as to curb costly urban/suburban sprawl and leapfrog development patterns.
- To achieve orderly growth and compact urban and suburban development.
- To provide the required community facilities and services in an efficient and timely manner in order to accommodate growth.

By identifying these objectives and using them as general guidelines in this Wastewater Needs Evaluation and Plan, consistency between future wastewater management goals and policies set within the New Castle County Comprehensive Development Plan is ensured.

SECTION 2

DESCRIPTION OF PLANNING AREA

2.1 LOCATION AND DELINEATION OF PLANNING AREA

New Castle County is the northernmost county in the State of Delaware. It is bounded on the north by the Commonwealth of Pennsylvania, on the west by the State of Maryland, on the east by the Delaware River, and on the south by Kent County, Delaware. The location of New Castle County in relation to these boundaries is illustrated in Figure 2-1.

Because of its strategic geographic and market location in the "Northeast Corridor," New Castle County is currently experiencing significant growth pressure. This situation exists not only for the urbanized area in the northern sector of the County, but also for the southern part of the County, which has historically been predominately rural in character.

The study area for this Wastewater Needs Evaluation and Plan includes that portion of New Castle County which extends from the Chesapeake and Delaware (C&D) Canal southward to the Smyrna River, which acts as the boundary between New Castle and Kent Counties. Also included in the study area are the Red Lion area, the Dragon Run area, and Delaware City, all of which are located just north of the C&D Canal. The delineation of the study area is shown in Figure 2-2.

The study area encompasses approximately 232 square miles (148,800 acres), or approximately 55% of New Castle County's total land area.

2.2 CLIMATE

The climate of New Castle County is classified as a humid, continental climate that is modified due to the proximity of the area to the Atlantic Ocean (USDA, 1970). The

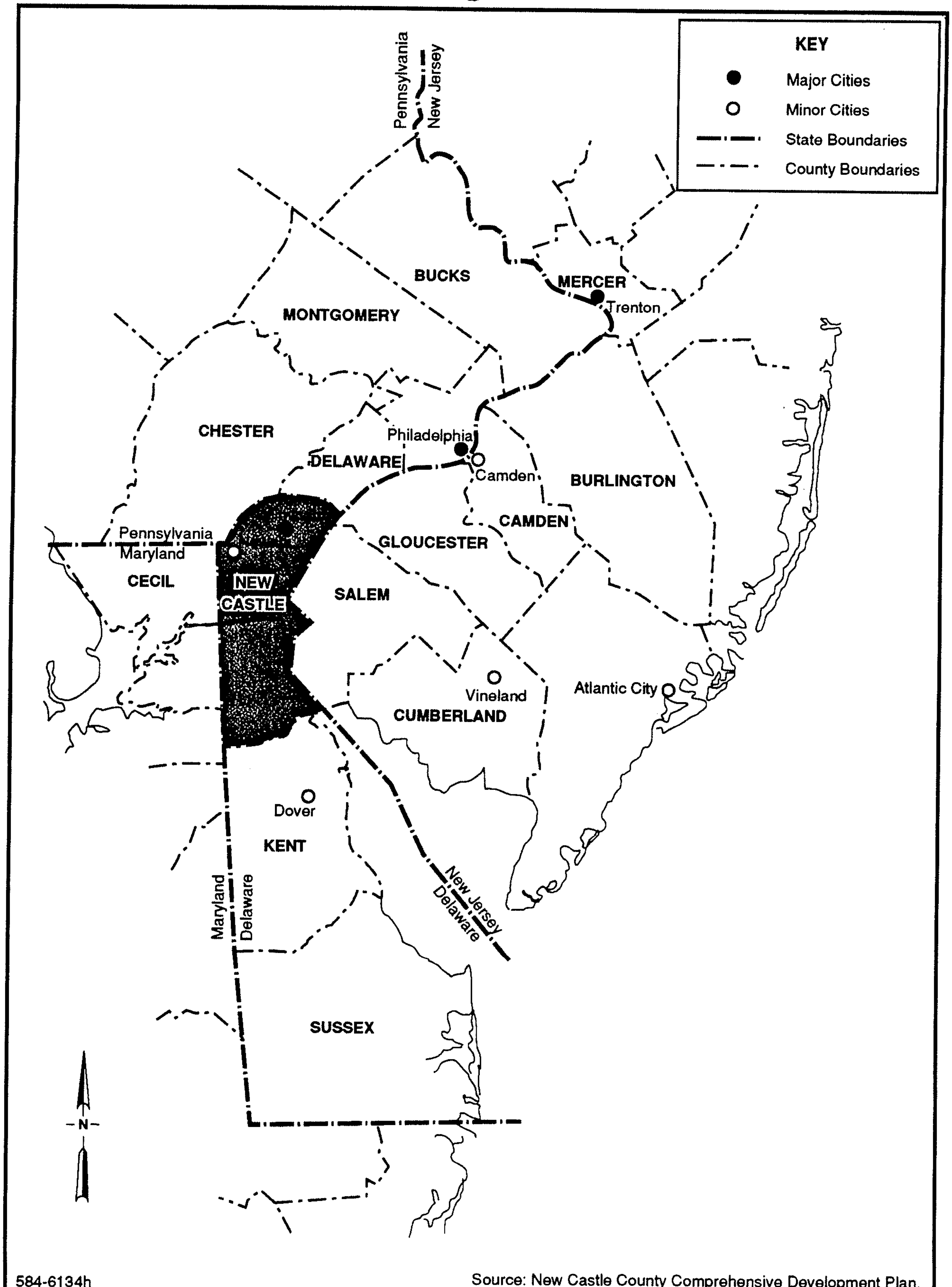


FIGURE 2-1 NEW CASTLE COUNTY AND SURROUNDING METROPOLITAN COUNTIES

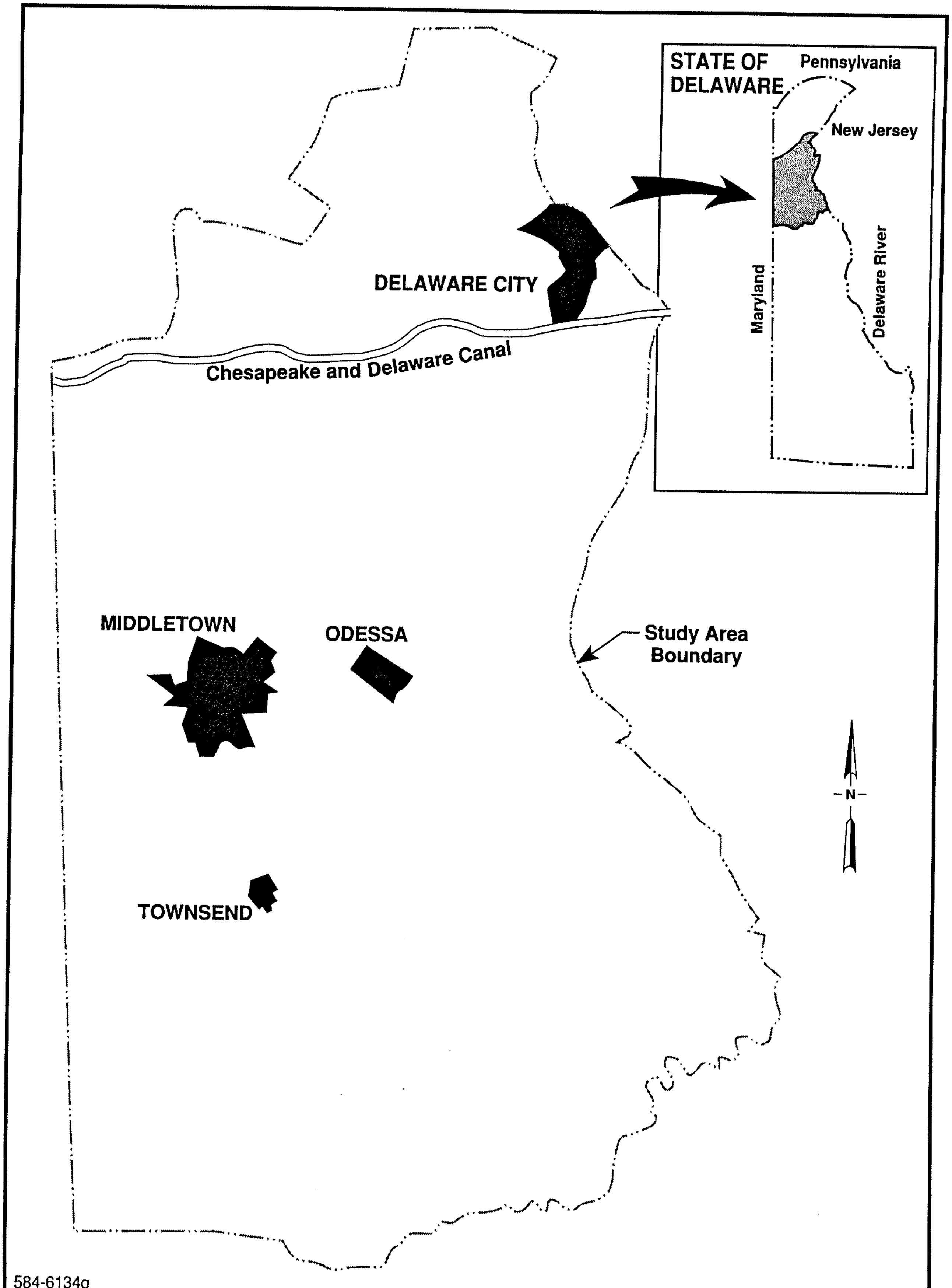


FIGURE 2-2 LOCATION MAP OF STUDY AREA

general flow of air is from west to east, but alternating high and low pressure systems dominate the climate during the winter months. In the summer, warm, moist air spreads northward from the south and southwest. Climatic data is recorded from the weather station at the Greater Wilmington Airport and is generally representative of the County.

The Atlantic Ocean modifies the air masses that pass over it before reaching the County. Much of the precipitation in the County is generated by winds associated with low pressure systems moving northward along the coast (USDA, 1979).

The recorded average annual temperature at the Wilmington weather station is approximately 54°F. Summers are warm and humid with daily high temperatures usually in the 80s (°F). July is typically the warmest month of the year, when temperatures average in the mid-to-upper 80s (National Weather Service, 1983). Winters are typically mild, with only 17 days on the average having maximum temperatures below freezing. January and February are usually the coldest months of the year, with average temperatures in the low-to-mid 20s (°F).

Records of the National Climatic Data Center (U.S. Department of Commerce) indicate that the yearly mean precipitation in Wilmington, Delaware, is approximately 45 inches. Precipitation is evenly distributed throughout the year. A significant amount of the summer rainfall is due to local thunderstorms that occur from June through August (Water Supply Plan for New Castle County, 1990).

2.3 TOPOGRAPHY AND PHYSICAL CHARACTERISTICS

The portion of New Castle County that is included in the study area (i.e., the southern portion of the County) is part of the Atlantic Coastal Plain, a large, wedge-shaped sedimentary area that was formed from marine sediments, outwash, and wind-produced materials deposited in layers. The bedrock of this area is as much as 2,400 ft below sea level in the southeastern corner of the County. The Coastal Plain represents 75% of the

County's land area. This portion of the County is largely flat, although there are some steeply sloped areas associated with various tributaries of the Delaware River.

The County in its entirety has approximately 76 miles of shoreline formed by the Delaware River and its tributary creeks. The land along the shoreline is slightly varied, ranging from low wetlands and marshes (the most prevalent coastal land form) to low-lying uplands with gentle slopes near the creeks.

In 1983, the County in its entirety had 20,800 acres of coastal/tidal wetlands, which represented approximately 7.6% of the total wetlands in the State and approximately 7.5% of the land area of New Castle County.

When settlement of New Castle County began in the upland areas, the County consisted almost entirely of a hardwood climax forest. Oaks are the dominant species in both wet and dry environments, with yellow poplar, beech, sweetgum, and black gum being the other most common trees. In 1974, forests occupied 60,407 acres, or 22.0% of the County. By 1982 approximately 21.4% of the County was forested, amounting to 58,760 acres, of which 8,619 acres were on farms (1982 Census of Agriculture).

According to the 1982 Census of Agriculture, an additional 84,120 acres were in farm use (77,566 acres of harvested crop land, 132 acres of pasture or grazing land). Specialized agricultural operations tend to predominate. Spatially, most of the land in agricultural use is located south of the C&D Canal.

The best agricultural lands (based on soil conditions) in the County are contained in a portion of the Coastal Plain that is exceedingly flat and known as "the Levels." In an area dominated by the Sassafras-Fallsington and Fallsington-Sassafras-Woodstown soils associations, the drainage system remains poorly formed, resulting in numerous small depressions containing lakes, ponds, and wetlands. The area south of "the Levels" is mixed hardwood forest and farmland. This mixture occurs, in part, because of the many areas of poorly drained soils that have made farming more difficult (Comprehensive Development Plan, New Castle County).

2.4 GEOLOGY OF THE STUDY AREA

The geology of the study area is consistent with its location on the Atlantic Coastal Plain. Several hundred feet of unconsolidated sedimentary strata in flat-lying to gently dipping formations overlie weathered crystalline bedrock (Woodruff, 1986; Spoljaric and Woodruff, 1970; Pickett and Spoljaric, 1971).

The oldest of the unconsolidated sedimentary formations overlying weathered crystalline bedrock is the Cretaceous age Potomac Formation. This formation consists of gravels, sands, silts, and clays deposited in a river environment. In the study area, the Potomac Formation varies from 500 to more than 1,000 ft in thickness. The Potomac Formation dips to the southeast and is unconformable, overlain by unconsolidated sedimentary deposits of the Cretaceous Matawan Group. The Matawan Group consists primarily of sands, silts, and clays of marine depositional environment that also dip gently to the southeast. The sediments of the Matawan Group occur in broad, generally continuous sheets of similar lithology. Deposits of the Matawan Group range in thickness from 0 to more than 200 ft across the study area.

Individual formations within the Matawan Group in the study area include the sands of the Cretaceous Magothy Formation, silts and clays of the Cretaceous Merchantville Formation, sands of the Englishtown Formation, and silts of the Marshalltown Formation. The fine silty sands of the Mount Laurel Formation overlie the Marshalltown Formation within the Matawan group.

In the southern part of the study area, sands of the Tertiary age Hornerstown Formation overlie sediments of the Matawan Group. This formation also dips gently to the southeast. Other Tertiary age sediments include the Vincentown, Nanjemoy, and Calvert Formations, which overlie the Hornerstown Formation. The Vincentown Formation is primarily sand, while the Nanjemoy and Calvert Formations are fine-grained silts and clays.

Sediments of the Cretaceous and Tertiary age formations in the study area occur in northeast-southwest-trending bands below horizontal sediments of Pleistocene and Holocene age of the Columbia Formation. The Columbia Formation unconformable overlies the Cretaceous and Tertiary sediments and is composed primarily of gravel, sands, and silts of nonmarine origin. The Columbia Formation thickens in valleys eroded into the underlying strata.

2.5 HYDROGEOLOGY OF THE STUDY AREA

The hydrogeology of the study area has been extensively documented by several authors, including Pickett and Spoljaric (1971), Woodruff (1986), and Spoljaric and Woodruff (1970).

These authors report that the Cretaceous, Tertiary, and Pleistocene sediments in the study area are capable of yielding significant quantities of potable water. The crystalline weathered basement rock is not considered a potable water supply in the study area.

In the northern part of the study area, the Cretaceous age Potomac Formation is used for both public and private water supplies. Sands of this formation are generally discontinuous channel deposits. In the central and southern parts of the study area, groundwater has been obtained from sediments of Cretaceous, Tertiary, and Pleistocene age. The deposits include the upper and middle Potomac Formations, the Magothy Formation, the Englishtown Formation, and the Tertiary age Vincentown Formation. Each of these formations subcrops the Columbia Formation or outcrops in a northeast-southwest-trending band in the study area. Stratigraphic conditions suggest that the majority of groundwater pumped from the Cretaceous and Tertiary Formations is under confined conditions, with overlying silts and clays providing aquitards. However, groundwater in the Columbia Formation occurs primarily under unconfined, water table conditions.

The presence of broad subcropping bands of Tertiary and Cretaceous age sediments indicates that these subcropping bands provide recharge pathways for groundwater to underlying confined aquifers, either directly to the outcropping formations or after passage through the overlying Columbia Formation into the subcropping formations.

In the central and southern parts of the study area, the Columbia Formation sediments thicken and provide a widely available water supply.

2.6 WATERSHED AREAS

The rivers and creeks of New Castle County can be characterized by the geologic province in which they originate and flow. The streams that are located in the study area generally originate in the Atlantic Coastal Plain. These streams are characterized by minimal gradient as they flow through the tidal marshes of the area. In contrast to the streams found in the northern portion of New Castle County (and in the Appalachian Piedmont province), these streams have smaller drainage areas, are shorter in length, and tend to have irregular branching of tributaries. The following subsections discuss the major drainage basins wholly or partially within the study area.

Red Lion Creek

Red Lion Creek originates in central New Castle County and flows in an eastward direction, approximately 4 miles north of the Chesapeake and Delaware (C&D) Canal, to its confluence with the Delaware River. The mainstream length of Red Lion Creek is 5 miles, and it serves a drainage area of 7,500 acres. Land use within the drainage basin is as follows: agricultural 48.0%; urban 6.0%; other uses 46.0%.

Dragon Run Creek

Dragon Run Creek originates near Kirkwood, Delaware, and is located between Red Lion Creek and the C&D Canal. In the first third of its length, the creek flows in a generally eastward direction through rolling farmland. The creek then flows through relatively flat farmland to its confluence with the Delaware River at Delaware City. The mainstream length of Dragon Run Creek is 8 miles, and it serves a drainage area of 5,500 acres. Land use within the drainage basin is as follows: agricultural 47.0%; urban 8.0%; and other uses 45.0%.

Chesapeake and Delaware (C&D) Canal

The C&D Canal is a manmade navigation channel connecting the Delaware River to the Elk River in Maryland. The canal is 450 ft wide and 35 ft deep. The net flow of the canal is in an eastward direction, and it is tidal throughout its length. The terrain along the canal is generally flat with gently rolling hills near the Maryland-Delaware state line. A large tidal marsh exists near the Delaware River. The mainstream length of the C&D Canal is 12.2 miles, and it serves a drainage area of 20,000 acres. Land use within the drainage basin is as follows: agricultural 49.0%; urban 3.0%; and other uses 48.0%.

Appoquinimink River

The Appoquinimink River originates generally west of Middletown and flows through gently sloped farmland to Silver Lake. Downstream of Silver Lake, the river flows through tidal marshes to its confluence with the Delaware River. The entire drainage basin of the river lies in the Atlantic Coastal Plain. The mainstream length of the Appoquinimink River is 16.0 miles, and it serves a drainage area of 30,000 acres. Land use within the drainage basin is as follows: agricultural 67.0%; urban 2.0%; and other uses 31.0%.

Blackbird Creek

Blackbird Creek originates in Blackbird State Forest. The upper portion of the basin is comprised of rural farmland, where the creek flows through gently rolling hills. The creek then meanders through a tidal marsh to its confluence with the Delaware River. The mainstream length of Blackbird Creek is 16 miles, and it serves a drainage area of 20,000 acres. Land use within the drainage basin is as follows: agricultural 50.0%; urban 1.0%; and other uses 48.0%.

Blackbird Creek is the only stream in the study area in which the United States Geological Survey (USGS) maintains a full gaging station. The gaging station is located at the State Route 463 Bridge, 13.8 miles upstream from its mouth. The drainage area upstream of the station is 3.85 square miles. The average discharge at the gaging station, recorded over the 33-year period of record, is 4.7 cubic feet per second (ft^3/sec).

Smyrna River

The Smyrna River is the southernmost river in New Castle County and forms the majority of the boundary between New Castle and Kent Counties. Originating near Clayton, Delaware, the Smyrna River flows in a northeasterly direction until it discharges into the Delaware River. The mainstream length of the Smyrna River extends 10 miles, mostly through tidal marsh. The drainage area served by the Smyrna River is 19,000 acres. Land use within the drainage basin is as follows: agricultural 67.0%; urban 7.0%; and other uses 26.0%.

Chester River

The Chester River, together with the Sassafras River and the Bohemia River, comprise what is designated as the Chesapeake Drainage System. The Chester River originates in southwestern New Castle County, runs westward through Maryland, and ultimately discharges to the Chesapeake Bay. The portion of the mainstream length located in Delaware is 2 miles long. Land use within the drainage basin is as follows: agricultural 76.0%; urban 1.0%; and other uses 23.0%.

2.7 RESOURCE PROTECTION AREAS

In order to protect groundwater and surface water from degradation of quality or quantity, Resource Protection Areas (RPAs) have been designated for New Castle County by the Water Resources Agency. The RPAs are designed to protect areas of highly permeable geology and areas in close proximity to surface water. Protection of the areas is achieved through land use management regulations. The regulations address issues such as residential development, commercial and manufacturing land use, underground storage, waste disposal, and hazardous substance use. All RPA regulations contained in this wastewater management plan are taken from the current ordinance. The following sections describe the four proposed RPAs and their applicability to the southern New Castle County study area. Figure 2-3 illustrates the RPAs found in the study area.

2.7.1 Cockeysville Formation RPA

The Cockeysville Formation RPA includes the land surface underlain by the Cockeysville Formation and the land surface that drains to the formation. It consists of a marble geologic formation located in the northwestern section of the County. The sensitivity of this formation is due to its highly fractured nature and the solubility of its rock material. Rapid infiltration of surface water and pollutants could easily endanger public supply wells already in place in the formation. Since the Cockeysville Formation lies in the northwestern part of the County, it is outside of the study area. Therefore, the requirements regarding this RPA are not applicable to the study area.

2.7.2 Wellhead RPA

The proposed Wellhead RPA designation applies to the land area surrounding a public water supply well capable of yielding more than 100 gallons per minute (gpm) where the water table is significantly influenced by pumping and where pollutants are reasonably likely to migrate toward and reach such wells. The public supply wells of Delaware City, Middletown, and Townsend do not currently meet the above conditions for establishment

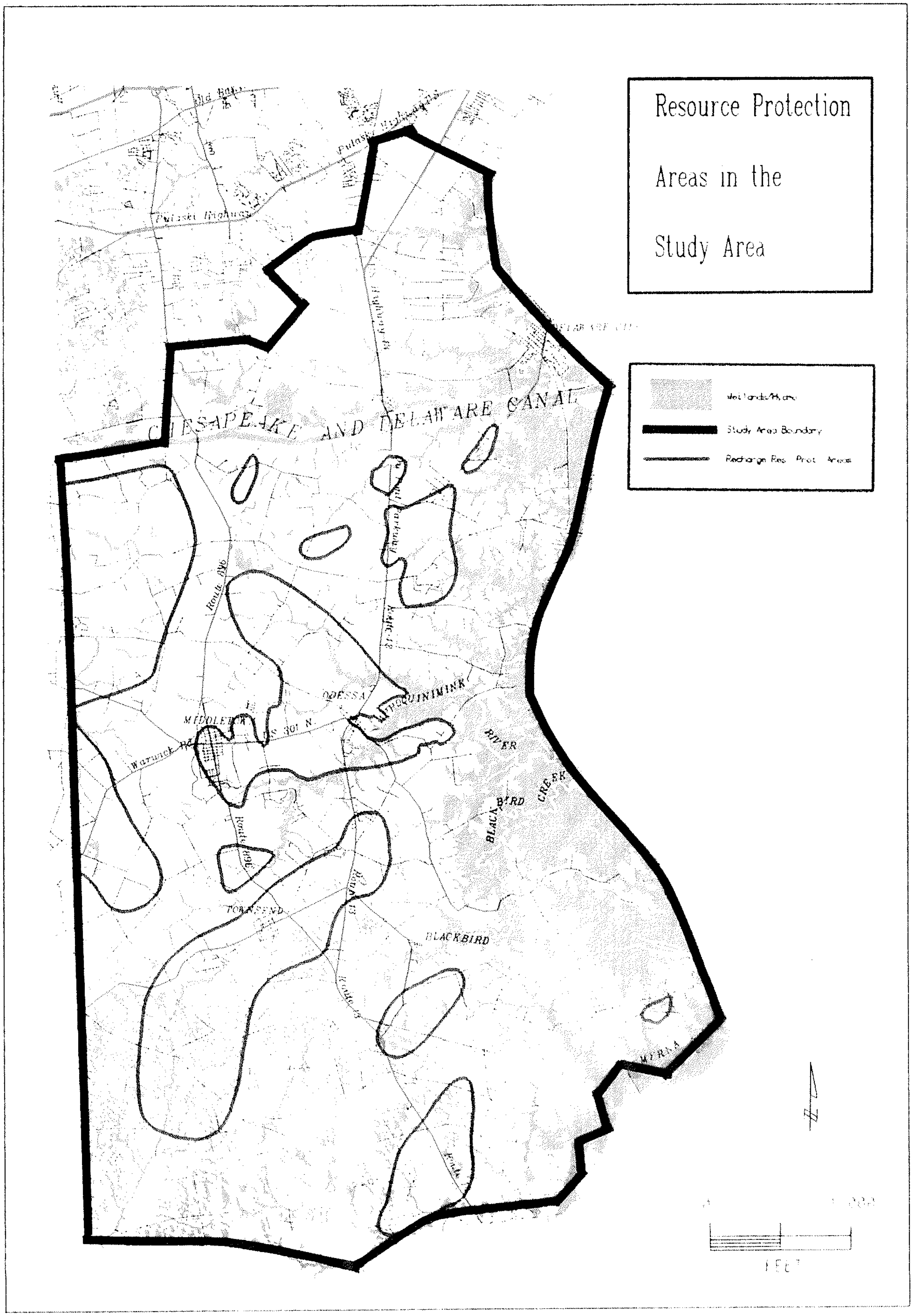


FIGURE 2-3 RESOURCE PROTECTION AREAS IN THE STUDY AREA

of an RPA. However, should these public supply wells or future public supply wells meet the above criteria, the Wellhead RPA requirements would be applicable.

2.7.3 Surface Water RPA

The Surface Water RPA consists of land surrounding the Hoopes Reservoir and the protective corridors upstream of public water supply intakes on the Brandywine Creek, Red Clay Creek, White Clay Creek, and Christina River. These protection areas are designed to prevent pollutants released upstream from reaching surface water intakes and contaminating public water supplies. The protective corridors include the upstream 100-year floodplains, steep slopes adjacent to the floodplains, and all water courses upstream of surface water supply intakes. Public water for the Red Lion district of the southern New Castle County study area is supplied by the intake on the Christina River. However, the intake and the portions upstream of it lie outside of the study area. All other surface waters in this RPA also lie outside of or have no direct effect on the study area. Therefore, the regulations governing the Surface Water RPA do not apply in the study area.

2.7.4 Recharge RPA

The Recharge RPA applies to areas where surficial geologic deposits consist of coarse sand and gravel beds, silty gravels, coarse sand, or coarse-to-medium sand, and have a hydraulic conductivity of 100 ft per day or greater. Surficial geologic deposits of these types apply to a few soils in the southern New Castle County study area. All RPAs currently in the study area are of the Recharge RPA classification, as shown in Figure 2-3.

Protection area requirements include taking proper precautionary measures to prevent leakages of hazardous substances and underground storage tanks (USTs). Residential land use is permitted if the rates of stormwater runoff and groundwater recharge are maintained at predevelopment levels. Municipal and industrial waste disposal that presents a potential source of contamination is prohibited. Agricultural waste disposal must follow a conservation plan approved by the USDA Soil Conservation Service (SCS).

2.7.5 Additional Considerations

In disposal areas in close proximity to surface waters, contamination of the surface water by excessive nutrients and/or bacteria must be prevented. Excessive bacteria levels have already been reported in certain surface waters, including the Christina River. Excessive nutrient levels can increase the rate of eutrophication (oxygen deficiency) in streams and surface waters (Water Supply Plan for New Castle County, Delaware (Churchman's EIS), Metcalf & Eddy, August 24, 1990, and telephone conversations with Peder Hansen, Water Resources Agency for New Castle County).

2.8 POPULATION AND ECONOMIC CHARACTERISTICS

2.8.1 Historic and Current Population

New Castle County is subdivided into planning districts as its fundamental geographic unit for data analysis and planning. The study area consists of the entire Middletown-Odessa-Townsend (M-O-T) and Red Lion planning districts, and portions of New Castle and Central Pencader planning districts. The study area represents more than one-half of the total land area of New Castle County. Figure 2-4 presents an overlay of the study area on a map delineating planning districts. Each planning district will be discussed separately.

The M-O-T planning district encompasses the area south of the C&D Canal, covering approximately 190 square miles, or 45% of the total land area of New Castle County. Residential development within the district is generally low-density development occurring along road frontages. There are four population centers within the district: the towns of Odessa, Middletown, Townsend, and Port Penn. Odessa and Port Penn are older communities that were developed to support water-related activities along the Delaware River. Middletown and Townsend were developed along inland railroad corridors and are agricultural communities. The incorporated areas of the district represent approximately 2,000 acres, or 1.6% of the total district land area; of this, only 130 acres of the district are considered as urban land use.

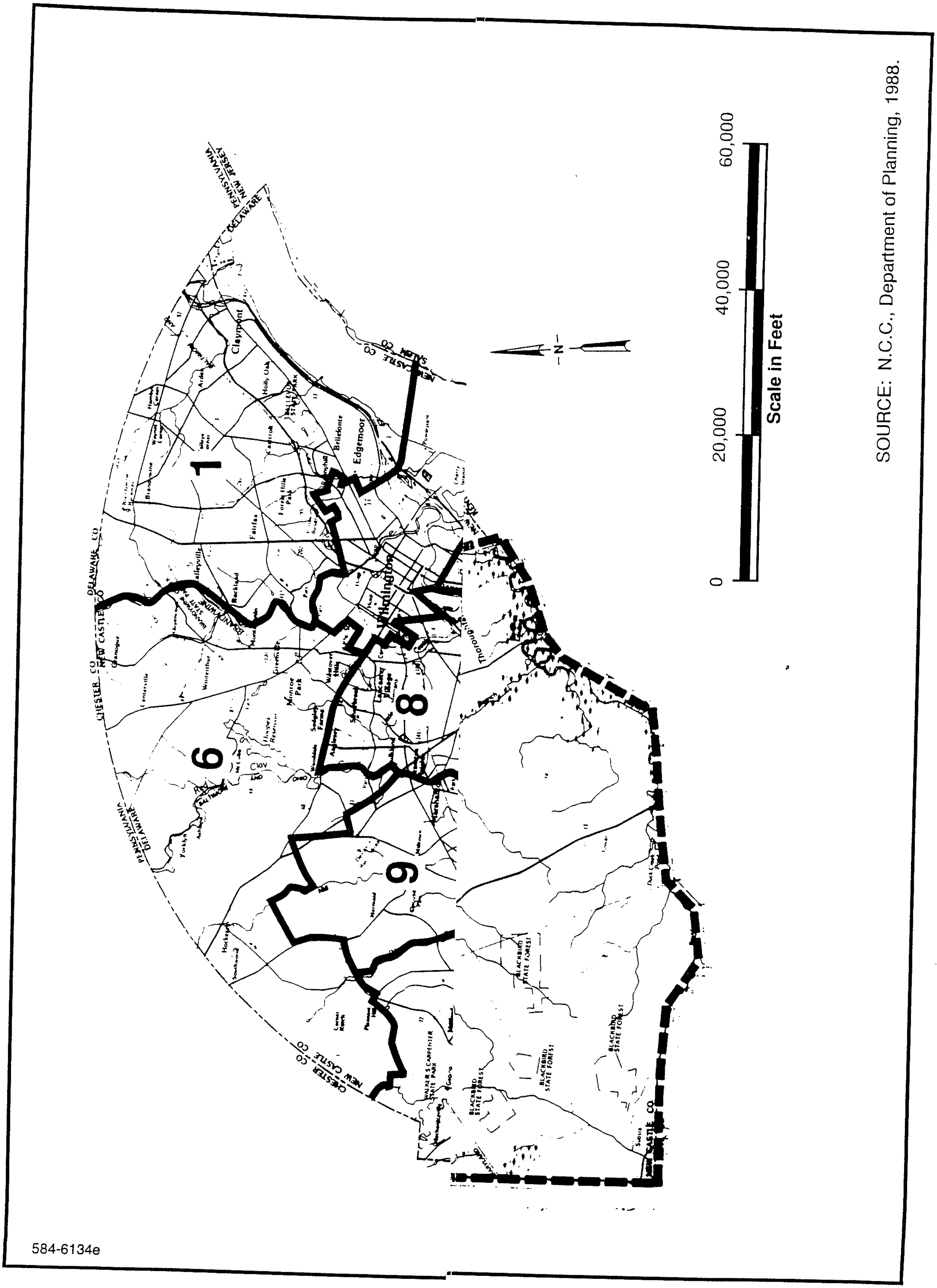


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FIGURE 2-4 PLANNING DISTRICTS WITHIN THE STUDY AREA

The Red Lion planning district is located in the center of the County and is bounded by Red Lion Creek, the Delaware River, the C&D Canal, and Delaware Route 71. Except for a group of petrochemical companies north of Delaware Routes 72 and 9, the district is generally agricultural in character, with low-density, scattered single family residential developments, primarily along road frontages. There is an extensive band of open space and dredge spoil areas along much of the U.S. Army Corps of Engineers' owned and maintained C&D Canal. In Red Lion, urban land represents 10.5% of the total district land area of 13,210 acres. Delaware City is the only incorporated area within the district, representing 7.4% of the district land area. Delaware City is an older community that was developed to support water-related activities along the Delaware River and the C&D Canal.

The planning districts of New Castle and Central Pencader represent only a small portion of the project area and total population. The portions of both districts included within the study area are mainly rural, with scattered low-density development. Land use by community character for each of the planning districts is summarized in Table 2-1.

Historically, New Castle County has been growing in population since its first census in 1790. As with the case of other cities in the Northeast, the City of Wilmington and its surrounding areas had increased its population from 19,686 persons in 1790 to 109,697 persons by the year 1900. By 1950, the County doubled its population to 218,879 persons. The next 20 years saw a tremendous growth in development and population in the County. During the 1970s, the major trend in the population characteristics was a decline in household size, which resulted in a lower percent growth in total population. Historical and current population of the planning districts that fully or partially lie within the study area are presented in Table 2-2.

As shown in Table 2-2, the population of the County increased by only 14.5% during the 1970-1990 period, while the M-O-T planning district's population grew by 85% during the same period. The Red Lion planning district, which is totally within the study area, had a very small percentage of growth in population during this period. The population of this

Table 2-1

Land Use by Community Character

Source: New Castle County Annual Profile - 1989 (1987 figures)

Planning District	New Castle*		Central Pencader*		Red Lion		M-O-T	
Community Character Type	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
Urban	3,170	13.5	590	2.9	1,480	11.2	130	0.1
Transition	5,150	21.8	880	4.2	90	0.7	1,340	1.1
Suburban	1,350	5.7	2,360	11.5	740	5.6	4,480	3.7
Suburban-Low	90	0.4	300	1.5	0	0.0	2,280	1.9
Rural/Open	12,490	53.0	16,440	79.9	9,920	75.1	111,460	91.6
Incorporated Area	1,320	5.6	0	0	980	7.4	2,000	1.6
Total	23,570	100	20,570	100	13,210	100	121,690	100

*Partially included in the study area

OPERATIONAL DEFINITIONS

Urban: Areas in which building mass and area predominates the lot area; architectural elements predominate over landscape elements.

Transitions: Residential lots less than 9,000 ft^2 in area.

Suburban: Residential lots greater than 9,000 ft^2 but less than 1.5 acres. Residential uses predominate.

Suburban-Low: Residential lots of 1.5 acres or greater. Residential uses almost exclusively.

Rural/Open: Residual area that includes open space, rural farmland, transportation network and facilities, etc.

Table 2-2

Historic and Current Population: 1970 - 1990
Study Area Planning Districts

Jurisdiction	Population (Number of Persons)			Percent Change	
	1970	1980	1990	1970-80	1980-90
New Castle County	385,856	398,115	441,946	3.2	11.0
Planning Districts					
M-O-T (F)	10,040	13,187	18,578	31.3	40.9
Red Lion (F)	3,623	3,930	4,033	8.5	2.6
New Castle (P)	51,635	56,134	64,839	8.7	15.5
Central Pencader (P)	2,091	8,605	16,705	311.5	94.1

Notes:

(F) - Fully within the study area.
(P) - Only partially within the study area.

Sources:

a. U.S. Department of Commerce, Bureau of Census, Census of Population and Housing, 1970, 1980, and 1990 Census - PL94-171.

b. WILMAPCO Series 70 Population Allocation (March 16, 1990).

c. Reapportionment Release of Population for Planning Districts Based on 1990 PL94-171 Draft Run of Census of Population (May 1, 1991).

planning district represents 16.1% of the total study area population. The New Castle planning district represents nearly 15% of the County population, but only 3.5% of the population of this district resides within the study area. Similarly, only 7.4% of the population in the Central Pencader planning district resides within the study area. Hence, the general growth trend in the study area is influenced primarily by the higher growth rate experienced by the M-O-T planning district, representing nearly 75% of the total study area population. Overall, the study area represents 5.7% of the total County population, although it comprises approximately 55% of the total land area.

Another factor important to wastewater planning is the typical household size (number of persons per household). The Wilmington Metropolitan Area Planning Council (WILMAPCO) 1988 estimate of household size was 3.13 persons per household in the M-O-T planning district. The Red Lion planning district had an average household size of 3.09 persons per household, while New Castle County's overall average household size was 2.79 persons. These estimates were shown to have lowered somewhat in the 1990 census. A comparison of these results with the WILMAPCO estimate is shown below:

		Persons per Household	
Source	**County Total**	**M-O-T**	**Red Lion**
WILMAPCO	2.79	3.13	3.09
1990 Census	2.62	2.87	2.83

This higher household size in the planning area indicates a lower number of households requiring service connections per population in the study area.

The density of the population in the M-O-T planning district has almost doubled during the past 20 years; however, this density in the M-O-T planning district is less than 10% of that for the entire County, which demonstrates the planning district's rural nature. As mentioned earlier, the M-O-T planning district is primarily an agricultural area in comparison to the major cities of Wilmington and Newark, which are located outside of the study area and constitute the major urban population of New Castle County.

The following tabulation shows the change in population density for the entire County and the study area planning districts from 1970 to 1990.

Area	Land Area (sq. mile)	Population Density Persons per sq. Mile		Persons per Acre	
		1970	1990	1970	1990
New Castle County	429.29	898.8	1,029.5	1.40	1.60
M-O-T Plan. District	190.14	52.8	97.7	0.08	0.15
Red Lion Plan. District	20.63	175.5	195.5	0.27	0.31

2.8.2 Economic Setting

New Castle County has become an attractive retail center for major consumer purchases because of favorable state policies on retail taxes. As a result, retail consumers are attracted from areas beyond the County boundaries.

The 25 largest employers in both the private and public sectors have a combined employment strength of approximately 80,000 persons; this value represents nearly one-third of the total County employment. By far, the largest employer in the county is the E.I. Du Pont de Nemours Company, which accounts for approximately 10% of all jobs in the County.

The majority of residents within the M-O-T planning district currently commute to work areas outside of the district. This situation is shown by the fact that the M-O-T planning district represents only 1.3% of the total County employment, although it represents more than 4.2% of the total County population. In the case of the Red Lion planning district, it represents 2% of the County employment, while the district's share in the County population was only 0.9% in 1990. This shows that people outside of the district commute into Red Lion for work; mainly to the petrochemical companies located north of Delaware Routes 72 and 9.

The County unemployment rates have fluctuated from 5.1% (of total civilian labor force) in 1970 to 7.5% in 1980, and declined somewhat steadily to 3.1% in 1989 (Delaware State Department of Labor, January 1990), as shown in the following tabulation.

	Unemployment Rate (% of Civilian Labor Force)			
	1970	*1980*	*1985*	*1989*
Civilian Labor Force	160,600	194,200	214,400	240,000
Persons Unemployed	8,100	17,800	11,400	7,400
Unemployment Rate (%)	5.1	7.5	5.3	3.1

2.9 EXISTING INFRASTRUCTURE

2.9.1 Water Supply Systems

2.9.1.1 Public Water Supply

Five public water supply systems exist within the study area. These systems include both municipally owned and investor-owned systems. The public water supply systems serving the study area are grouped as follows:

- Municipally Owned Water Supply Systems:
  - City of Delaware City.
  - Town of Middletown.
  - Town of Townsend.

- Investor-Owned Water Supply Systems:

    - Wilmington Suburban Water Corporation.
    - Tidewater Utilities.

Municipally-owned water supply systems must meet all requirements of DNREC and the State of Delaware Department of Health and Social Services, Division of Public Health. Investor-owned water supply systems are regulated by the Delaware Public Service Commission as well as by the DNREC and the State of Delaware Department of Health and Social Services, Division of Public Health. The following sections provide a summary and brief description of municipally- and investor-owned water supply systems in southern New Castle County.

City of Delaware City

Municipal water supply service to the Delaware City area is provided from two wells located in Delaware City with an estimated production capacity of 0.4 million gallons per day (MGD). The source of the groundwater is the Lower Potomac Aquifer. No industries are served by the Delaware City system. Total water consumption consists of residential use (88%) and unaccounted for use (12%). In 1988, approximately 2,000 residents were served by the Delaware City Water Supply System (Delaware DNREC as contained in Water Supply Plan for New Castle County, Delaware (Churchman's EIS), Metcalf & Eddy, November 2, 1990).

Town of Middletown

Five wells, located in Middletown and with an estimated production capacity of 0.7 mgd, provide water to the Middletown service area. The five wells draw water from the Magothy, Monmouth, Upper Potomac, Lower Potomac, and Potomac aquifers. In 1988, residential demand accounted for approximately 72% of the water drawn for the service area. The Middletown system serves approximately 3,200 residents. Industrial use accounts for 16% of the water demand, while the final 12% falls under unaccounted for use (Delaware

DNREC as contained in "Water Supply Plan for New Castle County, Delaware (Churchman's EIS), Metcalf & Eddy, November 2, 1990).

Town of Townsend

Water for the Townsend service area is provided by two wells located in Townsend and having an estimated production capacity less than 0.1 mgd. Both wells draw water from the Rancocas aquifer. Residential use accounts for 88% of the total water production from the Townsend wells. The final 12% consists of unaccounted for water use. Based on 1988 figures, approximately 510 residents were served by the town of Townsend system (Delaware DNREC as contained in Water Supply Plan for New Castle County, Delaware (Churchman's EIS), Metcalf & Eddy, November 2, 1990).

Wilmington Suburban Water Corporation

Two surface water treatment facilities provide water to the customers of Wilmington Suburban Water Corporation. The Christina Water Treatment Plant (WTP), a 6.0-mgd plant, draws water from Smalleys Pond on the Christina River. It supplies water to the southern portion of Wilmington Suburban's service area, which includes the Red Lion district. Wilmington Suburban's other treatment plant, the Stanton WTP, is located near the confluence of the Red and White Clay Creeks and has a capacity of 30 mgd. This WTP serves the northern portion of Wilmington Suburban's service area, which lies outside of the study area. Demand for water in Wilmington Suburban's total service area is divided between industrial (36%), residential (29%), interconnection sales (14%), commercial and institutional (9%), and unaccounted for (12%) uses. The total population served by Wilmington Suburban in all service areas in 1988 was approximately 98,200 residents (Delaware DNREC as contained in Water Supply Plan for New Castle County, Delaware (Churchman's EIS), Metcalf & Eddy, November 2, 1990).

Tidewater Utilities

Tidewater Utilities operates four wells to serve small residential areas south of the C&D Canal. In 1988, Tidewater Utilities' only two service areas were Summit Pond and Vandergrift Manor. Total pumping capacity of the four wells is approximately 61,000 gpd. The actual population served by Tidewater Utilities is unavailable, but its total number of service connections is 115 (Delaware DNREC and the Delaware Department of Health and Social Services, Division of Public Health as contained in Water Supply Plan for New Castle County, Delaware (Churchman's EIS), Metcalf & Eddy, November 2, 1990).

2.9.1.2 Private Water Supply

Southern New Castle County is principally an agricultural area. Because of its rural nature, private water supply systems are prevalent. Private water supply systems are divided into five categories: industrial, noncommunity, small community, irrigation, and residential. The following sections briefly highlight each category and list major water users in southern New Castle County, where known.

Industrial Systems

Industrial freshwater utilization varies within southern New Castle County, but typically includes cooling water and processing water uses. Freshwater use by self-supplied industries in New Castle County averaged 9.5 mgd in 1988. Major self-supplied industrial water users in southern New Castle County are Star Enterprises, Standard Chlorine, the Advanced Films Division of the James River Corporation, and the Cattail Hill Fish Farm. Star Enterprises of Delaware City draws water from 13 groundwater wells, two surface water intakes, and one interception trench. The wells and interception trench draw approximately 6.3 mgd from the Potomac and water table aquifers. The two surface water intakes are located on Red Lion Creek and Dragon Run and draw approximately 1.75 mgd. Standard Chlorine of Red Lion operates five groundwater wells. These wells are all drawing from the water table aquifer at a total rate of approximately 0.35 mgd. Advanced Films draws approximately 0.03

mgd from a groundwater source. Finally, Cattail Hill Fish farm of Middletown operates one intake on Deep Creek at approximately 0.05 mgd (Delaware DNREC as contained in Water Supply Plan for New Castle County, Delaware (Churchman's EIS), Metcalf & Eddy, November 2, 1990, and material contained in the above report from Delaware DNREC).

Noncommunity Systems

Noncommunity water suppliers consist of commercial (restaurants, motels, businesses), institutional (schools, and state and federal office buildings), and recreational (parks, campgrounds, museums) users with water demands less than 50,000 gallons per day (gpd). Large-capacity, noncommunity water drawers in southern New Castle County include Bayview Improvement Corporation, Delaware Correctional Center, Delaware State Police (Troop 9), Smyrna Rest and Information Center, and Saint Andrew's School. Bayview operates two wells at a maximum daily capacity of 10,000 gpd and serves a summer population of 125. The Delaware Correctional Center serves 1,400 people from two wells having an estimated daily demand of 225,000 gpd. The Delaware State Police serve 60 people by drawing from one well with a maximum daily capacity of 10,000 gpd. The Smyrna Rest and Information Center operates two wells with a maximum capacity of 30,000 gpd. An estimated summer population of 6,500 and a winter population of 2,500 is served by these two wells. Saint Andrew's School also operates two wells at a combined maximum capacity of 33,000 gpd. A winter population of 330 and a summer population of 10 is served by these wells (State Department of Health and Social Services, Division of Public Health and DNREC, Division of Water Resources as contained in Water Supply Plan for New Castle County, Delaware (Churchman's EIS), Metcalf & Eddy, August 24 and November 2, 1990).

Small Community Systems

Water to mobile home parks and to isolated residential areas is categorized as small community water supply. Small community suppliers south of the C&D Canal serve approximately 560 people at an estimated daily demand of 0.1 mgd. Large-capacity, small community suppliers in southern New Castle County include Cantwell Water Company, Frederick Lodge and Mobile Home Park, and Mount Pleasant Trailer Court. Cantwell Water Company serves 120 people from two wells with an estimated maximum capacity of 10,000 gpd. Frederick Lodge and Mobile Home Park operates two wells with an estimated maximum capacity of 18,900 gpd to serve 189 people. Mount Pleasant Trailer Court serves 114 people from three wells with an estimated capacity of 15,200 gpd (State Department of Health and Social Services, Division of Public Health and DNREC, Division of Water Resources as contained in Water Supply Plan for New Castle County, Delaware (Churchman's EIS), Metcalf & Eddy, August 24 and November 2, 1990).

Irrigation Systems

Private irrigation systems are common in southern New Castle County due to the area's dependence upon agriculture. Numerous private wells supply irrigation water during the summer growing season. Assuming a 92-day growing season that includes June, July, and August, 1988 irrigation demand was estimated at 4.72 mgd for southern New Castle County (University of Delaware, Department of Agriculture as contained in Water Supply Plan for New Castle County, Delaware (Churchman's EIS), Metcalf & Eddy, November 2, 1990).

Residential Systems

In southern New Castle County, private domestic wells account for a large portion of residential water supply. 1980 estimates from the U.S. Census Bureau indicated that more than 2,800 private domestic wells exist in southern New Castle County aquifers (U.S. Census Bureau as contained in Water Supply Plan for New Castle County, Delaware (Churchman's EIS), Metcalf & Eddy, November 2, 1990).

2.9.2 Wastewater Management Systems

There are four sewer service areas within New Castle County. In addition to New Castle County's own facilities, collection systems are operated by Wilmington, Newark, and

Middletown, with the service areas generally conforming to the respective political boundaries. Only Wilmington and New Castle County operate treatment plants, with flows from the other jurisdictions conveyed by the County to plants operated by either Wilmington or the County.

All wastewater originating north of Route 40 is collected and transmitted to the Wilmington Treatment Plant with ultimate discharge to the Delaware River. This plant has a capacity of 90 mgd, with current use at approximately 75 mgd. However, in order to meet anticipated demands, capital expansion will be needed before 1995. Two-thirds of the flow originates from New Castle County, including Newark, with the remaining one-third from the City of Wilmington.

South of Route 40 collection and treatment is provided by the County in Delaware City and Port Penn. However, wastewater flows from some areas south of Route 40 are conveyed to the Wilmington Treatment Plant for treatment. The County also serves the M-O-T area with collector sewers in Odessa and Townsend. These flows, along with those from Middletown, are conveyed to the County treatment plant located east of Odessa (New Castle County Annual Report, 1989).

Each of the aforementioned treatment and conveyance systems included in the study area (i.e., M-O-T, Port Penn, and Delaware City) is further discussed in Section 3.

2.10 REFERENCES

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SECTION 3

EXISTING WASTEWATER COLLECTION AND TREATMENT SYSTEMS

3.1 INTRODUCTION

The following section discusses the existing wastewater management infrastructure that is currently in operation in the study area. Information included in this section is based on published documents (including discharge permits) and on information supplied by the New Castle County Department of Public Works (DPW).

3.2 MIDDLETOWN-ODESSA-TOWNSEND (M-O-T) SYSTEM

3.2.1 Service Area

The M-O-T treatment and conveyance system, which is operated by New Castle County, serves the residents of Middletown, Odessa, and Townsend, as well as the population of Saint Andrew's School. Flows from these communities are carried by a combination of gravity sewers, pumping stations, and force mains to the M-O-T Regional Wastewater Treatment Plant (WWTP) located southeast of Odessa. The M-O-T Regional WWTP discharges into the Appoquinimink Creek.

3.2.2 Collection and Conveyance System

The collection and conveyance system that transports wastewater to the M-O-T Regional WWTP is an extensive piping network linking the communities of Middletown, Odessa, and Townsend. In essence, the system is comprised of three gravity collection systems interconnected by pumping stations, force mains, and a gravity interceptor.

The collection system of Townsend, the southernmost community, is comprised primarily of 8-inch vitrified clay pipe. Wastewater is transported by gravity to the northern end of town, where flows are diverted to a 10-inch vitrified clay trunk line that runs parallel to Wiggins Mill Pond Road (County Road No. 446). This trunk line extends approximately 3,300 ft from Townsend to the Townsend Pumping Station, located 0.1 mile northeast of Wiggins Mill Pond. The pump station is rated for a capacity of 139 gpm at 82 ft of head. The pump station, which was built in 1985, is presently experiencing daily flows that average 40,000 gallons according to the New Castle County DPW. The pump station discharges to a 6-inch force main, which extends northeast to Silver Lake Road where it connects to the M-O-T interceptor.

According to the New Castle County DPW, flows in Middletown, which on a daily basis average 0.33 mgd, generally travel in a southerly direction toward the M-O-T Regional Interceptor. The interceptor, which was constructed in 1981, extends from Blackbird-Middletown Road (County Road No. 896) to the M-O-T Regional WWTP. In the western portion of the interceptor (i.e., the section closest to Middletown), wastewater is conveyed by gravity to the Silver Lake Pumping Station, located east of Silver Lake Road. It is at this point where flows from Middletown, Townsend, and Saint Andrew's School join and are pumped to the eastern portion of the interceptor. From this point, flows are conveyed to the M-O-T Regional WWTP by gravity. Saint Andrew's School, located south of Middletown on Noxontown Lake Road (County Road No. 38) and DuPont Highway, pumps wastewater generated at its facility to the M-O-T interceptor. Flows from Saint Andrew's School average 30,000 gpd during the school year.

Wastewater generated in Odessa generally travels southward toward the Appoquinimink River. The average daily quantity of wastewater generated in this area is 10,000 gpd. Flows from Odessa are conveyed to the Odessa Pumping Station, located near State Road No. 299. The Odessa Pumping Station is also a junction point for the M-O-T interceptor. Therefore, all flows conveyed by the M-O-T collection system pass through the Odessa Pumping Station, where they are ultimately conveyed to the M-O-T WWTP.

It should be noted that a portion of flow seen at the M-O-T WWTP is attributed to nonmetered infiltration/inflow (I/I). I/I contributions are estimated by the New Castle County DPW to be approximately 0.11 mgd, or one-fifth of the total flow seen at the M-O-T WWTP.

In order to determine the capacity of the M-O-T conveyence system, the system was analyzed by using the Hydraflow software package. Hydraflow is a menu-driven computer program used to analyze and design sanitary sewer systems. Hydraflow can be used for design purposes, such as modeling lift stations with multiple pumps, for sizing pipes, or for setting invert elevations. It can also be used to evaluate existing systems by determining line capacities at full flow and comparing these capacities to actual flow conditions. For the southern New Castle County Wastewater Management Study, Hydraflow was used in the latter manner. Existing pipe lengths, pipe diameters, Manning's coefficients, invert elevations, and surface elevations were entered for the M-O-T treatment system interceptor. Data on pump stations and force mains were also inputted to the program. From these data, the Hydraflow program was used to calculate full-flow pipe capacities for all gravity lines. From these results, the gravity lines with the most limited flow capacity could be determined. For the force mains, Hydraflow did not calculate a line capacity. Capacities in these lines were assumed to be equal to the pump station capacity, taken from available pump curves.

Figure 3-1 is a simple schematic showing the limiting capacities in segments of the interceptor and the estimated capacities of the pump stations. For example, Figure 3-1 shows that in the line segment from Middletown to the Silver Lake Pumping Station, the lowest capacity segment between two adjacent manholes is 1.7 mgd. At least one segment in this line has a maximum capacity of 1.7 mgd. There are no lower maximum capacities in the line from Middletown to Silver Lake. These segments, if determined to inhibit existing or future flows, can be replaced, modified, or upgraded to allow for sufficient capacity.

3.2.3 M-O-T Treatment Facility

The M-O-T Regional WWTP is located on Old Corbit Road (County Road No. 424), southeast of Odessa. Treatment processes utilized at the facility consist of fine screening by a hydrosieve, primary settling, biological treatment by means of rotating bio-disks, final

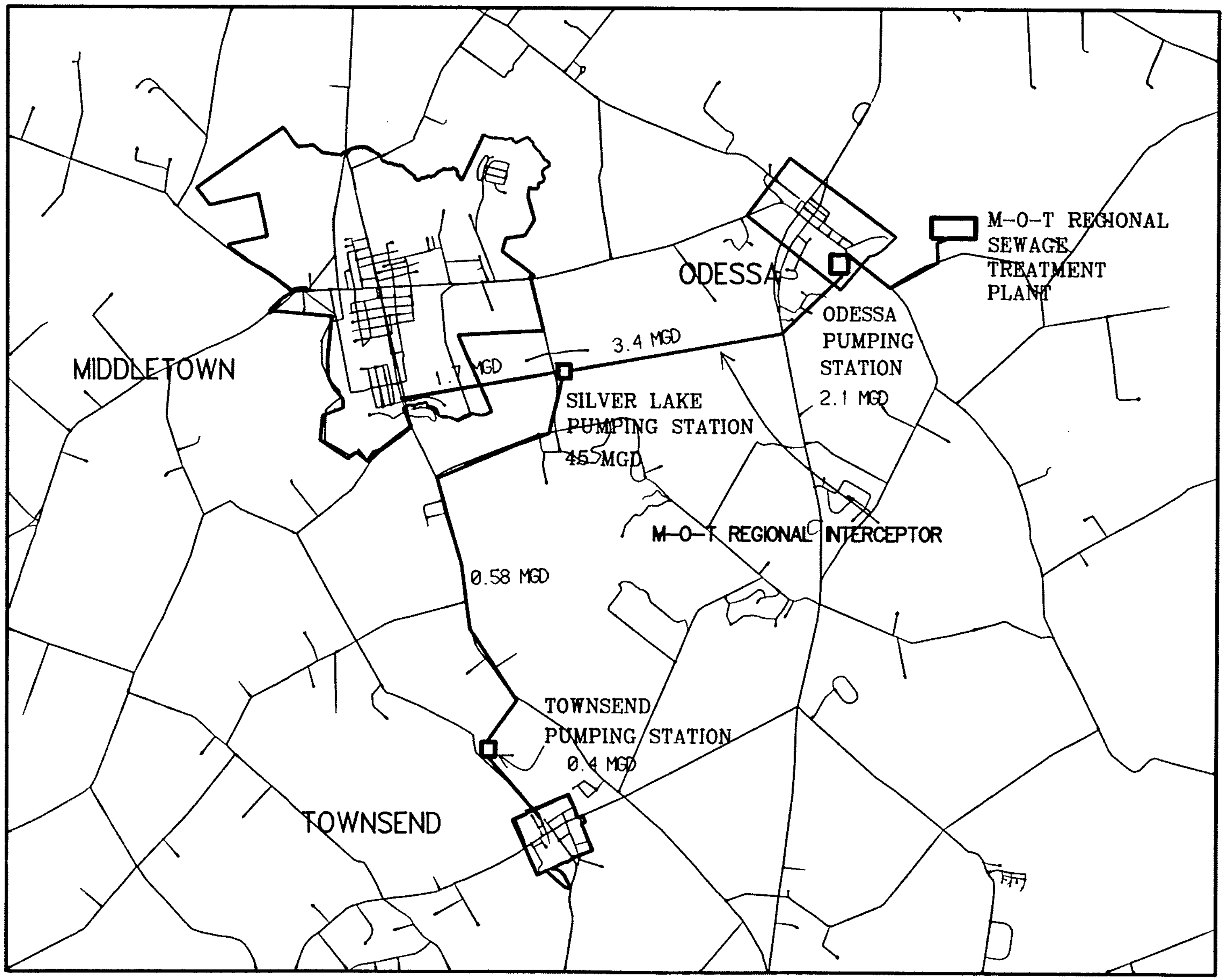


FIGURE 3-1 M-O-T COLLECTION AND CONVEYANCE SYSTEM

settling, sand filtration, and chlorination. A schematic of wastewater flow through the M–O–T plant is shown in Figure 3-2. The facility was constructed in 1981.

The M-O-T facility is currently rated for 0.5 million gallons per day (mgd). Other effluent limitations stipulated in the facility's NPDES permit are shown in Table 3-1. Discharge Monitoring Reports (DMRs) indicate that while the facility is generally meeting its discharge permit, it is experiencing a slight hydraulic overload at the present time. This condition led the New Castle County DPW to initiate steps that would result in an expansion of the facility. An alternatives analysis to upgrade and expand the M-O-T WWTP capacity was released in October 1991 (Tatman and Lee). This study evaluates various alternatives to meet a projected flow of 1.5 mgd for the 20-year planning period. The recommended alternative was for lagoon treatment and spray irrigation at two sites; one was near Odessa and the other was near Townsend.

The receiving stream for the M-O-T WWTP is the Appoquinimink Creek. The Delaware Department of Natural Resources and Environmental Control (DNREC) Division of Water Resources has indicated that the reach of the Appoquinimink in the vicinity of the M-O-T discharge is water quality limited and at times is not meeting water quality standards under present conditions. This conclusion has been based upon data that indicate that low levels of dissolved oxygen are related to elevated nutrient concentrations. Furthermore, DNREC has indicated that the Appoquinimink cannot support any additional nutrient loads and therefore will not sanction a plant expansion that may cause present conditions to worsen. Any increase in flow from the M-O-T WWTP would need to be accompanied by modifications that would limit nutrient discharges, primarily phosphorus.

3.2.4 Sludge Disposal

Organic solids generated from the treatment processes are handled in a fairly conventional manner. Settled solids are digested aerobically and hauled to the Wilmington Airport Pumping Station, where the sludge is conveyed to the City of Wilmington WWTP, located

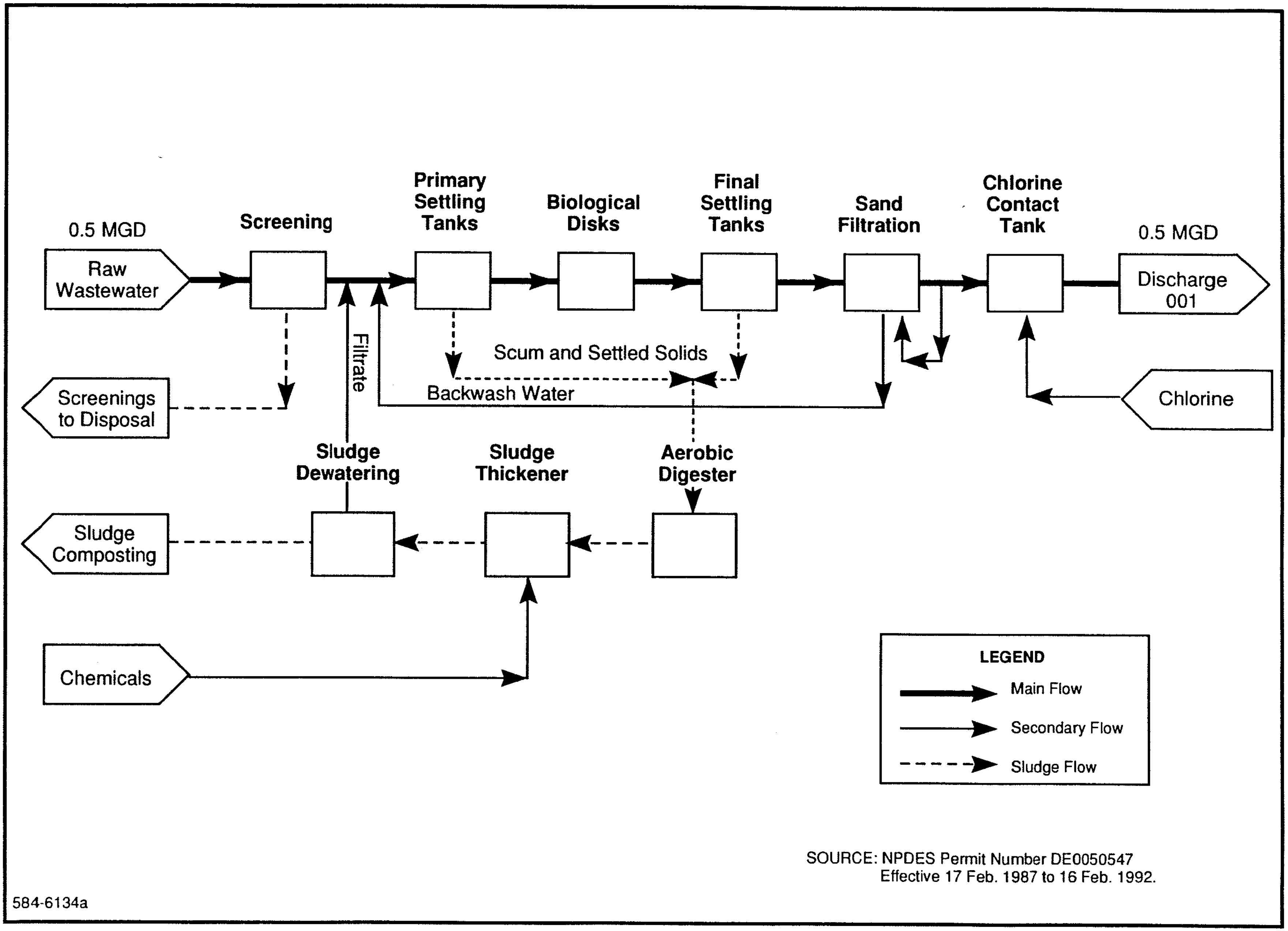


FIGURE 3-2 SCHEMATIC OF WASTEWATER FLOW M-O-T REGIONAL WASTEWATER TREATMENT PLANT ODESSA, NEW CASTLE COUNTY, DELAWARE

Table 3-1

Regional Wastewater Treatment Plant of Middletown-Odessa-Townsend Effluent Limitations

Parameters	Quantity of Loading		Concentration	
	Daily Average	Daily Maximum	Daily Average	Instant Maximum
Flow	0.5 mgd	--	--	--
BOD_5	63 lb/day	96 lb/day	15 mg/L	23 mg/L
TSS	63 lb/day	96 lb/day	15 mg/L	15 mg/L
Lead	0.6 lb/day	1.0 lb/day	0.15 mg/L	0.23 mg/L

NOTES:
1. Fecal Coliform - 200 colonies/100 mL.
2. pH - > 6.0 < 9.0.
3. Residual Chlorine - > 1.0 mg/L < 4.0 mg/L.

Source: NPDES Permit DE0050547.
Effective February 17, 1987, to February 16, 1992.

outside of the study area. Sludge at the Wilmington WWTP is processed for recycling as a soil amendment. The M-O-T facility was designed to treat sludge by aerobic digestion, thickening, dewatering, and composting. Currently, the dewatering and composting facilities are inoperable awaiting dewatering equipment replacement.

3.3 PORT PENN

3.3.1 Service Area

The Port Penn WWTP and collection system, which is owned and operated by New Castle County, serves the residents of Port Penn and Augustine Beach. Flows from these communities are carried by gravity sewer to the WWTP located east of Route 9, 0.25 miles south of Port Penn. The WWTP discharges treated effluent into the Delaware River.

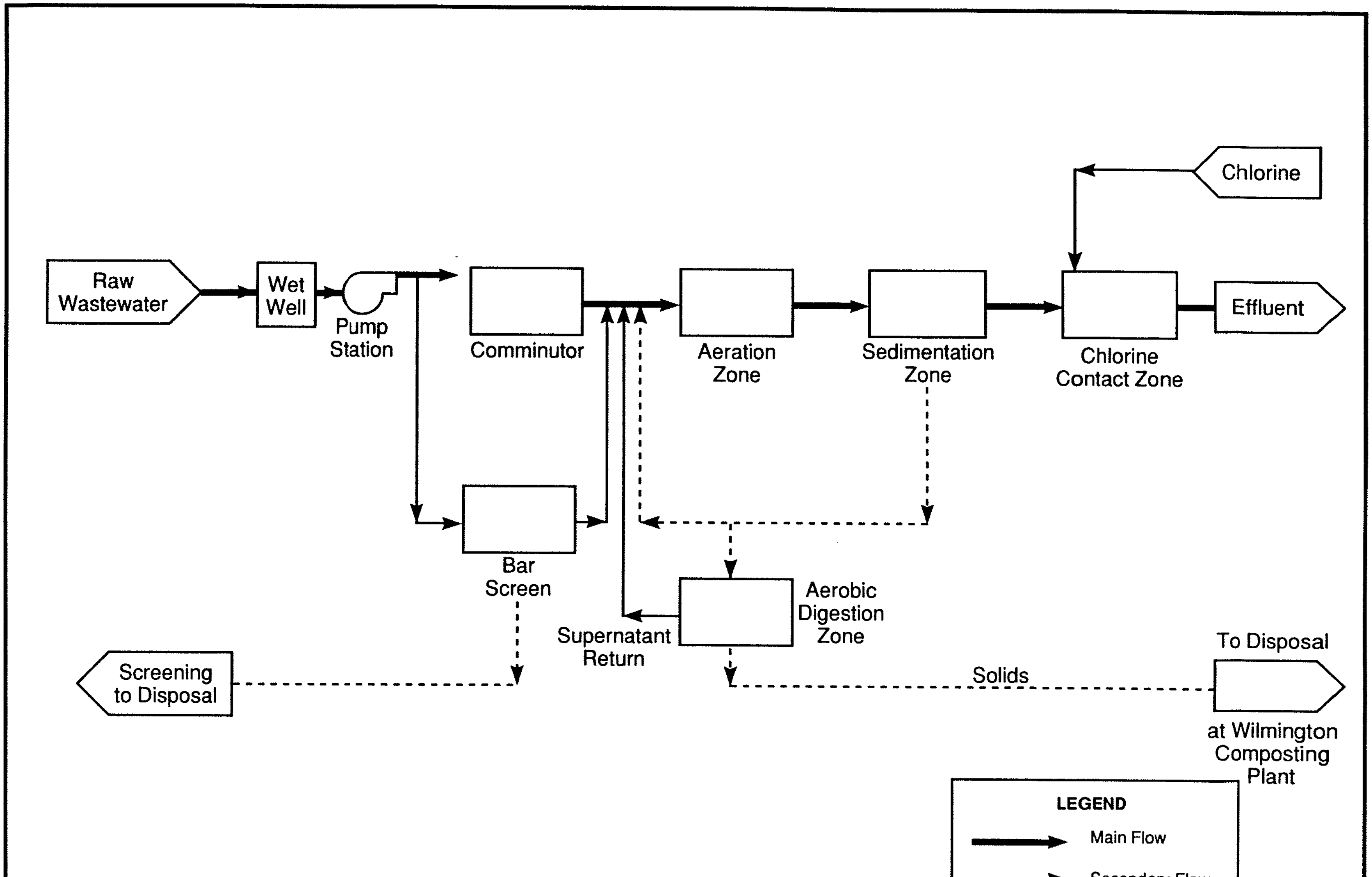
3.3.2 Collection and Conveyance

The collection and conveyance system that carries wastewater to the Port Penn WWTP consists of a northern and southern portion. The northern portion of the collection system carries wastewater from the Town of Port Penn to the WWTP. The northern portion consists primarily of 8- and 10-inch clay pipe. The southern portion of the system serves the community of Augustine Beach. The southern portion consists of 8-, 10-, and 12-inch clay pipe, as well as small sections of 4-inch cast iron pipe.

Both portions join at a common trunk line that leads to the WWTP. This line empties into a wet well and is ultimately pumped to the headworks of the WWTP.

3.3.3 Treatment Facility

The Port Penn WWTP is the smallest of the publicly owned treatment works (POTW) in New Castle County. A package activated sludge facility, the processes utilized include screening, comminution, aeration, sedimentation, and chlorination. A schematic of wastewater flow through the Port Penn WWTP is shown in Figure 3-3.



SOURCE: NPDES Permit Number DE0021539
Effective 29 October 1990 to 28 October 1995.

584-6134b

FIGURE 3-3 SCHEMATIC OF WASTEWATER FLOW PORT PENN WASTEWATER TREATMENT PLANT PORT PENN, DELAWARE

The Port Penn facility is currently rated for 0.05 mgd. Other effluent limitations stipulated in the facility's NPDES permit are displayed in Table 3-2. DMRs indicated that present flows to the plant average 30,000 gpd, and that the plant is operating well within the requirements of its permit.

3.3.4 Sludge Disposal

Solids generated from the treatment processes are digested aerobically at the Port Penn WWTP, after which they are transported to the Wilmington Airport Pumping Station, where the sludge is conveyed to the Wilmington WWTP. Sludge at the Wilmington WWTP is processed for recycling as a soil amendment.

3.4 DELAWARE CITY SYSTEM

3.4.1 Service Area

The Delaware City Sewage Treatment and conveyance system, which is owned and operated by New Castle County, serves the residents of Harbor Estates, the Governor Bacon Health Center, and Delaware City. Wastewater is transported by a system of gravity sewers, pump stations, and force mains to the Delaware City Sewage Treatment Plant (STP), located on the grounds of the Governor Bacon Health Center. The Delaware City STP discharges treated effluent into the Delaware River.

3.4.2 Collection and Conveyance System

The collection and conveyance system that transports wastewater to the Delaware City STP is an extensive network of gravity sewers. Pump stations and force mains are utilized to transport wastewater collected in the gravity sewers to the sewage treatment plant.

The Delaware City Trailer Court, located to the south of Delaware City, is serviced by approximately 1,000 ft of private sewer lines. Wastewater from the Trailer Court is then

Table 3-2

Port Penn Wastewater Treatment Plant
Effluent Limitations

Parameters	Quantity of Loading		Concentration	
	Daily Average	Daily Maximum	Daily Average	Instant Maximum
Flow	0.05 mgd	--	--	--
BOD_5	10 lb/day	15 lb/day	24 mg/L	36 mg/L
TSS	13 lb/day	19 lb/day	30 mg/L	45 mg/L

NOTES:
1. Fecal Coliform - 200 colonies/100 mL.
2. pH - > 6.0 < 9.0.
3. Residual Chlorine - > 1.0 mg/L < 4.0 mg/L.

Source: NPDES Permit DE0021539.
Effective October 29, 1990, to October 28, 1995.

pumped to an 8-inch line that carries the wastewater to the main collection system in Delaware City.

The community of Harbor Estates, also located to the south of Delaware City, has its wastewater collected by a gravity system. Wastewater generated in this area essentially flows north toward the main collector system in Delaware City.

The collection system in Delaware City is also comprised entirely of gravity sewers. Wastewater generated in Delaware City, as well as the wastewater flowing north from Harbor Estates and the Delaware City trailer court, flow east toward the Delaware River. Wastewater is pumped across the Old C&D Canal to the Delaware City STP. Wastewater generated in the Governor Bacon Health Center, where the Delaware City STP is located, is pumped north directly to the treatment facility.

3.4.3 Treatment Facility

The Delaware City STP is located on the grounds of the Governor Bacon Health Center, east of Delaware City. The treatment plant consists of two identical units, each utilizing the following unit processes: screening, primary and secondary aeration, sedimentation, filtration, and chlorination. Effluent is discharged through a common pipe to the Delaware River. A schematic of wastewater flow through the Delaware City STP is shown in Figure 3-4.

The facility is currently permitted to discharge 0.55 million gpd. Other effluent limitations stipulated in the facility's NPDES permit are shown in Table 3-3.

Recent DMRs indicate that on an average daily basis, the facility discharges between 0.4 and 0.45 mgd, well under the quantity allowed in the current permit.

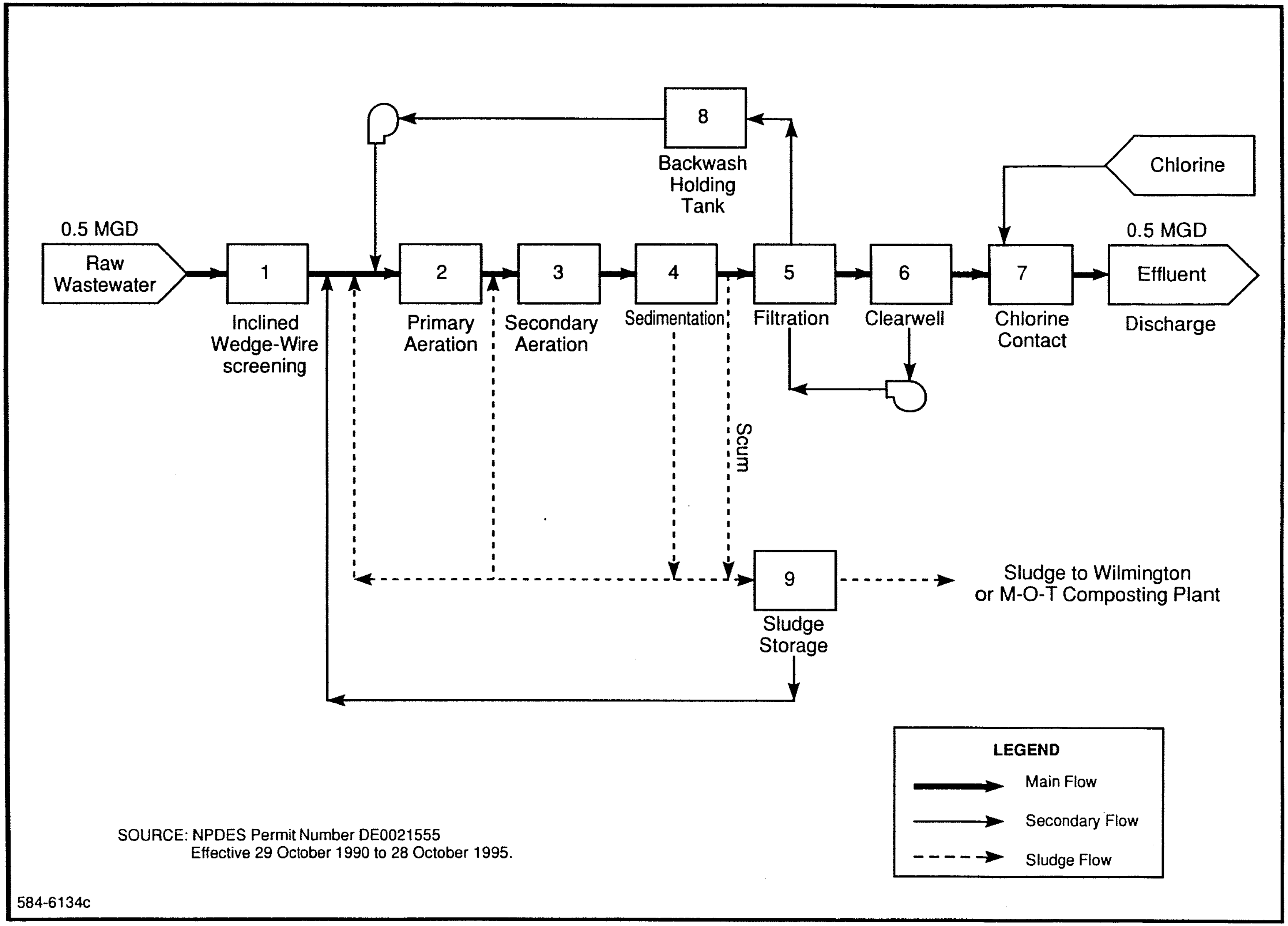


FIGURE 3-4 SCHEMATIC OF WASTEWATER FLOW DELAWARE CITY STP DELAWARE CITY, DELAWARE

Table 3-3

Delaware City Sewage Treatment Plant
Effluent Limitations

Parameters	Quantity of Loading		Concentration	
	Daily Average	Daily Maximum	Daily Average	Instant Maximum
Flow	0.55 mgd	--	--	--
BOD_5	55 lb/day	105 lb/day	12 mg/L	23 mg/L
TSS	69 lb/day	105 lb/day	15 mg/L	23 mg/L

NOTES:
1. Fecal Coliform - 200 colonies/100 mL.
2. pH - > 6.0 < 9.0.
3. Residual Chlorine - > 1.0 mg/L < 4.0 mg/L.

Source: NPDES Permit DE0021555.
Effective October 29, 1990, to October 28, 1995.

However, on a daily maximum basis, recorded flows have exceeded 0.65 mgd, indicating that the facility may be experiencing periodic hydraulic overloads. In regard to all other discharge parameters, the facility appears to be operating adequately.

3.4.4 Sludge Disposal

The Delaware City STP disposes of its sludge in much the same fashion as the M-O-T WWTP and the Port Penn WWTP. Digested sludge is periodically transported to the Airport Road Pumping Station, from which the sludge is pumped to the City of Wilmington WWTP. Ultimately, the sludge is transported from the City of Wilmington WWTP to the Delaware Reclamation Project where the sludge is disposed by co-composting.

3.5 PRIVATE TREATMENT FACILITIES

A total of 11 privately owned and operated wastewater treatment facilities exist in the study area. All of the private facilities that have been identified by the Delaware DNREC (Division of Water Resources) through the NPDES program are located in the portion of the study area north of the C&D Canal. Ten of the 11 facilities are associated with industrial wastewater generators, with the remaining facility providing treatment for a mobile home park.

A list of the privately owned treatment facilities operating in the study area and their NPDES permit numbers is provided in Table 3-4.

3.6 UNSEWERED AREAS

With the exception of the aforementioned sewered service areas (namely Delaware City, Port Penn, and M-O-T), the study area is essentially unsewered and on private on-site waste management systems. Of the 18,578 people residing in southern New Castle County (i.e., south of the C&D Canal) in 1990, it is estimated that more than 65% are served by on-site waste management systems.

Table 3-4

Private Wastewater Treatment Facilities
Southern New Castle County

Facility Name	NPDES Permit Number
DP&L Delaware City	DE 0050601
Star Enterprises	DE 0000256
Keysor Corp	DE 0050920
Formosa Plastics	DE 0000612
Georgia Gulf	DE 0000647
Occidental	DE 0050911
Standard Chlorine of Delaware	DE 0020001
Akzo Chemicals, Inc.	DE 0000272
Advanced Films Div., James River Corp.	DE 0000485
Dragon Run Terrace MHP	DE 0020176
Chloramone Corporation	DE 0050636

In recent years there has been growing concern over the number of failing on-site waste management systems in southern New Castle County. According to the Delaware DNREC, 26 investigations of on-site waste management failures were conducted in the study area during 1989 and 1990. In nine cases, new systems were installed to replace failing old systems. In the majority of the other cases, minor repairs (e.g., replacing broken lids) were required to remedy the failures. No one area appeared to be more prone to on-site failure than any other area.

An area where community on-site waste management failures have been identified by the New Castle County DPW is Bayview Beach (located south of Port Penn). At the present time, the New Castle County DPW is studying alternatives to correct the situation at Bayview Beach.

SECTION 4

PROJECTIONS OF FUTURE NEEDS

4.1 <u>POPULATION AND ECONOMIC GROWTH PROJECTIONS</u>

4.1.1 <u>Population</u>

As described in Subsection 2.4, the study area represents a small share (5.7%) of the total population of New Castle County even though the study area encompasses more than one-half of the total County land area. Additionally, it has been determined that growth in the project area is not accurately represented by the overall growth trends of the County. As a result, population forecasts for wastewater planning in southern New Castle County should be determined by evaluating the population growth trends for the smaller southern New Castle County geographic units rather than the County as a whole. Various sources of population projections were evaluated to find an estimate that would be the most appropriate for this Wastewater Needs Evaluation and Plan.

Three sources of population projections for the County were evaluated. These include:

- Delaware Population Consortium (DPC) - These projections are not dissaggregated below the County level, and hence would be inappropriate for project use.

- Wilmington Area Planning Council (WILMAPCO) - These projections are based upon the DPC projections at the County level, but allocate the overall population to subunits (traffic zones) within the County. The series of projections evaluated were WILMAPCO's latest revision (March 6, 1990), Series 70 Population Allocation at the traffic zone level. The series is oriented towards transportation/infrastructure planning and assumes that zoning will remain the same during the plan period.

- Water Supply Plan for New Castle County (Metcalf & Eddy), 1990 - These projections were developed to support water supply planning for the County and are based upon use of WRA's Population and Housing Allocation Model (PHAM). Although these projections remove the transportation bias inherent in the WILMAPCO projection, the area south of the Chesapeake and Delaware (C & D) Canal (the majority of the study area) is grouped as one unit. This level of definition is inappropriate for wastewater planning purposes.

The 1990 WILMAPCO Series 70 projections were selected for use and their traffic orientation noted. Data from the 1990 census became available during the course of this project. As the basis for population projection is the historic trend in population growth and the current (1990) population levels, it was determined that the 1990 population projections needed to be compared with the actual 1990 census counts. For the County total, the WILMAPCO projections were found to be 4% higher than the actual population as determined by the census. The 1990 population for New Castle County was 441,946 persons (U.S. Department of Commerce, Bureau of the Census, 1990 Census of Population and Housing), as compared to the WILMAPCO estimate of 459,613 persons. In the case of the DPC estimate, this figure was 1.3% over the 1990 census counts.

The performance of the WILMAPCO projections as compared to census data varied for each planning district within the County. For example, in the M-O-T planning district the WILMAPCO estimate for 1990 was 15,680 persons, while the actual population count was 18,578 persons, an increase of 18.5% over the WILMAPCO estimate. The 1990 WILMAPCO estimates for six of the 13 traffic zones in the M-O-T planning district were lower than the actual population, while the total County estimates were higher. Based on this observation, it was necessary to readjust the 1990 population for traffic zones within the study area as the first step toward projecting the population for the planning period (1990-2010). A comparison of the WILMAPCO projections with 1990 census counts for the traffic zones within the M-O-T area planning district is shown in Table 4-1.

The adjustment process used the 1990 Census Block Data and the corresponding maps identifying the various census tracts of the County. In addition to the 13 traffic zones within the M-O-T planning district, there is a total of 12 traffic zones within the Red Lion, New Castle, and Central Pencader planning districts that are fully or partially within the study area. Where traffic zones lie only partially within the study area (six traffic zones within the New Castle and Central Pencader planning districts are only partially within the study area), adjustments were made to reflect the development pattern within the portion of the traffic

Table 4-1

Comparison of WILMAPCO Projections With 1990 Census Counts for M-O-T Planning District Traffic Zones

Traffic Zone Number	1990 Population (Number of Persons)			
	Census Population[a]	WILMAPCO Projections[b]	Difference in WILMAPCO Numbers From Census Counts[c]	Percent Change in 1990 Census Counts Over WILMAPCO Projection[d]
560	1,530	1,083	(-)447	(-)41.3
561	1,372	622	(-)750	(-)120.6
562	587	872	285	32.7
563	231	422	291	45.3
564	2,719	2,902	183	6.3
565	729	966	237	24.5
566	1,394	679	(-)715	(-)105.3
567	1,198	627	(-)571	(-)91.1
570	1,850	1,398	(-)452	(-)32.3
572	1,915	2,194	279	12.7
573	443	419	24	5.7
574	4,125	2,925	(-)1,200	(-)41.0
575	485	571	87	15.1
Total for M-O-T Planning District	18,578	15,680	(-)2,898	(-)18.5

Notes:

[a]1990 population within traffic zones using the 1990 Census of Population for the blocks within census tracts.

[b]WILMAPCO Series 70 Projection Allocations by Traffic Zone, latest revision, March 6, 1990.

[c](-) sign denotes WILMAPCO numbers lower than the census counts for that traffic zone.

[d](-) sign indicates WILMAPCO numbers lower than the census counts.

zone lying within the study area as compared to the rest of that traffic zone. The baseline (1990) population for the study area is presented in Table 4-2. Table 4-2 reflects adjustments of the traffic zone population (estimated by WILMAPCO) to account for the 1990 Census of Population Counts.

WILMAPCO projection trends for the individual traffic zones within the study area were used to determine the planning period population projections by using the historic (1970 and 1980) and current (1990) figures. Adjustments were made in these trends using the overall growth prospects of that particular traffic zone taking into consideration the environmental (e.g., critical area) and manmade (e.g., transportation systems) features within or in the vicinity of that traffic zone. The general trend in population for each traffic zone was developed for the planning period (1990 to 2010), and the (5-year interval) intermediate years population numbers were extracted from the trend.

The study area population projections that were developed are presented in Table 4-2. The M-O-T planning district is projected to increase its 1990 population by more than 22,000 persons by the year 2010, representing a growth of approximately 118.7% during the 20-year planning period. This projected growth is similar to that of the WILMAPCO projections for the M-O-T planning district except that the base year (1990) actual population was 18,578 persons instead of the WILMAPCO estimate of 15,680 persons. Overall, the study area is projected to increase its population by approximately 122.5%, from 25,097 persons in 1990 to 55,840 persons by the end of the planning period (2010).

The small area population estimate and the projection methodologies applied for this Wastewater Needs and Evaluation Plan were presented at the Delaware Population Consortium meeting on September 12, 1991, and the above described approach was subsequently approved after deliberation.

Table 4-2

Population Projections for Traffic Zones Within the Study Area (1990-2010)

	Population (Number of Persons)					
Traffic Zone	1990[a]	1995[b]	2000[b]	2005[b]	2010[b]	Percent Growth 1990-2010
M-O-T Planning District						
560	1,530	2,040	2,550	3,170	3,800	148.4
561	1,372	1,860	2,370	2,840	3,300	140.9
562	587	700	850	1,020	1,300	121.5
563	231	240	500	800	1,180	410.8
564	2,719	3,200	3,700	4,350	5,100	87.6
565	729	1,160	1,740	2,480	3,300	352.7
566	1,394	1,800	2,200	2,600	3,100	122.4
567	1,198	1,510	1,810	2,020	2,250	87.8
570	1,850	2,340	2,950	3,600	4,400	137.8
572	1,915	2,280	2,700	3,300	4,000	108.9
573	443	620	850	1,160	1,550	249.9
574	4,125	4,680	5,120	5,560	5,900	43.0
575	485	600	760	980	1,450	199.0
M-O-T TOTAL	18,578	23,030	28,100	33,880	40,630	118.7
Other Traffic Zones	300	620	1,080	1,400	1,600	433.3
373[c]	300	620	1,080	1,400	1,600	433.3
374[c]	1,530	2,550	3,150	3,500	3,600	135.3
376[c]	175	370	630	820	900	414.3
377[c]	291	580	810	990	1,100	278.0
463[c]	145	290	380	550	790	444.8
464[c]	70	140	190	260	400	471.4
470	180	220	240	265	300	66.7
471	9	9	9	10	10	11.1
472	1,307	1,540	1,800	2,050	2,300	76.0
473	477	570	740	940	1,160	143.2
474	123	290	530	780	1,040	745.5
475	1,912	1,910	1,940	1,970	2,010	5.1
SUBTOTAL	6,519	9,089	11,499	13,535	15,210	133.3
Study Area TOTAL	25,097	32,119	39,599	47,415	55,840	122.5

[a]1990 population using the 1990 Census of Population for the blocks within census tracts.
[b]WESTON projections based on 1990 Census of Population and the WILMAPCO growth trends for traffic zones.
[c]Only partially within the study area.

4.1.2 Commercial Development Projections

The study area does not represent a significant share in the total business activities in the County. The County, as a whole, has a reputation as a desirable place to live and conduct business. If it maintains its reputation, a substantial amount of growth in this area can be anticipated due to its advantageous location with respect to the Greater Philadelphia Metropolitan Region and possibly from the Baltimore Metropolitan area, which is catering to the needs of the Washington, DC, growth. The study area communities of Middletown and Odessa and their surroundings are currently experiencing a development push that also includes proposals for golf courses, shopping centers, offices, and related commercial development. For example, the Willow Grove Mall, west of U.S. Route 13 and south of Delaware Route 299, is proposed to include:

- 243,000 ft^2 of office space.
- 300,000 ft^2 of commercial space.
- 120-room hotel.
- 18-hole golf course.

Other proposals in the general area of the Middletown-Odessa area include:

- Ash Farm - 211,075-ft^2 shopping center.
- Greenlawn - 293,000-ft^2 shopping center.
- Westfield - 150,000-ft^2 shopping center.
- Odessa Venture - commercial development.

All of these proposals project a major boost in the commercial growth within the study area. However, as pointed out by Delaware Department of Transportation Officials, these and other developments in the Middletown-Odessa area could result in the creation of major bottlenecks on the existing road network. It should be noted, however, that development proposals that are portrayed as likely may be purely speculative and may overestimate the available market.

WILMAPCO has developed employment projections for the County and the planning districts for the period of 1990 through 2010. Table 4-3 presents these projected employment numbers for the County and for the study area planning districts of M-O-T and Red Lion. Employment in commercial activities represented 38.7% of the total County employment in 1990. Commercial employment is projected to grow by 33.1% in the 20-year planning period.

The M-O-T planning district is projected to increase its commercial employment of 837 persons in 1990 to 1,005 persons by 2010. When compared to the potential for new developments within the M-O-T planning district, the WILMAPCO projections seem very low.

4.1.3 Industrial Growth Projections

The projected employment in manufacturing and industrial services categories for the County and the study area planning districts are also presented in Table 4-3. (These industrial categories were grouped together by WILMAPCO for the projection of employment by traffic zone.) The employment in these two categories represented 37.5% of the total 1990 employment in the County; it is projected to grow by 15.3% during the planning period. In the M-O-T planning district, there were 1,068 persons employed in these two categories in 1990, which is projected to increase by 15.1% in the next 20 years. The development proposals for Middletown-Odessa area do not contain specific industrial development activities. Hence, the WILMAPCO projections for the M-O-T planning district seem reasonable.

Table 4-3

Employment Projections
New Castle County and Study Area Planning Districts
(1990-2010)

Jurisdiction/Category	Employment (Number of Persons) 1990	2000	2010	Percent Growth 1990-2010
NEW CASTLE COUNTY				
Total Employment	227,870	264,581	283,682	24.5
Manufacturing	54,993	59,791	62,289	13.3
Industrial Services	30,469	34,229	36,230	18.9
Commercial	88,195	106,480	117,351	33.1
Community Services	54,213	64,081	67,812	25.1
M-O-T PLANNING DISTRICT				
Total Employment	2,853	3,237	3,367	18.0
Manufacturing	265[a]	315	327	23.4
Industrial Services	803	873	902	12.3
Commercial	837	964	1,005	20.1
Community Services	948	1,087	1,133	19.5
RED LION PLANNING DISTRICT				
Total Employment	4,341	4,608	4,480	3.2
Manufacturing	1,858	1,923	2,005	7.9
Industrial Services	832	868	868	4.3
Commercial	1,382	1,529	1,263	-8.6
Community Services	269	288	294	9.3

[a]WILMAPCO Series 70 Employment Allocations (adjusted upward to correspond with recent (Fall 1989) Delaware Population Consortium Projections (March 6, 1990).

4.2 WASTEWATER GENERATION AND CHARACTERISTICS – PROJECTIONS

4.2.1 Residential

4.2.1.1 Generation Rates

In establishing wastewater generation rates for this study, typical generation values from several references were identified and evaluated. Those references and values are as follows:

- In "Recommended Standards for Sewage Works" (Ten States Standards), it is stated that "new sewer systems shall be designed on the basis of an average daily per capita flow of sewage at not less than 100 gallons per day. This figure is assumed to cover normal infiltration..."

- In "Wastewater Treatment: Collection, Treatment, Disposal (Metcalf & Eddy, 1972), projected per capita residential water usage list for the State of Delaware in the year 2000 is 125 gallons per day per capita (gpdpc). This text also states that approximately 60% to 80% of per capita consumption will be sewage. Taking the upper limit (80%), this translates to 100 gpdpc of wastewater generation.

- In the Pennsylvania Department of Environmental Resources Sewage Manual, the design criteria for sewage flows generated in municipalities is 100 gpdpc, including infiltration.

- Information supplied by the New Castle County Department of Public Works has indicated that flows experienced at the M-O-T treatment facility equate to a per capita generation of approximately 100 gpd.

From the above information, it is concluded that the value of 100 gpdpc of sewage generation is a widely accepted value. There are no apparent conditions in the study area that would suggest this value should be increased. To the contrary, with the recent emphasis on the usage of water-saving devices (especially in new construction), this value may actually be a conservative figure. Therefore, the standard of 100 gpdpc of sewage generation is used throughout this study for residential sewage generation.

4.2.1.2 Residential Wastewater Characteristics

The typical composition of a medium-strength domestic sewage, as cited in Wastewater Engineering (Metcalf & Eddy), is as follows:

Constituent	Concentration (mg/L)
Total Suspended Solids	200
BOD_5	200
Chemical Oxygen Demand	500
Total Nitrogen	40
Free Ammonia	25
Nitrates	0
Total Phosphorus	10

Since no conditions have been identified that would result in a domestic sewage of a substantially higher strength, it is assumed that the composition of domestic sewage generated now and in the foreseeable future is essentially that of a typical medium-strength domestic sewage.

4.2.1.3 Forecast of Residential Flows

Both present and future residential flows presented in this study are based upon population figures and forecasts presented in Subsection 4.1 of this document.

Because of the rural and relatively homogenous zoning of the study area, forecasting those portions of the population that can and will be effectively served by some form of centralized collection and treatment system is to some extent, subjective. Under current zoning, it is difficult to precisely predict where individual subdivisions or housing clusters will be built; it is all the more difficult to quantify how many people will inhabit these subdivisions. Consequently, the existing information on population distribution does not support the identification of clearly definable "needs" with respect to wastewater treatment capacity.

Based upon overall population densities as indicated by current population forecasts, it is likely that it would not be cost-effective to provide centralized treatment to the entire population. At the same time, diffuse growth and the resultant reliance upon on-site systems may not be the preferred method of wastewater management in the study area. Therefore, a central question to be addressed by this study concerns the distinction, both economically and environmentally, between centralized collection, treatment, and disposal, and the extensive use of decentralized (on-site) treatment and disposal. The impacts of these issues will be explored and analyzed in this report. In order to frame this question and to provide a basis for these analyses, a projection has been made of the population that may be served by centralized systems if concentrated population development occurs (either naturally or under County management).

In order to estimate the potential sewered population flows, traffic zone population projections, as represented in Table 4-2, were examined. From this information, areas and populations that may be associated with concentrated development within the study area have been presumptively identified.

Based upon discussions with the Water Resources Agency for New Castle County (WRA), infrastructure management in the study area (at least with respect to water, wastewater, and stormwater management) may be functionally and administratively organized on the basis of major drainage basins within the study area. Therefore, Regional Service Districts (RSDs) based upon major drainage basins have been created and depicted. In the area south of the C&D Canal, projected traffic zone population data have been presumptively allocated to each RSD. While this approach has been adopted for the portion of the study area south of the C&D Canal, it has not been employed for the portion of the study area north of the canal for the following reasons:

- This area, which for convenience may be designated as the Red Lion district, is geographically and functionally related to the northern part of New Castle County.
- This area includes three relatively small drainage basin areas (Red Lion, Dragon Run, and the northern portion of the C&D Canal). It is assumed that

administration and management at this small scale would not be desirable or cost-effective.

- As will be discussed further, current information indicates that projected wastewater treatment needs for this portion of the study area are adequately addressed by current plans (largely by discharge to the City of Wilmington Wastewater Treatment Plant through an ongoing expansion of existing collection systems).

Consequently, for purposes of this plan, the portion of the study area north of the C&D Canal will be designated as the Red Lion district. This presumptive allocation of population, represented in Table 4-4, has been based solely upon relative portions of various traffic zones within each drainage basin, as well as upon qualitative consideration of identified population centers (M-O-T). Figure 4-1 shows the RSDs in the study area.

In order to define sewered populations, land use maps and the tax parcel database were examined in an effort to determine the locations and sizes of individual subdivisions that are either presently constructed or that have a high probability of being constructed in the future. By utilizing the Geographical Information System (GIS), the land use maps, the tax parcel information, and engineering judgment, four Public Service Zones (PSZs) were determined to have a high potential of new or increased population growth. The four PSZs, by drainage basin district, that have been identified are as follows:

Area Name	Approximate Geographic Location	RSD
Boyd's Corner	Intersection U.S. 13 and SR 896	C&D Basin
Summit	Intersection SR 71 and SR 432	C&D Basin
Middletown-Odessa	SR 299 Corridor	Appoquinimink Basin
Townsend	Immediate Area Surrounding Townsend	Appoquinimink Basin

The drainage basin to which each PSZ is assigned for management and administrative purposes is that basin in which the majority of the PSZ may lie. Depending upon actual population patterns, a portion of the PSZ may, to a limited extent, extend across drainage divides. It is assumed that the PSZ will be managed as a drainage basin entity. This may necessitate the pumping of some wastewaters across drainage divides.

Table 4-4

Projected Distribution of Population by Regional Service District (RSD)

RSD	Projected Population (2010)
Red Lion District	13,710
Chesapeake and Delaware (south of Canal) Basin District	9,000
Appoquinimink Basin District	17,590
Blackbird Basin District	4,950
Smyrna (New Castle County Portion) Basin District	5,340
Chesapeake Basin District	2,810

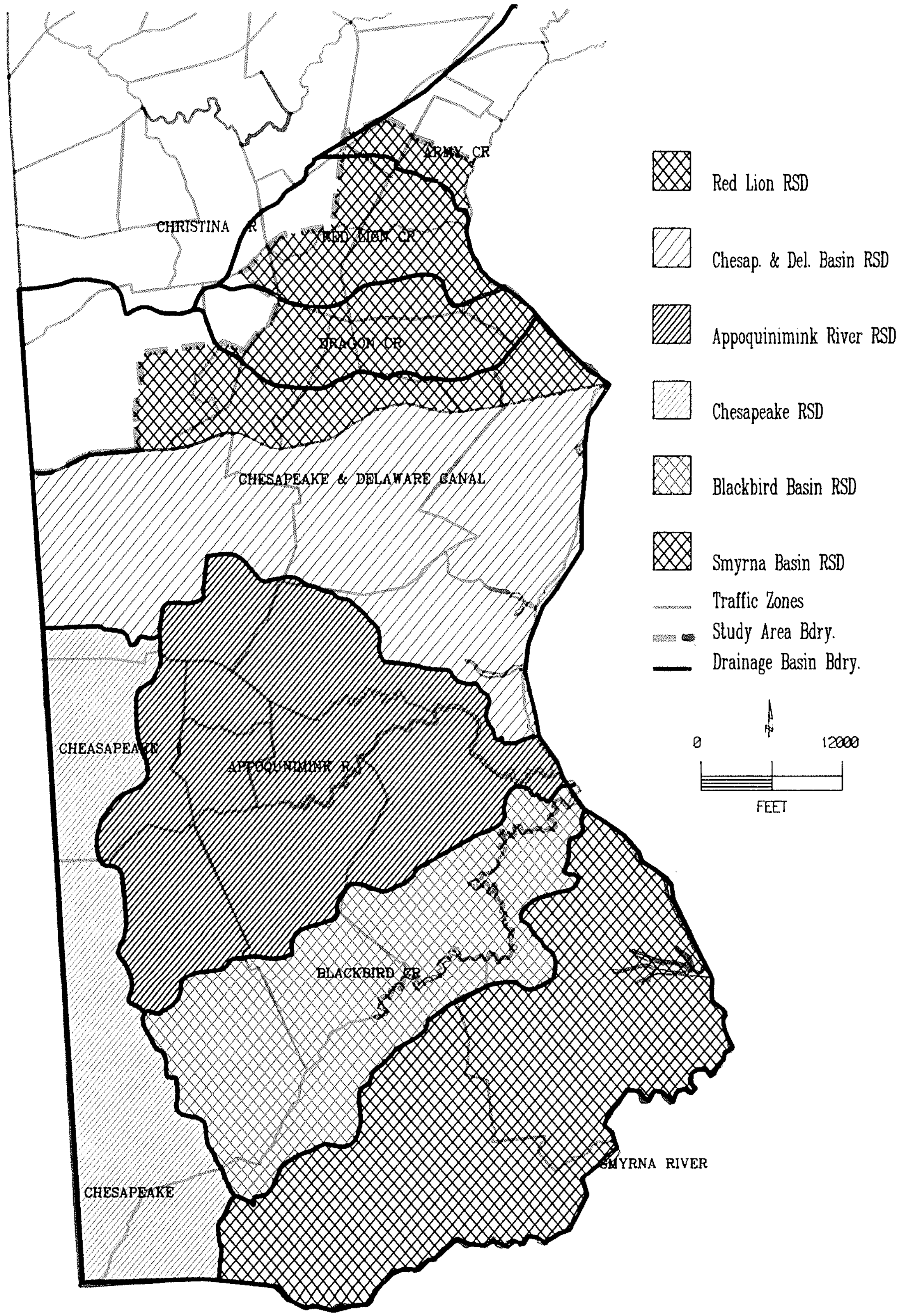


FIGURE 4-1 REGIONAL SERVICE DISTRICTS IN THE STUDY AREA

By taking the population figures that were determined at the traffic zone level and incorporating the information supplied from the land use maps and the tax parcel information, the percentage of the regional population (both existing and forecasted) that would likely be located in a particular PSZ was estimated. This population was determined to have a high potential of receiving public wastewater collection and treatment. Multiplying the population in a particular PSZ by 100 gallons per day (gpd) yields the projected residential wastewater flow for that PSZ.

It is assumed that the remaining population not accounted for in the PSZs will not receive public collection and treatment, and that their wastewater treatment needs will be supplied by on-site management systems. By taking this remaining population and dividing by 2.8 people per dwelling (New Castle County Comprehensive Plan), the total potential number of on-site management systems can be estimated.

In developing these presumptive population distributions, the overall population distribution for the study area as represented by the traffic zone projections is retained.

4.3 COMMERCIAL FORECAST

Forecasting commercial growth and wastewater generation resulting from commercial activities is somewhat more difficult than forecasting residential wastewater needs. While census figures and planning forecasts can be used to estimate residential wastewater needs, no such figures exist to base a forecast of commercial wastewater needs. Nonetheless, it is recognized that a commercial wastewater generation component will no doubt exist in the study area at sometime in the future.

For the purposes of estimating commercial wastewater flows, two primary assumptions have been made, namely:

- Wastewater generated by small commercial establishments (e.g., corner stores) are accounted for in the residential wastewater forecasts and will not be accounted for as a separate component.

- Commercial development that has been identified is limited to the immediate Middletown-Odessa area. In this area, approximately 1,300,000 ft^2 of commercial development is assumed.

In preparing its proposed development plan, Middletown has used a commercial wastewater generation rate of 0.1 gallon per square foot (g/ft^2) of commercial space. In the text "Water Supply and Pollution Control" (Clark, Viessman, and Hammer), typical commercial wastewater generation rates are given in the range of 0.16 to 0.18 gpd/ft^2. In order to avoid underestimating the quantity of commercial wastewater that may ultimately be generated, it was decided that the 0.18 gpd/ft^2 value would be used. Based on the aforementioned figure of 1,300,000 ft^2 of proposed commercial development, this translates to 234,000 gpd of commercially generated wastewater. This 234,000-gpd total will be added to the total residential flow generator in the Middletown-Odessa PSZ.

4.4 INDUSTRIAL FORECAST

According to the New Castle County Comprehensive Plan, no substantial industrial growth is foreseen to occur in the study area. For this reason, no allocation has been made for future wastewater contributions from industrial sources.

4.5 SUMMARY AND DISTRIBUTION OF FLOWS

Projected wastewater generation quantities and distribution of wastewater by RSDs and PSZs are presented in Table 4-5. It should be noted that Table 4-5 accounts for all major flows in the study area and places the origin of those flows in an approximate geographical location. Actual values (e.g., total flows) and the point of origin will ultimately be determined and influenced by the particular wastewater management alternative(s) chosen for that particular region.

Table 4-5

Distribution of Wastewater Generation

		Chesapeake and Delaware		Appoquinimink				
	Red Lion	Boyd's Corner	Summit	Middletown Odessa	Townsend	Blackbird	Smyrna	Chesapeake
Total Projected Population, 2010	13,710	5,200	3,800	13,770	3,820	4,950	5,340	2,810
Total Projected Residential Flow (gpd), 2010	1,371,000	520,000	380,000	1,377,000	382,000	495,000	534,000	281,000
Total Projected Commercial Flow (gpd), 2010	0	0	0	234,000	0	0	0	0
Total Projected Flow (gpd), 2010	1,371,000	520,000	380,000	1,611,000	382,000	495,000	534,000	281,000

*At 2.8 persons per lot.

SECTION 5

IDENTIFICATION OF WASTEWATER PLANNING CRITERIA

5.1 INTRODUCTION

As stated in the Comprehensive Development Plan of New Castle County, the natural resource base is a fundamental part of the character of the County community and a vital part of what makes New Castle County an attractive place to live and work. Therefore, given that the County's objectives include the protection and preservation of the natural resource base, growth and development should be managed consistent with this objective. In considering wastewater management, the criteria upon which wastewater management planning would be based must be identified and carefully evaluated in order that the natural resources of the area are not threatened when the wastewater management plan is implemented.

In this Wastewater Needs Evaluation and Plan, two main sets of criteria are considered with respect to the development and evaluation of wastewater management options: namely, environmental criteria and regulatory criteria. The environmental criteria that are discussed in this section are presented in order to illustrate the broad and varied range of natural resources that are present in the study area and to identify those resources that could potentially be impacted by wastewater management. The regulatory criteria are presented in order to define what limits are currently required by law with respect to the treatment and disposal of wastewater. While it is recognized that there is a certain amount of crossover between the two sets of criteria, they have been kept separate in this plan for the sake of clarity of presentation.

5.2 ENVIRONMENTAL CRITERIA

5.2.1 Wetlands

According to the New Castle County Comprehensive Development Plan, wetlands account for approximately 20,800 acres (7.6%) of the land area in New Castle County. These wetlands are primarily located in the southern portion of the County. It must be noted that tidal wetlands are considered to be part of the waters of the State of Delaware and as such are regulated by the Delaware Department of Natural Resources and Environmental Control (DNREC). The Army Corps of Engineers has jurisdiction over nontidal wetlands. A discussion on the applicable surface water regulations is provided in Subsection 5.3.1.

As a whole, wetlands in New Castle County (and in particular, the study area) are classified as being either tidal or nontidal. As the names imply, tidal wetlands are normally associated with tidally influenced estuarine environments, while nontidal wetlands are usually located in riverine environments that are not tidally influenced and in upland areas.

Tidal wetlands serve a number of important functions that are vital to the health of the Delaware River, the Delaware Bay, and the number of smaller streams throughout the southern portion of New Castle County. Some of these important functions include erosion protection, provision of habitat to both flora and fauna, and reduction of certain pollutants before they enter the Delaware River.

Nontidal wetlands are typically characterized by saturated soils, periodic high groundwater levels, and/or periodic flooding. Nontidal wetlands perform many of the same functions as tidal wetlands. In addition, nontidal wetlands serve an important role in the supply of both surface water and groundwater. Nontidal wetlands are often closely linked to groundwater aquifers and can serve as groundwater recharge points. In some cases, nontidal wetlands can serve as a source of water supply as potential reservoir sites. The addition of nutrients and other pollutants to such areas could adversely impact the quality of the groundwater.

Figure 5-1 illustrates the locations of wetlands (both tidal and nontidal) throughout the study area. Information gathered from both the National Wetlands Inventory and the Delaware DNREC were used in the production of Figure 5-1.

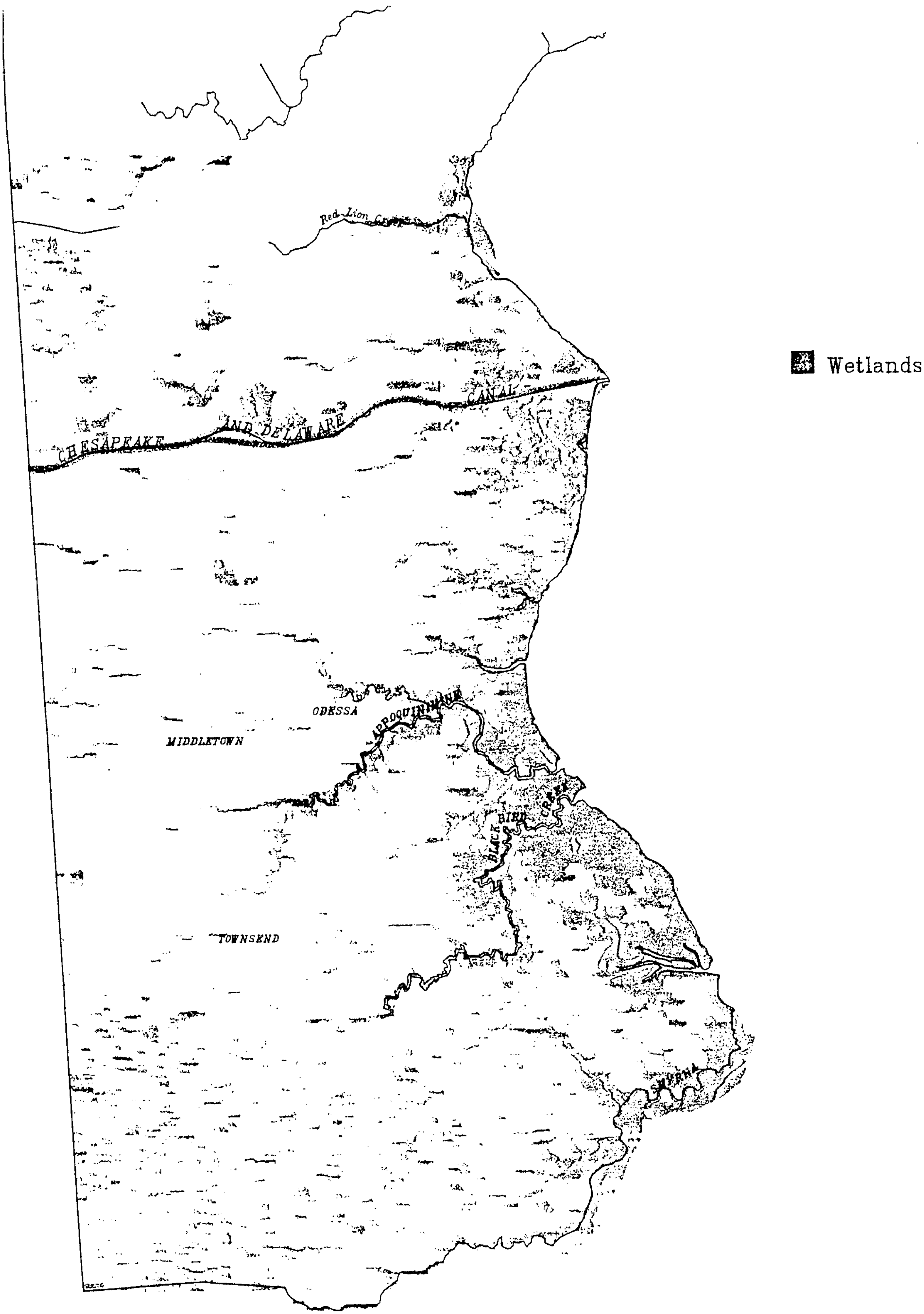


FIGURE 5-1 WETLANDS LOCATIONS IN THE STUDY AREA

5.2.2 Floodplains

Floodplains may be defined as the major portion of a stream valley that is covered with water when a river or stream overflows its banks. This flooding may occur as a result of heavy rains or snow melt. Floodplains within the study area are characterized as being either coastal or inland (riverine).

Inland floodplains serve as natural flood conveyance areas that store floodwaters and slowly release them to downstream areas. In addition, naturally vegetated inland floodplains may act in the same manner as wetlands in that they filter runoff and collect and hold nutrients, chemicals, and other pollutants.

The coastal floodplains serve to preserve the stability of the New Castle County shoreline. In addition, coastal floodplains harbor other natural resources such as tidal wetlands.

5.2.3 Drainageways and Surface Waters

In general, the drainageways of New Castle County (and in particular, the study area) serve a number of vital functions. The most obvious function is to permit the flow of surface water. In acting as natural aqueducts, drainageways provide a source of water to the coastal environments, feeding both tidal wetlands as well as near-shore, nontidal wetlands. They may also serve to link together a series of natural resources, such as nontidal wetlands. Where natural vegetative buffers exist, they may act in the same manner as wetlands in that they may function to filter nutrients and pollutants.

The locations of drainageways and surface waters within the study area are shown in Figure 5-2.

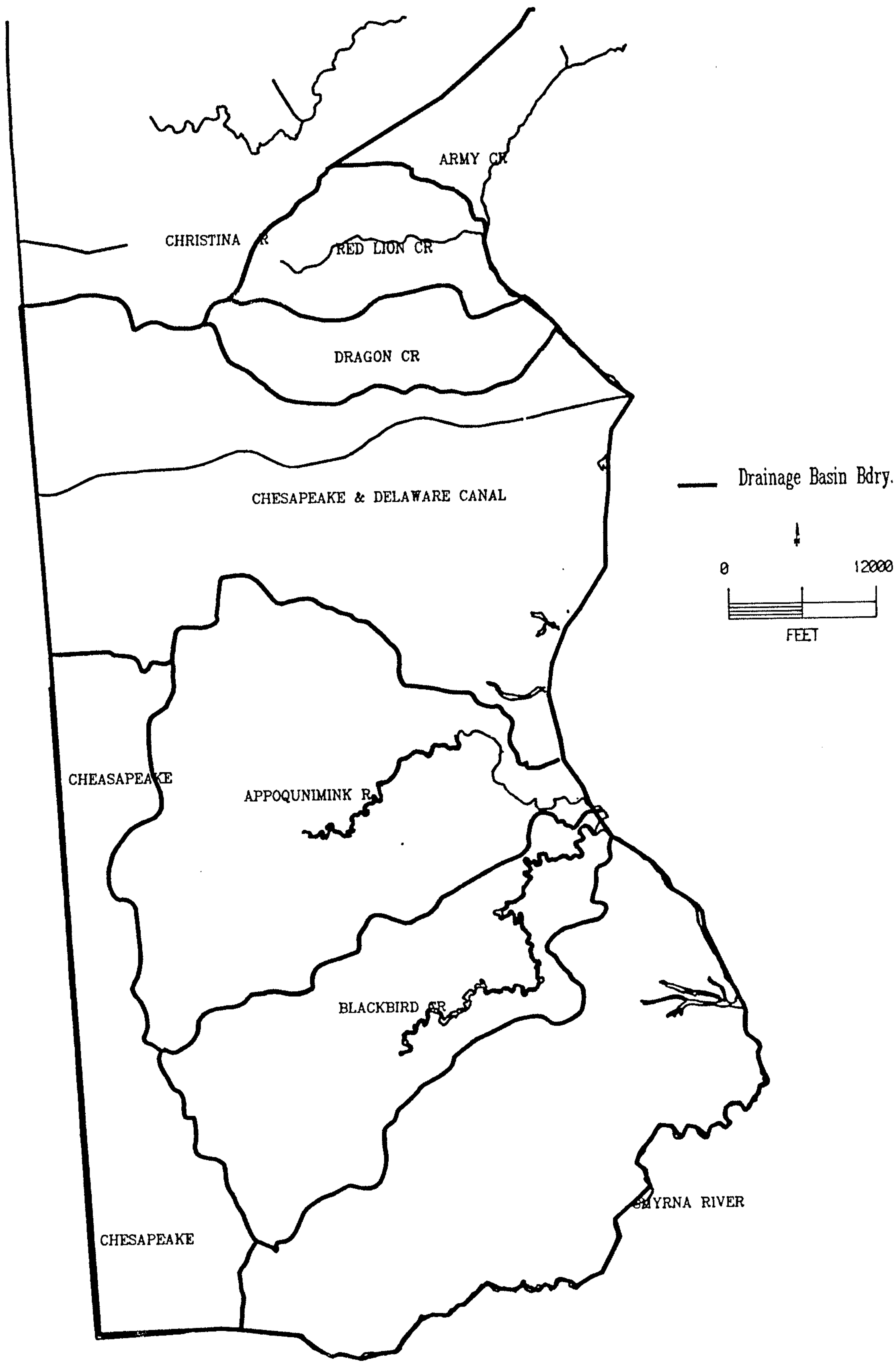


FIGURE 5-2 DRAINAGEWAYS AND SURFACE WATERS IN THE STUDY AREA

5.2.4 Recharge Resource Protection Areas

The vast majority of the study area is reliant upon groundwater for its supply of potable water. In fact, the portion of the study area located south of the Chesapeake and Delaware (C&D) Canal is entirely dependent upon groundwater for its drinking water supply. As a result of this dependence (as well as for the overall protection of groundwater and surface water resources), the Water Resources Agency for New Castle County (WRA) has designated certain areas as Resource Protection Areas (RPAs). RPAs are designed to protect areas of highly permeable geology and areas in close proximity to surface water. There are limitations on specific activities and wastewater disposal in the RPAs.

RPAs are discussed in detail in Subsection 2.7 of this document. Recharge RPAs, which are one of several RPA classifications, comprise all of the RPAs currently in the study area. Recharge RPAs are discussed in Subsection 2.7.4 of this document. The locations of Recharge RPAs are shown in Figure 5-3.

5.2.5 Critical Natural Areas

The New Castle County Comprehensive Plan defines a critical natural area as a unique habitat area, archeological site, or geological area, that by virtue of distinct character, cannot be replaced if destroyed. The Delaware Natural Heritage Inventory has identified 11 critical natural areas located in the study area. These areas are listed in Table 5-1 and illustrated in Figure 5-4.

In addition, eight ecologically sensitive areas containing unique natural communities and rare plants and animals have been identified. These areas are shown with the critical natural areas in Figure 5-4. Each of the sensitive areas contain at least one animal or plant

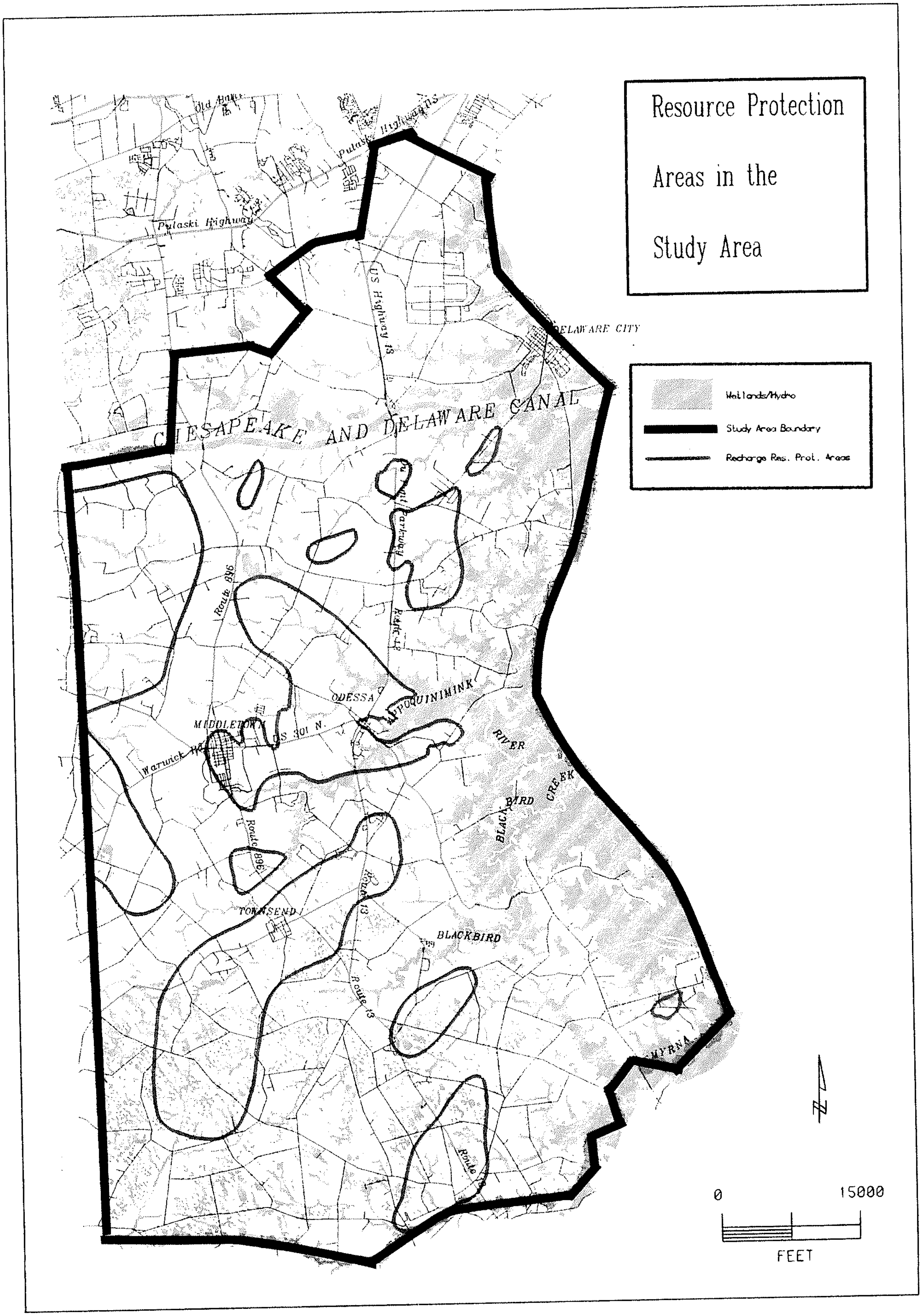


FIGURE 5-3 RESOURCE PROTECTION AREAS IN THE STUDY AREA

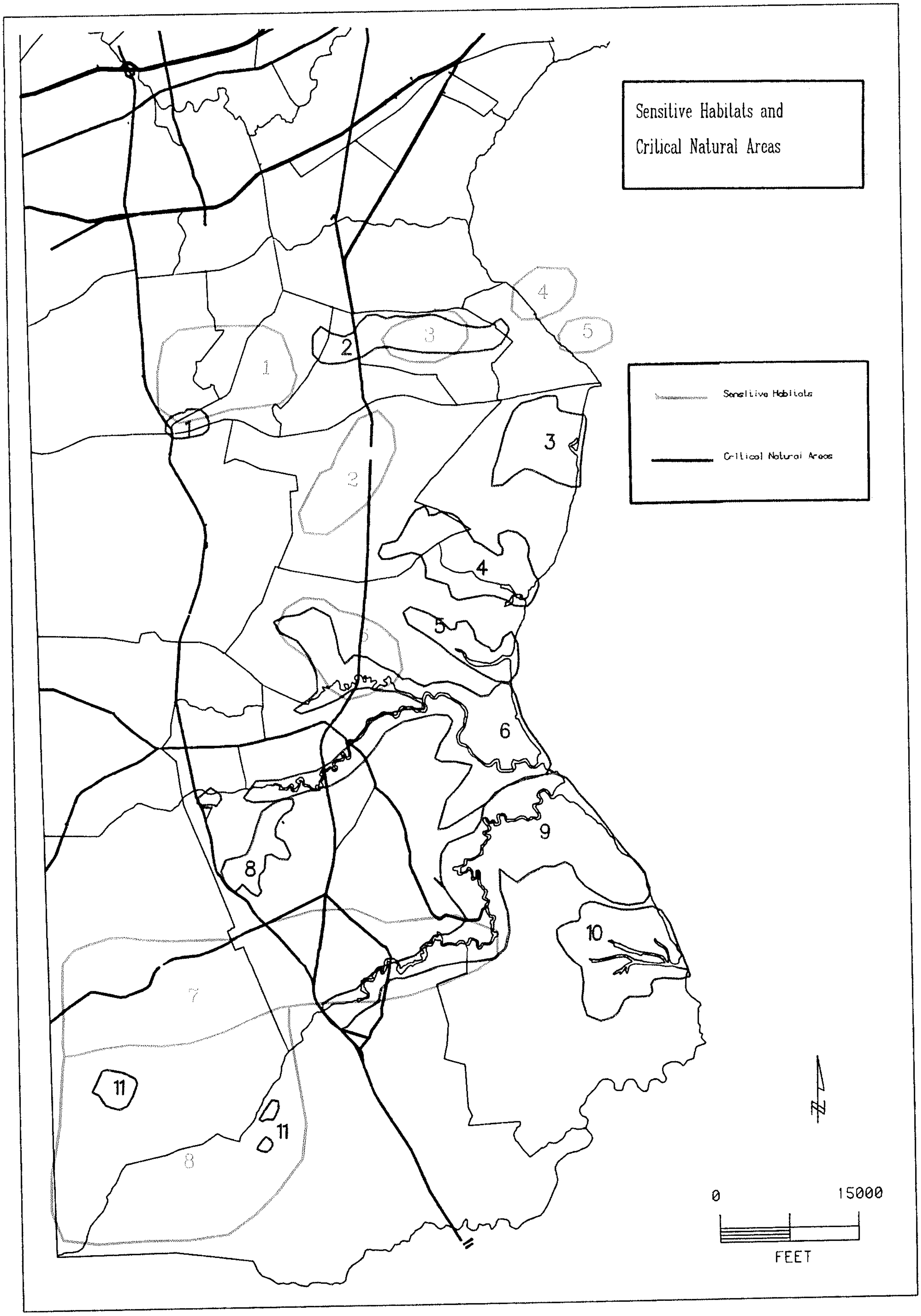


FIGURE 5-4 CRITICAL NATURAL AREAS AND SENSITIVE HABITATS IN THS STUDY AREA

Table 5-1

Natural Areas Shown in Figure 5-4

1 - C&D Canal
2 - Dragon Run
3 - Thousand Acre Marsh
4 - Augustine Creek
5 - Silver Run
6 - Appoquinimink River
7 - Pleistocene Plant Deposits
8 - Noxontown Pond
9 - Blackbird Creek
10 - Cedar Swamp
11 - Blackbird, Delmarva Bays

species that has a Natural Heritage Inventory ranking of S1 or S2. The definitions of these ranks are as follows:

- S1 — Extremely rare; typically five or fewer estimated occurrences in the state or only a few remaining individuals; may be vulnerable to extirpation.
- S2 — Very rare; typically between five and 20 estimated occurrences or with many individuals in fewer occurrences; often susceptible to extirpation.

It should be noted that no individual species have been named by the DNREC Division of Parks and Recreation. Individual species names are not released in an effort to deter poachers, collectors, etc., from further threatening these species. Therefore, before a decision can be made on whether a facility can be sited in a specific critical natural resource area, the DNREC Division of Parks and Recreation would have to provide its opinion on the specific species that would be impacted.

5.3 REGULATORY CRITERIA

5.3.1 Surface Water

Surface water quality for waters located in and around the study area is governed by two regulatory agencies, namely the Delaware River Basin Commission (DRBC) and the Delaware Department of Natural Resources and Environmental Control (DNREC). The general criteria for preservation of water quality set forth by each of these agencies is discussed below.

5.3.1.1 Delaware River Basin Commission (DRBC) Regulations

The effluent quality requirements of the Delaware River Basin surface waters are based upon specific water uses. Water uses that define regulations consist of the following:

- Agricultural, industrial, and public water supplies after reasonable treatment.
- Wildlife, fish, and other aquatic life.
- Recreation.

- Navigation.
- Controlled and regulated waste assimilation.

The Delaware River, including the Delaware Bay, has been divided into zones by the DRBC. Zones 5 and 6 are those zones that extend along the New Castle County shoreline, and therefore would be directly applicable to the study area.

Regulations for Delaware River Basin surface waters are contained in DRBC's Administrative Manual - Part III, "Water Quality Regulations," May 22, 1991. The following regulations apply to Publicly Owned Treatment Works (POTW) effluent discharge in the southern New Castle County study area:

1. General:

   a. Waters shall be substantially free from unsightly or malodorous nuisances due to floating solids, sludge deposits, debris, oil, scum, substances in concentrations or combinations which are toxic or harmful to human, animal, plant, or aquatic life, or that produce color, taste, odor of the water, or taint fish or shellfish flesh.

   b. Concentrations of substances shall not exceed those values given for rejection of water supplies in the United States Public Health Service Drinking Water Standards.

   c. Minimum Treatment — all wastes shall receive a minimum of secondary treatment, regardless of the stated stream quality objective. Secondary treatment must achieve at least 85% biochemical oxygen demand (BOD) reduction. Reduced efficiency of secondary treatment in colder months is acceptable.

   d. Disinfection — wastes containing human excreta or disease-producing organisms shall be effectively disinfected before being discharged into surface waters.

   e. Public Safety — effluents shall not create a menace to public health or safety at the point of discharge.

f. Threshold Odor Number:

   1. Not to exceed 24 at 60°C.

g. Synthetic Detergents:

   1. Maximum 30-day average of 1.0 mg/L.

h. Radioactivity:

   1. Alpha emitters - maximum 3 pc/L.
   2. Beta emitters - maximum 1,000 pc/L.

i. Bacteria:

   1. Fecal coliform: maximum geometric average of 200 per 100 mL.

   2. Enterococcus: maximum geometric average of 35 per 100 mL.

j. Turbidity:

   1. Maximum 30-day average, 40 units.
   2. Maximum 150 units, unless exceeded by natural conditions.

k. Alkalinity:

   1. Between 20 and 120 mg/L.

l. Ammonia:

   1. Not to exceed a 30-day average of 35 mg/L as nitrogen.

4. Zone 6: Zone 6 extends from Liston Point (River Mile 48.2) to the Atlantic Ocean (River Mile 0.0) on the Delaware River. All regulations for Zone 6 are the same as for Zone 5 except for the following differences for temperature and the addition of bacteria:

   a. Temperature:

      1. Maximum temperature shall not exceed 85°F (29.4°C).

   b. Bacteria:

      1. Coliform: Most probable number (MPN) shall not exceed federal shellfish standards in designated shellfish areas.

5.3.1.2 State of Delaware DNREC Regulations

DNREC has issued requirements for the discharge of wastewater to surface waters in the State of Delaware. A permit is required to discharge any pollutant from a point source unless the discharge is specifically exempted from permitting. The following minimum treatment requirements were taken from Section 7 of the State of Delaware DNREC "Regulations Governing the Control of Water Pollution," amended June 23, 1983:

- No person shall cause or permit any discharge of liquid waste to the Delaware River, the Delaware Bay, or Atlantic Ocean except liquid waste that has received at least secondary treatment and disinfection.

- No person shall cause or permit discharge of liquid waste to a lake or pond or any tributary thereof, except liquid waste that has received at least secondary treatment, filtration, nutrient removal, and disinfection.

- No person shall cause or permit any discharge of liquid waste to a stream, tidal or nontidal, except liquid waste that has received at least secondary treatment, filtration, and disinfection (excluding the Delaware River, the Delaware Bay, and the Atlantic Ocean).

- In areas in which Water Quality Standards are frequently violated, the Department shall establish a zone containing point source discharges that significantly contribute to violation of Water Quality Standards. If after an evaluation by the Department it is determined that Water Quality Standards will not be achieved through the application of treatment requirements and effluent limitations contained in Sections 7 and 8, additional effluent limitations shall be uniformly imposed on all dischargers within the zone to ensure compliance with Water Quality Standards.

In addition to these minimum treatment requirements, effluent limitations on surface water discharges are based upon a number of other criteria. Those criteria most applicable to discharges within the study area are those based on "A Practicable Level of Pollutant Removal Technology" and those based on "Water Quality Standards."

Surface Water Quality Standards, as established by DNREC, are based on and for the protection of beneficial uses of the waters of Delaware, such as public health and public recreation. Designated uses of those stream basins located within southern New Castle

County, as specified in DNREC's "Surface Water Quality Standards," (February 2, 1990) are shown in Table 5-2. Specific criteria based on these designated uses are too voluminous to be listed here, but are covered in their entirety in the aforementioned document. However, it should be noted that this document specifically states that, "It shall be the policy of this Department to minimize nutrient input to surface waters from any controllable source. The types of, and need for, nutrient controls shall be established on a site-specific basis." This policy has recently been exercised at the Middletown-Odessa-Townsend (M-O-T) treatment facility, where information collected by DNREC indicated that the reach of the Appoquinimink River in the vicinity of the effluent discharge was not meeting Water Quality Standards. In order not to exacerbate the situation, phosphorus loads to that stream system will be capped by DNREC in the near future. This means that any increase in discharge flow at the M-O-T facility will need to be accompanied by modifications that limit nutrient discharges, primarily phosphorus.

Based on a review of the applicable regulations and the trends in permitting actions by DNREC, it appears that a discharge to any stream within the study area, with the exception of the Delaware River, would require treatment facilities for nutrient removal. Consequently, in Sections 9 and 10, alternatives involving tertiary treatment and direct discharge are compared with alternatives involving secondary treatment and filtration and direct discharge to reflect this future possibility.

5.3.1.3 Summary of Surface Water Discharge Regulations

In summarizing the regulations governing surface water discharges for waters in and around the study area, the following general conclusions have been drawn about the level of treatment that is required now or will be required in the near future:

- Secondary treatment plus filtration will be required for a discharge to the Delaware River.
- Advanced treatment (nutrient reduction) may be required for a discharge to any other stream or lake within the study area.

Table 5-2

Designated Uses of Stream Basins in Southern New Castle County

Basin No.	Basin Name	Industrial Water Supply	Primary Contact Recreation	Secondary Contact Recreation	Fish, Aquatic Life, Wildlife[b]	Agricultural Water Supply
1	Appoquinimink River	x	[a]	x	x	[a]
4	Blackbird Creek	x	[a]	x	x	[a]
10	C&D Canal	x	-	x	x	-
11	Chesapeake Drainage System	x	x	x	x	x
35	Smyrna River	x	[a]	x	x	[a]

Notes:

[a]Designated for freshwater segments only.
[b]Includes shellfish propagation.

5.3.2 Wetlands

Wetlands within the State of Delaware are considered to be waters of the State, and therefore are governed by the same regulations that were identified in the previous section of this document.

5.3.3 Groundwater

As previously stated, groundwater is a precious natural resource in the southern portion of New Castle County. Considering the fact that the entire population of southern New Castle County is dependent on groundwater as a source of drinking water, preservation of groundwater quality in the study area is of paramount importance.

In developing this Wastewater Needs Evaluation and Plan, two wastewater treatment and disposal methods that could have the potential of impacting groundwater quality were considered. These methods are land application of treated wastewater and on-site waste management systems (septic systems). Discussions on the regulations governing the design and operations of these systems and how these regulations address preservation of groundwater quality are presented in the following subsections.

5.3.3.1 Land Application of Treated Wastewater

Regulations for land application of treated wastewater and sludge are contained in DNREC's "Guidance and Regulations Governing the Land Treatment of Wastes" (August 1988). Several parameters that should be considered when choosing a location for the land treatment of wastewater or sludge include the proximity to the waste source, the size of suitable land, the ease of access to the land, isolation of the area, utility availability, flood protection, the effect on nearby cultural and historical sites, and the ability to easily purchase land. Specific requirements that must be met when considering a site for the land treatment of wastewater include the following:

- Topography
  - For row crops: ≤ 7% slope.
  - For forage crops: ≤ 15% slope.
  - For forest: ≤ 30% slope.

- Soils
  - United States Department of Agriculture (USDA) Soil Conservation Service (SCS) permeability classification of moderately slow (0.02 to 0.6 inch/hr) or more.
  - Nonrestrictive soil layers.
  - Good drainage.
  - Ability to support vegetation.
  - Loading rates.
  - Wastewater loading must be no greater than 2.5 inches per week.
  - Instantaneous wastewater application rate must be no greater than 0.25 inch/hr.
  - If the seasonal high groundwater table is greater than 5 ft, the design percolation rate must be no more than 10% of the mean saturated hydraulic conductivity of the most limiting layer in the first 5 ft.
  - If the seasonal high groundwater table is less than 5 ft, it must have special evaluation by the Department.

- Soil and Cover Crop Compatibility
  - Inorganic constituents must be compatible with soils and cover crops.
  - Row crops must not be used for direct human consumption (prior to processing) if they are irrigated with wastewater containing domestic waste.
  - Unmanaged volunteer vegetation (weeds) is not an acceptable spray field cover for wastewater application.

- A variety of cover crops (forest, forage, grains, etc.) is best for application.

- Land should not require grading.

- Buffer Zones

  - 150-ft buffer required between the edge of the wetted field area and all property boundaries and the outer edge of the shoulder of public roads (or the edge of the road if no shoulder).

  - Internal roads closed to the public do not require buffer zones.

  - 100-ft buffer required between the wetted edge of a spray field and the edge of any perennial lake or stream.

  - 50-ft buffer required between spray fields and the edge of a spray field and the edge of any perennial lake or stream.

  - All domestic wells within 1,000 ft and all irrigation commercial, industrial, and public wells within 2,500 ft of the site must be identified. All on-site abandoned wells must also be identified.

- Storage Volume: at least 15 days of storage volume are required for land treatment of wastewater. Municipal systems may normally require 45 to 60 days storage to provide maximum flexibility in system operation.

- Land Requirements

  - The amount of land required depends on the site's assimilative capacity. Assimilative capacity is controlled by aboveground removal, permanent storage in the soil, and drainage removal.

  - The amount of land typically required (based on hydraulic loading) may vary between 120 to 300 acres for every 1 million gallons per day (gpd) of municipal wastewater depending upon hydraulic properties and management of the site (not including buffer zones).

The aforementioned guidance document also states a number of items that specifically address the treatment requirements prior to land application. Those items that are most applicable to this plan are as follows:

- BOD and TSS Reduction and Disinfection: preapplication treatment standards for domestic and municipal wastewater prior to storage and/or irrigation are as follows:

  - Sites Open to Public Access. Sites open to public access include golf courses, cemeteries, green areas, parks, and other public or private land not expressly closed to the public. Wastewater irrigated on public access sites must not exceed a 5-day BOD of 30 mg/L. Total suspended solids are limited to 30 mg/L. Disinfection to reduce fecal coliform bacteria to 30 colonies/100 mL is required.

  - Sites Closed to Public Access. All wastewater must be treated to a 5-day BOD of 50 mg/L at average design flow and 75 mg/L under peak loads. Total suspended solids are limited to 50 mg/L for mechanical systems and 90 mg/L for ponds. Disinfection is required for all wastewaters containing domestic wastes to yield a discharge not to exceed 200 colonies/100 mL fecal coliform at all times. Disinfection requirements may be waived when wastewater is irrigated in remote or restricted use sites such as forests.

- Maximum nitrogen removal occurs when nitrogen is land applied in the ammonia or organic form. Nitrate is not retained by the soil and leaches to the groundwater, especially during periods of dormant plant growth. Therefore, the preapplication treatment system should not produce a nitrified effluent.

  The Department recommends that aerated or facultative wastewater stabilization ponds be used for preapplication treatment, where possible. These systems generally produce a low-nitrate effluent well-suited for wastewater irrigation. When mechanical plants are employed for preapplication treatment, they should be designed and operated to limit nitrification.

- Pretreatment may consist of mechanical or pond-type systems. All systems must have provisions for storage either as a separate facility or incorporated into the pretreatment system if the efficiency of treatment is not compromised. Pretreatment ponds may be aerated, facultative, or a combined aerated/facultative system.

- Ponds used for preapplication treatment and storage must have impermeable liners.

- Nitrate concentration in percolate from wastewater irrigation systems must not exceed the state drinking water standard of 10 mg/L.

In addition to the above-mentioned items for the land treatment of wastewater, the following regulations apply to the land treatment of sludges:

- Topography:
  - Slopes must not be greater than 15%.
  - Forest systems can have slopes up to 30%.

- Soils:
  - USDA soil classification of sandy loam, sandy clay loam, silty clay loam, or silt loam.
  - Minimum depth from surface to impermeable strata of 24 inches.
  - Minimum depth from surface to seasonal high water table of 48 inches.
  - Soil pH must be adjusted to values of 6.5 or higher unless plant nutrient needs and soil chemistry preclude such values (nursery crops must have a pH of 5.8 or higher).

- Soil and Cover Crop Compatibility:
  - Public access to the sludge application area must be controlled for at least 12 months following sludge application.
  - Crops for direct human consumption may not be grown on the sludge application area for at least 2 years following application.
  - When sludge is applied to forage grasses, the grass must be cropped or closely grazed immediately before sludge application. After application, grazing by animals whose products are consumed by humans shall be prohibited for at least 1 month. Lactating dairy cows must wait 1 year before grazing on sludge application land.

- Buffer Zones: (see Table 5-3 for specific requirements).

Table 5-3

Buffer Zones for Land Treatment of Sludges

	Surface Application (ft)	Subsurface Injection (ft)
Occupied Off-Site Dwelling	200	100
Occupied On-Site Dwelling	100	50
Potable Wells	100	100
Nonpotable	25	25
Public Roads	25	15
Property Lines	50	25
Bedrock Outcrops, Stream, Tidal Water, Water Bodies	50	25
Drainage Ditches	25	25

5.3.3.2 On-Site Waste Management Systems (Septic Systems)

Prior to April 1991, on-site wastewater management systems in New Castle County were regulated and permitted by New Castle County. In April 1991, responsibility for regulation of and permitting of on-site systems was assumed by the Delaware Department of Natural Resources and Environmental Control (DNREC). It should be noted, however, that minimum lot sizes on which on-site systems are allowed fall under the jurisdiction of New Castle County zoning regulation and are therefore determined and governed by the County.

Requirements for the siting of on-site septic systems are contained in the State of Delaware DNREC Regulations Governing the Design, Installation, and Operation of On-Site Wastewater Treatment and Disposal Systems (July 1985). General criteria that should be considered when choosing an area for on-site septic systems include size, slope, streams, and bodies of water, existing and proposed wells, cuts and fills, soil profiles, water table levels, floodplains, and other encumbrances. Criteria contained in the regulations that must be met when choosing a site for septic systems are listed below:

- Slope: 0 to 30% (from 15% to 30% - system design must be done by an engineer).
- Landscape Position: areas with good surface drainage; no ponding or flooding.
- Soil Profile:
    - Soil depth: deep to very deep.
    - Soil drainage: well drained.
    - Soil texture: coarse to medium textured.
    - Soil structure: granular, blocky, subgranular blocky, and prismatic structure.
    - Depth to limiting zone: not less than 3 ft below the seepage bed.
- Percolation Rates:
    - 6 to 60 minutes per inch (gravity distribution system permitted).

- 6 to 20 minutes per inch with Department approval (gravity distribution system permitted).

- 60 to 120 minutes per inch - pressure distribution required.

- Less than 6 minutes per inch with Department approval (pressure distribution system required).

- Sizing:

  - Sizing shall be based on the estimated wastewater flow and either the results of the percolation test or the assigned permeability rates.

- Minimum Lot Sizes:

  - Single family residences with individual wells: 1 acre.

  - Single family residences with public water supply: 3/4 acre.

  - Single family residences located within an RPA: 2 acres.

  - Each lot or parcel must contain sufficient useable area to accommodate an initial and replacement system.

Table 5-4 contains details on the isolation distances mandated by DNREC for on-site wastewater treatment and disposal systems.

5.4 REFERENCES

1. State of Delaware DNREC, "Surface Water Quality Standards," February 2, 1990.

2. State of Delaware DNREC, "Guidance and Regulations Governing the Land Treatment of Wastes," August 1988.

3. State of Delaware DNREC, "Regulations Governing the Design, Installation, and Operation of On-Site Wastewater Treatment and Disposal Systems," July 1985.

4. New Castle County, "Comprehensive Development Plan," November 29, 1988.

5. Delaware River Basin Commission, "Water Quality Regulations" (Administrative Manual - Part III), May 22, 1991.

Table 5-4

Minimum Isolation Distances (ft)

Component	Well or Suction Line	Water Supply Pressure Line	Watercourse (Streams, Lakes, or Other Surface Water)	Dwellings, Property Line, Easement, or Right-of-Way	Other Active On-Site Systems	Natural or Manmade Slope Greater Than 25%
Septic Tank	50	10	25	10[f]	--	--
Grease Trap	50	10	25	10	--	--
Distribution Box	50	10	25	10	--	--
Dosing Chamber	50	10	25	10	--	--
Disposal Area[c]	100[a,d,e]	10	100[b]	10[g]	20	15
Diversion Valve or Box	50	10	25	10	--	--

Notes:

[a]Approval of a lesser distance to a minimum isolation distance of 50 ft may be approved by the Department if the well has a permanent watertight casing installed through the aquifer receiving the effluent from the on-site disposal system. The applicant shall provide documentation regarding well distances, depths, and construction to the Department upon request.
[b]Approval of a lesser distances to a minimum isolation of 50 ft may be approved by the Department if the watercourse has not been designated for use as public water supply or shellfish.
[c]For elevated sand mound systems, distances shall be measured from the outer edge of the berm or fill.
[d]For public or industrial wells, the minimum isolation distance shall be 150 ft. (Note: Paragraph 8.03(c) of Regulations Governing the Use of Water Resources and Public Subaqueous Lands states, "Every new or replacement well shall be located at least 150 ft from septic tanks, tile fields, and seepage pits.").
[e]For lots created by plat or deed recorded prior to 8 April 1984, an isolation distance of 50 ft between domestic and commercial wells and the disposal area may be considered by the Department where the lot size will not allow an isolation distance of 100 ft and an alternative source of water supply is not available. The well must be based to a depth of 50 ft exclusive of the screen and pressure grouted with either concrete or bentonite clay to a minimum depth of 40 ft. The applicant shall provide documentation regarding well distances, depths, and construction to the Department upon request.
[f]Except in the case of a septic tank for a central sewer system where the disposal field is not located on the same lot as the septic tank, in which case the distance shall be 5 ft from the interior lot or easement lines within a recorded subdivision.
[g]Except in the case of a central sewer system where the disposal area can be 5 ft from an interior lot or easement lines within a recorded subdivision.

Source: State of Delaware DNREC, "Regulations Governing the Design, Installation, and Operation of On-Site Wastewater Treatment and Disposal Systems, July 1985.

SECTION 6

EVALUATION OF ALTERNATIVE WASTEWATER MANAGEMENT TECHNOLOGIES

6.1 INTRODUCTION

In the previous section, environmental and regulatory criteria that are important for the development, evaluation, and siting of wastewater management alternatives were discussed. Wastewater management alternatives in the study area would be comprised of one or more treatment and/or disposal technologies. The specific alternatives that were identified for the study area are discussed in Section 9 of this report, while Section 10 contains an extensive comparative evaluation of these alternatives.

The following wastewater treatment technologies and disposal methods were utilized in the development of wastewater management alternatives:

- Conventional activated sludge treatment systems.
- Aerated lagoons.
- Filtration systems.
- Nutrient removal systems.
- Constructed wetlands.
- On-site waste management (septic systems).
- Land application of wastewater.
- Direct discharge of treated wastewater.
- Diversion of wastewater flow (from future growth) to existing wastewater treatment facilities (expanded to accommodate additional flows).

Most of the above wastewater treatment technologies and disposal methods are well established, and there is significant published information available on them. In addition, their advantages and disadvantages are well documented. Consequently, in this study, extensive descriptions and evaluations of all the technologies and disposal methods will not be provided. In Section 9 of this report, where the wastewater management alternatives for the study area are described, brief descriptions of the technology (as necessary to explain the alternative) have been included.

One disposal method (land application of wastewater) and one treatment technology (constructed wetlands) need to be discussed in detail because of the following reasons:

- Land application of wastewater offers several advantages that would make it an extremely viable method for implementation in the study area.
- Wastewater treatment through constructed wetlands is not well known and its use is not yet widespread.

Therefore, in this section of the report extensive discussions on land application of wastewater and constructed wetlands are provided.

6.2 LAND APPLICATION OF WASTEWATER

6.2.1 Process Overview

Land application is defined as the controlled application of treated wastewater to the plant-soil system with the objective of achieving acceptable waste treatment through natural physical, chemical, and biological processes. No direct discharge to surface water occurs with land treatment. The applied wastewater either transpires through crops, evaporates into the atmosphere, or infiltrates into and is transmitted through the soil into the groundwater. Pollutants are attenuated or removed from the wastewater during passage through the soil. Nitrogenous compounds are assimilated and utilized by surface vegetation. A properly designed and operated land treatment system will produce a percolate of high quality, and will therefore protect groundwater and surface waters.

There are many potential benefits of a properly designed and operated land application system. Land application processes recover and beneficially reuse wastewater nutrients through agriculture practices. While promoting vegetative growth, the wastewater receives an advanced level of treatment, thereby yielding a high-quality percolate. Land application of wastewater results in the reuse of water and the eventual (indirect) recharge of groundwater aquifers. Previously unused marginal land can be used beneficially. In addition, the land has the potential to be preserved as an open space. Historically, it has been shown that land application of wastewater can be cost-effective compared to other wastewater treatment alternatives. This is primarily because it requires a minimal amount of capital equipment and labor to implement and maintain (Metcalf & Eddy, 1979).

Land application of municipal wastewater consists of three principal processes: slow rate, rapid infiltration, and overland flow. A slow rate process, spray irrigation, involves the application of wastewater to vegetated land (at typical rates of 1 to 3 inches per week) for the dual purpose of treating the wastewater and meeting the water requirements for growth of the vegetation. Treatment of the applied wastewater is achieved by physical, chemical, and biological means as the wastewater percolates through the ground. The nutrients present in the wastewater are beneficially used by the vegetation. Rapid infiltration involves the application of wastewaters via land basins or by sprinkling at a high rate (typically 4 to 84 inches per week). The wastewater is treated by the microorganisms that naturally occur in the soil as the wastewater traverses through the soil matrix. In an overland flow process, wastewater is applied (at typical rates of 6 to 16 inches per week) at the higher elevations of sloped or terraced land with vegetation. Wastewater flows in the form of a thin sheet across the vegetated land surface, as the surface is relatively impervious. The wastewater receives treatment through physical, chemical, and biological means as the wastewater moves across the land surface (Metcalf & Eddy, 1979). Slow rate land treatment is the predominant form of land treatment for municipal and industrial wastewater and is the most suitable for conditions in Delaware because of predominant soil conditions. All further discussions of land treatment will therefore refer to the slow rate process only.

The performance objectives of a land treatment system are as follows:

- Quality standards for groundwater and surface waters are met.
- The system is operated to meet public health standards.

- The soil quality is maintained to ensure future use for agriculture, forestry, or other development.

  (Source: DNREC Guidance and Regulations Governing the Land Treatment of Wastes, August 1988.)

6.2.2 Evaluation of Process Requirements

Slow rate land application systems apply wastewater to a vegetated land surface with the applied wastewater being treated as it passes through the plant-soil matrix. Portions of the flow are used by the vegetation, while the remaining portion percolates to the groundwater. Application of the wastewater is conducted so that off-site surface runoff of the applied wastewater is avoided. The design of a slow rate land treatment system must consider:

- Wastewater volume and composition.
- The land's assimilative capacity for wastewater.
- The land area required.
- Pretreatment requirements before land application.
- Storage requirements.
- Groundwater quality.
- Buffer zones.
- Monitoring and security requirements.
- Agronomic crops assimilative capacity for nutrients in the wastewater.

To illustrate a typical wastewater application rate and the land area that may be required, a hypothetical slow rate system was designed on a limiting factor basis. The limiting factor for municipal wastewater will typically be either the hydraulic loading rate or the nitrogen loading to groundwater. For the design of a land application field in southern New Castle County, these two limiting factors were evaluated. In order to evaluate the land application area requirements, it was first necessary to estimate the amount and quality of the wastewater that would be entering the land treatment facility. As indicated earlier in Section 4, four Public Service Zones (PSZs) were identified in the study area, and wastewater flows from these PSZs could be treated and disposed of in a land application facility. Table 6-1 shows the amount of wastewater from each PSZ that could be treated by land treatment. Since the largest amount of wastewater that would have to be land

Table 6-1

Land Treatment Flows by PSZ

PSZ	Land Treatment Flow (mgd)
Boyd's Corner	0.5
Summit	0.3
Boyd's Corner and Summit (Combined)	0.8
Middletown and Odessa	0.6
Townsend	0.4
Middletown, Odessa, and Townsend (Combined)	1.0

treated was estimated to be 1.0 million gallons per day (mgd), land areas were calculated for 0.1 to 1.0-mgd flow rates at increments of 0.1 mgd. Assumptions were made regarding the quality of wastewater to be land treated. In order to reduce the pathogen content and to minimize the nuisance potential of the applied wastewater it was assumed that the wastewater would receive secondary treatment using aerobic lagoons. Following secondary treatment, the wastewater was assumed to have a total nitrogen content of 20 mg/L and an ammonia nitrogen content of 15 mg/L. These levels represent those typically found in secondary treated effluent; however, these concentrations will certainly vary depending on the type of treatment process used, the method of operation, etc.

6.2.2.1 Hydraulic Loading Rate

A water balance was first completed to estimate the hydraulic loading rate that would be used for sizing land application systems. The methodology that was followed was the same as that prescribed in DNREC's "Guidance and Regulations Governing the Land Treatment of Wastes." The hydraulic loading rate is determined from the following equation:

$$Lw = ET - Pr + Pw$$

Where:

Lw = Maximum allowable hydraulic wastewater loading rate

ET = Potential evapotranspiration

Pr = Design precipitation (5-year return period)

Pw = Design percolation rate

Both ET and Pr were calculated or monitored by appropriate methods and are provided in tabular form in DNREC's "Guidance and Regulations Governing the Land Treatment of Wastes." Pw was calculated using the following formula:

$$Pw = 0.10 \times K$$

Where:

0.10 = Safety factor

K = Vertical hydraulic conductivity

For soils in the New Castle County study area, the range of hydraulic conductivities was found to be 0.63 to 2.0 inches/hr. In developing the water balance, a conservative vertical hydraulic conductivity of 0.63 inches/hr was used. When the water balance was performed, it was found that February would be the limiting month, with a loading rate (Lw) of 8.84 inches/week. However, the DNREC maximum limit for design wastewater loadings is 2.5 inches/week with an instantaneous wastewater application rate of 0.25 inches/hr. Therefore, a hydraulic loading rate of 2.5 inches/week (year-round) was used for calculating land area requirements in this illustrative example.

In addition to the water balance, a nitrogen balance was also performed on the applied wastewater and the allowable hydraulic loading rates (based on the nitrogen balance) were calculated. The assumptions that were used to develop this balance were the following:

- Total nitrogen concentration in treated effluent would be 20 mg/L.
- Ammonia nitrogen concentration in pretreated effluent would be 15 mg/L.
- Nitrogen would be applied at the site through rainfall and fixation at a rate of 5 lb/acre year.
- Maximum loss of nitrogen through ammonia volatilization would be 5% of the total ammonia applied.
- Maximum loss of nitrogen through denitrification would be 20% of the total nitrogen applied for forest crops and 15% for forage crops.
- Vegetative cover will consist of either a forest or a forage crop. The most conservative forest cover is red pine, with a nitrogen uptake rate of 110 kg/ha.yr. The most conservative forage crop is clover, with a nitrogen uptake rate of 175 kg/ha.yr.
- Nitrate concentration in percolate from wastewater irrigation systems must not exceed the drinking water standard of 10 mg/L.

The nitrogen balance resulted in the required loading rates and land areas shown in Table 6-2. As can be seen from this table, the calculated hydraulic loading rates for both

Table 6-2

Land Areas Required Based on Nitrogen Balance

Average Daily Flow (mgd)	Hydraulic Loading Rate (inches/week)		Land Area Required (ac)	
	Red Pine Forest	Clover	Red Pine Forest	Clover
1.0	1.95	2.42	132.2	106.5
0.9	1.95	2.42	119.0	95.9
0.8	1.95	2.42	105.8	85.2
0.7	1.95	2.42	92.5	74.6
0.6	1.95	2.42	79.3	63.9
0.5	1.95	2.42	66.1	53.4
0.4	1.95	2.42	52.9	42.6
0.3	1.95	2.42	39.7	32.0
0.2	1.95	2.42	26.4	21.3
0.1	1.95	2.42	13.2	10.6

the cover crops were lower than the rate (2.5 inches/week) based on the water balance analysis.

Consequently, these lower hydraulic loading rates were based on the nitrogen balance and the limiting values and were used to estimate the land area requirements for this example, as discussed in the following subsections.

6.2.2.2 Required Land Areas

Land requirements for spray fields were estimated based on hydraulic loading rates as discussed in the previous subsection.

Following estimation of the required land areas based on the nitrogen balance, the storage volume and the additional land area required to dispose of this stored wastewater were calculated. Storage volumes consist of the sum of three separate storage components:

- Operational Storage — storage required for wastewater not applied on weekends or during harvesting periods.
- Inclement Weather and Emergency Storage — storage for periods of excess rainfall or snowfall, saturated and frozen soil conditions, and equipment failure.
- Water Balance Storage — storage required as a function of wastewater flow, wetted field area, and the wastewater loading rate.

Using the flow and loading rates for the study area, the sum of the storage components resulted in a storage capacity of approximately 10 days. However, the minimum amount of storage capacity required by DNREC is 15 days. It should be noted that a 40- to 60-day storage capacity is typically required for municipal wastewater. The primary reason for the extended storage capacity is the fact that application fields may be frozen for an extended period during the year. Therefore, a 60-day storage capacity was used. The additional area required to treat this 60-day storage capacity was also calculated. Therefore, the total wetted area consists of the area required to treat the average daily flow, as well as the area required to treat the wastewater that would be stored. Since this total wetted area will be used for wastewater application even in periods where there is no storage, the actual wastewater loading will be slightly lower than the hydraulic loading rates shown in Table 6-2.

Table 6-3 contains estimates of the required area and the hydraulic loading rates based on treatment of average daily flow and storage (60-day capacity). In Table 6-3, areas required for the treatment and storage lagoons and the buffer zones are not included. Estimates of the area required for treatment and storage were made and added to the total wetted area. In developing these estimates, it was assumed that the aerated lagoon that would be used for treatment would have a detention time of 5 days with an average water depth of 10 ft. Aerated ponds are generally 6 to 20 ft in depth with detention times of 3 to 10 days (Reed, S.C., Middlebrooks, E.J., and P.W. Crites, "Natural Systems for Waste Management and Treatment," 1988. The storage lagoon would have a 60-day capacity and an average depth of 10 ft. The total land area requirements are shown in Table 6-4. Table 6-4 does not contain areas required for buffer zones. Buffer zone requirements were discussed in Section 5 of this report.

6.3 CONSTRUCTED WETLANDS

The use of constructed or artificial wetlands as a functional part of wastewater treatment is an alternative technology that has slowly been gaining acceptance since the early 1970s. A primary reason for this growing acceptance is the rapidly escalating costs of construction and operation associated with conventional treatment facilities. Constructed wetlands and other similar "soft technologies" that may use more land but are lower in energy requirements and labor costs are becoming particularly attractive to smaller rural and suburban communities where land is available to construct these systems.

It should be emphasized that natural wetlands are considered to be "Waters of the State" and therefore are subject to the same water quality regulations as any other surface water. Therefore, natural wetlands cannot be used for wastewater treatment.

Table 6-3

Land Area Required Based on Average Daily Flow and Storage Treatment

Average Daily Flow (mgd)	Wastewater Loading Rate (inches/week)		Wetted Field Area Required (ac)	
	Red Pine Forest	Clover	Red Pine Forest	Clover
1.0	1.79	2.22	220	177
0.9	1.79	2.22	198	160
0.8	1.79	2.22	176	142
0.7	1.79	2.22	15	124
0.6	1.79	2.22	132	106
0.5	1.79	2.22	110	88
0.4	1.79	2.22	88	71
0.3	1.79	2.22	66	53
0.2	1.79	2.22	44	36
0.1	1.79	2.22	22	18

Table 6-4

Total Land Area Required
(Excluding Buffer Zones)

Average Daily Flow (mgd)	Total Area Required (ac)	
	Red Pine Forest	Clover
1.0	240	179
0.9	216	161
0.8	192	143
0.7	168	125
0.6	144	107
0.5	120	89
0.4	96	72
0.3	72	54
0.2	48	36
0.1	24	18

Constructed wetlands are rarely, if ever, used as a sole wastewater treatment process. They are typically used to provide a higher level of treatment than may be readily attained by the use of treatment processes such as facultative lagoons.

Constructed wetlands may be described as a type of "attached growth" biological system of wastewater treatment and share many similarities with other "attached growth" biological systems, such as trickling filters and rotating biological contactors. These systems require a substrate for the development of biological growth. Performance of these systems is dependent on both detention time and contact opportunities between the wastewater and the biological growth. Performance is limited by such factors as the availability of oxygen and temperature.

Constructed wetlands fall into two classifications, namely free water surface systems (FWS) and subsurface flow systems (SWS). An FWS typically consists of basins or channels with a natural or constructed subsurface barrier. It could also be constructed with a synthetic impervious liner to act as a subsurface barrier to prevent seepage, soil, or another suitable medium to support the emergent vegetation and the water that flows over the soil surface at relatively shallow depths. The shallow water depth, low flow velocity, and presence of plant stalks and vegetative litter regulate water flow (Reed, S.C., Middlebrooks, E.J., and P.W. Crites, "Natural Systems for Waste Management and Treatment," 1988).

An SFS, like an FWS, is a constructed wetland consisting of a trench or channel subsurface barrier of clay or a synthetic liner. A bed containing the media (or substrate) that supports the growth of the emergent vegetation is placed on the barrier or liner. This media typically consists of sand or rock. The system is built with a slope of 1 to 3% from inlet to outlet. Wastewater is introduced into the inlet end of the system where it flows into the channel filled with the media. The wastewater flows horizontally through the rhizosphere (root zone) of the wetland plants. During the passage of the wastewater through the rhizosphere, the wastewater is treated by means of filtration, sorption, and precipitation processes in the soil and by microbiological degradation. The effluent is collected at the outlet channel for discharge. A cross section of a typical SFS is illustrated in Figure 6-1.

Removal of biochemical oxygen demand (BOD) in constructed wetlands is primarily the result of metabolism by bacteria and other microorganisms indigenous to the plant stalks and/or the rhizosphere. Likewise, the removal of nitrogen is primarily accomplished by the bacterial nitrification/denitrification that occurs within the system, although some nitrogen is adsorbed on the plant surfaces and substrate. Uptake of nitrogen by the plants themselves is a secondary treatment mechanism in constructed wetlands, although only a minor fraction of total nitrogen is removed in this manner.

Phosphorus removal in constructed wetlands occurs primarily as the result of adsorption on plants and/or substrate, and, to lesser degree, from the formation of insoluble compounds and precipitation. Phosphorus removal in many wetland systems is ineffective because of the limited amount of contact between the wastewater and the soil. SWS appear to have a higher potential for phosphorus removal because they are designed to have wastewater flow through the substrate, thereby increasing the opportunity for contact between the substrate and the wastewater.

Pathogen destruction in constructed wetlands is due to natural die-off, predation, and the disinfection action of ultraviolet light. One strong advantage of constructed wetlands is that the final effluent can be further disinfected, if necessary. This disinfection can produce waters suitable for unrestricted reuse applications.

Control of insect vectors, particularly mosquitos, is another concern in the operation of constructed wetlands. While mosquitos are a documented problem in FWS, they are not a problem in SFS (subsurface flow). In fact, this is one of the major reasons for the use of an SFS.

A final factor that should be considered in deciding whether or not to use a constructed wetland for wastewater treatment is that this technology requires relatively large amounts of land as compared to other conventional wastewater treatment technologies. This disadvantage is offset, to some extent, by the advantage that the technology does not require large mechanical components, such as is required with conventional systems.

At the present time, documentation on the performance of constructed wetlands is limited. Since this is an emerging technology, few systems have been in operation long enough to perform detailed monitoring. In the "Design Manual: Constructed Wetlands and Aquatic Plant Systems for Municipal Wastewater Treatment" (EPA Document EPA/625/1-88/022), the performance of several constructed wetland systems is discussed. A summary of the performance data for the facilities discussed in that document is presented in Table 6-5. The performance of several pilot-scale systems is presented in Table 6-6. As can be seen from these tables, in general, the removal efficiencies for BOD_5 and TSS match those achieved by other secondary treatment systems. In addition, it appears that the effluent quality achieved by these systems could allow effluent to be discharged (to surface waters or land) under all but the most stringent discharge criteria.

6.4 REFERENCES

1. State of Delaware DNREC "Guidance and Regulations Governing the Land Treatment of Wastes," August 1988.
2. EPA Process Design Manual "Land Treatment of Municipal Wastewater," October 1981 and October 1977.
3. Metcalf and Eddy, Inc., "Wastewater Engineering, Treatment, Disposal and Reuse," Second Edition, McGraw-Hill, 1979.
4. Natural Systems for Waste Management and Treatment; Reed, Middlebrooks, and Crites; McGraw-Hill, 1988.

Table 6-5

Summary of Performance Data for Constructed Wetlands

Project	Flow, m^3/d	Wetland Type	BOD_5, mg/L		SS, mg/L		Percent Reduction		Hydraulic Surface Loading Rate, $m^3/ha\text{-}d$
			Influent	Effluent	Influent	Effluent	BOD_5	SS	
Listowel, Ontario (12)	17	FWS[a]	56	10	111	8	82	93	---
Santee, CA (10)	---	SFS[b]	118	30	57	5.5	75	90	---
Sidney, Australia (13)	240	SFS	33	4.6	57	4.5	86	92	---
Arcata, CA	11,350	FWS	36	13	43	31	64	28	907
Emmitsburg, MD	132	SFS	62	18	30	8.3	71	73	1,543
Gustine, CA	3,785	FWS	150	24	140	19	84	86	412

[a]Free water surface system.
[b]Subsurface flow system.

Source: Design Manual: Constructed Wetlands and Aquatic Plant Systems for Municipal Wastewater Treatment (EPA Document Number EPA/625/1/88/022).

Table 6-6

Performance of Pilot-Scale Constructed Wetland Systems

Location	Wetland Type	Effluent Concentration, mg/L					
		BOD_5	TSS	NH_4	NO_3	TN	TP
Listowel, Ontario	FWS[a]	10	8	6	0.2	8.9	0.9[c]
Arcata, CA	FWS	<20	<8	<10	0.7	11.6	6.1
Santee, CA	SFS[b]	<30	<8	<5	<0.2	---	---
Vermontville, MI	Seepage basin wetland	---	---	2	1.2	6.2	2.1

[a]Free water surface system.
[b]Subsurface flow system.
[c]Alum treatment provided prior to the wetland component.

Source: Natural Systems for Waste Management and Treatment, Reed, S.E., Middlebrooks, E.J., and R.W. Crites. McGraw-Hill, 1988.

SECTION 7
RESOURCE PROTECTION

7.1 BACKGROUND

Developing and implementing a wastewater management program requires a balance between the need for cost-effective treatment and disposal of wastewater and the need to protect and conserve human health and environmental resources. The early development of wastewater treatment during the mid-to-late 19th century focused upon protection of human health, since the failure to do so was the most obvious and compelling impact of the discharge of untreated wastes. In particular, the disposal of treated wastewater to areas relatively isolated from direct human use was employed, with the prevailing philosophy that the assimilative capacity of the earth, and in particular, its surface water bodies, was nearly infinite, at least in comparison to the quantities of wastes disposed.

It is now recognized that the disposal of wastewater, even after treatment, must be accomplished in a way that considers broad regional (rather than merely local) health and environmental goals. This attitude comes from the recognition that with continued societal development, truly remote disposal of wastewater may not be possible. It is also based upon an understanding of the interrelationships among the various components of the environment, such that disposal to one component (for example, land disposal) may ultimately affect other components (groundwater and/or surface waters). Finally, the recognition that these environmental components, singly or in combination, do not represent an infinitely large disposal reservoir heightens the need to appropriately manage disposal.

As a consequence of the above issues, the concept of resource protection should be an integral part of wastewater planning. This approach should consider both protection of the resource and protection of the eventual use of that resource (for example, consumption of groundwater).

The characteristics of the southern New Castle County area reinforce the significance of these issues. On one hand, this area is and will remain, to a large extent, rural in nature. This rural character and the associated natural resources are significant components of the overall living standard in the area. At the same time, this pattern of development suggests that individual (on-site) wastewater systems and/or land disposal technologies may be inherently attractive and cost-effective approaches to wastewater management.

At the same time, however, the southern New Castle County area is dependent upon groundwater sources for water supply purposes, including not only public water supplies typically drawn from deeper aquifer zones, but also a significant number of private wells that typically draw from shallow aquifer zones.

Consequently, wastewater disposal options in the study area, particularly those that employ disposal to land, should consider both the protection and the beneficial reuse of all resources, and groundwater in particular. In this section, these wastewater disposal options are evaluated in light of resource protection issues.

7.2 IMPACTS ON GROUNDWATER QUALITY

As previously indicated, the development of planning strategies that protect natural resources is one of the goals of this study. The quality of groundwater is one of the most important of these natural resources. In this section, the potential impact on groundwater quality associated with domestic wastewater disposal to groundwater is evaluated. The regulatory standards used in this study are the Delaware DNREC regulations. These regulations were designed to keep groundwater pollution below the federal Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs) for pollutant concentration, and thus to be protective of both human health and environmental quality.

Two wastewater management techniques that are considered viable options for the disposal of domestic wastewater in the study area and that discharge on or just below the ground surface include:

- Land application of wastewaters, primarily through spray irrigation and slow rate infiltration.
- On-site wastewater management systems, or "septic" systems.

Each of these wastewater treatment methods commonly discharge treated wastewater that carry potential contaminants that may migrate down to the aquifer. Nitrate is considered as the potential contaminant of greatest importance in the study area and serves as the basis for recommendations that influence planning decisions. Nitrate flows at approximately the same rate as natural groundwater and it seldom degrades once it is in the groundwater system. Other contaminants such as bacteria and metals resulting from wastewater disposal move far less rapidly.

A Maximum Contaminant Level (MCL) has been established under the Safe Drinking Water Act (SDWA). The MCL for nitrate is 10 mg/L. MCLs apply to drinking water in public systems as delivered at the point of consumption. The movement or transport of nitrate in groundwater is strongly influenced by the concentration of nitrate in the water supplied to the soil, the slope of the groundwater table, and other physical characteristics of the aquifer through which the groundwater flows. These physical characteristics include the permeability (transmissivity) of the aquifer. When nitrate from a treated wastewater source is added to the groundwater at a level greater than the ambient level, it generally migrates in a shape referred to as a "plume". The plume often occurs in the shape of an oval parallel to the direction of groundwater flow, with one end of the oval at the source of pollution. The size of a plume often grows larger with time, depending upon the characteristics of the pollutant and the aquifer. It is important in the design and construction of land-based wastewater disposal and reclamation systems to produce a final nitrate concentration that will not create a detrimental plume in the aquifer.

The intent of current DNREC regulations is to prevent pollutants in groundwater from reaching MCL values. In the case of land application of wastewater, the regulations require that the application system prevent wastewater with pollutant concentrations above MCLs from entering the water table. However, septic systems discharge water with pollutant concentrations significantly above MCL values to the aquifer and depend upon the effects of dilution from rainwater and natural groundwater flow, adsorption/desorption, ion exchange, and bacterial action to reduce concentrations below MCL values. In this study, a goal of preventing groundwater above MCL concentrations from migrating beyond a property boundary was used.

7.2.1 Existing Conditions

Across the study area a strategy has been in place for many years to prevent the spread of pollution above MCL values in groundwater by creating standards on the types of treatment and manner in which wastewater may be discharged. Limited information is available within the study area with which to judge the success of this strategy. Extensive information collected by the State of Delaware Department of Health, the Delaware Geological Survey, and the College of Agriculture at the University of Delaware indicated that very limited water quality data exist that could be used to relate a source of pollution to a concentration of that pollutant detected in groundwater in the study area. This is particularly true for water supply wells that supply a single home. These wells are common in the study area and sometimes draw water from the water table aquifer. In addition, many of the records obtained by the Delaware Department of Health reflect locations at which a groundwater quality problem was already known to exist, thus biasing any conclusions. In the case of larger capacity wells used to supply public water service, much more extensive information is available on water quality. However, in the study area all of the known public water supply wells are deep enough that they are within a confined aquifer and have a far lower risk of contamination (Woodruff, 1986; Spoljaric and Pickett, 1971; and Spoljaric and Woodruff, 1970). Little is known about ambient concentrations of nitrate in the unconfined aquifer. However, limited sampling suggests background concentrations of nitrate from 2 to 30 mg/L. The ambient concentration is thought to average approximately 3 mg/L (Delaware Geological Survey, personal communication).

A source of nitrate other than wastewater disposal that may contribute to this ambient quality includes nitrates in agricultural fertilizer. The general rate of application of fertilizers to row crops in New Castle County is presently approximately 120 pounds of nitrogen per acre per year (Ritter, personal communication) for corn and 30 to 60 pounds of nitrogen per acre per year for soybeans. This loading, due to no-till farming practices as well as double cropping, has persisted for the last 10 years. Prior to 1980, conventional agricultural practices contributed approximately 60 pounds of nitrogen per acre per year. Because of the predominance of land currently in agricultural use, as discussed in Subsection 2.6, agricultural fertilization represents a potentially substantial source of nitrate contribution.

Despite the small amount of data available from the study area on groundwater quality, many studies have been performed to evaluate the effectiveness of the types of waste disposal considered in this study, including land application of wastewater and septic system performance. These studies have been used to develop regulations to protect groundwater quality. Land application of wastewaters is now stringently regulated. Many studies have been performed that have accurately established the engineering controls required for the management of an effective land application system with small environmental risk. However, groundwater contamination resulting from septic systems is controlled primarily through the restriction of the minimum building lot size on which a septic system can be placed and by siting the system based on the soil characteristics of the site. This method of control is somewhat haphazard compared to the level of manageability associated with other disposal techniques, such as land application.

The following subsections discuss the potential impact on groundwater associated with the major wastewater treatment and reclamation methods suggested for the study area that dispose of treated water on or just below the ground surface.

7.2.2 Groundwater Quality and Land Application of Wastewater

Land application of wastewater through the use of spray irrigation and subsequent slow rate infiltration is considered the preferred method of wastewater renovation for certain parts of the study area because of significant advantages to be gained by the low level of operation and maintenance required, the high degree of control of water quality obtainable, and the beneficial reuse of water. These advantages were discussed in detail in Subsection 6.2 of this report. Siting and operations requirements for land application of wastewater are designed to prevent wastewater with concentrations of pollution above MCL values from entering the groundwater. Current DNREC regulations for the land application of wastewater require proper siting of spray fields based on soil characteristics of the irrigation site, groundwater monitoring, and the control of treated water pollutant concentrations. Concentrations above MCL values in the groundwater are prevented by stringent source concentration control, the natural dispersive effects of groundwater flow, and pollutant degradation within the soil zone (Freeze and Cherry, 1979). Thus, the land application of wastewater through spray irrigation and slow rate infiltration represents a high degree of control of the groundwater quality in the study area.

Land application requires site-specific engineering design based on soil characteristics. Well-designed systems have relatively few operational requirements and great flexibility. Lagoons are the treatment of choice because of their simplicity, but mechanical treatment plants can be utilized. Pumps and aerators must be cared for and uptake crops must be periodically harvested. Continual influent, effluent, and groundwater monitoring is needed. The costs for these operation and maintenance items must be borne by the users of the systems. This means that there are minimum-sized communities that can utilize such systems to be competitive with conventional wastewater treatment. To date, only two spray sites have been approved by New Castle County. Once operating, these sites will serve 126 and 282 housing units, respectively.

7.2.3 Groundwater Quality and Individual Septic Systems

The protection of groundwater resources is more difficult in areas where septic systems are used. This is because conventional septic systems produce effluent wastewaters with concentrations significantly above federal MCL values. Nitrate occurs in the range of 62 ± 21 mg/L (Bauman and Schafer, 1985) in the effluents from septic systems. Reduction of nitrate concentration in this effluent wastewater is generally assumed to occur in one of two ways: 1) dilution of the wastewater through percolating rainwater; and 2) nitrate destruction, or "denitrification." Because the capacity for soils to remove nitrate from the groundwater through denitrification varies from one soil type to another, it is often assumed to be negligible. In that case, dilution is the most important way in which concentrations of septic system pollutants may be reduced. Dilution of groundwater that has been polluted by septic system effluent normally occurs through mixing with fresh rainwater and with fresh groundwater flowing below the system. The degree of dilution necessary to bring septic system pollution below MCL limits is widely discussed in scientific literature. There have been two major types of studies that discuss the effects of septic systems on groundwater quality:

- Studies in which groundwater quality is directly measured through the collection and analysis of groundwater samples.
- Mathematical modeling studies in which the theoretical amounts of nitrate dilution and denitrification in groundwater are calculated or estimated.

As can be expected, studies of housing developments with individual septic systems indicate that the probability of groundwater pollution on a large scale or regional basis decreases as the spacing between water supply wells and septic systems increases. Studies by researchers such as Ford et al. (1980), Miller (1972), Walker et al. (1973a), and Woodward (1961) suggest that the risk of groundwater contamination is high when septic systems are used in developments with lot sizes of less than 0.5 acres. Conversely, the risk of groundwater contamination was reduced when septic systems were placed on lots of 1 acre or larger because the spacing between systems allowed greater dilution of the effluent in groundwater.

Investigations utilizing mathematical models to protect groundwater quality are widely used as a reliable planning tool for protecting regional groundwater resources. These investigations have generally reported more conservative results than did case study investigations. Investigators such as Geraghty and Miller (1978), Perkins (1984), Trela and Douglas (1978), Hordon and Nieswand (1978), Bauman and Schafer (1985), Kraeuter (1982), Andersen et al. (1977), and the New Mexico Environmental Improvement Division (1984) performed studies that used mathematical models to show that septic systems on lot sizes of less than 0.8 to 1.0 acres had a significantly higher risk of polluting groundwater with nitrates above the MCL. Most of these studies used a mathematical modeling technique known as "mass-balance" modeling. This simple method averages the concentration of a pollutant over the entire area of interest. The study by Kraeuter (1982) for New Castle County used mass-balance modeling techniques to generate septic system suitability data for the study area. Based on these data, Kraeuter (1982) recommended that septic systems be allowed on lots of no less than 2 acres. This recommendation was instrumental in establishing regulations for minimum lot sizes in Resource Protection Areas (RPAs) where septic tanks are employed. Similar types of analyses have been used in many other planning studies to arrive at a minimum building lot size that would allow sufficient dilution of septic system pollutants to prevent exceeding the MCL on a regional basis.

Mass-balance modeling techniques are important because an assumption that was used in the development of both the New Castle County and the previous DNREC regulations was that mass-balance modeling studies could serve as examples to determine an appropriate "density" (or spacing) of septic systems that would prevent groundwater from exceeding the MCL. The density of septic systems and the resulting determination of appropriate minimum building lot sizes have important implications for housing density in the unsewered parts of the study area. Septic system density may not be the same as minimum building lot size. It is possible that one septic system could serve two or more dwellings. To preserve open spaces, the County allows clustering of dwelling units provided that the resultant average density of combined dwelling and open space areas meets the minimum building lot size per unit. In clustered developments, the County may require the use of community septic systems (more than one dwelling per system) or the use of open spaces for drain fields. For this study, the term septic system density normally refers to a minimum lot size where individual septic systems are used.

Because of the averaging of concentrations that occurs when using mass-balance models, the concept of "isolation distance" (the separation between an on-site septic system and a receptor) cannot be specifically evaluated by mass-balance modeling. Currently, Delaware requires a minimum 100-ft isolation distance between a water supply well and sources of contamination. Although it is beyond the scope of this study to address the adequacy of a 100-ft isolation distance, concern has been raised relative to the cumulative impact on groundwater quality in a region that relies mainly on wells and septic systems. New Castle County has asked at what point does the density of the septic tanks (i.e., minimum lot size) exceed the dilution potential of the groundwater, and do concentrated plumes of contaminants merge downstream from major subdivisions. Isolation distance is particularly useful when considering the impact of septic systems on a water supply well located on the same property (as well as on adjacent properties). Isolation distances can be determined by other modeling techniques that more effectively model local groundwater conditions.

Analytical and numerical mathematical groundwater flow and transport models that calculate concentration versus distance from a source are more appropriate for determining the proper isolation distance. Analytical and numerical modeling techniques have been widely applied to solve very complex groundwater flow and transport simulations for conservative contaminants such as nitrate (Bauman and Schafer, 1985; and Andersen et al., 1988). Depending upon the model used, important factors such as soil and aquifer properties may be simulated. Many widely accepted analytical and numerical models have been reported in scientific literature and applied at many sites. In addition, many of these techniques are routinely accepted by regulatory agencies such as the United States Environmental Protection Agency (U.S. EPA) and the Water Supply Branch of the United States Geological Survey (USGS).

The application of one of the widely accepted analytical or numerical modeling techniques would provide a more accurate basis for evaluating the impact of septic systems on groundwater quality in the study area. However, because the implementation of one of these models is beyond the scope of this study, it is recommended that the County proceed in establishing this type of model in the future. In addition, the data required to implement this modeling approach are presently not available and would need to be collected.

The majority of available information and conclusions with respect to the impact of septic tanks on groundwater quality appear to be based upon the performance and effluent quality achievable by conventional septic tank systems. Typical septic effluent may contain as much as 80 mg/L of nitrogen as well as high concentrations of organics. In recent years, advanced on-site treatment and disposal systems have been developed that offer the potential of improved performance and, therefore, reduced discharge of undesirable constituents to the ground. In some cases, some degree of denitrification may even be possible, reducing the potential nitrate loading in the discharge. It should be apparent that the use of these systems, assuming adequate controls on their installation and operation, may allow a higher level of on-site system development (and/or smaller lot sizes), while maintaining levels of groundwater protection comparable to conventional systems.

7.2.4 Minimum Lot Size Determination

At the County's request, an initial assessment was made using existing data for the area south of the C&D Canal to determine if the present minimum lot size was protective of long-term groundwater quality. Several models were evaluated to determine their data requirements and appropriateness for providing this type of evaluation on the distribution of a conservative pollutant such as nitrate. The results of this review are found in Appendix C.

Previous evaluations of minimum lot size in the study area, conducted by Kraeuter, made use of a mass-balance modeling technique. As previously mentioned, this technique neglects to account for the natural plume that usually forms downgradient of a septic system. For purposes of comparison, two of the previously reviewed mass-balance modeling techniques were applied to study area conditions. The models used by Kraeuter (1982) and Geraghty and Miller (1989) were used to provide a basis for comparative evaluation of model results and model sensitivity to input parameters. The Kraeuter (1982) model was chosen because it was previously used as guidance to establish the 2-acre minimum lot size standard now in effect for unsewered parts of the study area overlying resource protection areas (RPAs), and with on-site water supply. Both models were applied using more stringent "failure-rate" criteria than the 1 in 4 criteria used by Kraeuter (1982). In this failure-rate assumption, the frequency of septic system nitrate level exceedance of MCL values was chosen as once in

20 years (the 5th percentile rainfall year for dilution models). This failure-rate criteria was equivalent to failure once during the average 20-year lifetime of a septic system.

The method of Kraeuter (1982) was applied to determine a more conservative interim minimum lot size requirement by extrapolation of the recharge values used in the original Kraeuter (1982) study. Assumptions by Kraeuter (1982) regarding wastewater quantity and quality, recharge water nitrate concentration, and on-site well pumpage were maintained. The equation resulting from these assumptions was:

$$A = \frac{584000}{Q_r} \qquad \textit{Equation (1)}$$

where:	A	=	Building lot area (acres)
	Q_r	=	Quantity of recharge water as determined by WATBUG in gallons per acre per year (gal/acre/year)
	Note:		Q_r (millimeters per year) x 1,069 = Q_r (gal/acre/year)

Kraeuter (1982) then used the computer algorithm WATBUG to calculate the volume of recharge water (Q_r) across a building lot using information such as: 1) four different soils groups; 2) three different rainfall year percentiles; and 3) "discount" factor for impervious surface area on a building lot. A matrix of minimum lot size for rainfall percentile versus soils groups was then developed and used to support a recommendation of 2 acres as an appropriate minimum lot size for the study area.

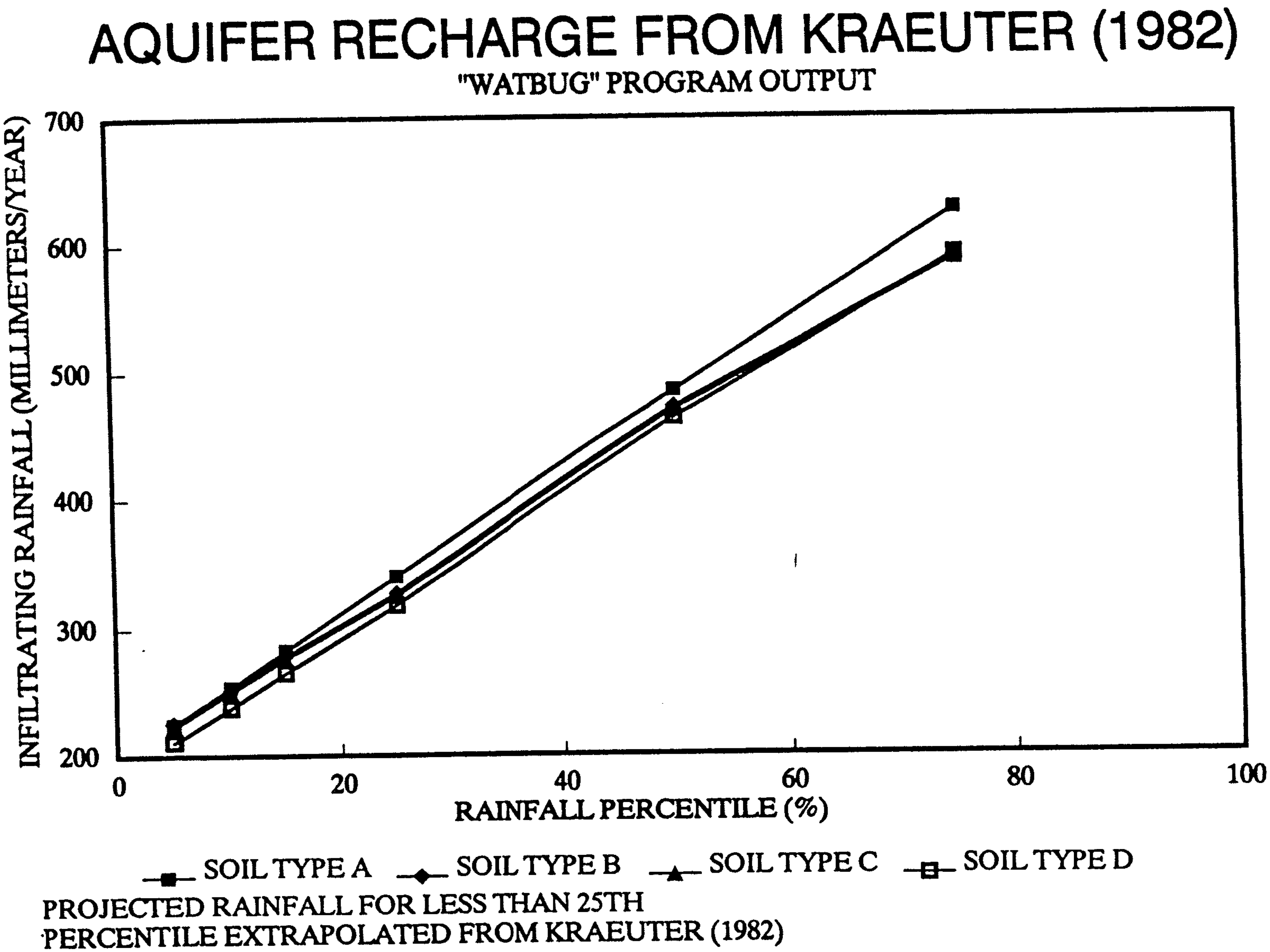
In this study, the WATBUG output recharge values in millimeters per year (mm/yr) shown in Table 7-1 (Kraeuter, 1982) were extrapolated using linear regression to the 5th, 10th, and 15th percentile rainfall years for the four soils groups. The 5th percentile rainfall year is equivalent to a 1 in 20 incidence of exceedance of the MCL for nitrate. A constant discount value of 15% for impervious lot surface was maintained for each of these rainfall percentile years. Table 7-1 and Figure 7-1 show the results of this extrapolation of the WATBUG

Table 7-1

Kraeuter (1982) WATBUG Program Output Extrapolated Rainfall Infiltration Rates in Millimeters per Year

Soils Group	Rainfall Year		
	5%	10%	15%
A	226	254	283
B	226	253	279
C	224	251	277
D	211	239	266

FIGURE 7-1


AQUIFER RECHARGE FROM KRAEUTER (1982)
"WATBUG" PROGRAM OUTPUT
INFILTRATING RAINFALL (MILLIMETERS/YEAR)
700
600
500
400
300
200
0
20
40
60
80
100
RAINFALL PERCENTILE (%)
SOIL TYPE A
SOIL TYPE B
SOIL TYPE C
SOIL TYPE D
PROJECTED RAINFALL FOR LESS THAN 25TH
PERCENTILE EXTRAPOLATED FROM KRAEUTER (1982)

program results, while Table 7-2 shows the minimum lot size calculated from the extrapolated recharge values using Equation 1. As was previously discussed, this mass-balance modeling technique averages nitrate concentration across the entire building lot.

The distribution of recharge versus rainfall percentile shown in Figure 7-1 shows a dominantly linear trend for the 25th, 50th, and 75th percentile rainfall years. This observation suggests that the extrapolation of WATBUG results to the 5th, 10th, and 15th percentile years was able to accurately predict aquifer recharge.

The minimum lot sizes calculated for the 5th, 10th, and 15th percentile rainfall year recharge values (Table 7-2) demonstrate that the most conservative minimum lot size requirement was 3.0 acres. This lot size was calculated for the 5th percentile rainfall year and the poorest soil type (soils group D). Using the mass-balance model assumptions of Kraeuter (1982), this lot size would be protective of groundwater quality and federal MCL on a mass-balance basis for 19 of 20 years of operation. Because a 20-year lifetime for an on-site septic system is normally considered acceptable, a failure rate of 1 year during the lifetime of the system was chosen as an acceptable risk for the protection of groundwater quality.

The results of this analysis may be compared with those from application of the Geraghty and Miller (1989) model using input data that matched as closely as possible the input parameters for analysis previously discussed. It should be noted that the model developed by Geraghty and Miller (1989) allowed a much more detailed analysis of influent and effluent water quality and water volume than did the model employed by Kraeuter (1982).

A number of iterations of the Geraghty and Miller model were run, increasing the total land area from 1 acre, until a lot size was reached where the nitrate concentration just equalled the MCL. As shown in Table 7-3, the results of applying the Geraghty and Miller (1989) mass-balance model using input very similar to that used in the re-analysis of the data used in Kraeuter (1982) indicated that a minimum building lot size of 3.0 acres per home was

Table 7-2

Minimum Required Lot Sizes (Acres)

Soils Group	Rainfall Year		
	5%	10%	15%
A	2.8	2.5	2.3
B	2.8	2.5	2.3
C	2.9	2.6	2.3
D	3.0	2.7	2.4

Table 7-3

Geraghty and Miller (1989)
Mass-Balance Model Output

Input:	
Allowable nitrogen concentration	10 mg/L
Fertilized land area	41,460 ft^2
Weight of nitrogen in fertilizer	0.5 lb/1,000 ft^2/yr
Nitrogen leached from turf	50%
Total land area	43,560 ft^2
Natural land area	0 ft^2
Impervious land area	2,100 ft^2
Annual precipitation	26.1 in/yr (5% rainfall year)
Daily water use per person	75 gpcd
Nitrogen concentration in household water	1 mg/L
Annual nitrogen input per person	9 lb/yr
Nitrogen loss in septic tank	10%
Nitrogen loss in soils	0%
Natural recharge	8.7 in/yr (5% rainfall year)
Number of persons per home	2.8 persons/home
Output:	
Based on the program assumption and inputs, the optimum density of homes at this site is 3.0 acres per house.	

appropriate. This value assumed a failure rate criteria of 1 in 20 (5th percentile rainfall year).

It is important to note that significant contributions of nitrate in the groundwater may result from ordinary lawn fertilization under drought conditions. In the analysis shown in Table 7-3, the contribution of nitrogen leached from turf fertilization was a significant fraction of the nitrate contributed by the domestic septic system. This source of nitrate is generally not recognized, but could be a source of nitrate pollution in clustered developments.

The results of these two mass-balance models estimate that an interim minimum lot size of approximately 3 acres would be acceptable until further study can be completed. As previously discussed, mass-balance models are not indicative of actual groundwater conditions, and regulations based on this approach should only be used where insufficient data are available to incorporate actual groundwater flow conditions. It is recommended that New Castle County collect baseline data regarding water quality in southern New Castle County and perform a more accurate quantitative model analysis to allow an improved understanding of potential disposal requirements to ensure protection of this vital resource. Until this study is completed, the County should pursue a conservative approach to groundwater management. The risks to the County's water supply, as well as the high cost of mitigating regionwide septic tank failures, warrant this type of approach until additional data collection and modeling are completed.

7.2.5 <u>Recommendations for Land Application Systems</u>

Available studies and data suggest that existing regulations provide stringent engineering controls for the design and implementation of land application systems and provide sufficient protection to preserve groundwater quality in the study area. The additional benefit of recharge to the aquifer will be provided through the land application process. Through proper engineering design of the land application system, the low concentration of contaminants in effluent wastewater provides adequate assurances for groundwater protection.

7.2.6 Recommendations for Septic Systems

Because of the lack of consistent, comprehensive information on existing groundwater quality in the project area, the level of risk associated with septic systems could not be sufficiently determined. Information was also unavailable to evaluate the performance and impact of the existing systems already installed in the project area.

Considerable concern was raised over the development of "plumes" of pollutants that may occur as a result of cumulative impacts associated with many septic systems in a region. Current regulations, based on averaging of pollutants over a building lot, do not account for migration of groundwater with pollutants above MCL values beyond the boundary of the lot. Consideration should be given to determining the downgradient impacts of septic system discharge from proposed developments prior to approval.

The possibility is high for the failure of these systems, mainly because these systems are seldom or never monitored. In addition, if soil conditions are poor or if the systems have been designed or installed incorrectly, the cost of maintaining these systems will be excessive. Eventually, another treatment system will need to be installed.

New Castle County is currently undertaking the task of remediating various on-site systems throughout the County. Over the past 10 years, New Castle County has completed 25 separate capital projects involving the replacement of failing on-site systems with dry sewers. These projects have involved approximately 500 homes at an estimated cost of 5 million dollars (Source: New Castle County Department of Public Works).

The County should also consider the potential advantages of alternate on-site treatment systems for areas where development may continue beyond areas served by public collection systems. Examples of alternate on-site systems that the County may want to consider are as follows:

- Shallow placement systems.
- Elevated mound systems.

- Sand filter systems.
- Denitrification and disinfection systems.

These advanced on-site systems offer the potential for a greater degree of groundwater quality protection (and/or the potential for a higher level of development with current groundwater quality protection criteria) by virtue of their improved pollutant removal performance. At the same time, it should be recognized that such systems would likely require a higher level of investment on the part of the property owner. Finally, it must be noted that the need would remain for conscientious County and state management and oversight with respect to installation, operation, and maintenance of such systems, particularly in light of what may be increased operational demands on the property owner.

Lastly, and most importantly, there is clearly an urgent need for the collection of baseline groundwater quality data in the unconfined area and the conduct of a definitive modeling study on the impact of septic systems before the project area is more intensely developed in areas where public sewer service will not be available. The costs to the County and the risks associated with coming in at a later date to correct septic system failure can be considerable. In general, it was felt that septic tanks give a low level of groundwater protection.

7.3 EVALUATION OF SUITABILITY FOR LAND DISPOSAL

For determination of the suitability of an area for on-site waste management (septic) systems or land application of treated wastewater, an on-site inspection and site-specific evaluation is required. However, for areawide wastewater management planning purposes, a more general approach must be used to estimate the location and extent of areas suitable or unsuitable for the wastewater management alternatives being evaluated. A general approach makes it possible to suggest where alternative waste disposal systems would be more appropriate on an areawide basis.

The general approach used in this evaluation was to build a model of the project area on a Geographic Information System (GIS) that includes information coverages of physical characteristics critical to the site selection and performance of the alternatives being evaluated. The model was prepared to show the locations of wetlands, surface water bodies, RPAs, and public water supply wellheads; depth to groundwater; and soil classifications. The first step of the evaluation included developing a composite soils series capability/suitability map for the area based upon Soil Conservation Service (SCS) soil classifications for each soil type and ranking its corresponding severity of limitations for wastewater disposal. This was done for both on-site septic systems and land application. This step builds upon previous evaluations of soils in New Castle County for capacity mapping completed in conjunction with the Areawide Waste Treatment Program (Svatos and Goehring, 1977).

The second step of the evaluation was to screen areas related to water resources that would be unacceptable for these alternatives because of severe limitations and their potential to contribute to water pollution problems. For example, areas subject to periodic flooding pose a major limitation because flood waters may lift and transport effluent/raw sewage from the site of the system.

Lastly, the composite soils series capability map was overlain with the second map on water resources, producing a third map showing general areas where on-site septic systems (or for the second run, land application) might be appropriate on an areawide basis.

7.3.1 Evaluation Criteria

The criteria selected for the evaluation of the environmental suitability of southern New Castle County for various types of wastewater disposal were developed from a careful review of regulatory standards. Existing GIS databases were selected that could be used to determine land suitability given each physical requirement stated in the regulatory standards. The regulatory standards used to establish suitability criteria were from pertinent New Castle County and the State of Delaware regulations.

Regulatory standards were reviewed for two wastewater management alternatives. The first review was for standards that relate to the suitability of land for private, domestic septic system placement. The second review was to identify standards that relate to the disposal of wastewater by various land application methods. In the second review, it was assumed that the most feasible method of waste disposal would be land application followed by slow rate infiltration of wastewater (see discussion on land application methodologies, Section 6).

Two classes of environmental criteria were common to the regulatory standards for both of these wastewater disposal methods. For purposes of the GIS evaluation, these classes of criteria were divided into soils-related criteria and water-related criteria. The first major class of criteria was related to soil characteristics. Published soil characteristics of the New Castle County soil series from the United States Soil Conservation Service (SCS) mapping of New Castle County and mapped soil series contained in the County's GIS format computer database developed in 1977 were used to screen the study area for suitability for both on-site system and land treatment of wastewaters.

The water-related criteria described in the regulatory standards were:

- Depth to groundwater.
- Proximity to wetlands.
- Proximity to surface water bodies.
- Proximity to groundwater pumping wellheads.
- Proximity to Resource Protection Areas (RPAs).

Each of these criteria was available as a computer database in GIS format for the study area.

7.3.2 Composite Soils Series Capability Mapping

7.3.2.1 On-Site Septic Systems

As defined by the SCS, soil suitability for the application of septic tank effluent is determined by the following soil characteristics:

- Slope.
- Drainage class.
- Permeability.
- Depth to restrictive soil horizons.

Based on these characteristics, the SCS has classified the soil series as having slight, moderate, and severe limitations for on-site septic system use. For example, permeability refers to the soil's ability to perform its function of filtering wastes. Because soil varies with depth, the suitability of a soil for septic systems is determined by the permeability of the least permeable layer. Slopes limit septic systems because of the need to control lateral effluent flow. For each soil series reported by the SCS to exist in the study area, SCS descriptions were used to assign numerical scores to these characteristics. A composite suitability score from 0 to 3 was then assigned to each soil series. For some soil, an exclusionary score (0) was assigned because one soil characteristic was so severely limiting that it outweighed all of the others. For example, an exclusionary score (0) was assigned to hydric soil. An arithmetic mean of the characteristics score was used as the composite suitability score for all soils not assigned an exclusionary score.

These composite scores were then compared to mapped soil series in the study area. Each soil series in the study area was assigned a score using this method. Appendix A lists these characteristics and composite scores. After this composite score was color-coded on the GIS, the resulting map was used to evaluate areas with soils characteristics suitable for on-site septic system placement. Figure 7-2 shows the results of composite soil series suitability for septic system placement.

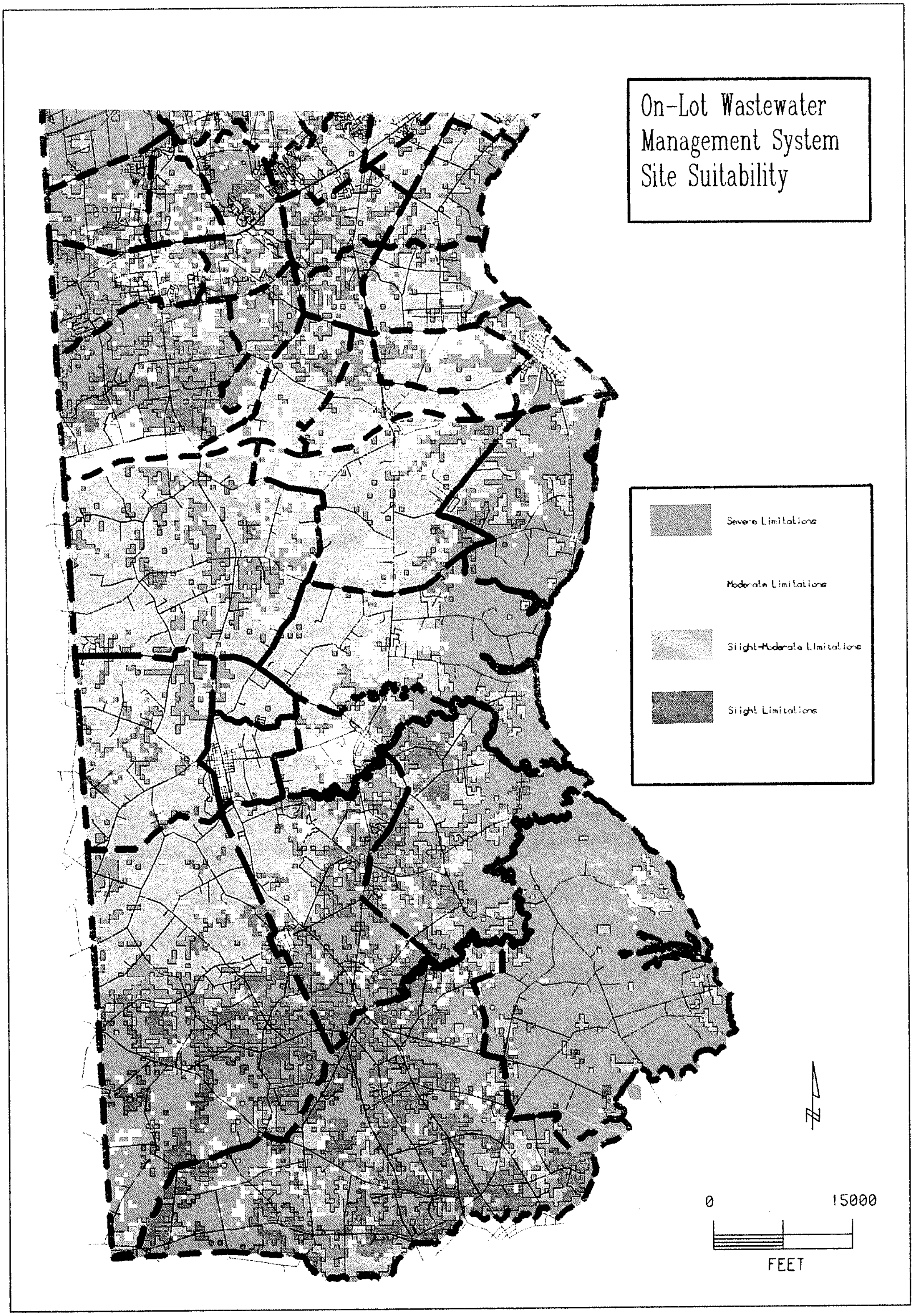


FIGURE 7-2 SOIL SERIES SUITABILITY FOR SEPTIC SYSTEM PLACEMENT

7.3.2.2 Land Application Systems

A review of New Castle County and State of Delaware regulations for land application of wastewater indicated that the following soil characteristics affected soil suitability for land application of wastewaters:

- Slope.
- Drainage.
- Permeability.
- Restrictive horizons.
- Soil texture.

Each of these soil characteristics was evaluated and assigned a numerical score based on the descriptions of soil series in the SCS Study of New Castle County (SCS, 1970). Based on the score assigned to each soil characteristic, composite scores from 0 to 3 for land application suitability were assigned to each soil series in the study area using the method described for on-site septic system composite score assignment. Both individual characteristic and composite numerical scores for each soil series are given in Appendix A. Examples of soil characteristics that resulted in an exclusionary score of (0) included:

- Wetlands.
- Hydric soils.
- Gravel sets and clay sets.

The composite score for each soil series' suitability for land application of wastewater was color-coded on the GIS. Figure 7-3 shows the results of composite soil series suitability for land application of wastewaters. This map was used to evaluate overall suitability for land application of wastewater when combined with additional groundwater-related criteria.

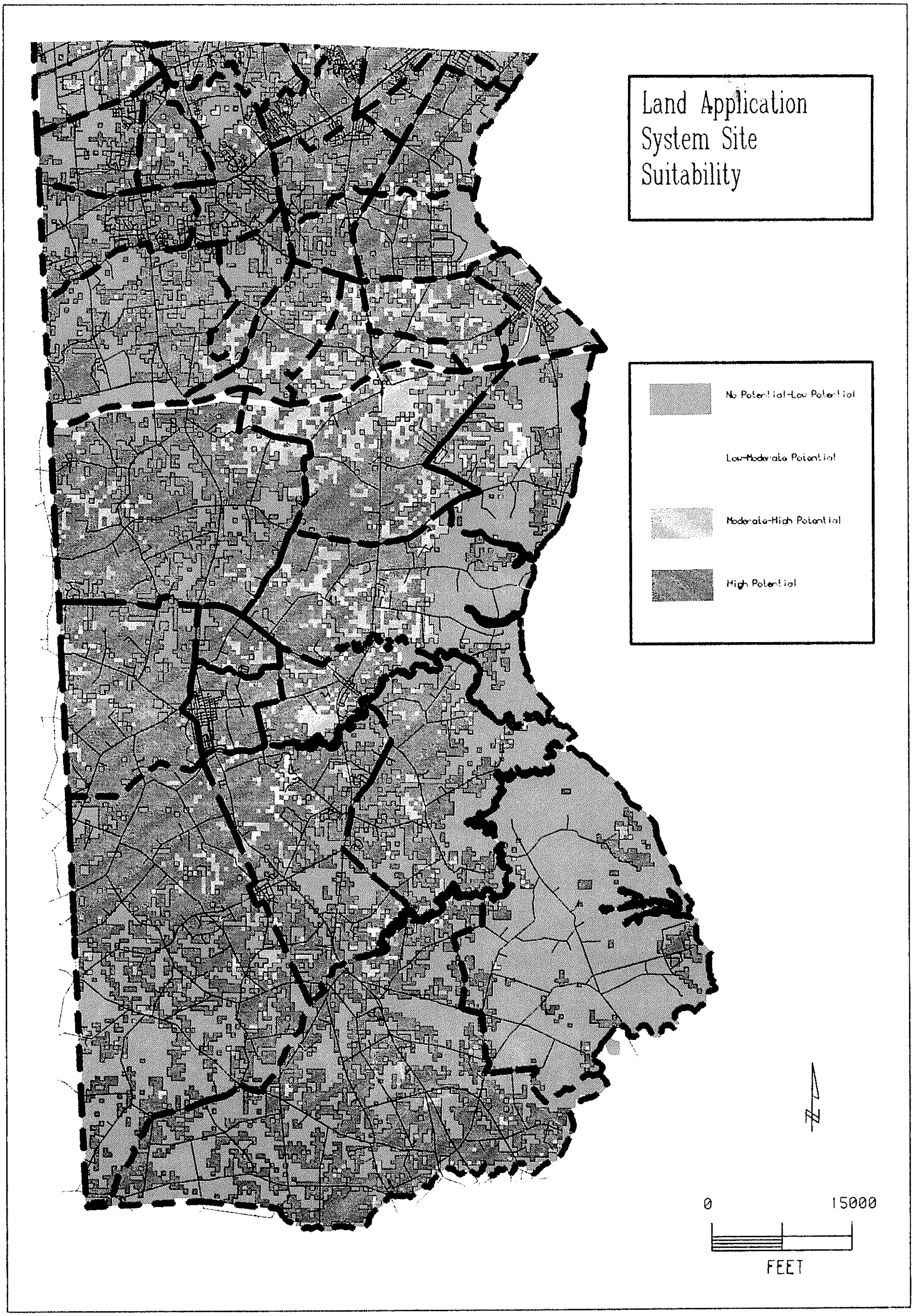


FIGURE 7-3 SOIL SERIES SUITABILITY FOR LAND APPLICATION OF WASTEWATER

7.3.3 Water Resource Map

The criteria used to screen water-related conditions for suitability for wastewater disposal were evaluated in a different manner than soil-related criteria. Each water-related criterion was considered exclusionary because of the sensitivity of water as a resource.

The criteria that were used to evaluate both septic system and land treatment methods of waste disposal were as follows:

- The depth to groundwater database developed by the Delaware Geological Survey. Areas within which the database indicated that the depth to groundwater was less than 5 ft were excluded from consideration for either septic system or land treatment methods.
- Wetlands as shown on the National Wetlands Inventory (NWI) GIS database were excluded because they were probably indicative of perched water table conditions, impermeable soils, or land at or below the perennial water table. Because of possible map inaccuracies and seasonal variations in wetland sites, areas within 100 ft of a wetland were also excluded from consideration for either disposal method.
- Perennial streams and their associated floodplains were also excluded from consideration. In addition, all areas within 100 ft of a stream or floodplain were excluded because of the uncertainties surrounding both the mapping of the stream/floodplain location and the effects of water table elevation changes that influence the boundaries of wetlands associated with streams and their floodplains.

In addition to these databases, two additional sources of information were used solely to evaluate land treatment alternatives:

- Areas within 2,500 ft of a public or commercial well (Wellhead Resource Protection Areas) were highlighted for special consideration because of sensitivities for land application methods.
- Groundwater Recharge RPAs were highlighted on the final composite suitability maps as areas where both possible advantages and disadvantages exist for land application methods of wastewater disposal.

The exclusionary nature of the hydric soils criteria developed from the soils evaluation contributed to the evaluation of groundwater suitability. By excluding this groundwater-related criteria, the remaining areas were considered likely to fulfill most groundwater-related regulatory requirements for either septic system suitability or land application suitability. Figure 7-4 shows a mapped composite of areas excluded by the water resource criteria.

7.3.4 <u>Final Suitability Maps</u>

As previously discussed, a general approach has been taken to suggest where alternative waste disposal systems would be appropriate on an areawide basis. In this last step, suitability maps were developed for on-site septic systems and land application systems. The suitability maps were developed by overlaying the water resource maps with the composite soil capacity maps to identify areas where wastewater disposal can occur. Within the areas able to be developed, subareas have been ranked high, medium, and low for their potential to support the waste management alternatives being evaluated.

7.3.4.1 Septic System Suitability

Figure 7-5 shows the composite suitability for septic system placement after the exclusion of areas with unsuitable water-related characteristics along with the ranking of the remaining areas for soils suitability for septic systems. Clearly, large areas of southern and eastern New Castle County appear to be unsuitable for private below ground septic system placement based upon the general physical characteristics of the area. These areas would require some alternative method of private waste disposal if they were to be more heavily developed without a regional waste disposal facility available. However, large areas of central, western, and northwestern New Castle County appear to be generally suitable for septic systems. A breakdown of soil suitability for on-site systems for the portion of the study area south of the canal is shown below:

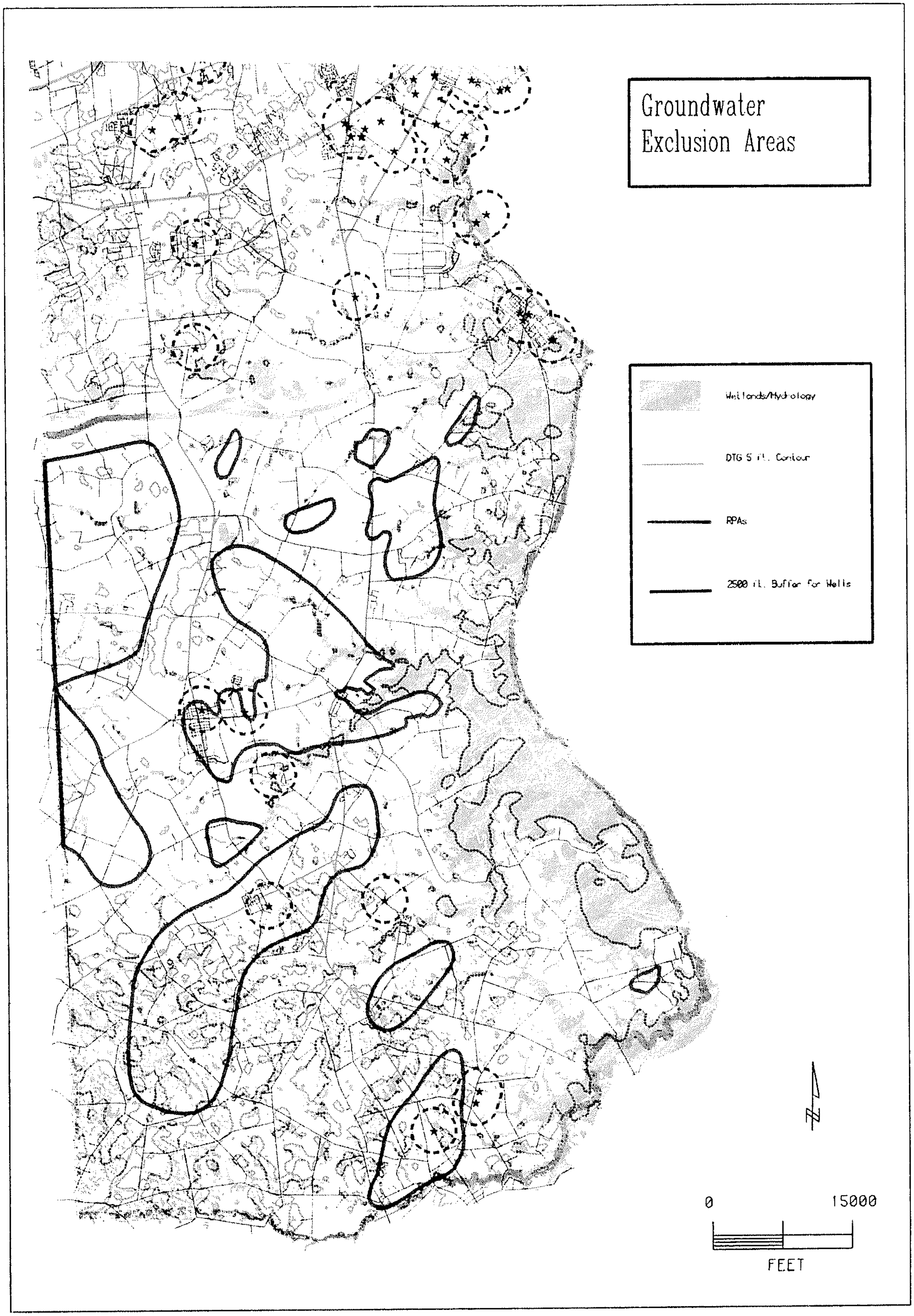


FIGURE 7-4 WATER RESOURCE EXCLUSION AREAS

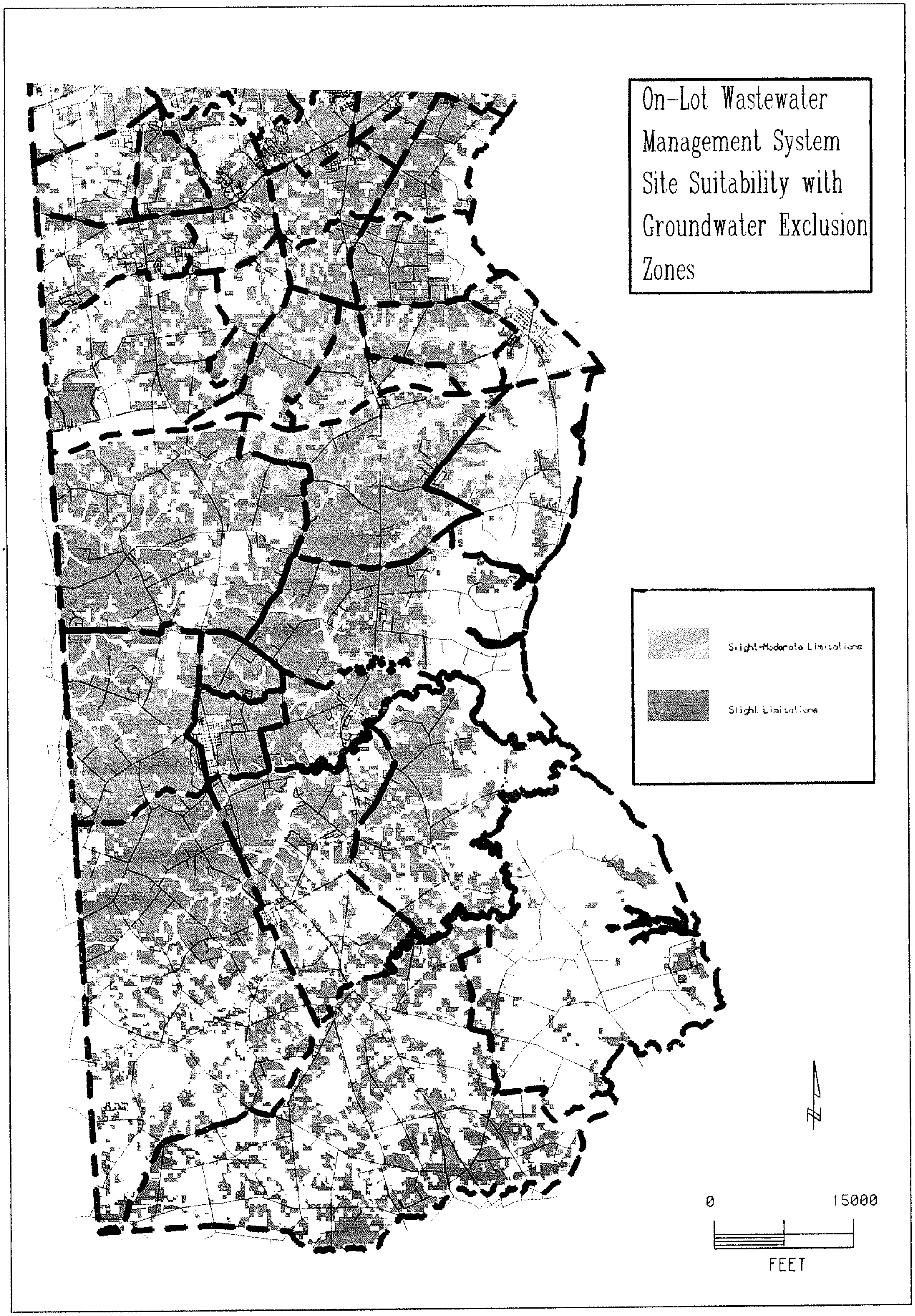


FIGURE 7-5 COMPOSITE SUITABILITY FOR SEPTIC SYSTEM PLACEMENT

Limitations	Acreage	Percentage
Severe	52,228	43.25
Moderate	8,916	7.38
Slight to Moderate	41,895	34.70
Slight	16,850	13.95
No Rating	863	0.71

7.3.4.2 Land Application Suitability

Figure 7-6 shows the composite physical suitability for land application of wastewater following the exclusion of areas with unsuitable water resource characteristics, along with the ranking of soils types within the study area. As in Figure 7-5, large areas in the southern and eastern portions of the study area appear to be generally unsuitable for land application of wastewaters without additional engineering controls to provide adequate resource protection. However, the central, western, and northwestern portions of New Castle County appear to contain large areas with suitable physical characteristics for land application of wastewater. A breakdown of soil suitability for land application for portions south of the Canal is shown below:

Potential	Acreage	Percentage
Low	53,902	44.64
Moderate	475	0.39
Moderate to High	9,873	8.18
High	56,503	46.79

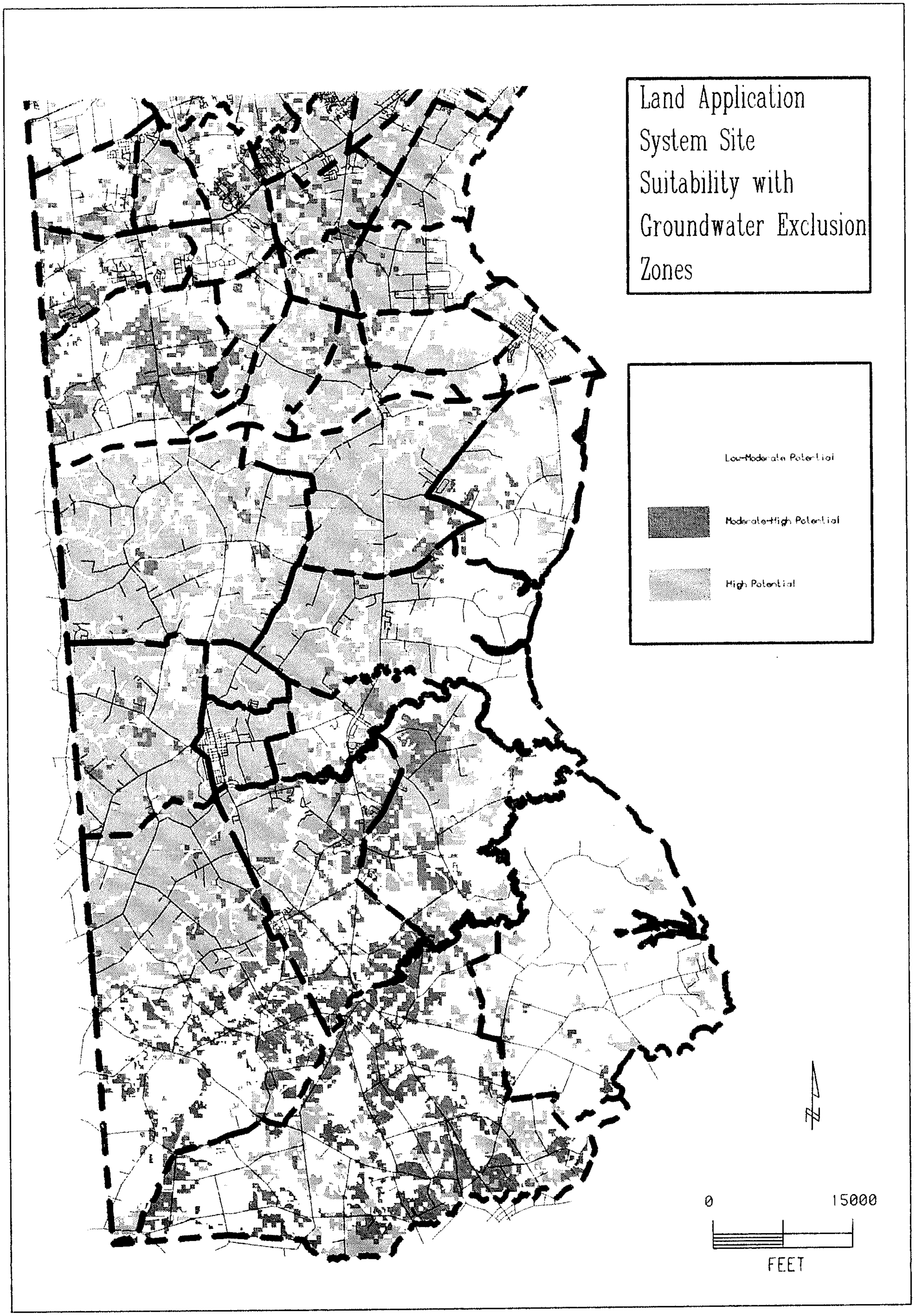


FIGURE 7-6 COMPOSITE SUITABILITY FOR LAND APPLICATION OF WASTEWATER

SECTION 8

DEVELOPMENT OF WASTEWATER MANAGEMENT SCENARIOS

8.1 INTRODUCTION

Effective wastewater management planning should seek to satisfy various community goals, including but not limited to, performance, reliability, cost-effectiveness, the protection of human health and the protection of environmental resources. Each of these goals is, in itself, a desirable result of the planning and implementation process. To some extent, however, these goals may be, or appear to be, in conflict. Therefore, the final plan must seek the best possible compromise among these goals by examining various alternatives to meet projected needs.

In many cases, the range of feasible alternatives for meeting projected needs is framed by existing patterns of development and infrastructure. However, in the case of the southern New Castle County planning area, the historically rural development pattern does not define the configuration that the area may assume under continued development pressure in the future. While to some extent this lack of apparent definition may be considered a liability, it can also be viewed as an opportunity to use proactive growth management to foster specific sets of community goals. Infrastructure components, and most pertinently, wastewater management services, are one of the goals that could be addressed by growth management polices.

This section will present a series of wastewater management scenarios that are offered as different approaches to wastewater management in the southern New Castle County area. The key issues to be addressed in the plan are:

- To what extent have current wastewater management practices impacted the study area's surface water and groundwater quality?
- What is the projected demand for land development in the study area over the next 20 years?

- What types of wastewater management systems can be effectively utilized in the study area to meet this demand?

- Whether the study area can rely on on-site systems for long-term waste management?

- How wastewater systems in the study area will be managed?

- What associated land use development controls and water quality protection strategies need to be developed consistent with the wastewater management plan?

The objectives of this plan are to identify the types of wastewater systems that should be applied in the study area to achieve the wastewater management goals of New Castle County. Inherent in this plan is the need to integrate land use development decisions and water resource protection goals with reliable and cost-effective wastewater management systems.

In an effort to establish a strategic direction toward wastewater management decisions in the study area, three management scenarios have been defined. They are described later in this section.

8.2 WASTEWATER MANAGEMENT PLAN DEVELOPMENT ISSUES

An examination of how neighboring states and counties are coping with balancing development pressures and environmental objectives shows an increasing awareness for the need to effectively manage the provision of wastewater management services. Researchers for the Chesapeake Bay Program, for example, are identifying changes in the biological communities of the Chesapeake Bay, including dramatic declines in major fisheries, which may be related to the intensity of human activities throughout the Chesapeake Basin. Several human activities, in particular human population growth, urban development, changing agricultural practices, and the types of wastewater systems that support such human activities, have increased the quantity of nutrients and toxic substances entering the Chesapeake Bay. These activities have reduced the extent and productivity of certain aquatic and terrestrial habitats.

With the deterioration of the Chesapeake Bay as a strong potential, the federal government and states in the Chesapeake Region have developed restoration programs. The State of Maryland has enacted regional guidelines for fish, wildlife, and plant habitats, and restrictions on rates and locations of new land development. These programs are part of a coordinated regional effort to adopt pollution prevention strategies; that is, establishing programs and regulations that stop pollution at its source before unacceptable wastes are produced. Protecting water quality through proper wastewater management is one of the pollution prevention strategies that is being developed.

In light of these trends, it should be recognized that the purpose of the southern New Castle County's wastewater management plan is to prepare a long-term wastewater management strategy that is based upon the area's geology, soil characteristics, water conditions, topography, and existing and projected wastewater generation. As such, the plan must be based upon the environmental constraints of the area and be designed to protect the area's surface and groundwater resources from improper or inadequate wastewater management practices.

As the County proceeds to formulate a wastewater management strategy for southern New Castle County, it is critical to understand the environmental and economic implications of the existing land development and wastewater management activities in the study area. The current pattern of activities can best be described as a proliferation of subdivisions utilizing septic systems on lots of less than 1 acre. An emerging trend is proposed subdivisions with independently owned and operated land application systems. The environmental and economical consequences of this pattern can be described as follows:

- The cumulative impact of septic systems (on small lots) may have damaging impacts on groundwater quality.
- Failing septic systems are expensive to replace, as evidenced in other portions of New Castle County in recent years.
- Should the County have to exercise trusteeship, independently owned and operated land application systems could be inefficient for the County to

manage, and can become costly to operate in the long-term if mechanical or structural problems emerge.

However, the economic and environmental risks associated with these current trends are difficult to quantify and measure. As seen in the Chesapeake Region, a pollution prevention strategy is emerging as the method for ensuring future environmental quality. Therefore, the basis of a pollution prevention strategy for this study area is to address the critical question, "What problems might emerge with the continued use of septic systems in the study area, and what can be done to ensure that the future use of septic systems (and other forms of wastewater management systems) can help to prevent costly and damaging pollution problems from occurring?"

8.3 APPROACH TO WASTEWATER MANAGEMENT SCENARIOS

As previously mentioned, three potential wastewater management scenarios have been defined for the study area. The scenarios are essentially "pictures" or "snapshots" of how the study area may look under different land development strategies. In each case, the scenarios deal with the conflicting goals of providing water quality protection while allowing for continued economic and population growth in different ways. The scenarios are:

- Current Planning - Presents a future development pattern that would most likely occur if existing trends continue (Scenario 1).
- Expand Existing Wastewater Service Areas - Concentrate new high-density development around existing wastewater management infrastructure (Scenario 2).
- Provide New Wastewater Service Areas - Expand wastewater infrastructure by providing new public services to outlying areas via new Public Service Zones (PSZs) (Scenario 3).

The evaluation of each of these scenarios should consider the following issues:

- Which pattern of land use development is preferred for the study area.

- How much of the projected future development should be allowed to take place using septic systems.

- Whether the provision of wastewater systems should be used to help shape a desired future development pattern.

- Whether the County should adopt a pollution prevention strategy for southern New Castle County if it means directing growth to PSZs and adopting larger lot size restrictions for the continued use of septic systems.

- How important other land use management objectives, such as open space or agricultural protection, may be within the context of this wastewater management plan.

This study will evaluate the technical and economic aspects of these options from the standpoint of wastewater management. However, it must be recognized that the issues noted above, and therefore the choice among growth management strategies, involve a broad range of societal decisions with respect to the future structure of the community. As such, the choice among these options cannot, and should not, be made solely upon the results of the wastewater management analyses.

The following subsections provide additional detail on each scenario. Sections 9 and 10 are directed toward the identification and evaluation of alternative management technologies that could be used within each scenario. For example, both land application systems and centralized treatment systems can be applied to provide new wastewater systems infrastructure to developing areas.

8.4 SCENARIO 1 - CURRENT WASTEWATER MANAGEMENT PLANNING

8.4.1 Description

Under Scenario 1, current development trends continue during the next 20 years. New facilities are constructed in the Middletown, Odessa, and Townsend (M-O-T) area to expand to 1.5 mgd (subject to NPDES permit issuance) to serve the towns of Middletown, Odessa, and Townsend, with minimal extended service outside their municipal boundaries. Development outside the M-O-T area (and other smaller sewer service areas) will be supported by on-site systems at prevailing densities and by privately owned and operated small community (e.g., spray irrigation) systems. The Boyd's Corner and Summit areas are expected to be the locations for continued scattered subdivision development. This scenario is illustrated in Figure 8-1.

8.4.2 Issues

The following issues are associated with this scenario:

- The use of on-site systems in this fragile environment raises concerns about the ability of area resource managers to protect water quality. At issue is the threat of the cumulative use of septic systems at prevailing residential densities. As discussed in Section 7, however, the degree of risk associated with the continued use of on-site systems is currently difficult to quantify.

- The potential for scattered independently owned and operated small community systems presents a management problem and potential water quality/health impacts arising from improperly operated systems. Scattered independently owned and operated systems are not an effective means for providing public sewer services. New Castle County will be principally responsible for the long-term operation of these systems.

- Should existing or future wastewater systems (outside the current public service areas) fail, then expensive replacement systems would be needed sometime in the future by the County.

8.4.3 Advantages

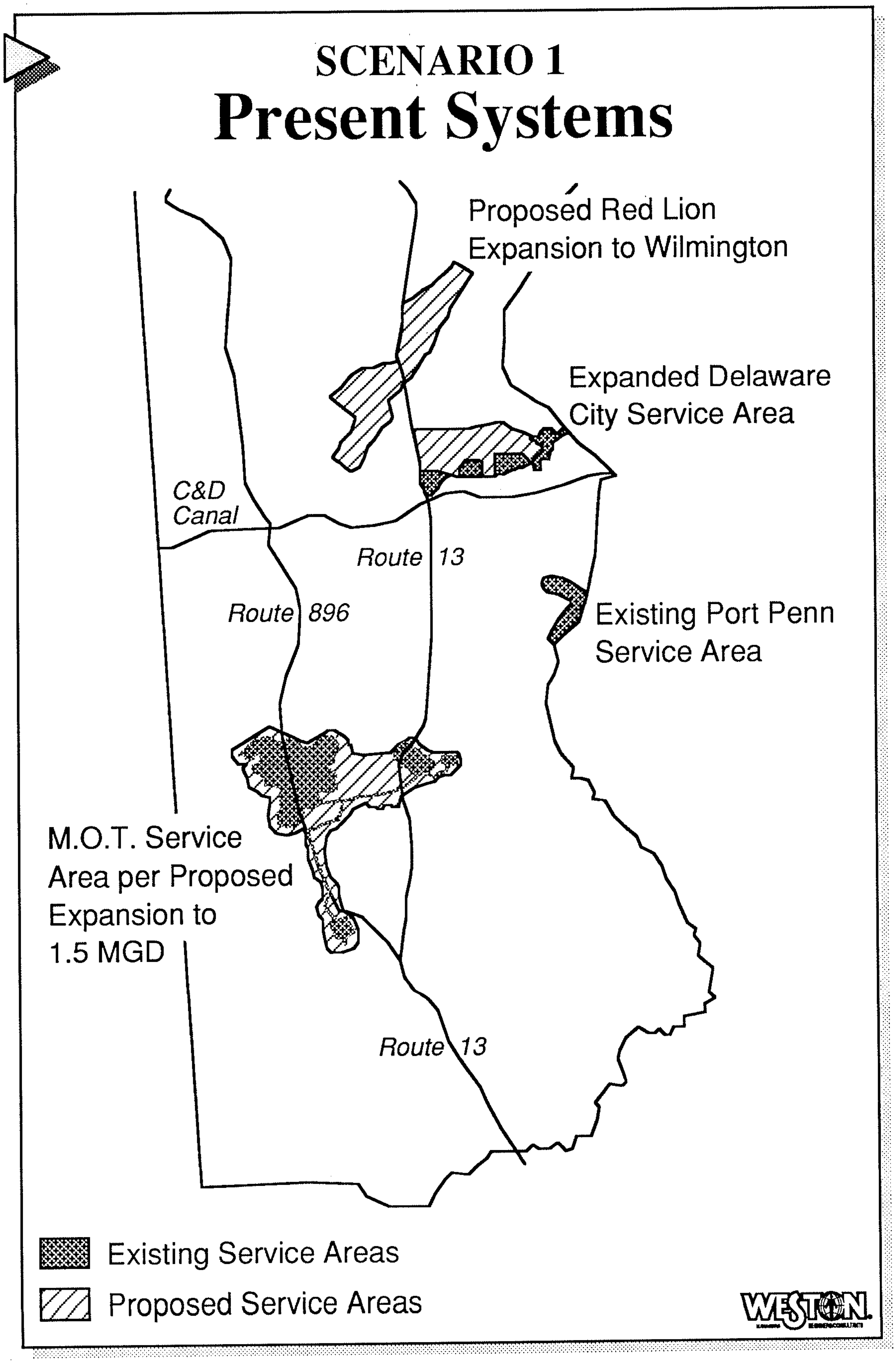
The following advantages are associated with this scenario:

- No changes needed in wastewater infrastructure planning.
- No new public investment is needed (beyond current planning).

8.4.4 Disadvantages

The following disadvantages are associated with this scenario:

Figure 8-1


SCENARIO 1
Present Systems
Proposed Red Lion
Expansion to Wilmington
Expanded Delaware
City Service Area
C&D
Canal
Route 13
Route 896
Existing Port Penn
Service Area
M.O.T. Service
Area per Proposed
Expansion to
1.5 MGD
Route 13
Existing Service Areas
Proposed Service Areas
WESTON

- The potential exists for pollution problems due to the cumulative impact of numerous and closely packed septic systems on water quality (not easily quantified).

- The potential exists for costly remediation of failed on-site systems, as seen in other portions of the County.

- This scenario places the County in a position of assuming management of independently owned and operated land application systems that fail to perform adequately.

8.5 SCENARIO 2 - EXPAND EXISTING WASTEWATER SYSTEMS

8.5.1 Description

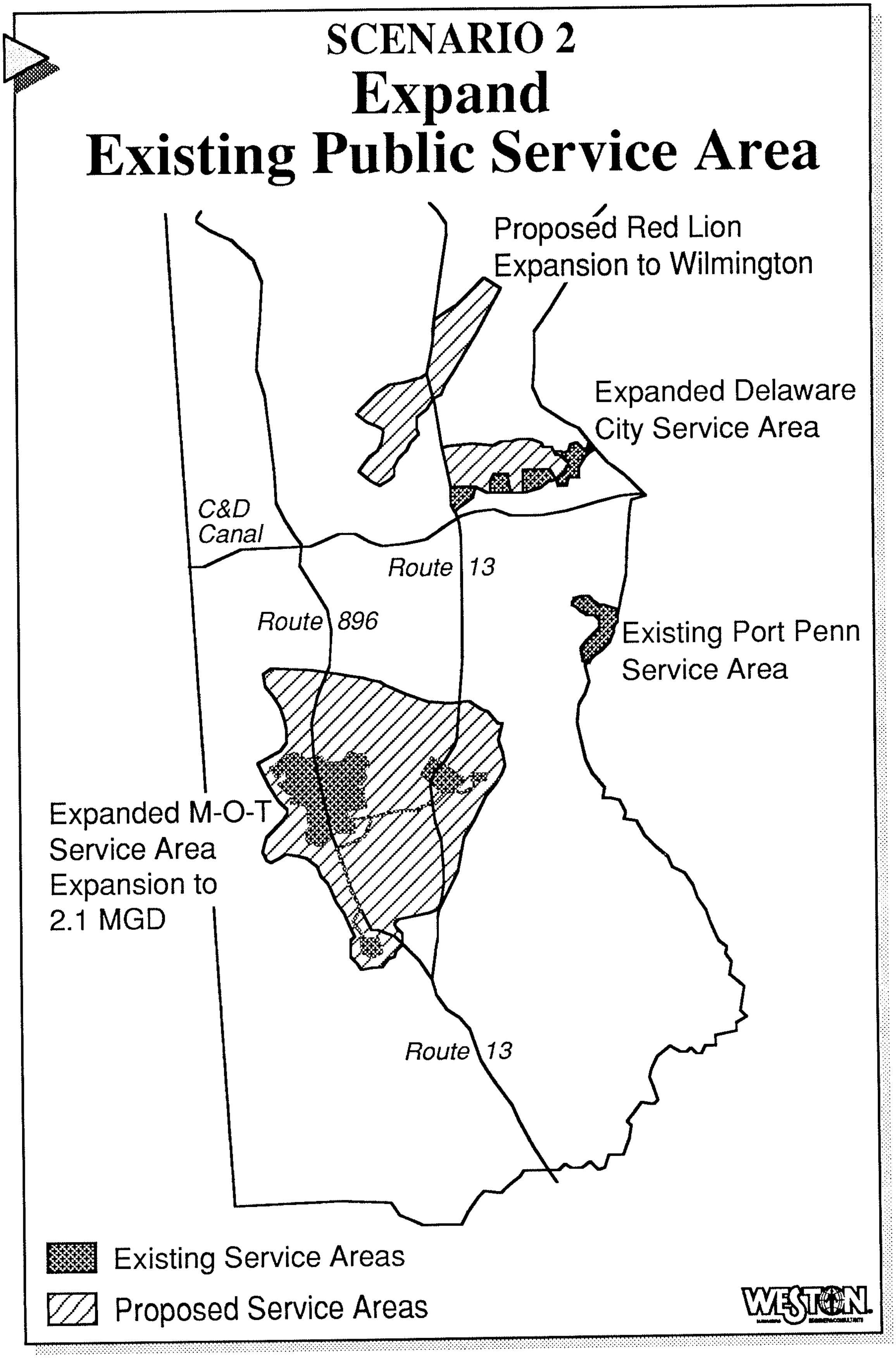
Scenario 2 would concentrate new development around existing centralized wastewater management infrastructure. Of the existing centralized wastewater systems in the study area, the M-O-T system is potentially expandable to 2.1 mgd through the construction of new facilities and could accommodate sewer line extensions beyond its current sewer service area. Development outside the expanded M-O-T service area would be supported by on-site systems. For those areas, new residential development densities (calling for larger minimum lot sizes) may be required. Where possible, cluster developments would be encouraged. No new subdivision developments using centralized land application systems would be allowed for subdivisions with less than 350 units. Revised subdivision plat procedures would be implemented to provide for maximum on-site systems siting and design. Complementary land use planning and zoning would be needed to integrate wastewater systems decisions with land use management objectives. Scenario 2 is illustrated in Figure 8-2.

8.5.2 Issues

The following issues are associated with this scenario:

- Projected demand pressures for housing in the Boyd's Corner and Summit areas would be encouraged in the M-O-T area. The expanded M-O-T service area extends into the Boyd's Corner and Summit areas.

Figure 8-2


SCENARIO 2
Expand
Existing Public Service Area
Proposed Red Lion
Expansion to Wilmington
Expanded Delaware
City Service Area
C&D
Canal
Route 13
Route 896
Existing Port Penn
Service Area
Expanded M-O-T
Service Area
Expansion to
2.1 MGD
Route 13
Existing Service Areas
Proposed Service Areas
WESTON

- There are many existing platted (but unbuilt) subdivisions at prevailing densities in the Boyd's Corner and Summit areas, which if constructed, could present problems (as discussed in Scenario 1).

- Complementary zoning and land use policies would be needed to direct new development into the PSZs.

- Groundwater monitoring programs may be necessary to identify potential contamination problems outside PSZs.

- Public education programs would be established to promote proper maintenance of on-site systems. Mandatory septage pumping and system inspections could be implemented if on-site problems appear, or could be directed to areas where marginal soils exist.

8.5.3 Advantages

The following advantages are associated with this scenario:

- This scenario offers the potential for preservation of open space and agricultural uses due to concentrated development near existing centers and large-lot zoning in rural areas.

- The scenario minimizes the need and cost to provide public services to outlying areas. In addition, it maximizes existing public service investments.

8.5.4 Disadvantages

- This scenario encourages high-intensity development to the M-O-T service area. Complementary land use controls may be needed to fully implement this scenario, which would require the passage of new zoning regulations and delineations.

- This scenario leaves platted (but unbuilt) subdivisions in the Boyd's Corner and Summit areas at prevailing densities, which if constructed could present problems (as discussed in Scenario 1).

- This scenario may leave over-extended capacity in the M-O-T system if residential development does not materialize. In order to prevent this, the County would need to phase improvements and expansions.

8.6 SCENARIO 3 - PROVIDE NEW WASTEWATER MANAGEMENT SERVICES

8.6.1 Description

Scenario 3 would provide new public wastewater management services to outlying areas. In response to pressures for development in the Boyd's Corner and Summit areas, new wastewater infrastructure would be provided to accommodate new development. In Sections 9 and 10, wastewater system alternatives, such as land application options, will be examined to service these new areas. The potential exists for a new PSZ in the Boyd's Corner/Summit areas. Development outside of this PSZ would be supported by on-site systems with larger lot sizes. Scenario 3 is illustrated in Figure 8-3.

8.6.2 Issues

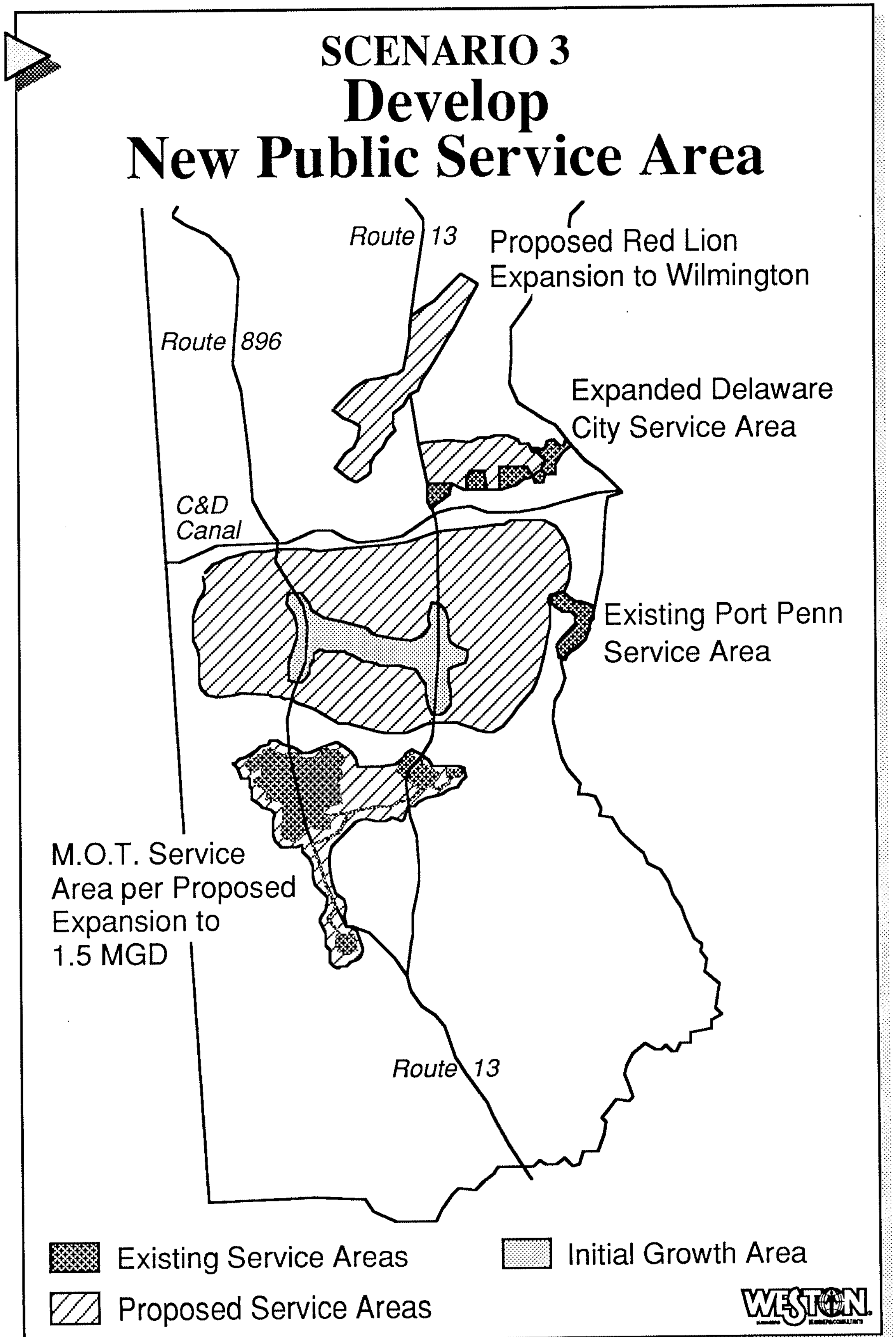
The following issues are associated with this scenario:

- This scenario limits the number of future on-site systems in the study area.
- Up-front public sector investment would be required to acquire land and equipment and to prepare plans and designs. This investment needs to take place soon, i.e., before additional subdivision applications are filed so that the County can direct new development to the new PSZs.
- Staging of infrastructure investments would be needed to control public sector expenditure and minimize potential problems of overextending service capacity. (This becomes a serious issue if the development that is anticipated does not materialize or if the platted, but unbuilt subdivisions are constructed with on-site systems instead of connecting to the PSZs.)
- Public education for proper on-site system maintenance would be necessary.
- Groundwater monitoring programs may be necessary to identify potential problems.

8.6.3 Advantages

This scenario has the following advantages:

Figure 8-3


SCENARIO 3
Develop
New Public Service Area
Route 13
Proposed Red Lion
Expansion to Wilmington
Route 896
Expanded Delaware
City Service Area
C&D
Canal
Existing Port Penn
Service Area
M.O.T. Service
Area per Proposed
Expansion to
1.5 MGD
Route 13
Existing Service Areas
Initial Growth Area
Proposed Service Areas

- Existing platted (but unbuilt) subdivisions in the Boyd's Corner and Summit areas may be reconfigured to connect to a PSZ, rather than remain with on-site systems.

- As a pollution prevention measure, this scenario allows future development on smaller lot sizes to occur in PSZs.

- New PSZs in the Boyd's Corner/Summit areas can enable the easy replacement of failing septic systems in the future, if the need arises.

8.6.4 Disadvantages

This scenario has the following disadvantages:

- This scenario requires expansion of the County sewer infrastructure, requiring investment of public funds.

- Complementary land use planning and zoning controls are needed.

8.7 COMPARISON OF SCENARIOS

As previously discussed, selection among these scenarios would be based upon a variety of planning considerations, many of which lie beyond the scope of this wastewater management plan. In terms of wastewater management strategies, the difference among these scenarios will be formally analyzed in Sections 9 and 10. However, the potential difference among these alternatives in terms of wastewater quantities is illustrated in Table 8-1.

the effluent discharge of the present facility, it is possible that surface water discharge to the present receiving stream (the Appoquinimink River) will require tertiary treatment. In consideration of this situation, a cost evaluation based on present worth analysis has been recently performed by New Castle County's consultant, Tatman and Lee Associates. That evaluation determined that the most cost-effective and environmentally sound alternative proposes aerated lagoons as the treatment component and land application as the disposal component.

The expansion of the M-O-T system would provide for the needs of the Middletown - Odessa and the Townsend PSZs. Under Growth Management Scenario 2, as reflected in this alternative, all other portions of the planning area not addressed in Subsection 9.2 would employ individual (i.e., on-site) wastewater management.

9.2.3 Growth Management Scenario 3

Under Growth Management Scenario 3 (Provision of New Wastewater Management Services), areas of concentrated development (as represented by the Boyd's Corner and Summit PSZs considered in Section 4) would be fostered as a matter of public planning. In such a case, additional public collection, treatment, and disposal systems would be required to serve the PSZs. To the extent that these systems are not currently in place, there are several ways in which they might be implemented. These options will be considered in the following alternatives.

All other portions of the planning area not addressed in Subsection 9.2 would employ individual (i.e., on-site) wastewater management.

9.2.3.1 Alternative IIIA - Centralized Secondary Treatment with Surface Water Discharge

This alternative, as well as all of the following alternatives, assumes that under Growth Management Scenario 3 future population growth will be concentrated primarily in the Boyd's Corner and Summit areas of the study area. These areas have previously been defined as potential PSZs (see Section 4). Under this alternative, the combined C&D Basin (Boyd's Corner and Summit PSZ areas) would be served by a new centralized collection, treatment, and disposal system. The treatment system would consist of a conventional activated sludge facility with post-treatment filtration. Disposal of effluent would occur via a discharge outfall to surface water, with the Delaware River being the candidate of choice.

9.2.3.2 Alternative IIIB - Centralized Tertiary Treatment with Surface Water Discharge

Under this alternative, wastewater from the Boyd's Corner and Summit areas (as a combined PSZ) would be collected and treated by an activated sludge facility augmented by nutrient removal (nitrification/denitrification). The effluent from this facility would be discharged to the C&D Canal or the Appoquinimink River.

9.2.3.3 Alternative IIIC - Centralized Secondary Treatment with Land Application

Under this alternative, the combined Boyd's Corner and Summit PSZ would be serviced by a new centralized collection, treatment, and disposal system. The treatment system would consist of an aerated lagoon. Effluent from the treatment system would be discharged to a land application site.

9.2.3.4 Alternative IIID - Decentralized Secondary Treatment with Centralized Land Application

Under this alternative, individual subdivisions in the Boyd's Corner and Summit areas would be responsible for the treatment and storage of wastewater generated by that subdivision. The County would develop and maintain one central spray application disposal facility for the combined PSZ with sufficient ultimate capacity to meet the projected needs. Private developers would be required to: (1) obtain an allocation at the County facility; and (2) to develop and maintain storage, treatment, and conveyance facilities at the subdivision level.

9.2.3.5 Alternative IIIE - Centralized Secondary Treatment with Constructed Wetlands and Surface Water Disposal

Under this alternative, the combined Boyd's Corner and Summit PSZ would be serviced by a new centralized collection, treatment, and disposal system. The treatment facility would consist of an aerated lagoon. Effluent from the lagoon would be discharged to a constructed wetland where removal of nutrients would occur. Treated effluent from the constructed wetland would then be discharged to surface waters. This alternative would be used to provide a higher safety factor with respect to resource protection.

9.2.3.6 Alternative IIIF - Centralized Secondary Treatment with Constructed Wetlands and Land Application

This alternative is essentially the same as Alternative 3E, with the major difference being the disposal component. Treated effluent from the constructed wetland would be discharged via land application.

9.2.3.7 Alternative IIIG - Tertiary Treatment with Land Application

Under this alternative, the combined Boyd's Corner and Summit PSZ would be serviced by a new centralized collection, treatment, and disposal system. The treatment system would consist of an activated sludge plant equipped for nutrient removal. Effluent from the treatment system would be discharged to a land application site. As is the case with Alternative 3F, this alternative would be used to provide a higher level of safety with respect to protection to groundwater, as well as having the potential for using this treated effluent for irrigating recreational or open space lands.

SECTION 10

EVALUATION OF WASTEWATER MANAGEMENT ALTERNATIVES

10.1 INTRODUCTION

The wastewater management alternatives identified in Section 9 will be evaluated in this section to consider which alternative or alternatives best meets the projected future wastewater management needs of the southern New Castle County area. These alternatives will be subjected to comparative analyses based upon environmental, technical, and economic considerations. Each of these major evaluation factors has a number of specific criteria that address a broad spectrum of wastewater management concerns. The specific criteria upon which this evaluation was conducted are as follows:

Environmental Criteria

- Impact to Groundwater.
- Impact to Surface Water.
- Preservation of Agricultural Lands/Rural Character.
- Protection of Public Health.

Technical Criteria

- Implementation Requirements.
- Constructibility.
- Ease of Operation and Maintenance.
- Reliability.
- Adaptability.
- Public Acceptance.

Economic Criteria

- Treatment and Disposal System Capital Costs.
- Conveyance System Capital Costs.
- Operation and Maintenance Costs.

Each of these specific evaluation criteria will be defined and discussed in the following subsection.

10.2 DEFINITION OF EVALUATION CRITERIA

10.2.1 Environmental Criteria

10.2.1.1 Impact to Groundwater

As was previously discussed in this document, southern New Castle County is entirely dependent upon groundwater for its supply of drinking water. Any adverse impacts to groundwater in the area could have serious consequences for the residents of southern New Castle County. In contrast, any treatment and/or disposal technique that would allow for safe recharge of the groundwater by treated effluent would preserve or even regenerate this precious resource.

10.2.1.2 Impact to Surface Water

The preservation of almost all of the natural resources identified in previous sections of this document is directly or indirectly related to the quality of surface water. Any degradation of surface water quality could affect not only these natural resources, but could also restrict the many human activities (e.g., recreation, shellfish harvesting) associated with and dependent on the quality of surface water. Therefore, any wastewater management alternative that could result in the serious degradation of surface water quality would be considered unacceptable.

10.2.1.3 Preservation of Agricultural Lands/Rural Character

The majority of agricultural land found in New Castle County is located south of the C&D Canal. According to the New Castle County Comprehensive Development Plan, the purposes of preserving this land and the business of agriculture associated with the use of this land are as follows:

- Preserve and enhance the local economic base.
- Promote local self-sufficiency.
- Preserve and conserve a nonrenewable resource.
- Reduce urban and suburban sprawl.
- Control public costs.
- Conserve energy.
- Preserve rural character and lifestyles.
- Maintain agricultural resources reserves for future generations.

An area that has prime farmland soils is often also prime development land. Uncontrolled urban sprawl and leapfrog development tend to accelerate the land conversion process. New Castle County is cognizant of the fact that growth management policies that promote compact, orderly development and discourage leapfrog development patterns will help preserve agricultural activities and the rural character of the area by preventing premature intrusions of uses, intensities, and densities that are incompatible with agricultural operations and the subsequent rural character of the area. Strictly speaking, the preservation of agricultural lands and rural character is based upon economic and societal judgement separate from wastewater management. At the same time, however, wastewater management alternatives that promote compact, orderly development may be more cost-effective (in terms of funds for public facilities) and may also be more desirable than alternatives that promote scattered, haphazard growth.

10.2.1.4 Protection of Public Health

The protection of the health of the residents in and around New Castle County is arguably the most important single aspect of wastewater management. Domestic wastewater contains pathogens that can cause serious illness if the wastewater is not properly treated and disposed. In addition, domestic wastewater may contain significant levels of pollutants that appear to be innocuous (such as nitrates), but at high concentrations may be damaging to certain segments of the population (e.g., methemoglobinemia in infants). Therefore, all wastewater management alternatives have been evaluated on the basis of their ability to protect all segments of the population on a consistent basis.

10.2.2 Technical Criteria

10.2.2.1 Reliance Upon On-Site Systems

This factor considers the degree upon which New Castle County will depend on on-site systems in the future. It is felt that total reliance upon on-site systems is undesirable because of potential adverse impacts to water resources from failing systems and the potential liability to regional government agencies (County and State) who must finance alternative methods if these systems fail. In addition, dependence upon on-site systems tends to foster development in a haphazard manner, in contrast to centralized development, which typically occurs in response to an easily accessible public collection and treatment system.

10.2.2.2 Implementation Requirements

This factor will consider the ease with which each alternative can be implemented. The feasibility of implementation by existing agencies under existing laws and regulations will be addressed.

10.2.2.3 Constructibility

Several factors are considered in evaluating the constructibility of an alternative. These include complexity, unusual construction requirements, and land requirements for construction. The ability to maintain an acceptable level of treatment during the construction of new facilities is an important aspect of constructibility at current treatment plant sites. Construction costs (which are represented in the economic evaluation) are not considered here; however, it is recognized that these factors will likely affect cost. This subjective evaluation emphasizes the higher risk (fewer qualified contractors, greater potential for delays, problems, permit violations, etc.) that could result from more complex construction requirements.

10.2.2.4 Ease of Operation and Maintenance

Ease of operation and maintenance is based on the level and mix of skills required by the operating staff, and on the amount of operator attention required for process control and system maintenance. The number of employees and other operation and maintenance cost issues (presented in the economic evaluation) are not considered here. These issues could impact recruitment of personnel (small "pool" of needed skills), training needs, and consistency of process performance.

10.2.2.5 Reliability

Evaluation based on reliability considers a treatment alternative's proven ability to consistently meet required treatment levels. Reviews of this nature help to establish the credibility of the alternative. Alternatives that employ technologies with a proven track record are viewed as more favorable than those with new and unproven technologies.

10.2.2.6 Adaptability

This review addresses the alternative's capacity to meet not only initial needs, but to effectively and efficiently accommodate subsequent modifications to meet future needs. Factors include ease and type of modification necessary to meet increased flow or degree of treatment requirements, additional land requirements, and the degree to which initial effluent quality can be expected to exceed initial requirements. Such flexibility is important since development of the planning area and regulatory requirements over the next 20 years will certainly vary to some extent from current projections.

10.2.2.7 Public Perception

This factor considers those aspects of an alternative that the public may perceive as having negative side effects associated with the implementation of a particular alternative, and which result in opposition or inconvenience. These perceived negative side effects could include odor problems, propagation of insects, and exposure to aerosol and airborne organic compounds or pathogens.

10.2.3 Economic Criteria

10.2.3.1 Treatment Plant Capital Costs

This factor includes the estimated construction cost of each wastewater management alternative, engineering costs, an allowance for related project costs, an allowance for the cost of land (where applicable), and an allowance for contingency. The level of estimation is conceptual and is primarily suitable for the comparison of alternatives.

Capital costs for conventional treatment facilities were estimated by using cost curves developed by EPA and as presented in the document "Construction Costs for Municipal Wastewater Treatment Plants" (EPA/430/9-83/004). Costs for constructed wetlands were developed from the documents "Design Manual, Constructed Wetlands and Aquatic Plant Systems for Municipal Wastewater Treatment" (EPA/625/1-88/022), and "Areawide Assessment Procedures Manual" (EPA-600/9-76/014). Estimated construction costs were revised to reflect August 1991 dollars by using the ratio of Engineering News Record (ENR) indices, and operation and maintenance costs were revised by using the ratio of Consumer Price Indices.

10.2.3.2 Capital Costs of New Conveyance Systems

Certain alternatives may require construction of new interceptor sewers, pump stations, and force mains to convey flow to the proposed treatment facility. The cost elements and methodology noted under "Treatment Plant Capital Cost" apply here as well. Cost curves used in estimating these costs were taken from the document "Construction Costs for Municipal Wastewater Conveyance Systems" (EPA 430/9-81/003), as well as from the documents cited above.

It should be noted that the capital costs for conveyance systems are somewhat tenuous. Since it is not within the scope of this study to actually site new treatment facilities, assumptions as to the probable locations of future treatment works were made and the length of the necessary conveyance system was estimated. The actual location of any new treatment facility may differ substantially from the assumed location, and the length of components and the subsequent costs of the actual conveyance system will change.

10.2.3.3 Operation and Maintenance Costs

Annual costs of operation and maintenance of treatment facilities (and any new conveyance facilities) were estimated. These estimates reflect the costs of personnel, services, materials, supplies, and equipment necessary to provide adequate operation and maintenance services. These estimates were based upon the aforementioned published cost information.

10.3 EVALUATION METHODOLOGY

As was previously discussed, the evaluation of the wastewater management alternatives considered economic (objective), technical (subjective), and environmental (subjective) factors. Cost is tangible and can be easily evaluated and compared. Many other factors that have a bearing on alternative selection are intangible; that is, they are subjective in nature. Therefore, each person or agency may have a different opinion on the relative importance of each factor in selecting the best alternative. The lowest cost alternative may fare poorly on subjective factors, and therefore may not be the best alternative.

Because the majority of these criteria are subjective, they have not been given numeric ratings or quantitative totals/rankings. Each alternative was subjected to evaluation under each criterion, and a judgment was made as to how well each alternative performs. The values that were used are as follows:

- Promotes/Favorable/Low Cost.
- Neutral/No Effect.
- Detracts/High Risk/High Cost.

The relative performance of each alternative was then compared and considered along with the economic evaluation of each alternative.

A matrix of the identified wastewater management alternatives and the evaluation criteria has been prepared to illustrate how each alternative fared in the evaluation under each of the given criteria. This matrix is presented in Figure 10-1. The rationale upon which each alternative was evaluated is presented in the remainder of this section.

Conceptual cost information for each alternative is presented in Table 10-1.

In addition, the present worth of operation and maintenance for both conveyance systems (i.e., pump stations) and treatment facilities was calculated. An interest rate of 8% was used to calculate the present worth over a 20-year period. A comparison of the present worth and total cost of each of the alternatives is shown in Table 10-2.

10.4 EVALUATION OF WASTEWATER MANAGEMENT CRITERIA

10.4.1 Alternative I - No Change to Present Wastewater Planning

Environmental Criteria

The present course of wastewater planning in southern New Castle County predicates that the majority of wastewater generated by future population will be treated by on-site waste management systems (i.e., septic systems). These systems are the most common means of treating domestic wastewater, particularly in rural and unincorporated areas without sewer systems. Properly sited, designed, constructed, and operated on-site systems offer an efficient and economical wastewater management alternative. However, discharge from septic tanks and cesspools has also been identified as the second largest source of groundwater contamination in the country (Council of Environmental Quality, Eleventh Annual Report, 1980). It is felt that widespread use of on-site systems at the required densities could potentially have an adverse impact on groundwater quality in southern New

○ Promotes/Favorable/Low Cost
◍ Neutral/No Effect
● Detracts/High Risk/High Cost

Evaluation Criteria

Alternative	Environmental: Groundwater Quality/Quantity	Surface Water Quality	Agricultural/Farm Resources	Public Health	Technical/Institutional: Reliance on Onsite Systems	Implementability	Adaptability	Reliability	Ease of O & M	Constructability	Public Perception	Economic: T. P. Capital Costs	Convey Sys Capital Costs	O & M Costs
I Current Wastewater Management	●	○	●	◍	●	○	○	◍	○	○	◍	○	○	○
II Expand Existing Service Areas	○	○	○	○	◍	○	○	○	○	○	◍	○	○	○
III Create New Service Areas														
A Secondary/Surface Disposal	◍	◍	○	○	○	◍	●	○	◍	◍	○	◍	◍	◍
B Advanced/Surface Disposal	◍	○	○	○	○	◍	●	○	●	◍	○	●	◍	●
C Secondary/Land Application	○	○	○	○	○	○	○	○	○	○	◍	◍	◍	○
D Decentralized/Land Application	○	○	○	○	○	◍	○	○	○	○	◍	○	◍	○
E Secondary/Constructed Wetlands	◍	○	○	○	○	●	◍	○	○	○	○	◍	◍	○
F Secondary/Const Wetland/Land Appl	○	○	○	○	○	●	◍	○	○	○	◍	◍	◍	○
G Advanced/Land Application	○	○	○	○	○	○	●	○	●	◍	◍	●	◍	●

Summary of Alternative Evaluation

Table 10-1
Comparative Economic Evaluation of Wastewater Management Alternatives

Alternative	Capacity (mgd)	Capital Cost ($ million)				O & M Costs ($ million)			
		Pump Stations (Total)	Force Main (Total)	Treatment Plant (Total)	Treatment Plant ($/gpd)	Pump Stations (Annual)	Treatment Plant (Annual)	Pump Station ($/1,000 gal)	Treatment Plant ($/1,000 gal)
I A	NA	NA	NA	NA	NA	NA	NA	NA	NA
II A	0.6[a]	0.158	1.22	3.048	5.08	0.020	0.164	0.09	0.75
III A	0.8	0.308	2.21	4.49	5.61	0.051	0.344	0.17	1.17
III B	0.8	0.308	1.76	6.032	7.54	0.051	0.492	0.17	1.68
III C	0.8	0.308	1.76	4.065	5.08	0.051	0.219	0.17	0.75
III D	0.8	0.308	1.76	3.77	4.71	0.051	0.184	0.17	0.63
III E	0.8	0.308	1.76	0.795	0.99	0.051	0.083	0.17	0.28
III F	0.8	0.308	1.76	4.565	5.70	0.051	0.23	0.17	0.79
III G	0.8	0.308	1.76	9.80	12.25	0.051	0.535	0.17	1.83

[a] Additional service in the M-O-T area.

NA = Not applicable.

Table 10-2

Comparison of Capital Costs and Present Worth of Selected Alternatives

	Present Worth[a] O & M Conveyance ($ million)	Present Worth[a] O & M Treatment Plant ($ million)	Capital Cost Conveyance System ($ million)	Capital Cost Treatment Plant ($ million)	Total Costs ($ million)
IIA	0.199	1.610	1.378	3.048	4.822
IIIA	0.498	3.819	2.518	4.490	11.325
IIIB	0.498	5.272	2.068	6.032	13.870
IIIC	0.498	2.592	2.068	4.065	9.223
IIID	0.498	2.248	2.068	3.770	8.584
IIIE	0.498	1.257	2.068	0.795	4.618
IIIF	0.498	2.258	2.068	4.565	9.380
IIIG	0.498	5.694	2.068	9.800	18.060

[a]Present worth calculated at 8% interest over 20-year period.

Castle County. In addition, it is felt that the development pattern that would result from this form of wastewater management would result in scattered growth throughout the study area. This pattern of development would encroach on prime agricultural lands and eventually lead to a decline in agricultural activities. It is for these reasons that this alternative has received relatively low marks based on the selected environmental criteria.

Technical Criteria

One of the overwhelming advantages of on-site systems is the simplicity associated with their design, installation, and operation. The systems are reasonably reliable, even though individual systems will fail if not correctly designed, installed, or maintained.

Economic Criteria

Because there are no direct capital costs to New Castle County or to the State of Delaware associated with this alternative, no economic evaluation was made based on these criteria. Maintenance of the systems requires that solids be pumped from the septic tank every 2 to 3 years at a cost to the individual owner of approximately $100. The costs to the County are limited to administrative costs associated with monitoring and enforcement.

10.4.2 Alternative II - Expansion of the M-O-T Facility

Environmental Criteria

This alternative utilizes aerated lagoons as its treatment component and land application as its disposal component.

Application of treated effluent results in the eventual (long-term) reuse of water resources by diverting the water resources to the groundwater. This process allows for the "recycling" of water resources. If properly designed and managed, the impacts to the groundwater supply will be beneficial in nature. Under current regulations, the safety of groundwater as a water supply source in terms of nitrate levels is protected. Since no effluent reaches surface waters, there is no negative surface water impact. From a public health perspective, concerns with aerosol dispersal of pathogens, vectors, and crop contamination have been documented and have not been a problem. A properly designed and managed facility can further eliminate these concerns. Finally, since this alternative is based on the assumption that the served population will be located in a relatively small land area and at a sufficiently high density to justify public wastewater collection, it preserves agricultural land that would otherwise be lost in a scattered growth development pattern.

Technical Criteria

Both aerated lagoons and land application are proven technologies. Construction and implementation of these technologies are standard procedures. They are easily expandable, with the availability of land being the limiting factor. They both require low operator attention and maintenance as compared to other engineered wastewater treatment systems.

Land application has historically been met with public opposition when it is initially introduced to an area as a wastewater disposal alternative. This opposition is usually based on the public's misunderstanding of such issues as pretreatment requirements, required quality of percolate, and aesthetics. While initial resistance is possible, through proper public education, the public may ultimately accept a properly designed and operated land application system. Also, the public may accept land application if they have seen similar systems in operation over a period of time and as they become better informed of the benefits associated with it.

Economic Criteria

Aerated lagoons and land application are two of the more inexpensive wastewater treatment technologies in use today. Capital costs associated with this combined treatment and disposal option are estimated to be $5.08 per gallon per day (gpd) treated. The largest cost factor associated with land application is the cost of the land. Substantial capital cost savings would be realized if the need to purchase land could be minimized or avoided. Annual operation and maintenance costs are estimated to be $0.75 per thousand gallons treated. Capital costs of a conveyance system necessary to transport wastewater are estimated to be $1.38 million. The estimated operation and maintenance costs for this system are estimated to be $0.09 per thousand gallons transported.

10.4.3 Alternative IIIA - Conventional Secondary Treatment with Surface Water Discharge

Environmental Criteria

This alternative utilizes activated sludge with filtration as the treatment component and surface water discharge to the Delaware River as the disposal component.

While this alternative does not directly contribute to the degradation of groundwater, it also does not make beneficial use of the treated effluent (as does land application). For this reason, this alternative was given a neutral mark for protection of groundwater quality. Furthermore, any discharge to surface waters introduces pollutants into the water body, and therefore has the potential to degrade the quality of that body of water.

This alternative is based on the assumption that the served population will be located in a relatively small land area and at a sufficiently high population to justify public wastewater collection. Therefore, it preserves agricultural land that would otherwise be lost in a scattered growth development pattern and has been given a favorable mark for preservation of agricultural lands. Finally, this alternative does protect public health and has been given a favorable mark based on that criteria.

Technical Criteria

Due to the stringent regulatory requirements associated with the quality of a surface water discharge (in this case, an interstate waterway), implementation of this alternative is somewhat more difficult than alternatives that utilize land application as their disposal conventional activated sludge facility. Capital costs associated with the treatment facility are estimated to be $7.54 per gpd of capacity. The estimated operation and maintenance costs are estimated to be $1.68 per thousand gallons treated.

Conveyance system costs for this and all subsequent alternatives assume that identical components will be used in the construction of these systems. These components consist of two pump stations (one rated at 0.5 mgd and the other at 0.3 mgd) and 27,000 ft of force main. This assumption has been made based upon estimated flow contributions for Summit and Boyd's Corner, and likely transmission distances to candidate treatment facility sites.

Capital costs associated with the conveyance system are estimated to be $2.07 million. Operation and maintenance costs are estimated to be $0.17 per thousand gallons transported.

10.4.5 Alternative IIIC - Centralized Secondary Treatment with Land Application

Environmental Criteria

In general, it is felt that those alternatives that utilize land application of treated effluent are potentially more protective of environmental resources than those that discharge to surface waters. By discharging treated effluent to the land, this water may constitute a resource and is not simply discarded as a waste product. The natural treatment processes inherent to land application allow for an advanced level of treatment to occur before the effluent comes in contact with the groundwater aquifer. Lysimeters are required by law in order to ensure that percolate quality is maintained. No effluent is discharged to surface waters, thereby ensuring the maintenance of surface water quality. Lands used for disposal are sequestered from public contact (unless a higher treatment and disinfection are achieved prior to application), thereby favoring protection of public health. Therefore, this alternative and all of the other alternatives that utilize land application are given favorable marks based on the environmental criteria listed.

Technical Criteria

As was discussed in the evaluation of Alternative IIA, wastewater treatment by aerated lagoons and disposal by land application is reliable, easy to operate and maintain, easy to implement and construct, and relatively amenable to future expansion of treatment capacity. Therefore, this alternative has been given favorable marks under these criteria. A neutral mark for public acceptance has been given for the reasons discussed under Alternative IIA.

Economic Criteria

As was previously discussed, wastewater treatment by aerated lagoons and land application is one of the most cost-effective methods available. Capital costs for this alternative are estimated to be $5.08 per gpd of capacity, and operation and maintenance costs are estimated to be $0.75 per thousand gallons treated. Capital costs associated with the conveyance system are estimated to be $2.07 million, and the operation and maintenance are estimated to $0.17 per thousand gallons transported.

10.4.6 Alternative IIID - Decentralized Treatment with Centralized Land Application

Environmental Criteria

This alternative has been given favorable marks for all of the environmental criteria based upon the reasons previously discussed under Alternatives IIA and IIIC.

Technical Criteria

This alternative has been given identical marks to the other alternatives that utilize aerated lagoons and land application, with the exception of implementability. This alternative will require that the New Castle County Department of Public Works (DPW) enter into a trustee ownership agreement with the developers who build the individual lagoon systems. This agreement ensures that DPW will continue to operate and maintain the individual lagoon systems in the event of a default by the developer. It is felt that this potentially puts DPW at risk since any repair of a faulty system could become the responsibility of DPW. This risk could be minimized by vigilance on the part of DPW during design, construction, and initial operation of the individual systems. Nonetheless, based on this potential risk, a less than favorable (neutral) mark has been given for implementability.

Economic Criteria

This alternative stipulates that the cost of construction, operation, and maintenance of the individual lagoon systems be carried by the individual developers. Therefore, the only costs that are the responsibility of New Castle County are the construction, operation, and maintenance of the disposal site and the construction, operation, and maintenance of the conveyance system. Obviously, this alternative is relatively inexpensive in terms of cost to New Castle County. Capital costs associated with this alternative are $4.71 per gpd capacity, and operation and maintenance costs are estimated to be $0.63 per thousand gallons treated. Conveyance system costs are identical to the other options utilizing aerated lagoons and land application.

10.4.7 Alternative IIIE - Centralized Secondary Treatment with Constructed Wetlands and Surface Water Discharge

Environmental Criteria

This alternative is similar to Alternative IIIB, differing in the method of treatment. Tertiary treatment is attained by aerated lagoons followed by constructed wetlands treatment in which nutrient levels are further reduced. The ultimate level of treatment and the method of disposal are identical to Alternative IIIB. Therefore, based on the selected environmental criteria, the marks for Alternative IIIE are identical to Alternative IIIB.

10.4.9 Alternative IIIG - Conventional Tertiary Treatment with Land Application

Environmental Criteria

Under this alternative, an activated sludge facility equipped with additional processes that further reduce nitrogen and phosphorus is utilized as the treatment component and land application is utilized as the disposal component. Since this alternative utilizes land application, for reasons previously discussed under Alternatives IIID and IIIF, this alternative is graded favorably under the selected environmental criteria. In addition, the added potential benefits cited in the evaluation of Alternative IIIF are also valid for this alternative.

Technical Criteria

This alternative is considered relatively easy to implement and is reliable, and is therefore graded favorably in these categories. Construction of conventional activated sludge facilities is more difficult than the construction of aerated lagoons and/or constructed wetlands, and therefore has been graded less than favorable (neutral) in this category.

As was previously discussed in the evaluation of Alternative IIIB, conventional activated sludge facilities are difficult to expand, and the additional unit processes necessary to achieve tertiary treatment and handle and dispose of wastewater sludge require a greater level of attention to operate and maintain. Therefore, this alternative has been graded unfavorably in these categories. Finally, since this alternative utilizes land application as it is disposal component, it is felt that it would initially be viewed negatively in the eyes of the general public.

Economic Criteria

Of all the alternatives evaluated in this study, this alternative is by far the most costly to construct and operate. Capital costs of the treatment facility associated with this alternative are estimated to be $12.25 per gpd of capacity. Operation and maintenance costs of the treatment facility are estimated to be $1.83 per thousand gallons treated. Capital and operation and maintenance costs of the conveyance system are identical to the other alternatives.

10.5 SUMMARY OF WASTEWATER MANAGEMENT ALTERNATIVES

As previously discussed, a fundamental issue in wastewater management planning for the southern New Castle County area concerns the decision between extensive reliance upon individual on-site systems and the use of centralized infrastructure systems. While the ultimate choice between these options depends on a variety of factors related to overall planning and development goals for the study area, it is possible to discuss these options (as well as alternatives for implementing these options) from the standpoint of wastewater management planning.

The choice between these options is represented by contrasting Scenario 1 (on-site systems) with Scenarios 2 and 3 (centralized systems). The distinction between Scenarios 2 and 3 lies in how, and to what extent, additional centralized systems are developed.

Scenario 1 would appear to present the lowest cost option (in terms of cost to the County) because the majority of wastewater disposal costs are borne by the individual landowner. However, at least three factors must be weighed against this apparent advantage: 1) concerns over the impact of widespread use of on-site systems on regional groundwater quality; 2) the effects of proliferation of on-site systems on County planning goals; and 3) the potential cost to the County (both economic and noneconomic associated with potential failures in on-site systems). Table 10-3 presents a comparison of the number of on-site systems that would potentially be in use by the year 2010. These numbers are somewhat tenuous and are based on the assumptions that each dwelling unit (comprised of 2.8 people) will have an individual system. However, the numbers do illustrate the fact that there will be a substantial number of on-site systems in use by 2010, and this number of systems will be affected by the scenario that is ultimately chosen.

Table 10-3

Comparison of Number of On-Site Systems in 2010 by Scenario

	Scenario 1		Scenario 2		Scenario 3	
	Unsewered Population	Total On-Site	Unsewered Population	Total On-Site	Unsewered Population	Total On-Site
Red Lion	1,175	420	1,175	420	1,175	420
Summit	3,800	1,357	1,355	484	857	306
Boyd's Corner	6,350	2,268	3,665	1,309	1,991	711
M-O-T	7,818	2,792	7,818	2,792	7,818	2,792
Blackbird	8,900	3,179	8,900	3,179	8,900	3,179
Total	28,043	10,015	22,913	8,183	20,741	7,408

The first two of these issues are interrelated. Based upon the evaluations presented in Section 7 of this study, the adequacy of relying upon extensive use of on-site systems in terms of groundwater protection is uncertain. Additional investigation in this area is warranted to better assess potential impacts. At present, it appears that the best guidance for the development of on-site systems would include the use of relatively large lot sizes. However, this approach may be at odds with County planning goals in terms of land use planning. These factors, coupled with the costs that the County may incur for correcting septic system failures (even if properly zoned/sited), suggest that on the basis of factors other than treatment system cost, this scenario may not be preferred.

If the County ultimately chooses to reject Scenario 1 in favor of the expanded use of centralized facilities, a variety of approaches, as presented in this section, may be available to implement those facilities. It is also likely that the decision to reject Scenario 1 will be accompanied by and supported by refinements in development planning to accommodate projected population growth within areas designated for development. In such a case, refined population and flow estimates for public service should be available and should be used for revising the evaluation of alternatives. However, on the basis of current information, the following distinctions can be drawn from the wastewater management alternatives:

1. Discharges to surface waters (as represented by Alternatives IIIA and IIIB) will face more stringent discharge standards and therefore higher capital and O&M costs. Additional discharges to streams other than the Delaware River may not be a viable option. Discharge to the Delaware River may also face increasing treatment standards. The Delaware River is not a convenient discharge point for some portions of the study area.

2. The use of constructed wetlands as a wastewater treatment technology remains in a relatively early stage of development. While promising in terms of potential treatment performance and cost, there is relatively limited full-scale experience with such systems. Therefore, selection of this technology as a primary component of wastewater management for the area is premature. The status of this technology should be monitored over time. If accumulated experience confirms the viability of this technology, it may be reconsidered as additional capacity needs develop.

3. Land application of treated wastewater (Alternatives II, IIIC, and IIID) appears to have potential advantages in the southern New Castle County area. As long as sufficient quantities of suitable land are available at reasonable cost, land application can be a reliable and cost-effective approach. Some potential may exist for aquifer recharge.

Based upon the evaluation presented in Section 7 of this report, it appears that sufficient quantities of suitable land may be available to accommodate currently projected needs. However, as discussed in Section 7, additional characterization of existing soil and aquifer conditions may be warranted to confirm and/or revise the current understanding of soils suitability. Site-specific characterization studies would then be employed during the project planning phase to confirm site suitability.

It should also be acknowledged that the current evaluation of land application system requirements as represented in Alternatives IIIC and IIID is based upon current regulations that specify a percolate quality of 10 mg/L or less of nitrate nitrogen. Should groundwater protection goals require higher percolate quality, the use of land application would likely be accomplished through: 1) lower application rates (and therefore larger total land application facility sizes); or 2) advanced pre-application treatment, as represented by Alternative IIIG.

SECTION 11
MANAGEMENT AND IMPLEMENTATION

11.1 INTRODUCTION

Based upon the issues and concepts presented in this study, it appears likely that significant portions of the population in the southern New Castle County planning area will continue to be served by private wastewater treatment facilities rather than by centralized public systems provided by the County. While these private service components have generally been referred to as on-site systems in this study, a variety of community systems may exist (such as community septic tanks or the use of private decentralized waste collection and treatment coupled to centralized disposal as represented by Alternative IIID).

The extent of reliance upon such approaches will depend upon the growth management scenario adopted and implemented by the County. However, County management and oversight of such systems will be required to ensure that the overall goals with respect to wastewater planning are achieved. As of April 1991, the responsibility for permitting and regulating septic systems in New Castle County has been assumed by the State of Delaware Department of Natural Resources and Environmental Control (DNREC) where State-level regulations have superseded previous County authorities. Several requirements that were previously incorporated into the New Castle County septic regulations are not reflected in the State septic regulations. For example, lot-size minimums and subdivision application definitions have been subsequently drafted into zoning ordinances to permit County approval.

This section of the report describes the management program for the southern New Castle County study area necessary for the implementation of the wastewater systems described previously under the wastewater management development scenarios. This section is organized in the following manner:

- Overview of management program requirements.
- Options for managing subdivision development.

11.2 OVERVIEW OF MANAGEMENT PROGRAM REQUIREMENTS

The purpose of this section is to describe the various elements of a management program for the wastewater systems considered in the study area plan. A discussion of the current regulatory framework implemented by DNREC and considerations for enhancements to the on-site and subdivision requirements is provided to develop enhanced management options for the County. The presentation of the management program elements is intended to serve as a baseline (or model) that forms the basis of a management program for the County. Various basic management program functions are described herein. They include:

- Planning.
- Permit issuance.
- System installation.
- Operation and maintenance.

Each of these program functions are separately delineated for on-site systems and small community systems. They are identified separately because management considerations for on-site systems are very different from those of small community systems. A key issue to both, however, is how the responsibility for management functions is assigned between the homeowner (who may have part or all of the wastewater system on his property) and the community (which may be responsible for the performance of the entire system). Management strategies that address system maintenance and related management issues will be described in this section.

The following discussion will describe each of the basic management program functions for on-site systems and small community systems.

11.2.1 On-Site System Management Program Functions

Table 11-1 presents the typical management program functions that are associated with the proper management of on-site systems. Functional requirements are identified for each of the activities. Functional requirements describe regulatory enforcement measures that are

Table 11-1

Management Program Requirements: On-Site Systems

Program Function	Typical Activities	Functional Requirements
• On-Site Systems Planning	• Site Suitability Analysis - Conduct detailed analyses of soil limitations for individual on-site development sites and subdivisions. Subdivision lot designs and layouts must be compatible with soils limitations. Lot dimensions should be adjusted to fit site conditions.	• Site Suitability Analysis - Site work must be performed by a certified soils scientist. Licensing, certification, and training of site evaluators is required to ensure that only qualified professionals are performing this function. At a minimum, soil profiles should be done at each change in soil type. When questionable, a soil profile examination or percolation test should be conducted at each lot. In marginal soil conditions, detailed testing should be performed for the drain field replacement area as well.
	• Oversight of Site Evaluation - Provide oversight or independent review/verification that site suitability information provided with the subdivision development plan application has been accurately prepared.	• Oversight of Site Evaluation - Some observation of soils testing should be performed by a qualified independent reviewer. This reviewer will also dictate when questionable or marginal conditions require more detailed analysis.
	• Development Plan Review/Approval - Conduct a review of the development plan to ensure its consistency and compatibility with on-site systems regulations and local land use planning and zoning. Also, ensure that the proposed plan is compatible with other County environmental and growth management plan policies.	• Development Plan Review/Approval - Review lot layout as compared to site topographic features and soil suitability for on-site systems. Stipulate that subdivision approval must be a requirement for a septic system installation permit and that a septic system permit be required as a prerequisite to the issuance of building or occupancy permits.
	• Evaluation of Minimum Lot Size/Zoning Classifications - Regulations and procedures for on-site systems design, siting, and density are intended to protect public health and groundwater quality. Nitrate contamination from septic systems is a potential hazard to human health and the environment.	• Evaluation Minimum Lot Size/Zoning Classifications - Land use planning and zoning requirements need to be compatible with on-site systems regulations in order to protect groundwater resources and public health from septic system contaminants. Groundwater monitoring for nitrates and groundwater modeling can be applied to establish protective standards for septic system use through density controls and zoning.

Table 11-1

Management Program Requirements: On-Lot Systems (continued)

Program Function	Typical Activities	Functional Requirements
• Permit Issuance	• System Design - Select appropriate on-site system based upon the site suitability results. Prepare construction drawings and specifications.	• System Design - Performance standards and construction specifications should be established to provide alternative systems where marginal site conditions are present. Standard on-site system should be allowed only in areas with optimum site conditions. Licensing, certification, and training of system designers may be necessary unless a requirement for professional engineers or soil scientists is established.
	• Design Review and Approval - Review submittal drawings and approve system design. Issue permit for system construction.	• Design Review and Approval - The permit for septic system installation should be required before a building permit is issued.
• System Installation	• System Installation - Follow design drawings and install system, subject to proper construction techniques.	• System Installation - The licensing, certification, and training of septic system installers may be necessary particularly for alternative systems.
	• Installation Inspection and Approval - Oversight of system installation, preparation of as-built drawings, and maintenance of record of installation in the permit file.	• Installation Inspection and Approval - Typically, an inspection prior to system completion is required unless site conditions or system complexity dictates more detailed inspections.
• Operation and Maintenance	• Conduct Periodic System Inspections - On a regularly scheduled basis or in response to a reported problem (or concern), the on-site system should be inspected to determine if sludge accumulation in the tank is significant or if drain field problems exist.	• Conduct Periodic System Inspections - Inspectors should be trained and perhaps certified and licensed to perform these duties. Characteristics of failing systems should be available and emergency maintenance procedures clearly defined for homeowner reference.

Table 11-1

Management Program Requirements: On-Lot Systems (continued)

Program Function	Typical Activities	Functional Requirements
	• Septage Pumping - On a regularly scheduled basis or in response to a problem, the tank should be pumped and the septage properly treated and disposed of.	• Septage Pumping - Septage should only be pumped when sludges build at the tank bottom or at some regulated frequency (e.g., every 3 years). A manifest system to track the occurrence of tank pumping and disposal would aid in ensuring proper disposal and identification of trends (or problems). Regulation of septage disposal is necessary to ensure that the septage is being properly treated.
	• Systems Replacement - Repair or replace failing on-site systems when it is determined that a health problem exists or when system does not properly function. Issue permits and inspect major repairs/ replacement work.	• System Replacement - Site evaluations should be required to define appropriate system replacement alternatives. Installation inspections are needed to ensure that maximum care is given to proper installation.
	• Groundwater Monitoring - Assess the extent of contaminant release (e.g., nitrates) from septic systems and establish a mechanism for evaluating trends in regional groundwater quality. Link monitoring effort of regional groundwater management program/aquifer protection plan in addition to the identification of potentially failing on-site systems.	• Groundwater Monitoring - A comprehensive program for groundwater management and problem detection is essential in sensitive environments. Groundwater monitoring of contaminant plumes and early warning detection of problems could mitigate costly groundwater pollution abatement efforts.
	• Public Education - Inform public of maintenance procedures, proper systems operations, and water conservation techniques. Respond to inquiries, complaints, or potential problems.	• Public Education - An informed public can benefit and support on-site management program efforts.

needed to fully carry out the provisions of the typical activities within each program function.

11.2.1.1 Planning

The planning function encompasses activities associated with future subdivisions and homesites within the study area. Principal planning activities include site suitability analysis for proposed land development projects (e.g., subdivisions) and approvals of land developments that propose on-site systems. The critical requirements in planning for future developments (where on-site systems are intended) are decisions regarding the actual locations of on-site systems. The siting decisions for on-site systems should be made first, then the subdivision layout determined. In this approach, the most suitable land is reserved for on-site systems, and sites are thoroughly evaluated to verify that the site conditions are suitable for wastewater disposal.

11.2.1.2 Permit Issuance

This management function involves the selection of the appropriate on-site system, consistent with the site evaluation results. Current DNREC requirements for the issuance of on-site systems are outlined in Sections 5.01000 to 5.03000 of the regulations. Briefly, these regulations stipulate the site evaluation requirements, construction and repair guidelines, and the permit denial and appeal process. Site suitability and design standards are enforced by refusing to approve plans or issue permits for septic systems and building/occupancy permits. Critical to this process is the requirement that subdivision approval be provided before a septic system permit is issued and that a septic permit be required prior to the issuance of a building permit.

This function involves the oversight of installation of the on-site system. It ensures that the system construction adheres to the approved location and design, and that a record of the installation is prepared for the permit files. The DNREC regulations provide specific technical requirements for system installation under Section 6.00000 (Design and

Construction) for disposal systems, excavations, materials, and site restoration. This function is designed to ensure the quality and integrity of installed systems and provide for the long-term operational condition of permitted systems.

11.2.1.3 Operation and Maintenance

The operation and maintenance (O&M) of on-site systems generally involves the periodic pumping of septage from the septage tank, replacement of failing systems, and education of homeowners on the proper use of septic systems. The DNREC septic regulations governing O&M are currently limited to Section 8.0000 (Maintenance), which stipulates owner responsibility for on-site systems, including septage pumping and record-keeping. The regulations specify that DNREC may impose additional O&M requirements for individual or community on-site systems to ensure continuity of performance on a case-by-case basis. This type of regulatory prerogative is extremely helpful in imposing more stringent O&M activities where septic systems are located in higher density areas or in areas of marginal suitability conditions (more intensive management activities can be provided). However, additional O&M requirements to enhance the protectiveness of current legislation may include:

- Periodic inspection of the tank condition and sludge contents, and drain field operation.
- Groundwater monitoring of the potential resource impact associated with the use of on-site systems. Concerns about the contaminant release (e.g., of nitrates) from on-site systems can be identified, as well as changes in the region's groundwater quality condition as on-site systems are added to the region.

In instances where formalized on-site management programs have been instituted, some public sector entity, such as a special district, town, county, etc., is charged with the responsibility for providing various management services. Otherwise, homeowners are the principal entity responsible for the O&M of on-site systems in their yard. The County should leverage, to the maximum extent practicable, the site-specific regulatory requirement for enhanced inspection and monitoring activities in instances where the permit review process details increased potentials for impacts to groundwater resources. Additionally, this provision allows the County to participate more fully in gaining control over O&M activities that serve to protect the long-term environmental goals specified in the Comprehensive Plan for permitted uses within the floodplain areas, aquifer formations, wetlands recharge areas, or other designated zones (e.g., RPAs) for the protection of water resources.

11.2.2 Small Community System Management Program Functions

Regulations governing the management of community systems are contained in Section 5.11000 of the DNREC septic regulations. By definition, community systems include on-site systems that serve more than one lot or parcel, condominium unit, or planned development unit. Table 11-2 presents the typical management program functions that are associated with the proper management of small community systems. Small community systems consist of conventional or alternative sewers combined with centralized treatment systems. These systems can serve a town or region, depending on the need, or may be centralized to a specific subdivision or neighborhood (i.e., a cluster system) where site restrictions pose problems with on-site system use at individual homesites.

11.2.2.1 Planning

The proper management of small community systems begins with sound planning and siting decisions made during the land development review (i.e., subdivision plat submission) process. For small community systems (as with on-site systems), sound planning involves making the right decisions regarding the type of treatment systems to be used (i.e., a community treatment system versus connection to a regional treatment plant), and the layout/design of the subdivision to allow for the most suitable sites to be reserved for land application (i.e., wastewater or disposal). This program function also includes utility extension policy and decision-making procedures where decisions regarding the timing of community system extensions are made so that centralized services are offered to a greater portion of the region. The planning and approval function for small community systems is

Table 11-2

Management Program Requirements: Small Community/Cluster Systems

Program Function	Typical Activities	Functional Requirements
• Small Community/ Cluster Systems Planning	• Site Suitability Analysis - Prepare evaluations of alternative methods for providing centralized wastewater collection and treatment. As part of the subdivision plat submittal, alternative collection and treatment systems should be explored, including connection to existing regional wastewater treatment system.	• Site Suitability Analysis - Site work must be performed by a certified soil scientist. Licensing, certification, and training of site evaluators is required to ensure that only qualified professionals are performing this function. Detailed hydrogeologic and permeability studies may also be required for land application systems.
	• Oversight of Site Evaluation - Provide oversight or independent review that site suitability information is provided with the subdivision development plan application to ensure that it has been accurately prepared.	• Oversight of Site Evaluation - Some observation of soils testing should be performed by a qualified independent reviewer. This reviewer will also dictate when questionable or marginal conditions require more detailed analysis.
	• Development Plan Review/Approval - Conduct a review of the development plan to ensure its consistency and compatibility with on-site systems regulations and local land use planning and zoning. Also, ensure that the proposed plan is compatible with other County environmental infrastructure and growth management plan policies.	• Development Plan Review/Approval - Review lot layout and compare to site topographic features and soil suitability for on-site systems. Stipulate that subdivision approval must be a requirement for septic system installation permit and that a septic system permit be required as a prerequisite to the issuance of building or occupancy permits.
	• Utility Extension Policies - Establish wastewater service zones and determine/identify time-phased approaches for extending sewer lines out to remote developments. Also, link wastewater treatment system decisions for proposed developments to applicable phasing schedule.	• Utility Extension Policies - Integrate subdivisions plat submissions reviews with utility extension programs. Determine if short-term or longer term constraints impact individual subdivision development decisions.
• Permit Issuance	• System Design - Select appropriate on-site system based upon the site suitability results. Prepare construction drawings and specifications.	• System Design - Conformance standards and construction specifications should be established to provide alternative collection and treatment systems. Designs drawings and construction should be performed by a Professional Engineer.

Table 11-2

Management Program Requirements: Small Community/Cluster Systems (continued)

Program Function	Typical Activities	Functional Requirements
	• Design Review and Approval - Review submittal drawings and approve system design. Issue permit for system construction.	• Design Review and Approval - An approved subdivision plat is a prerequisite to building permit issuance. The system managing entity (if different that the applicant) should participate in the design review process.
• System Installation	• System Installation - Follow design drawings and install system, subject to proper construction techniques.	• System Installation - The system owner (developer) should place a performance bond with the completed system and an open letter-of-credit for the management entity to utilize if repairs are needed. This is particularly needed where private systems are built.
	• Installation Inspection and Approval - Oversight of system installation, preparation of as-built drawings, and maintenance of record of installation in the permit file.	• Installation Inspection and Approval - The system management entity (if different from the applicant) should participate in the construction supervision to ensure that the installation is properly performed.
• O&M	• Perform Routine Maintenance - Provide necessary services to properly maintain the collection and treatment system. This will involve daily maintenance and routine inspections.	• Perform Routine Maintenance - Maintenance personnel should be trained to provide the needed services for small community systems.
	• System Repair - Perform necessary repair/replacement of worn equipment or unit failures to ensure proper system function.	• System Repair - User fees should incorporate a reserve fund to provide for spare parts and emergency capital for necessary repairs. For privately managed systems, performance bonds or letters-of-credit should be made available to assist in repair/replacement activities.

Table 11-2

Management Program Requirements: Small Community/Cluster Systems (continued)

Program Function	Typical Activities	Functional Requirements
	• Groundwater Monitoring - Where land application systems are utilized, groundwater sampling will be needed to assess the extent of contaminant release from the land application system, and establish a mechanism for evaluating trends in regional groundwater quality. Link monitoring effort to regional groundwater management program/aquifer protection plan.	• Groundwater Monitoring - A comprehensive program for groundwater management and problem detection is essential in sensitive environments. Groundwater monitoring of contaminant plumes and early warning detection of problems could mitigate costly groundwater pollution abatement efforts.
	• Public Education - Inform public of maintenance procedures, proper system operation, and water conservation technologies. Respond to inquiries, complaints, or potential problems.	• Public Education - An informed public can benefit and support an on-site management program. This is particularly true where innovative technologies are utilized.

currently jointly shared by New Castle County, DNREC, and other advisory and regulatory agencies, such as the Department of Public Works, State Highway Division, Conservation Districts, and others, in the form of a Subdivision Advisory Committee (SAC). The SAC is empowered with broad approval and recommendation responsibility to provide review and input to small community systems and other infrastructure developments that are advanced through the subdivision application process.

11.2.2.2 Permit Issuance

This function involves the review and approval of subdivision plats submitted by developers that call for the placement of small community systems. The review process should evaluate alternative small systems technologies and recommend a system for the review agency to approve. As previously stated, the permit review and approval process incorporates a recommendations and concurrence step by the SAC that can provide valuable site-specific regional planning comment. A pre-application process (Section 9.00000) can facilitate agency review of site characteristics that may impact the suitability of the proposed community system. This step involves a general review of the wastewater treatment development plan (as part of the overall subdivision approval application) and permits the County to function through the SAC to screen for applications that do not meet related resource protection and other infrastructure ordinances.

11.2.2.3 System Installation

This function involves the oversight of the system construction process to ensure that the actual system installation adheres to the plans and specifications. The regulations (Section 5.11060(b,d)) stipulate that the permitted system remain financially solvent through construction, operation, maintenance, and emergency repair as well as provide an account of collected user fees to be maintained for the sole purpose of carrying out the functions of the community system. The requirements of performance bonds or letters of credit by waste system developers and owners are not required under the present permit regulations; however, it can be a critical component of a management program. In addition to providing assurances for the future operational status of the system, the requirement for financial commitments will reduce the potential for the County, as the local government entity, from assuming liability for failed or abandoned systems.

11.2.2.4 Operations and Maintenance (O&M)

The O&M of small community systems typically requires more intensive involvement by the managing entity staff than on-site systems. Operational activities can occur daily, and depending upon the technology, the precise operational activities may vary significantly. The current regulations specify that responsible parities inspect community systems at least annually (Section 5.11050), or more frequently as specified by the permit. A critical requirement for small community systems, however, is the provision of a reserve fund for system repair/rehabilitation. This is a key issue for privately built and operated systems, where past performance in other parts of the United States has demonstrated that system O&M (particularly repairs or replacement of failing expensive equipment) is a low priority for homeowner-run management entities (e.g., homeowner associations).

The next subsection describes the options for applying subdivision management as a tool for implementation of the proposed wastewater scenarios for southern New Castle County.

11.3 OPTIONS FOR SUBDIVISION MANAGEMENT

The management of the subdivision development process for the wastewater management scenarios (Scenarios 1 and 3) represents opportunities for New Castle County to leverage private development to support the selected wastewater management program. As a participating member of the SAC, the subdivision application process may be applied to assist the County in directing projected regional subdivision growth to enhance the regional planning and development goals, as well as to provide adequate wastewater management services to new development areas. The following subsection presents a brief overview of the requirements and format of the subdivision application process and a discussion of the unique features of the application process for each wastewater management scenario.

11.3.1 Subdivision Application Process

Recognizing that development is an integral component of the New Castle County planning process, an application and approval process for subdivision participation in the wastewater planning strategy is a necessary step. As part of the New Castle County Code regarding the definition of subdivision and land development plans (Ordinance No. 91-133), the County has defined separate subdivision applications into minor and major applicants based on the size and complexity of the project. Development proposals that fall under the category of minor subdivisions include applications involving less than five lots and 10,0000 ft^2 of gross leasable space for residential or commercial units. Major applications consist of multiresidential or diversified development for improvements resulting in 10,000 ft^2 or more and include enhancement to more that five lots or strip development. The codified definitions provide the County with a mechanism of applying review standards related to land development issues that can impact and control the proliferation of community wastewater systems.

The application process is intended to evaluate the subdivision plat (i.e., plan) to provide wastewater treatment and the suitability of the plan to meet the constraints of the New Castle County regional management structure. Additionally, the application process provides a mechanism to review the subdivision wastewater management strategy with the prevailing water quality criteria and geophysical conditions surrounding the site. The application process may also be used to direct regional growth patterns to public service areas and provide protective development through the implementation of treatment systems and management programs. Key elements to be considered in the subdivision application process, relative to wastewater treatment, include:

- General information:
  - Project location.
  - Applicant information.
- Size of the subdivision:
  - Proposed wastewater management system.

- Site suitability analysis.

- Soils analysis.
- Hydrology and permeability.
- Existing sewage disposal facilities on adjacent lots.
- Drinking water availability.
- Existing and proposed water supplies (wells, reservoirs, etc.) in the vicinity.
- Consideration of sensitive areas:
    - Wetlands protection.
    - Historical and archaeological protection.
    - Wildlife and habitat degradation.
- Alternative sewage facilities analysis.
- Wastewater facilities plan:
    - Public notification and input requirement.

In general, the requirements of the application process are structured to permit New Castle County the maximum ability to provide input towards ensuring comprehensive and integrated wastewater planning and permit the subdivision applicants the flexibility to devise individual wastewater solutions structured to their specific needs. To obtain timely review of the sewage facilities planning in relation to the New Castle County planning and approval schedule, it is recommended that applicants complete the soils and site suitability evaluations early in the planning process. This information will determine if the subdivisions can be served by a combined on-site wastewater management system or if alternate strategies will be required. If soils are found to be unsuitable, other sewerage facility alternatives will need to be evaluated. Other environmental factors such as potential impacts to wetlands, protected plant and animal species, prime agricultural land, and water supply must also be resolved early in the planning process. The completed and approved subdivision application ensures development of consistent planning with regard to the selected wastewater management strategy for New Castle County. These requirements are addressed through a preliminary subdivision approval process, implemented by DNREC

(Section 9.02000), to provide initial review and nonbinding statement of feasibility regarding on-site or community systems.

The application process is best suited for individual developers or cohesive groups of homeowner applicants that meet the established combined minimum lot size criteria to provide information for review and approval by various New Castle County planning and public works entities. The applicant should attempt to review prior planning completed for the development tract. Documentation supporting a request for subdivision approval should be completed by the developer and submitted to DNREC using a developed application format to include descriptions of the site evaluation and each pertinent area of the wastewater management plan. An example check list of items and suggested information requirements for a subdivision application is presented in Appendix C. DNREC will review and act on this submittal after receipt of the completed submittal and determine if the proposed project is consistent with the State sewage facility plan or suitable for on-site system use. New Castle County, as a member of the SAC, will have the opportunity to participate and comment in the application process once the developer has submitted a preliminary plan. At this juncture, the County may review the proposed development plan and provide recommendations based upon the consistency of the subdivision application with minimum lot size, land use, planning and development goals, or other ordinances that impact the County concurrence of the application.

As a member of the SAC, New Castle County agencies (Departments of Planning, Highways, and Public Works) may provide DNREC with specific recommendations for the approval or denial of the application based on County-specific development and resource protection initiatives. The existing subdivision application process offers major potential for New Castle County to provide direction to the subdivision applications with regard to County-level wastewater management requirements that are not addressed in the State septic regulations.

11.3.2 Subdivision Options in New Castle County

The role of subdivision planning within the context of wastewater management programs in New Castle County is expected to vary with each wastewater treatment system development scenario previously described in this document. Additionally, the features of the subdivision planning process will also vary with respect to the overall planning process. For each of the developed scenarios, the subdivision application process can be used to support regional planning initiatives for use of open and agricultural land, growth of demographic centers, pollution prevention initiatives, groundwater protection, and implementation of an effective wastewater management program for New Castle County.

Scenario 1: Current Planning of Wastewater Management Programs — Under this scenario, it is expected that the current development trends will continue. The Middletown, Odessa, and Townsend (M-O-T) service area is expanded to 1.5 mgd with little or no sewerage treatment extended outside municipal boundaries. Growth in the Boyd's Corner and Summit areas is expected to be supported by on-site systems at prevailing densities and scattered small community systems operated by subdivision applicants. Platted but unbuilt developments will be governed by existing requirements for a 0.75-acre minimum lot size. Under the prevailing requirements, expected flows may negatively impact water quality and health concerns. Scattered and independently operated subdivision wastewater systems will be difficult to incorporate into future sewerage or regional wastewater planning. Growth in the M-O-T area will be continued to be serviced by the expanded wastewater treatment facility and offers some potential for correcting remotely located subdivisions.

Permitting and inspection programs are recommended as part of the application process to incorporate small community and on-site systems within the County wastewater management program. Additionally, New Castle County should consider requiring performance bonds or other sureties for the continued O&M of the community systems within its jurisdiction in excess of current level financial responsibility stipulated in Section 511060(b) of the State regulations. New Castle County wastewater management options and participation in the subdivision application review and approval criteria must also incorporate planning to ensure that regional wastewater treatment development is consistent with State and local pollution prevention initiatives. The difficulties associated with regulating varied land applications and small community centralized systems can, in some cases, result in increased challenges for the County to satisfy both its planning and land use function with the need to ensure protective environmental standards.

<u>Scenario 2: Expand Existing Wastewater System</u> — Scenario 2 seeks to concentrate new development around the existing M-O-T wastewater infrastructure by expanding the current facility to 2.0 mgd capacity and increasing sewerage beyond the present service area. Development outside of the public service zone would be supported primarily by on-site systems; however, new minimum lot sizes may be required. Additionally, no new subdivision developments using small community systems would be allowed with less than 350 EDU.

Although the strategy of this scenario is to focus on growth in the M-O-T study area, this scenario offers several advantages for the subdivision application process in the Boyd's Corner and Summit zone. The requirements for a larger minimum lot size and 350-unit subdivisions will limit potential cluster expansion in the area to larger subdivisions with developed (and presumably better managed) wastewater management facilities. On-site proliferation, particularly on small lot sizes, will be restricted providing additional protection to groundwater resources. The subdivision application process will provide New Castle County with the mechanism to direct the selection and placement of wastewater management facilities of applicants to areas consistent with regional planning and environmental goals. It would be beneficial to the regional groundwater resources for the application process to apply to existing platted, but yet unbuilt subdivisions. As previously discussed, the implementation of subdivision wastewater facilities at prevailing densities may result in groundwater resource problems. New Castle County may advantageously utilize the subdivision application process to direct growth in this area to controlled and low-density-spaced community development. The paced development and growth in this area, controlled by the stringent subdivision application process, can facilitate protection to sensitive environmental and regional pollution prevention initiatives.

The subdivision application process should incorporate an enhanced inspection program to allow New Castle County to retain management control over treatment effectiveness of the systems. Currently, the requirement for a pre-cover inspection (Section 5.04000) by DNREC and the requirement for annually performed inspections by the responsible party or owner (Section 5.11050) may not offer adequate protection to ensure that systems are fully operational and that potential impacts are not occurring to protected resources. Because of the large-scale development of cluster systems, developers should be required to post performance bonds to ensure effectiveness of the system. Additionally, New Castle County may consider developing specific ordinances to require the use and operation of holding tanks within the M-O-T service area for subdivision applicants where service has not yet been provided. This County-level regulatory action is consistent with the State requirement for the temporary use of holding tanks (Section 5.13040) and will provide a mechanism to address wastewater disposal for previously approved subdivision applicants. The provision of septage disposal capacity will also assist in ensuring adequate maintenance and that the systems do no fail.

Scenario 3: Provide New Wastewater Management Services — This scenario specifies the development of a new wastewater service zone within the Boyd's Corner/Summit area. Development outside of this zone would be supported by on-site systems with larger lot sizes and a restriction for future subdivisions of 350 EDU. Development outside of these service zones would be supported by on-site systems conforming to a minimum lot size.

The focus of this scenario is to direct the majority of future growth to the Boyd's Corner and Summit region and accommodate this growth with expanded centralized wastewater treatment coverage. The staging of the infrastructure development of the centralized system must consider the previously platted subdivisions to ensure that the unbuilt subdivisions are not built with on-site systems that were permitted under the prior lot size regime. The use of holding tanks, described in Scenario 2, also applies as a mechanism to provide for interim wastewater disposal. The approval process for subdivision applicants for current development should also consider consistency with the phased build-out and connection with the public service zone. Planning for the build-out of the public service zone may also include consideration of existing subdivisions or high-density areas serviced by on-site systems for initial connection. Installation and periodic inspection, including installation of New Castle County discharge flow measurement devices for rate setting, should be incorporated into the approval permitting process.

By developing and codifying County-specific ordinances, the subdivision application process can assist the County in regulating development in the regions outside of the service area. Subdivision applicants outside of the service zone area are required to meet the large-lot minimum of EDUs and to develop management plans for acceptable land application treatment systems. The permitting and approval process in these cases should also consider regional land use and zoning to ensure that encroachment of agricultural and environmentally sensitive areas is minimized. Strict definition of the service zones and consistent County policy for build-out and treatment capacity allocation within the service zones will assist in deterring pressure by subdivision applicants outside of the zone for connection variances.

11.4 SUMMARY

The improved O&M of individual on-site systems and small cluster systems can help promote larger system operation and performance, as well as protect groundwater resources. O&M, however, is only one of several critical functions that need to be applied to improve the overall management of on-site and small systems. Management functions involve a wide range of services intended primarily to address the entire life cycle of system performance; that is, from the initial system selection and siting process to its design, construction, and operation. All of these functions combined will contribute to the goals of improved system performance, reliability, and environmental protection. The current State septic regulations, administered by DNREC, provide the basic tool for addressing many of the management and planning issues described for the preceding wastewater development scenarios. Several general areas for control and prevention of failing on-site or community systems are not presently mandated that may provide additional capability for New Castle County to protect groundwater resources and avoid acceptance of liabilities for failing systems. These include development of County-specific ordinances to require periodic inspection and verification of the operational status of in-place systems and posting of financial sureties for system performance and O&M that will protect the County from assuming receivership of failing systems. In addition, the County may consider the development of groundwater monitoring programs in unsewered development areas and aquifer resource zones as a means of quantifying the efficacy of the wastewater management program.

The subdivision planning process is one of the key tools available to local governments to implement effective small wastewater system management programs. Within the context of subdivision planning are various procedures intended to promote detailed site investigations and reviews of site conditions so that wise decisions are made regarding the type and placement of appropriate wastewater systems. The general rule is to find the most suitable soils for on-site or small community systems first, then plan the layout of roads, houses, and open space around (i.e., outside) those suitable areas. As member of the SAC, New Castle County agencies are provided with the opportunity to review subdivision applications and to direct recommendations for approval or denial pursuant to the application consistent with County ordinances and planning for infrastructure development. It is recommended that New Castle County fully utilize its review and concurrence role to direct subdivision development in service zones and unsewered areas by reviewing the adequacy of existing ordinances or promulgating additional legislation to provide for enhanced minimum lot size requirements, land use and zoning,and resource protection.

Innovative subdivision design utilizing cluster zoning provisions will also enable developers to downsize lot sizes, while providing larger areas of open space. These open space areas could also be used as sewage disposal field locations. Private developer cooperation in this management program is critical to its success. A thorough understanding of planning principles and objectives by the applicant and reviewer will promote consistent and sound decision-making. However, the local government unit (i.e., New Castle County) should become an active participant in system design reviews and installation inspections of all cluster and small centralized systems built in the County. Furthermore, as previously discussed, a performance bond or letter of credit should be posted by the developer when these systems are proposed. In this way, the County has an opportunity to ensure that these systems will operate successfully when they become part of the public domain.

Finally, placing emphasis on good planning and siting decisions up-front will lessen the need for stringent mandatory maintenance programs (especially for on-site systems). Therefore, effective on-site maintenance could be performed through comprehensive public education programs, which avoids numerous complex institutional and legal issues associated with the public maintenance of privately owned individual on-site systems.

Underlying the success of a wastewater management program is a comprehensive, environmentally targeted land use plan. Before an adequate wastewater management program can be effectively implemented, it must be supported by a land use plan. In this way, the subdivision planning tools, increased minimum lot sizes, and public wastewater service zone concepts can be effectively implemented.

SECTION 12

CONCLUSIONS AND RECOMMENDATIONS

This Wastewater Needs Evaluation and Plan has analyzed potential wastewater service requirements that may develop over the next 20 years (until 2010) as a result of projected growth and development pressures in the southern New Castle County planning area. It has also explored various ways in which the projected demand can be met by the agencies responsible for providing and managing such services. Key considerations in developing these options include not only reliability and cost-effectiveness, but also the protection of environmental resources in this area.

12.1 FINDINGS

The following findings have been drawn from this study:

- Based upon population projections originally developed by WILMAPCO, the total population within the planning area is expected to grow by 122.5% by the year 2010, from 25,097 to 55,840 persons. Associated with this population growth is likely to be a normal level of commercial development as necessary to provide goods and services to that population. Based upon current New Castle County planning projections, substantial industrial growth is not foreseen.

- This projected growth pattern would result in a substantial increase in the total daily wastewater generation from 2.5 million gallons per day (mgd) to approximately 6.0 mgd in 2010 (based upon sewered and unsewered populations and projected commercial flows). The characteristics of this wastewater are likely to be those typical of domestic wastewater and will not include significant industrial components.

- Current County plans provide for sufficient wastewater treatment capacity at the Wilmington and Delaware City sewage treatment plants to accommodate needs of the project area north of the Chesapeake and Delaware Canal. However, this is not the case in the project area south of the Canal.

- Current zoning and planning policies and ongoing land development south of the Canal appear to be leading towards dispersed residential development that is not conducive to service by centralized wastewater treatment facilities.

- While current wastewater management policy would foster accommodating the projected growth by reliance upon individual (on-site) wastewater disposal systems, this approach is questionable from the standpoint of environmental resource protection, high risks to correct the problem in the future, and other community goals as established by the New Castle County Comprehensive Development Plan.

- Groundwater protection is of primary importance. Currently all water supply systems in the project area rely upon local groundwater sources. Although some public supply systems obtain water from deeper aquifers, private domestic wells in shallow aquifers account for the largest portion of residential water supply. It appears that this area will continue to rely indefinitely on groundwater as its source of supply.

- While it may be possible to accommodate projected growth by extensive reliance upon individual (on-site) wastewater management systems, other approaches more protective of groundwater resources were evaluated. Three scenarios were identified that contrasted different development patterns in terms of methods that could be used to provide wastewater services. Scenario 1 presented the current wastewater management policy, which calls for the continued reliance on on-site systems to meet the demands outside of existing public wastewater service areas. Scenario 2 presented the expansion of the existing M-O-T public service area and treatment facilities to accommodate projected growth, while Scenario 3 presented the development of a new public service area in the Boyd's Corner/Summit areas. Both Scenario 2 and 3 recognize the continued use of on-site wastewater systems for outlying areas. However, an increase in the minimum lot size in such areas has been proposed to protect groundwater supplies.

- From the standpoint of wastewater management, the choice among these scenarios reflects a trade-off between concerns over potential environmental impacts of extensive use of private on-site wastewater management and disposal and the higher infrastructure requirements associated with public facilities. Based upon the analyses presented in this study, reliance upon extensive on-site systems in terms of groundwater protection is discouraged.

- Additional investigation into potential environmental impacts for on-site systems is warranted. Based upon present information, resource protection considerations indicate that stringent siting criteria, including the requirement for relatively large lot sizes, should be employed in areas where on-site systems will be employed. Consequently, reliance upon on-site systems as the primary wastewater management approach for the study area would result in relatively large areas of land being devoted to residential development. If this development pattern is determined to be unacceptable in terms of comprehensive planning goals, scenarios relying upon on-site systems should be rejected in favor of those employing centralized wastewater management.

- Projected growth using public wastewater management systems can be accommodated by expansion of the M-O-T regional system (Scenario 2) or development of new public service to serve development in the Boyd's Corner/Summit area (Scenario 3). It is likely that expansion of the M-O-T regional system would require the development of additional treatment capacity for discharge to land, since additional discharge through the existing treatment system and to the Appoquinimink River is not a viable option.

- Among treatment and disposal options for new public service systems in the study area, land application of treated wastewater is considered to be the most promising option at the strategic level. Current plans underway by DPW for land application at M-O-T are consistent with this study's findings. Factors to be considered in the final selection of this approach at a particular site include: 1) verification of the groundwater quality protection criteria that will be applied to this discharge option; and 2) verification that sufficient areas of suitable land are available for discharge.

- Under the development assumptions and wastewater management scenarios used in this study, the permitted capacity of the existing M-O-T facility will be exceeded by 1995. Sewered flow in the combined Boyd's Corner/Summit areas (if developed) may exceed 400,000 gpd by 1995. In order to allow for design, construction, and startup of facilities to meet these additional needs, determination of wastewater management and development strategies should be made as expeditiously as possible.

12.2 GENERAL PLANNING RECOMMENDATIONS

Based upon these findings the following recommendations are made:

Scenario 1 — Implementation of this wastewater development strategy is not recommended due to the potential impact on groundwater quality as a result of the cumulative impact of high density on-site wastewater management systems. Additionally, there is a high likelihood that the continued use of on-site systems at prevailing densities will result in costly remediation and a management burden for the County in the future. While some of the specific goals stipulated in the Comprehensive Development Plan (e.g., preservation of open areas, encourage growth in areas where capital facilities are provided, manage development so that infrastructure is not overloaded) can be accommodated under this scenario, specific County-level legislation for stringent adherence to future planning and zoning ordinances will be required to ensure growth within acceptable parameters. Other key criteria, namely protection of public health, control of public costs, and resource preservation, are not adequately addressed by this wastewater development plan and therefore result in the nonendorsement of this strategy.

Scenario 2 — Expansion of the existing M-O-T public service area is recommended under the following conditions that:

- The County, in consideration of proposed public wastewater infrastructure, consider the location of new proposed uses on the future land use phase map, proposed development areas, and the potential for an expanded and/or additional 5-year growth area around M-O-T.
- Adopt an interim larger minimum lot size requirement for on-site septic system (3-acre minimum for development outside the PSZ).
- Re-examine existing land use and revise the Comprehensive Plan and zoning ordinance to reflect implementation strategies for development in the M-O-T area.
- Implement complementary land use and development policies to direct new growth to the M-O-T service area through higher land use and zoning densities.
- Develop appropriate control mechanisms to address pollution potential from platted (but unbuilt) subdivisions with on-site disposal below the minimum lot size.
- Revise existing major subdivision and land development application processes to encourage usage of combined wastewater treatment systems that conform to adjusted minimum lot size requirements and availability of small community wastewater treatment systems outside the service area.
- Implement groundwater monitoring and modeling programs in the study area to identify potential groundwater pollution and support development of new regulations (County and State).

Scenario 3 — Implementation of a wastewater management strategy requiring the development of new PSZ in the Boyd's Corner/Summit area is recommend under the following conditions that:

- Evaluate financing alternatives and bond capacity to support public costs associated with development of a new PSZ.

- Develop and augment the wastewater planning and management process to accommodate the increased wastewater infrastructure management requirements.

- The County re-examine existing land use and revise the Comprehensive Plan and zoning ordinance to reflect the implementation strategies for the Boyd's Corner/Summit area.

- The County adopt an interim larger minimum lot size requirement for on-site septic systems (3-acre minimum for development outside the PSZ).

- The County develop an infrastructure implementation plan to consider the staging requirements of wastewater collection and treatment systems with other planned expansion and maintenance programs, e.g., transportation, utilities, and access needed for planned commercial, industrial, and residential development areas within the PSZ.

- The County develop and adopt complementary land use and zoning controls growth to the Boyd's Corner/Summit area through higher land use and zoning densities and limit on-site septic systems in the PSZ.

- The County revise the existing major subdivision application permitting process to require installation of provisional holding tanks pending the availability of sewerage connections within the PSZ: modify subdivision application process to conform to adjusted combined minimum lot size for permits outside PSZs.

- The County, in consideration of proposed wastewater infrastructure, consider the creation of new proposed uses on the future land use map, proposed development areas (PDAs), and the potential for expanded and/or additional 5-year growth areas around the Boyd's Corner/Summit area.

- The County develop appropriate control mechanisms to address pollution potential from plotted but unbuilt subdivisions with on-site disposal below the minimum lot size.

- The County and State implement groundwater monitoring and modeling programs in the study area to identify potential groundwater pollution and support development of new regulations.

As this evaluation plan supports implementation of either Scenario 2 or 3, the decision for final selection will rest with further refinements to existing County planning and development forecasting. The decision between Scenario 2 and 3 will incorporate consideration of sequenced activities to obtain needed and presently unavailable planning information, evaluate project financing options, restructure existing regulations and ordinances, and ultimately address the specific programmatic requirements for the selected management system. These recommendations can be classified into two general groups relative to required actions to facilitate the County decision-making process for selection between the endorsed alternatives. Sequencing of the specific activities for the recommendations will be dependent upon final selection of a wastewater management alternative for southern New Castle County. The recommendation groups have been structured to combine the common activities required for either selection into an initial timeline of activities that are separate from specific situational activities that will be required for implementation of each wastewater scenario:

- General Activities:
  - Revise Comprehensive Plan.
  - Conduct economic/financing analysis.
  - County wastewater development decision.
- Scenarios 2 and 3:
  - Design wastewater treatment and collection systems.
  - County approval of wastewater treatment system and collection design.
  - Permit application and approval process.
  - Revise subdivision application process.
  - Review/revise on-site wastewater treatment regulations for:

    Holding tanks/dry sewer (and other interim facilities)
    Use of advanced/innovative technologies
    Minimum lot size
  - Implement interim regulations for subdivision and other development pending PSZ connection.
- Develop and authorize service fees and rates for PSZ and/or County.
- Implement NCC management authority for PSZ.

The grouping and activities are presented in Table 12-1 to identify relevant action leads and schedule considerations for sequencing of activities. The impacts and time consideration for each of these general groups are based upon the analysis supported by this current evaluation of New Castle County wastewater needs and the specific recommended activities outlined below.

12.3 PLAN IMPLEMENTATION RECOMMENDATIONS

12.3.1 Recommendation 1 - Change Current Wastewater Management for the Southern Service Area

It is recommended that the County change its current wastewater management strategy for the Southern Service area which relies heavily on on-site wastewater management systems for its long-term growth. Scenario 1 should be rejected due to the potential impact on groundwater, and other environmental resources, and the high risks to correct problems in the future. The County should authorize its staff to further evaluate other infrastructure needs and impacts so that a preference for Scenario 2 or 3 can be established.

Because of current wastewater flows at the M-O-T treatment facility, the County should continue actions underway to increase permitted capacity to 0.65 mgd as well as continue plans to expand treatment capacity to meet expected short-term demands.

12.3.2 Recommendation 2 — Modify Land Use Requirements and Comprehensive Plan to Accommodate Wastewater Management

It is recommended that the County re-evaluate the Comprehensive Development Plan to establish quantitative guidelines for achieving the general goals stipulated in that Plan. This will result in specific information to support new land use and zoning ordinances, validation and establishment of new minimum lot sizes, and specific strategies to promote preservation of County resources. Information developed from the re-evaluation of the Comprehensive Plan should be utilized to guide final selection of the wastewater management plan.

Table 12-1

Recommendations for Implementation of Wastewater Management Plan

Recommendation	Action Lead	Schedule
1) Change current wastewater management for the Southern Service area. a. Reject Scenario 1 - Existing Wastewater Management policy. b. Authorize County Staff to further evaluate Scenarios 2 and 3. c. Pursue upgrade of MOT capacity to meet current shortage.	New Castle County Council	Spring 1992
2) Modify Land Use Requirements and Comprehensive Plan to Accommodate Wastewater Management. a. Establish an interim 3-acre minimum in low-density residential areas relying on on-site wastewater systems. b. Designate higher density areas for public treatment and disposal. c. Amend Areawide Wastewater Management Plan for the Southern Service area (208 Plan)	New Castle County Planning Department, DNREC	Initiate immediately - modify comprehensive plan and unsewered zoning ordinance by January 1993.

Table 12-1

Recommendations for Implementation of Wastewater Management Plan (continued)

Recommendation	Action Lead	Schedule
3) Select Wastewater Management Scenario/Plan a. Complete current upgrade to MOT facilities b. Finalize plan for expansion of M-O-T service area (Scenario 2) or development of PSZ in Boyd's Corner/Summit area. (Scenario 3) c. Adopt final wastewater management plan and define public and private service functions. d. Develop contractual procedures and plan for design and construction services in accordance with DNREC regulations.	New Castle County DPW	Implement as soon as possible after conclusion of Recommendation 1 after allowing public comment period. Schedule release of design RFP for June 1993.
4) Identify Infrastructure Facilities Planning Area and Timing of Services a. Prepare financing study on services, development sequencing, cost allocations, etc. b. Recommend public investments in land and equipment for future service areas. c. Define private sector (i.e., developer) financial responsibilities for system construction, maintenance, and connection.	New Castle County Planning Department, DPW	Conduct concurrently with Recommendation 2 for task findings to be incorporated into wastewater management scenario selection.

Table 12-1

Recommendations for Implementation of Wastewater Management Plan (continued)

Recommendation	Action Lead	Schedule
5) Revise Subdivision Application Process a. Establish County Requirements for private wastewater treatment and collection systems. b. Incorporate analysis of alternatives. c. Establish O&M requirements for homeowners and developers.	New Castle County Council and Planning Department	Initiate at conclusion of Recommendations 3 and 4. Schedule completion for June 1994.
6) Reclassify Platted (Unbuilt) Subdivisions a. Examine each unbuilt subdivision and compare to revised requirements. b. Require revision and resubmittal of subdivisions which are not in compliance.	New Castle County Planning Department	Initiate at conclusion of Recommendation 5. Schedule for completion of approval process of January 1995.

Table 12-1

Recommendations for Implementation of Wastewater Management Plan (continued)

Recommendation	Action Lead	Schedule
7) Implement Comprehensive Groundwater Characterization Program a. Pursue cooperative arrangement with USGS/DGS to implement comprehensive groundwater monitoring program. b. Refine soils and geology data sufficient to support groundwater characterization. c. Redefine necessary minimum lot size to protect groundwater. d. Modify regulations (NC Co. and DNREC) to include necessary changes to requirements and approval procedures. e. Modify Comprehensive Plan based upon findings of investigations.	WRA of New Castle County, DNREC, USGS, and DGS	Implement groundwater monitoring program as soon as possible after the Wastewater Needs Evaluation and Plan has been approved.

This evaluation plan identifies several critical land use, zoning, and groundwater protection measures, i.e., establishment of protective minimum lot size and implementation of protection policies (supported by monitoring and modeling program) that must be addressed as an initial step in developing a responsive and environmentally protective wastewater management strategy for the proposed study areas. The New Castle County Comprehensive Development Plan currently does not adequately describe the intended development from which to derive pro-active wastewater management planning. The County will need to examine and establish specific land use criteria, density zones, groundwater protection policies, residential/commercial/industrial forecasts, and land allocation. Issues currently addressed in sections of the Comprehensive Development Plan pertain to density bonuses, performance zoning, cluster development, protection of open and public spaces, agricultural preservation, and quality-of-life objectives for the County. However, these general objectives are not adequately developed to support critical evaluation for wastewater scenario selection.

Critical components of a Comprehensive Land Use Plan that are derived from the wastewater management process are:

- Location (and protection) of land suitable for public wastewater disposal facilities.
- Delineation of areas where low-density development (using individual on-site systems) are appropriate from a community development point of view (at the 3-acre minimum lot size).
- Delineation of areas through zoning classifications where cluster developments (i.e., application of small community systems where gross densities are maintained at the 3-acre minimum, but individual lot sizes are smaller) are to be located.

Primary leadership in this task will reside with the County Planning Department, who will be responsible for ensuring development of policies and supporting implementation actions that are consistent with the long-term growth objectives of the County.

12.3.3 Recommendation 3 — Selected Wastewater Management Scenario/Plan

It is recommended that the County finalize planning for expansion of M-O-T service area or development of new PSZ in the Boyd's Corner/Summit area based upon review findings from Recommendation 1. Additionally, the County should establish specific wastewater management functions and technical criteria for collection and treatment (in accordance with state regulations) to guide the process of designing and constructing the selected management option. The evaluation has developed two wastewater management scenarios (Scenarios 2 and 3) that are anticipated to meet wastewater needs through the 20-year planning period (2005). Based upon present information, treatment and land application of projected wastewater quantities is considered the most promising approach under either of the scenarios. Final selection of the wastewater management system, however, has not been recommended in this study for the reasons cited in the previous recommendation, and cannot be determined until this information is available.

Integrated participation from the New Castle Department of Public Works, County Engineering Office, Water Resources Agency, ratification by County Council, and consultation with DNREC will be required to accomplish this task.

12.3.4 Recommendation 4 — Identify Infrastructure Facilities Planning Area and Timing of Services

Concurrent with the formulation of a process for design and construction of the selected wastewater management option (i.e., formulation of an RFP, selection of a design engineer and contractor, and operations startup), as described in the previous recommendation, it is recommended that the County undertake an examination of financing alternatives to include cost allocations, County debt-worthiness, level of public investment, and opportunities for private sector financial participation. Key issues in this task that are expected to influence overall cost will be selection of wastewater management options, treatment technology, and the need for suitable acreage for land application-based treatments. It is also recommended that the County develop a coordinated infrastructure development plan with other public services (roadway construction/maintenance, transportation services, provision of water and pertaining to land use, projected densities, and protection policies (Recommendation 1) will be required to supplement revisions to the application process. In addition to the development of protective subdivision application requirements, the County should establish and incorporate into the application approval process the sewerage connection and O&M responsibilities for homeowners and developers to limit County liability for system failure or abandonment.

Implementation results from the task will require legal review and reconciliation with DNREC regulations set forth under 7 Del. C. Chapter 60. This task will require lead action from the New Castle Department of Planning and County Attorney's Office with cooperative review and concurrence from the WRA, DPW, and engineering office.

12.3.6 Recommendation 6 — Reclassify Platted (Unbuilt) Subdivisions

In addition to revising the subdivision application process to address future development, it is recommended that the County conduct an evaluation of present platted (but unbuilt) subdivisions to determine compliance with the ordinances developed under Recommendation 1 and application requirements established under Recommendation 4. The evaluation should result in reclassification of the existing platted subdivisions in accordance with ordinances and guidelines adopted by New Castle County. This could require revision and resubmittal of subdivision applications found to be in noncompliance. Citizen participation and involvement of the affected developer groups should be incorporated in the review as a working component of the decision-making process. Responsibility for this task includes integrated participation from the New Castle County Planning Board, DPW, WRA, and private sector concerns.

12.3.7 Recommendation 7 — Implement Comprehensive Groundwater Characterization Program

Existing information gaps in terms of environmental constraints on wastewater disposal options should be addressed. These efforts should include: 1) updating and refining the soils characteristics database in the planning area to support the siting of wastewater disposal facilities, where necessary; and 2) the development of area-specific groundwater data (in terms of quality and flow patterns) to allow an improved understanding of potential disposal requirements to ensure protection of this vital resource. Concurrently, the growing body of knowledge on the transport of pollutants in groundwater and the contribution of land disposal technologies to groundwater pollution should be closely monitored. Developments in analytic and modeling methods in combination with area-specific groundwater information can provide means of more definitively managing the implementation of land disposal options.

It is recommended that the County develop and implement a Comprehensive Groundwater Characterization Program consistent with the requirements of the Plan to protect groundwater resources and maintain continuous monitoring controls over the effectiveness of the adopted wastewater management systems. The County, with participation and input from DNREC, should review existing regulations and define specific monitoring and programmatic requirement (permits and regulations) to ensure protection of County and State groundwater resources. In addition, remapping of soils in the study area should be expedited to support development of land disposal options. This effort should be prioritized to address areas currently considered most promising (based upon soils mapping presented in this study) and areas of most immediate need (based upon development pressure). These areas would include the north and northwest portions of the study area (Boyd's Corner, Summit, and Middletown areas). Goals of the program should include development of transport models to support analysis and possible modification to set-back distance and minimum lot-size designations, soil suitability mapping, and consideration of innovative/alternative on-site and centralized treatment systems for future development.

Implementation of this recommendation will require lead actions from the New Castle County Water Resources Agency and DNREC.

12.4 RECOMMENDED SCHEDULING GUIDELINES

The capacity of the M-O-T facility will be exceeded by 1995. For the purposes of scheduling final implementation of the selected wastewater management alternative, a development period of 3 to 5 years is anticipated. This period includes adoption of the Southern New Castle Wastewater Needs and Evaluation Report finding to on-line status of the selected wastewater management system. The scheduling information presented in these recommendations assumes a median implementation period of 4 years to accomplish recommended actions based upon average requirements for planning, design, and construction of collection and treatment facilities. This estimate, however, is expected to vary significantly depending upon final alternative selection (Scenario 2 or 3). Scenario 2 will result in the most expeditious implementation period as a result of existing wastewater infrastructure and reduced design and construction activities than would be associated with the development of a new PSZ (Scenario 3). A timeline of schedules for initiation and completion of recommended activities is presented in Table 12-2 to suggest reasonable guidelines for New Castle County progress in accomplishing wastewater alternative selection, implementation of supporting regulatory mechanisms, and provision of on-line services. The schedule assumes a start date keyed to the submittal and adoption of the recommendations presented in this evaluation and proceeds through implementation of the selected wastewater management system in June 1996.

TABLE 12-2

SOUTHERN NEW CASTLE COUNTY

IMPLEMENTATION SCHEDULE

RECOMMENDATION	1992	1993	1994	1995	1996
1) Revisit land use Requirements Comprehensive Plan and Zoning Ordinances					
a. Establish Interim 3 acre minimum					
b. Land use and density					
c. Groundwater Protection					
2) Select Wastewater Management Scenario/Plan					
a. Finalize expansion plan					
b. Adopt final plan					
c. Develop Implementation Plan					
d. Prepare Request For Proposal					
e. Design and Construct Facilities					
3) Identify Infrastructure Facilities Planning Area and Timing of Services					
a. Financing study on					
b. Public investments					
c. Private sector finances					
d. Interim measures					
4) Revise Subdivision Application Process					
a. Analysis					
b. Refine timing					
c. Operation and Maintanence Requirements					

TABLE 12-2

SOUTHERN NEW CASTLE COUNTY

IMPLEMENTATION SCHEDULE

RECOMMENDATION	1992	1993	1994	1995	1996
5) Reclassify Platted (unbuilt) Subdivisions					
a. Suddivision applications					
b. Revision/ Resubmittal					
6) Implement Groundwater Monitoring Program					
a. Establish Interim 3 acre minimum					
b. Collect baseline groundwater quality data					
c. Perform groundwater modeling					
d. Remap soils					
e. Reveiw current regulations					
f. Revise Comprehensive Plan					
g. Establish new minimum lot size					

APPENDIX A

SOIL RATINGS FOR LAND APPLICATION USE

Soil Rating for Land Application Use							
ID No. (1)	Soil Symbol (2)	Slope	Drainage	Permea-bility	Restrictive Horizon	Texture	Overall Suitability
1	Ad	3	0	3	0	3	0
2	Ad	3	0	3	0	3	0
3	Am	3	0	0	3	0	0
4	Ba	3	0	0	3	3	0
5	Bu	3	3	3	2	3	2.8
6	Bu	3	3	3	2	3	2.8
7	Bu	2	3	3	0	3	0
8	Ch	3	3	3	3	3	3
9	Ch	3	3	3	3	3	3
15	Cs	3	3	3	3	3	3
16	Cs	2	3	3	3	3	2.8
17	Cs	1	3	3	3	3	2.6
18	Cu	0	0	0	0	0	0
22	Ek	2	3	3	3	3	2.8
24	El	3	0	0	3	3	0
25	Em	3	0	0	3	3	0
26	Em	3	0	0	3	3	0
27	En	3	3	3	3	3	3
30	Fa	3	0	3	3	3	0
31	Fs	3	3	3	3	3	3
39	Gn	2	0	3	1	3	0
41	Gp	0	0	0	3	0	0
42	Ha	3	0	3	3	3	0
45	Jo	3	0	3	3	3	0
46	Ke	3	0	0	3	3	0

Soil Rating for Land Application Use							
ID No. (1)	Soil Symbol (2)	Slope	Drainage	Permea-bility	Restrictive Horizon	Texture	Overall Suitability
47	Ke	3	0	0	3	3	0
48	Ke	2	0	0	3	3	0
49	Kp	2	0	0	3	3	0
52	Ma	0	0	0	3	0	0
53	Mc	3	3	3	3	3	3
54	Me	3	3	3	3	3	3
55	Me	3	3	3	3	3	3
56	Me	2	3	3	3	3	2.8
57	Me	2	3	3	3	3	2.8
58	Me	1	3	3	3	3	2.6
59	Me	1	3	3	3	3	2.6
60	Mk	3	3	3	3	3	3
61	Mk	3	3	3	3	3	3
62	Mk	2	3	3	3	3	2.8
63	Ms	3	3	0	3	3	0
64	Mt	3	3	3	3	3	3
65	Mt	3	3	3	3	3	3
66	Mt	2	3	3	3	3	2.8
67	Mt	2	3	3	3	3	2.8
68	Mv	3	0	0	3	0	0
69	Nm	3	3	3	3	3	3
70	Nm	3	3	3	3	3	3
71	Nm	2	3	3	3	3	2.8
72	Nn	2	3	3	3	3	2.8
74	Nn	1	3	3	3	3	2.6
77	Ot	3	0	3	3	3	0

Soil Rating for Land Application Use							
ID No. (1)	Soil Symbol (2)	Slope	Drainage	Permea-bility	Restrictive Horizon	Texture	Overall Suitability
78	Ou	3	0	0	3	0	0
79	Po	3	0	3	3	3	0
80	Ru	3	3	3	3	3	3
81	Ru	2	3	3	3	3	2.8
82	Sa	3	3	3	3	3	3
83	Sa	3	3	3	3	3	3
84	Sa	2	3	3	3	3	2.8
85	Sa	2	3	3	3	3	2.8
86	Sa	1	3	3	3	3	2.6
87	Sa	1	3	3	3	3	2.6
88	Sm	0	3	3	3	3	0
89	St	3	3	0	3	0	0
90	St	2	3	0	3	0	0
91	St	0	3	0	3	0	0
93	Ta	2	3	3	3	3	2.8
94	Tm	3	0	0	3	0	0
96	Wc	3	0	0	3	3	0
97	Wc	3	0	0	3	3	0
98	Wo	3	3	3	3	3	3
99	Wo	3	3	3	3	3	3
100	Ws	3	3	3	3	3	3
101	Ws	3	3	3	3	3	3

Footnotes:
(1) ID Number - as identified by New Castle County.
(2) Soil Symbol - as defined by the USDA SCS.
(3) Slope as mapped by the SCS:
- A = 0-3% - C = 8-15% - E = >25%
- B = 3-8% - D = 15-25%

Capability Class - as defined by the SCS.

(4) Drainage Class:

0 = Very poorly drained
1 = Poorly drained
2 = Somewhat poorly drained
3 = Moderately well drained
4 = Well drained
5 = Somewhat excessively drained
6 = Excessively drained

(5) Permeability:

0 = <.02 inch/hr, slow
1 = 0.2-0.6 inch/hr, moderately slow
2 = 0.6-2.0 inch/hr, moderate
3 = 2.0-6.0 inch/hr, moderately rapid

(6) Impermeable horizon:

X-fragipan horizon

(7) Textures

0 = Sand
1 = Loamy sand
2 = Sandy loam
3 = Silt
4 = Loam
5 = Silt loam
6 = Silty clay loam
7 = Sandy clay
8 = Clay loam
9 = Sandy clay
10 = Clay
11 = Silty clay

(8) On-site septic suitability rating as determined by the SCS:

1 = Slight limitation
2 = Moderate limitations
3 = Severe limitations

(9) Land Application Suitability Rating:

0 = Not suitable
1 = Low potential for land application use
2 = Moderate potential for land application use
3 = High potential for land application use

Land Application Criteria:

Slope = <15%
Drainage >4ft, well drained
Permeability = 0.02 inch/hr or better
DTW = 4 ft+
Impermeability = 0.02 inch/hr or better
Texture = SL, SCLL, SICLL, SIL, L (2,4,5,6,7)

	Not Suitable 0	Low 1	Moderate 2	High 3
Slope %	>25	15-25	8-15	0-8
Permeability (in/hr)	<0.02	-	-	>0.02
Drainage Class	0,1,2	-	-	3,4,5,6
Restrictive Horizon	<24 inches	24-36 inches	36-48 inches	>48 inches
Texture	0,1,3,8,9,10,11	-	-	2,4,5,6,7

APPENDIX B

EXAMPLE CHECKLIST ITEMS AND SUGGESTED INFORMATION FOR SUBDIVISION APPLICATIONS

APPENDIX B

EXAMPLE CHECKLIST
ITEMS AND SUGGESTED INFORMATION FOR SUBDIVISION APPLICATIONS

General Information

- Name and address of subdivision development project.
- Topographic map (7.5 minute USGS) with plotted development area.
- Project description narrative.
- Documentation of financial assurance.
- Plot plan of the subdivision development.
- Alternative analysis narrative.

Site Evaluation Information

- Site investigation and hydraulic conductivity test report.
- Total acreage, plot layout, and EDUs.
- Aerial photography or detailed surface topographic map showing drainage contours.
- Sensitive environments survey and mitigation plan (if applicable).
- Natural diversity inventory letter documenting resolution of conflict (if applicable).
- Statement of no impact to environmental resources and compliance with pollution prevention initiatives.

Wastewater Treatment Design

- Wastewater collection and treatment design (with PE approvals).
- Total sewage flows and wastestream analysis.
- Interim holding facility design and connection plan (if applicable).
- Discharge point plotted on topographic map for small-flow treatment facilities.
- O&M plan.

- Septage treatment and management plan.

Confirmations and Assurances

- Letter of credit or bonding (as required).
- Letter granting allocation to project (if applicable).
- Proof of public notification.

APPENDIX C

GROUNDWATER QUALITY MODELING

APPENDIX C

GROUNDWATER QUALITY MODELING

Many types of models can be used to evaluate the distribution of a conservative pollutant such as nitrate. The most commonly applied modeling technique in planning studies is that of mass-balance. In mass-balance modeling, the average concentration of contaminants is determined across an area, in this case a building lot. Various mass-balance models use different assumptions to calculate the average concentration of nitrate. For purposes of this study, four mass-balance models were evaluated in detail:

- A modification of the Douglas Nutrient Dilution Model by Hordon and Nieswand (1978).
- A mass-balance model by Kraeuter (1982) that used soils characteristics specific to the study area to calculate the amount of aquifer recharge (through application of a computer program called WATBUG).
- A wellhead recharge protection model used by Frimpter et al. (1988).
- A computer program for calculation of mass-balance nitrate contamination created by Geraghty and Miller (1989).

Each of the four models assumed that recharge water was provided by direct percolation of recharge through pervious soils and that dilution of nitrate-carrying groundwater was the primary means of improving groundwater quality. Also, all four models assumed that there was no destruction of nitrate or denitrification after nitrate pollution reached the groundwater, that is, nitrate behaved conservatively.

Each of the reviewed mass-balance modeling techniques had specific assumptions and techniques for its particular application. These specific characteristics may be summarized as follows:

- Hordon and Nieswand (1978) used the aquifer yield to determine the aquifer recharge rate and the amount of nitrate dilution that might by expected. They assumed that the steady-state rate of water withdrawal from the aquifer was equal to aquifer recharge. In addition, they employed a "pollutant renovation factor" that estimated the total denitrification capacity of the soil prior to nitrate impacting the groundwater. As with three of the four models reviewed, Hordon and Nieswand (1978) assumed a maximum allowable concentration of 10 mg/L total nitrate dissolved in the groundwater. In addition, this model assumed no contributions of nitrate other than from septic systems.

- Kraeuter (1982) used a mass-balance modeling approach that served as the basis for the current standard of a 2-acre minimum lot size for unsewered parts of the study area without self-supplied water. This study used information on soils types from a computerized water budget analysis referred to as WATBUG developed at the University of Delaware. In addition, this analysis used estimated rainfall for the 25th, 50th, and 75th percentile rainfall years for the study area. Rainfall for these percentile rainfall years was used to estimate when insufficient rainfall would be present to dilute nitrate to levels below the 10 mg/L MCL value. This model took into account soil type, land cover, temperature, and precipitation rate. One of the conclusions of this study was that soil permeability had little effect on the amount of recharge to the aquifer. Other soil properties, such as its ability to perform denitrification, were assumed to be negligible. This study concluded that a rainfall year below the 25th percentile (1 of 4 rainfall years on average, or 3 of 12 months during a year) would result in exceedances of the MCL for nitrate.

- The study by Frimpter et al. (1988) differed from the other three modeling techniques reviewed because its analysis focused on receptor locations. This model calculated the total nitrate loading at a receptor by summing the various effects of upgradient nitrate sources and estimating their impacts based on source concentration and distance from receptor. This model required a general knowledge of groundwater flow direction near the receptor. In addition, specific knowledge of the receptor's geologic setting was assumed. This modeling study used a planning goal of 5 mg/L maximum nitrate concentration. One of the limitations of this modeling approach was that each potential receptor was evaluated separately and the effects of each possible nitrate source were evaluated differently for each receptor.

- The fourth model reviewed was produced by Geraghty and Miller (1989) as a quantitative modeling technique for establishing the maximum density of septic systems. Using a computer program, this model accounted for sources of nitrate other than septic systems, including the concentration of nitrate in precipitation, and from sources of nitrate such as lawn or crop fertilization. In addition, the model was capable of accounting for pervious and impervious land surfaces and the denitrification capacity of the soil. Other parameters, such as annual precipitation, soil type, and climate, could also be used as input. Despite the large number of variables that were accounted for in this model, each parameter had to be estimated. Estimates of each parameter were difficult to generalize for the study area.

The common weakness of the reviewed mass-balance modeling approaches was that each neglected to account for the natural plume that forms at, and downgradient of, a septic system. Because mass-balance approaches average over the entire building lot, they ignore near-source changes in nitrate concentrations. In these studies that used a maximum allowable nitrate concentration of 10 mg/L, the averaging of concentrations would almost certainly result in concentrations of nitrate exceeding MCL values because all four models assumed nitrate source concentrations of 30 to 50 mg/L. For this reason, the modeling approaches that were reviewed, and mass-balance models in general, are not considered to be the most appropriate method for calculating the density of septic systems in the study area.

WATER RESOURCES AGENCY
FOR NEW CASTLE COUNTY

MEMORANDUM

TO: Southern New Castle County Wastewater Needs Evaluation and Plan
Project Management Committee

FROM: R. Peder Hansen *RH*
Engineer

DATE: April 2, 1992

SUBJECT: Public Comments on the Weston Report

Enclosed are the public comments received as of close of business on April 1, 1992. The comments received include one oral comment via phone and three written comments.

Please review these comments for discussion at the PMC meeting scheduled for April 7, 1992 at 1 p.m. at DNREC in Dover.

2701 CAPITOL TRAIL, NEWARK, DELAWARE 19711 (302) 731-7670

WATER RESOURCES AGENCY
FOR NEW CASTLE COUNTY

MEMORANDUM

TO: File

FROM: R. Peder Hansen
Engineer

DATE: March 13, 1992

SUBJECT: Public Comment, RE: So. NCC WWNEP

I received a call today from Mr. James Bailey, 205 Money Road, Townsend, DE 19734. He wanted to convey his comments on the Southern New Castle County Wastewater Needs Evaluation and Plan. His comment was essentially "Why not just discharge the treated wastewater in the Delaware River? It is being done by the City of Wilmington, Port Penn, and Delaware City, why not here?"

2701 CAPITOL TRAIL, NEWARK, DELAWARE 19711 (302) 731-7670

MAR 3

March 17, 1992

315 Thomas Landing Road
Middletown, De. 19709

Mr. Peder Hansen
Water Resources Agency for
New Castle County
2701 Capitol Trail
Newark, De. 19711

Dear Mr. Hansen,

In response to your request for recommendations or comments regarding spray irrigation on the Sheats' farms, I respectfully submit a viable alternative. I understand that the sewage treatment plant in Delaware City works very well with minimum problems. New Castle County owns enough land where the present M.O.T. plant is located to build a plant big enough to handle the sewage and then dispense it into the river. We are opposed to spray irrigation because of the potential hazzard to our drinking water because of the recharge area, and to air quality. There are fresh water wetlands on most of the farms in this area, and we want to preserve our clean water, air, and Natural resources.

Thank you,

Mary Harris

Mary Harris

Division of Water Resources

Water, the state and nation's most vital natural resource, cannot be taken for granted. When we turn on the faucet, we expect plenty of good, clean water. But we are coming face to face with the reality that water supplies are not unlimited and that the wastes we dump on the land can end up in our drinking water.

Conserving and protecting our water resources is everybody's responsibility -- government, industry, farmers, individuals. Each of us in Delaware benefits from clean water; we must learn to be its guardian.

The Division of Water Resources monitors, manages and protects Delaware's ground and surface waters, wetlands and underwater lands by:

- permitting wells and septic systems
- regulating spray irrigation and other land treatment of wastes such as sludge
- protecting Delaware's sensitive coastal areas, tidal wetlands and underwater lands from inappropriate uses
- helping towns pay for new or upgraded wastewater treatment systems

Phone numbers you can use

Citizen complaints -- 1-800-662-8802

Septic system permits/site evaluations -- 739-4691 or 856-4561

Well permits -- 739-4793

Development Advisory Service -- 739-6399

Stream Quality -- 739-4590

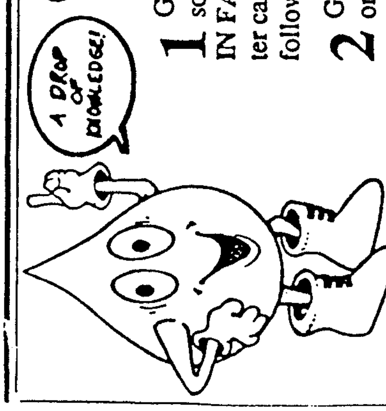
Stream discharge/sludge/spray permits -- 739-5731

Inland Bays/Delaware Bay programs -- 739-4590

Delaware Department of Natural Resources and Environmental Control
89 Kings Highway Dover, DE 19901

GROUNDWATER -- Delaware's buried treasure

Some Common Groundwater Myths



Groundwater provides drinking water for two-thirds of the people in Delaware.

1 Groundwater always flows from north to south.
IN FACT: Depending on location, groundwater can flow in any direction -- but usually follows land contours!

2 Groundwater flows in underground rivers or lakes.
IN FACT: Groundwater flows through cracks and pores between soil and rock particles!

3 Groundwater drawn from wells has been underground thousands of years.
IN FACT: Typical drinking water wells in Delaware yield groundwater a few years to a few decades old!

4 Groundwater is always pure because soil filters out all impurities.
IN FACT: Harmful bacteria in water can be filtered out by soil, but many chemical pollutants are not changed and remain in the water!

5 If water is stained, it must be polluted.
IN FACT: Stained water doesn't necessarily mean that it's contaminated!

6 Everything we put on the ground pollutes water.
IN FACT: Soil bacteria, air and water can break down many but not all substances!

Doc. No. 40-08/91/07/01

MAR 3 0

Odessa - Delaware - 19730

March 27, 1992

Water Resources Agency
c/o R. Peter Hansen
2701 Capitol Trail
Newark, DE 19711

Dear Sir:

I'm opposed to Spray irrigation as a means of sewage disposal.

An alternative to the above method is, a pumping station drawn by architect Mr. Douglas Robb. This can be found in the New Castle County Department of Public Works. It was designed August 23, 1978 and printed October 22, 1979. The contract number is 1978 - 32.

It is a "Pumping Station with Future Plans".

Sincerely yours,

Leonor P. Hampson

Leonor P. Hampson

RECOMMENDATIONS FOR WASTEWATER DISPOSAL FOR LOWER NEW CASTLE COUNTY BY THE PUBLIC

(as suggested by Mr. Zimmerman of D.N.R.E.C. at public meeting March 3, 1992)

On page 10-15 of "Wastewater Evaluation and Plan for Southern New Castle County", "IIIA Conventional Secondary Treatment With Surface Water Discharge", it states that although discharging into streams protects groundwater, it introduces polutents into the water body, constructing this kind of facility is more costly than lagoons. NOT SO!

The county estimated that costs will be between $10,000,000 and $13,000,000 for the lagoon and spray system.

Before the resolution to "Amend the Capital Program to Revise the Project Description of the M-O-T Treatment Plant Upgrade (W36)" was introduced and adopted on April 23, 1991, county engineers had apparently planned to upgrade the existing plant to increase capacity of the plant from .65 m.g.p.d. to 3.0 m.g.p.d. at a cost of $10,747,000. The county would be getting three times the capacity for the same or less expenditure.

Why did county spend hundreds of thousands of taxpayers money on studies, testing and evaluation when they already had a plan to upgrade the existing plant? A correctly engineered plant should expell an acceptable level of effluent into a stream that empties into the Delaware River. Rivers have great potential to cleanse themselves, especially the mouth of the river that empties into the bay. The Appoquinimink empties into the part of the Delaware that is near that point.

Continuing with the proposal to use lagoons and spray fields, county will request at a later date more money to buy more land to accomodate more spray fields and lagoons.

Consideration should be given to the request by N.C.C. to D.N.R.E.C. to empty 900,000 g.p.d. from existing plant into the Appoquinimink Creek, even though a considerable sum must be allocated to upgrade the plant; a less expensive and a more acceptable solution than a regional land application system on controvertial sites.

Modification of existing plant that would limit nutrient discharge, primarily phosphorous, should be considered. This recommendation was in the initial planning and was ignored. Upgrading of the plant would then give the M-O-T area 3.0 m.g.p.d., more than the 1.5 m.g.p.d. being requested at present.

Observations and recomendation by Estell wisniewski

Introduced by: Mr. Roberts
4/23/91

RESOLUTION NO. 91- 102

AMEND THE CAPITAL PROGRAM TO REVISE THE PROJECT DESCRIPTION OF THE M.O.T. TREATMENT PLANT UPGRADE (W36)

BE IT RESOLVED: That the Capital Program for New Castle County as approved by Resolution No. 90-108 is hereby amended by deleting the matter in brackets and adding the matter underlined on the attached Exhibit "A".

Adopted by County Council
of New Castle County on

President of County Council
of New Castle County

SYNOPSIS: This Resolution would amend the M.O.T. Treatment Plant Upgrade (W36) description to include spray irrigation options and alternative sites.

FISCAL NOTE:

This resolution would approved changing the description of the M.O.T. Treatment Plant Upgrade (W36) description to include spray irrigation options and alternative sites. Since this description change has been included in the proposed FY'92 Capital Program, a FY'92 program amendment will not be necessary.

EXHIBIT "A"

NEW CASTLE COUNTY
CAPITAL PROGRAM
FY 1991-1996
(in thousands)

Department: Public Works
Activity: Sanitary Sewers
Development Program: Treatment / Process

Proj. No.	Project Information	Funding Source	Prior Auth.	Avail. Balance 2/28/90	Obligated Amount 2/28/90	%	1991	1992	1993	1994	1995	1996	Bal. to Complete	Total Cost
W05	TREATMENT PLANT IMPROVEMENTS	BONDS		-	-	-								0
		FEDERAL		-	-	-								0
		STATE		-	-	-								0
	Description:	OTHER	50	-	-	-								50
	Various Capital Equipment replacements and upgrades at County treatment plants.	TOTAL	50	3	47	94%	0	0	0	0	0	0	0	50
	Timing: Complete	Work Description through 1990: Deauthorize					through 1991:				Balance 1992 to Completion:			
W36	M.O.T. TREATMENT PLANT UPGRADE	BONDS	2500	-	-	-		8000						10500
		FEDERAL		-	-	-								0
		STATE		-	-	-								0
	Description:	OTHER	247	-	-	-								247
	Increase Capacity of Treatment Plant from .65 mgd to 3.0 mgd. Spray Irrigation options & Alternative Sites	TOTAL	2747	2553	194	7%	0	8000	0	0	0	0	0	10747
	Timing: Construction FY92	Work Description through 1990: Purchase spare RBC Modification to RBC process to increase from .65 to .90 mgd					through 1991: Engineering Design for Expansion				Balance 1992 to Completion: Expansion to 3.0 mgd Funding revisions to account for Middletown contribution ($6.3mil)			
	LABORATORY FACILITY	BONDS		-	-	-		200						200
		FEDERAL		-	-	-								0
		STATE		-	-	-								0
	Description:	OTHER		-	-	-								0
	Relocated and Expanded Laboratory Facilities	TOTAL	0	0		0%	0	200	0	0	0	0	0	200
	Timing: FY92	Work Description through 1990:					through 1991:				Balance 1992 to Completion: Construction			

D-8

4/22/91

RECOMMENDATIONS FOR WASTEWATER DISPOSAL FOR LOWER NEW CASTLE COUNTY BY THE PUBLIC

(as suggested by Mr. Zimmerman of D.N.R.E.C. at a public meeting March 3, 1992)

In reviewing maps of "Land Application System Site Suitability" with"Groundwater Exclusion Zones", I question the choice of the site presently being considered for regional land application sewage disposal system, as the site is relatively small in comparison to similar areas west and north and south of Odessa.

It is my opinion that suitability sites as defined on these maps would accept numerous incividual land application systems and, or regional systems on a smaller scale.

As personell connected with New Castle County wastewater disposal planning have said at public meetings, that they would consider disposing of the present plant once a land application system was installed, there is then no reason to continue to zero in on the area southeast of Odessa as the dumping ground for all of the M-O-T growth area. Granted, the infrustructure already in place makes it an attractive solution, but the pipeline from the Silverlake pumping station to the Odessa pumping station has been a continuing problem with ghost dumping of unknown contaminents.

Buying land in the immediate area south and west of Middletown (condemning land if necessary) would eliminate this lengthy pipeline and it's problems by discharging directly into lagoons and spray fields.

Granted, there are residences in that area and land owned by St. Andrew's School, and that the administrators of the school would not readily agree to the proposal to sell land or to lease it for a twenty year period(suggestion: students could run track around lagoons) and concemnation would have to be considered. Take note, however, that there are residences surrounding the Sheats dairy farm optioned by the county for that purpose. The fear of contamination of ground water and concern for esthetic value is just as great as it would be in that area south and west of Middletown. This area southeast of Odessa is not as isolated an area as New Castle County would like it to be, or has perceived it to be.

Observations and recommendations by Estella Wisniewsli

continued page 3

RECOMMENDATIONS FOR WASTEWATER DISPOSAL FOR LOWER NEW CASTLE COUNTY BY THE PUBLIC

(as suggested by Mr. Zimmerman of D.N.R.E.C. at a public meeting March 3, 1992)

If the county continues to be adamant in pursuing their present plan to purchase the site southeast of Odessa, the county should then be prepared to buy every home in the vicinity at a cost that would enable property owners to duplicate existing homes and landscapes. These homes are adjacent to the Sheates dairy farm, across a secondary two lane road and others backing up to the Sheats property. The county could then recoup costs by selling these properties

When this site was chosen for this lagoon, spray irrigation system,no consideration was given to the impact it would have on the people living in the immediate area. We were not notified, we had no inkling of the county's plans. Our protests and suggestions at public meetings since last May have at times been met with ridicule, this is the way I at times have perceived the reaction by public officials.

There are many farms surrounding Middletown, the town where most of the sewage comes from; lagoons could be situated on one site and effluent piped to another site as is the system for the town of Oxford, Pa. Federal funds were used for their system. New Castle County should try for Federal funds. New Castle County decided not to go for Federal funding in I975 due to E. P. A. regulations creating delay. Hasty decisions were made then, hasty decisions are being made today. Hasty decisions in the 70's concerning the existing sewage disposal plant for the M-O-T area resulted in apparently inappropriate design for the plant resulting in the inability of the existing plant to process the sewage effectively for the I.0 million gallons per day originally voted for by Odessa, Townsend and Middletown. This has resulted in new plans being formulated just ten years after beginning of present plant operations, although it was to have been part of a twenty year waste water treatment plan, resulting in New Castle County taxpayers again having to pay for expensive evaluation and proposed installation of an entirely new sewage disposal system

Poor decisions were made then, and poor decisions are being made now.

Observations and recomendations by Estell Wisniewski

continued page 4

RECOMMENDATIONS FOR WASTEWATER DISPOSAL FOR LOWER NEW CASTLE COUNTY BY THE PUBLIC

(as suggested by Mr. Zimmerman of D.N.R.E.C. at a public meeting March 3, 1992)

Consideration should be given to piping effluent from lagoons near Middletown to state owned Blackbird forest. This proposal should be thoroughly evaluated; "requirements to disinfect wastewater could be waved when wastewater is irrigated in remote or restrcted use sites such as forests(1) thus saving cost of installation of equipment." Apparently a forest has the potential of excellent removal efficiency of nitrogen and phosphorous."(2)

Apparently trees grow faster when irrigated with effluent, thus producing products that can be used by the state to foster activity with monetary reimbursement to the state.

If county is adamant in pursuing installation on the Sheats farm, southeast of Odessa, county should consider permitting the farm to revert to forest, thus preventing runnoff, contributing to esthetic value of surrounding area and hopefully aleviating polution of groundwater.

County till now has permitted entire forests to be levelled by developers who put up forests of housing in its stead, resulting in problems of sewage disposal, loss of potable water, flooding, and lack of other necessary infrastructure.

Constituents should hold their elected officials responsible for hasty decisions that cannot be reversed.

Perhaps responsibility for disposal of sewage from Middletown and Townsend should revert back to those respective municipalities, and developers of new developments south of the C. and D. canal should shoulder responsibility for a separate combined system, and not expect the entire taxpaying population of N. C. County to continue subsidizing solutions to problems created by rapacious overbuilding of N. C. County by greedy developers.

(1) page 5-20; fourth paragraph; Wastewater Evaluation and Plan for Southern N. C. County 1/19/92

(2) page 63; E.P.A. Municipal Waste Water Reuse; Selected Readings on Waste Reuse 9/91

Observations and recommendations by Estell Wisniewski

continued page 6

RECOMMENDATIONS FOR WASTEWATER DISPOSAL FOR LOWER NEW CASTLE COUNTY BY THE PUBLIC

(as suggested by Mr. Zimmerman of D.N.R.E.C. at a public meeting March 3, 1992)

The E.P.A. in a public release- "Health Effects of Land Treatment; Is it really safe" states that the "Clean Water Act" requires that land treatment systems must meet certain standards just like traditional systems. Both must ensure the safety of discharge into surface waters, but because land treatment can impact groundwater supplies, such systems must ensure that all discharges into groundwater acquifers will not contaminate the drinking water".

The concept of lagoons for holding raw sewage is perceived to be a safe concept. I perceive them as huge cesspools. Would you want three enormous cesspools encompassing forty-five acres in your back yard? One million gallons of untreated sewage per day flowing in and passed on by gravity flow to the next to be sprayed onto the remaining three hundred acres of farmland. Lagoons situated outside of the town of Oxford, are miles out-of town, with high wire fencing to keep children and animals from drowning in the muck. This is what New Castle County is planning to put in our back yards and front yards.

Lagoons can leak, regardless of what county advisers claim. Even a foot and a half clay liner specified by the E.P.A. cannot keep muskrats from burrowing through permitting raw sewage to flow through and leach into ground water or flow onto land with human habitations or into wetlands. These lagoons are ten to twenty feet deep with the muck at the bottom cleaned only perhaps once every three years. The muck,or sludge,is considered to be an additional liner.

Recommendations for maintaining the lagoon system in Laurel, Del. were to hire a keeper that would become a part time hunter, besides becoming a part time expert on mosquito control and on algae. Recommended equipment-a twenty-two caliber rifle, traps, bait, and cyanide pellets. (1)

(1)"Morning News, January6, 1965 by Nan Clements and February 3, 1965 by Larry Van Goethem

Observations and recommendations by Estell Wisniewski

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
& ENVIRONMENTAL CONTROL
DIVISION OF WATER RESOURCES
89 KINGS HIGHWAY, P.O. BOX 1401
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POLLUTION CONTROL BRANCH (302) 739-5731
FACILITY SUPPORT BRANCH (302) 739-5081
WETLANDS & AQUATIC PROTECTION BRANCH (302) 739-4691

May 11, 1992

Mr. James Bailey
205 Money Road
Townsend, DE 19734

Dear Mr. Bailey:

Thank you for your comment on March 13, 1992 via telephone on the Southern New Castle County Wastewater Needs Evaluation and Plan. As I understand it, your comment essentially is why not just discharge the treated wastewater from the M.O.T. plant to the Delaware River because it is being done by the City of Wilmington, Delaware City, and Port Penn?

Direct discharge to the Delaware River from the M.O.T. plant has significant shortcomings when compared to other options (spray irrigation or discharge to the Appoquinimink River). There is the economic cost of additional pipeline required, the additional environmental cost of alteration or destruction of wetlands during pipeline construction, the additional environmental threat from pipeline breaks, and the additional regulatory hurdles (U.S. Army Corps of Engineers, Delaware River Basin Commission) to be overcome to name a few. The present worth economic cost alone is estimated at $32,125,000 ($10,708/1000 gallons of capacity) compared to $14,464,000 ($7,232/1000 gallon of capacity) for spray irrigation.

Because of the shortcomings cited, direct discharge to the Delaware River has not been recommended as an option for wastewater disposal in Southern New Castle County. Again, thank you for your comments, and if you have additional comments or questions, do not hesitate to contact Peder Hanson at (302) 731-7670.

Sincerely,

Robert J. Zimmerman, Chairman
SNCC Wastewater Mgmt. Plan
Project Management Committee

Delaware's good nature depends on you!

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May 11, 1992

Ms. Mary Harris
315 Thomas Landing Road
Middletown, DE 19709

Dear Ms. Harris:

Thank you for your comments regarding spray irrigation on the Sheats' farms. You are correct in that a larger treatment plant could be built at the present M.O.T. plant site. However, a surface water discharge plant would also generate potential hazards to our drinking water, air quality, and fresh water wetlands. Spray irrigation offers better environmental protection at a lower economic cost than direct stream discharge.

We share your concerns over protection of our environment and natural resources. Spray irrigation will only be permitted on the Sheats' farm after sufficient demonstration (through the Design Development Report which is currently under preparation) that the facility will not deleteriously affect the drinking water, air quality, wetlands and natural resources of the area.

If you have additional comments or comments, do not hesitate to contact Peder Hansen at (302) 731-7670.

Sincerely,

Robert J. Zimmerman, Chairman
SNCC Wastewater Mgmt. Plan
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May 11, 1992

Ms. Leonor P. Hampson
P.O. Box 77
Odessa, DE 19730

Dear Ms. Hampson:

Thank you for your comments regarding spray irrigation as a means of sewage disposal. The pumping station you refer to in your letter is part of the current M.O.T. collection and conveyance system. The pumping station therefore can not serve as an alternative spray irrigation.

Again, thank you for your comments. If you have additional comments or questions, do not hesitate to contact Peder Hansen at (302) 731-7670.

Sincerely,

Robert J. Zimmerman, Chairman
SNCC Wastewater Mgmt. Plan
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May 11, 1992

Ms. Estelle Wisniewski
139 Taylors Bridge Road
Townsend, DE 19734

Dear Ms. Wisniewski:

Thank you for your comments and recommendations concerning wastewater disposal for southern New Castle County. The purpose of this letter is to reply to your concerns. Your comments and recommendations relate directly to the proposed upgrade/expansion of the existing M-O-T wastewater treatment plant, located east of Odessa, Delaware. Questions contained in your correspondence, submitted for the public meeting of March 3, 1992, concern technical issues, the rationale for selecting the Sheats Farm as a proposed spray irrigation site, and various editorial comments. In order to systematically answer your questions and concerns we have grouped same into eight general categories as follows:

1. A stream discharge wastewater system is more cost-effective than the lagoon spray irrigation system proposed for the Sheats Farm. The County's choice of using the Sheats Farm for spray irrigation is questioned.

2. Adequate considerations were not given to other areas in the M-O-T region for placement of a lagoon spray irrigation system.

3. The proposed lagoon spray irrigation system at the Sheats Farm will have a negative impact on adjacent property values as well as people living in the immediate area.

4. Effluent from the proposed spray irrigation system may be allowed to runoff into adjacent creeks and wetlands.

5. Ground water aquifers which supply local wells may be polluted by the proposed spray irrigation system.

6. Lagoons are not safe for treatment and storage of wastewater and can leak.

7. Health problems will arise due to mosquitoes.

8. Recreational and forest uses should be considered with the proposed spray irrigation systems at the Sheats Farm.

The following are our observations and discussions concerning your public comments.

1. **A stream discharge wastewater system is more cost-effective then the lagoon spray irrigation system proposed for the Sheats Farm.**

New Castle County did consider various alternatives, including stream discharge, land treatment, and a combination of the two, for the expansion and upgrading of the M-O-T wastewater treatment plant. As will be discussed and presented below, New Castle County found that maximizing stream discharge, was not as cost-effective as the proposed lagoon and spray irrigation system for the Sheats Farm. Following is a brief history of the upgrade/expansion of the M-O-T project.

January 1990 - April 1990

In April 1990, BCM Engineers, Inc. completed an alternative Study to increase the capacity of the M-O-T treatment plant from 0.5 million gallons per day (MGD) TO 3.0 MGD. The study, which was conducted to respond to developmental pressures in the area, included the evaluation of several methods to reach a 3.0 MGD capacity.

At the conclusion of the study, BCM recommended that the M-O-T expansion be performed as a two phase process. Phase I would be an interim solution to increase the existing plant's capacity to 0.9 MGD. This phase would relieve initial developmental pressures while the more extensive Phase II was implemented. The Phase II project for 2.1 MGD would be constructed at the existing site.

BCM's cost estimate for the capital expenditure for a 3.0 MGD stream discharge plant was $14,622,000. Of the $14,622,000 original estimate, $4,472,000 was required for upgrading sludge dewatering and for composting facilities. This cost did not include legal, administrative of engineering fees, a construction bond, or a contingency. Adjusting the BCM estimate to include a bond, engineering , and a contingency brings the total to approximately $17,500,000. In addition, BCM estimated that the annual operation and maintenance (O&M) costs for this alternative to be $1,023,800. The present worth of this alternative has been calculated to be $27,476,593 or $9,159/1000 gallons of treatment capacity.

April 1990 - January 1991

The BCM study also included an evaluation of the assimilative capacity of the Appoquinimink River for receiving the increased discharges from the M-O-T plant. The study determined that discharges of up to 5.0 MGD from the M-O-T plant would not have an adverse impact on the water quality, human health and aquatic life in the Appoquinimink if the discharge quality remained at 15 mg/l each for BOD5 and suspended solids. A report of this investigation was submitted to the Delaware Department of Natural Resources and Environmental Control (DNREC).

BCM and DNREC disagreed over the study's conclusions. DNREC felt that the Appoquinimink could not support any additional nutrient load above the current levels. DNREC stated that they could not sanction any expansion at M-O-T that would exacerbate the current situation. In January 1991, DNREC notified the County that phosphorus limits would be established for the M-O-T plant when the permit was issued for the requested 0.9 MGD. DNREC also stated that dechlorination system for disinfection would be required to eliminate chlorine in the effluent. DNREC further indicated in their January 1991 letter that they had additional concerns about discharges to the river beyond 0.9 MGD based on an effluent quality of 15 mg/l, BOD5 and suspended solids. DNREC stated that they believed that it was in the County's best interest to consider land treatment for the future. This was confirmed in the pending new (draft) National Pollution Discharge Elimination System (NPDES) permit.

February 1991 - December 1991

Recognizing the time delays and futility in challenging DNREC's decision, and facing the prospect that: (1) The existing plant flow had already exceeded the permitted capacity causing New Castle County to be subject to violations and fines; (2) New Castle County had to meet contractual obligations to Middletown to accommodate 750,000 gallons per day of wastewater flow, and (3) DNREC had limited the stream discharge to a maximum of 0.9 MGD. The County started early in 1991 looking at other options (other than the one recommended by BCM), including land treatment. The County recognizes that in order to meet the contractual agreement with Middletown and future growth demands in the area, a capacity beyond 0.9 MGD was required.

In April 1991, New Castle County Council amended the capital program by revising the project description of the M-O-T treatment plant upgrade (Department of Public Works project number W36. The budget reflects the total County contribution to the 3 MGD expansion at $10,747,000. The budget also anticipated a balance of $6,300,000 to be contributed by Middletown after the plant is expanded to 3 MGD. The budget total

($10,747,000 + $6,300,000 =) $17,047,000 is consistent with the BCM figures as mentioned above. Around that time, the County retained Tatman & Lee Associates to conduct a study of methods to incorporate land treatment into the M-O-T system. Eight public forums have been held to present and discuss land treatment (spray irrigation) with interested citizens.

In the first meeting at Odessa Fire Hall on May 29, 1991, the County gave a brief background history of the M-O-T plant. The County pointed out that while the plant can not meet the expected capacity of 1.0 MGD, it has demonstrated high waste removal efficiency at lower flow rate. As a matter of fact, the plant received an award from EPA in 1987 for its outstanding performance. One major weakness of the plant is its lack of storage or buffering capacity to allow a part of the plant to be taken out of service for the purpose of handling major plant maintenance and any up-set problems. As the County unveiled the land treatment proposal, many people voiced their opposition to land treatment. The people also voiced concern about the County's management of the plant. We presented the reorganization and improvements the Public Works Department has undertaken to improve operation and maintenance of the County's sewer facilities. The County wants to do the right thing in serving all the citizens. The County set up a citizen advisory committee to inform and share input. The County also offered interested citizens a chance to tour spray irrigation facilities at Oxford, Pa, Longwood Gardens and Kendal at Longwood. As these meetings progressed, the people became more informed and the opposition diminished to a small group.

In August 1991, DNREC issued a preliminary draft permit for the M-O-T plant with a flow limitation of 0.9 MGD. In the draft permit, an 18 month compliance schedule to meet the phosphorus and chlorine limitations is dictated. The draft permit also mandates that the County "fully evaluate land treatment options and to the maximum extent practicable utilize land treatment technology to achieve compliance with the phosphorus limits".

Spray irrigation is not new technology. It has many technical and environmental benefits which other waste treatment alternatives do not have. It is simple to maintain. The County also recognizes that spray irrigation systems are favorably endorsed by both DNREC and EPA as environmentally sound. Spray irrigation is also endorsed by local environmental groups or agencies such as the Brandywine Valley Association, the Delaware Nature Society and the Water Resources Agency, as a viable wastewater treatment alternative which offers environmental benefits. Roy F. Weston, the engineering firm which has just completed the wastewater management plan for southern New Castle County, has recommended land treatment as the best treatment alternative to be considered for future planning options for the area south of the canal.

In the fall of 1991, a study of various combinations of stream discharge and spray irrigation options for the M-O-T area was completed. Two alternatives were determined to be the most favorable. One of these has a total capacity of 2.0 MGD including 0.5 MGD of discharge to the Appoquinimink, 0.5 MGD spray irrigation at the Wiggins Farm and 1.0 MGD of spray irrigation at the Sheats Farm. The capital cost for this alternative was estimated to be $12,710,600. This estimate includes the purchase of the Sheats Farm, bond, contingency, and engineering fees. The annual O&M costs were estimated to be $287,600. The present worth of this alternative is $14,463,960 or $7,232/1000 gallons of capacity.

While these alternatives were developed, the alternative to build a conventional 3 MGD plant at the existing M-O-T with 20,000 feet of outfall pipe line for discharge directly into the Delaware River were examined. Approximately 2,000 feet of the outfall pipe would be in sensitive wetlands and would require special construction with piles to minimize damage to the wetlands. The capital cost for this alternative is estimated to be $21,750,000 and the annual Operation and Maintenance (O&M) cost is estimated to be $1,066,242. The present worth of this alternative is $32,125,059 or $10,708/1000 gallons. It is estimated that it would take at least two years to secure all the necessary environmental permits. It is evident that this option is not feasible.

2. **Adequate consideration was not given to other areas in the M-O-T region for placement of a lagoon spray irrigation system.**

As our consultant, Tatman and Lee Associates have evaluated 26 wastewater alternatives and presented these alternatives at three public meetings. Enclosed as Attachment A is a summary of the wastewater alternative analysis to upgrade and expand M-O-T dated October 10, 1991. This study clearly shows that areas were considered in the Townsend and Middletown regions as well as in the vicinity of the existing wastewater treatment plant. This extensive analysis used a detailed criteria evaluation including cost to determine that the utilization of the Sheats Farm and the Wiggins Farm, located north of Townsend, was the most cost effective solution. As required by the draft NPDES permit, New Castle County will present a detailed feasibility study to the Department of Natural Resources and Environmental Control (DNREC) which will present the evaluations of these alternatives.

3. **<u>The proposed lagoon spray irrigation system at the Sheats Farm will have a negative impact on adjacent property values as well as people living in the immediate area.</u>**

Lagoon/spray irrigation systems have been used in the United States since as early as 1890. It is reported that there are over 7000 of these lagoon/spray irrigation systems in operation in the United States.

Extensive research and studies of these facilities have been performed. For example, in 1981 the Environmental Protection Agency conducted an investigation titled "The Effects of Wastewater Spray Irrigation Systems on Adjacent Residential Property Values". As shown on Chapter 5, titled "Conclusion", the following is stated: "However, neither the recorded data collected nor the interviews conducted have proven conclusively that adjacency to a spray irrigation system adversely affects residential property values. On the contrary, the sales data collected seems to indicate that the buffers and open space character of the spray irrigation system have added value to properties located nearest to those facilities".

Penn State University, located in State College, Pennsylvania, has a spray irrigation system which has been in operation for over 25 years. At a public meeting held on December 5, 1991 in Middletown, Dr. William Sopper reported that the spray irrigation system has not negatively impacted adjacent property values. In State College, the spray irrigation system has been an asset and, if anything, adjacent property values have tended to increase.

In July 1973 the American Public Works Association, in cooperation with the Environmental Protection Agency, conducted a field survey of 100 facilities where spray irrigation was utilized for domestic or industrial wastewater effluent disposal. Conclusion #21 on Page 4 of that report states, "Observations in the field and surveys of land application systems did not reveal the existence of specific health hazard and disclosed very little concern over threats to the health of on-site workers, residence of neighboring areas, domestic animals or wildlife or of those who consumed or came in contact with the land applied wastewater".

In addition, it must be recognized that throughout the United States, spray irrigation systems are used where there is a high level of public exposure to the disposal system. This would include golf courses, park lands, picnic areas, college grounds, lawns of residential communities as well as football fields.

4. **Effluent from the proposed spray irrigation system may be allowed to run off into adjacent creeks and wetlands.**

A specific goal of the design and operation of spray irrigation systems is to prevent direct runoff of the treated wastewater. This is accomplished by irrigating only when there is vegetative cover on the soils and by applying the wastewater at an application rate less than 1/4 inch per hour.

As part of the site evaluation conducted at proposed spray sites in Delaware, soil permeability testing is performed. These tests determine how quickly the soil can absorb the treated wastewater. The results of the tests are utilized during the design to choose a spray application rate lower than the rate at which the soil can accept the water; therefore, runoff does not develop.

Also, the spray fields are divided into "zones"; often seven zones are utilized. Each zone is irrigated only one day a week, receiving up to a maximum of 2-1/2 inches of treated wastewater. Generally, after an area has been irrigated, it is not again irrigated for another seven days.

Finally, there is provided a buffer zone, which is an area between the wetted spray areas and any adjacent areas such as roads, creeks, and wetlands. This buffer zone assures no impact on the adjacent areas.

In addition to the vegetation, buffer zones, and benefits from the moist soils, the design and placement of an irrigation system is performed with slope considerations in mind. Irrigation will not occur on steep slopes.

In summary, the well designed and operated spray irrigation systems in the area, including Delaware and Southeast Pennsylvania, have had no reports of problems with runoff.

5. **Groundwater aquifers which supply local wells may become polluted by the proposed spray irrigations system.**

One of the most significant benefits of a spray irrigations system is that it provides a "living filter" mechanism because of the vegetation cover and the soil itself. The treated effluent is further treated by the land application practice to make the water potable and safe for recycling. There are many spray irrigation systems in the United States which are used to provide a source of recharging the groundwater supply so that it may be used again as drinking water. In the referenced survey done by EPA and the American Public Works Association in 1973, out of 100 spray irrigation systems there were no reports of groundwater contamination. In addition, there are local systems that spray over or adjacent to public water supplies allowing the treated wastewater, after filtration through the vegetation and soil, to be reused. These systems are at Oxford, Pa. and the Penn State University.

More specifically, in relationship to the Sheats Farm, it is recognized that a portion of the farm is in a resource protection area. The Design Development Report, as required by the DNREC, must demonstrate that the groundwater will not be polluted by the sprayed effluent. The Design Development Report is being prepared at this time; however, preliminary results indicate that groundwater pollution should not be a problem. There appears to be three separate aquifers under the Sheats Farm. Most of the local wells in the area are receiving their water from the deepest or third aquifer. The treated effluent, after being applied to the Sheats Farm and being filtered and purified as discussed in Item 4, will enter the upper aquifers and flow away from the Sheats Farm, and does not appear to enter the local deep wells. This reflects the initial findings and the data will be further evaluated and discussed, in detail, in the Design Development Report.

6. <u>Lagoons are not safe for treatment and storage of wastewater and can leak.</u>

It was reported by EPA in 1975 that there were over 6,000 lagoon treatment systems in the United States. These lagoon systems have an excellent track record in performance, providing a high level of treatment and storage for both domestic and industrial wastewater. The literature clearly shows that lagoon systems are a highly effective, reliable method of providing the necessary secondary biological treatment of wastewater.

It is recognized that improperly designed and constructed lagoons can leak; however, the DNREC requires that a liner system be provided to address this concern. It is required by DNREC that liners have a level of impermeability of 1×10^{-7} cm/sec (one inch per year). To provide assurances to the local residents, the County will install a double liner system to further mitigate this concern.

An additional level of protection includes monitoring wells which are placed around the lagoons to monitor the quality and movement of ground water. Three lagoons will be proposed at the Sheats Farm. The storage capacity of the lagoons will be so large that any one can be taken out of service for cleaning, repair or general maintenance while the others provide treatment.

Muskrats may have burrowed holes along the banks of lagoons which have not been properly managed. Proper management controls include: (1) fencing around the lagoons; (2) maintenance of the fence; (3) keeping the grass trimmed on the interior lagoon bank slopes; and (4) weekly patrol around lagoons to detect and repair any burrow holes. The largest lagoons proposed for the Sheats Farm will have rip rap stone around the interior lagoon bank to allow varying water level for storage capabilities. This rip-rap is not the natural habitat environment for muskrats. The rip-rap for the Sheats Farm will be similar to the rip-rap at the lagoons at Oxford PA.

7. <u>Health problems will arise due to mosquitoes.</u>

The EPA has conducted extensive research into the health impacts of spray irrigation systems. Enclosed as attachment B is a brochure published by the Environmental Protection Agency concerning the health risk of spray irrigation systems. In this brochure, EPA reports "Properly planned and operated land treatment is an effective method of water purification and a safe and beneficial method of irrigation. The land treatment of municipal wastewater already enjoys a long and successful history in this country".

In addition, extensive research work performed at Penn State University has clearly shown there are not any health problems arising from a spray irrigation system. In Item 3 above, the American Public Works Association Survey done in 1972 did not report any health problems related to spray irrigation systems. Spray irrigation systems are designed and operated in such a manner to preclude any ponding of water which could serve as sites for mosquito breeding. It has been demonstrated in the many spray irrigation systems in the United States that there are no health problems associated with mosquitoes.

8. <u>Recreational and forest uses should be considered with proposed spray irrigation systems at the Sheats Farm.</u>

New Castle County is giving consideration to the utilization of portions of the Sheats Farm for recreational and/or park use. The farm could be incorporated into the Greenways Program of the State. After the soil and hydrogeological investigations have been completed and the preliminary design has been performed, methods to integrate recreational uses into the project will be evaluated.

In summary, we believe that these responses to your observations and recommendations demonstrate that the County can provide a high level of assurance that lagoon/spray irrigation systems not only have a proven track record of high efficiency, but can also be an asset for a community. A lagoon spray irrigation system can provide the following benefits:

* <u>Aesthetics</u> - A wastewater treatment system, which is normally a somewhat objectionable facility, can become an aesthetic attribute of the site. <u>There are not any odors produced by these facilities.</u>

* **Ease of operation** - Simplicity of this type of system results in ease of operation. These facilities require very little routine mechanical maintenance and are less subject to biological upsets.

* **Economics** - Both capital and operational costs are less than comparable mechanical treatment systems.

* **Overall Environmental Impacts** - The concept of water recycle, coupled with the "natural" method of treatment, results in minimal adverse impact on the environment

* **Pollution Prevention** - Stream deterioration and pond eutrophication are virtually eliminated by the spray irrigation technique.

* **Public Acceptance** - Local residents and governmental agencies have commended these systems. Aesthetically pleasing lagoons and preservation of open space become assets. Wildlife and wetlands remain undisturbed.

* **Recharge** - Used water is treated and returned to the groundwater.

* **Reduced maintenance** - Due to the simplicity of operation, the operational headaches and maintenance costs are drastically reduced.

* **Reliability and flexibility** - The long lagoon retention times provides both storage and buffer in enhancing treatment efficiency. The relatively few operational problems makes this type of systems unusually reliable.

In closing, your comments have been taken seriously and given due consideration. Again, we wish to thank you for your comments and look forward to working cooperatively with you and other residents to solve the areas wastewater disposal problems in an environmentally and fiscally sensitive manner. If you have additional comments or questions, do not hesitate to contact Peder Hansen at (302) 731-7670.

Sincerely,

Robert J. Zimmerman, Chairman
SNCC Wastewater Mgmt. Plan
Project Management Committee