CHAPTER FOUR

PERSPECTIVE ON GROUNDWATER IN SUSSEX COUNTY

This chapter will cover specific groundwater aspects in Sussex County in three sections. The first section will identify the general problems discussed in Chapter Two which are prevalent in Sussex County. This section will include a population analysis of each municipality to give an idea of how densities, expressed as households per square mile, and subsequent on-site wastewater disposal systems can be expected to increase in the next ten years. The second section will identify and locate major and minor aquifers and their respective critical recharge areas in the County. The final section of the chapter will summarize potential consequences of ignoring or mismanaging the problems discussed in the first sections.

GROUNDWATER PROBLEMS

Water Quality

Point Sources

Wastewater Treatment Plants:

There are limited areas of Sussex County which are presently served by municipal wastewater collection and treatment facilities. Table III displays existing facilities, their level of treatment, and their discharge flow in million gallons per day (MGD) in 1975. Note that there are no facilities in the County with tertiary treatment capabilities, although proposals have been made to upgrade the Musconetcong Sewage Authority's treatment plant from secondary to tertiary level treatment.

As of late 1981, the Sussex County Municipal Utilities Authority has designed and is taking bids on a regional facility to be located in the Upper Wallkill drainage basin. This facility is slated to include a treatment process for county-generated septage in addition to a domestic sewage treatment process to handle waste from Franklin and Hamburg Boroughs and part of Hardyston Township.

Landfill Leachate:

The vast majority of commercial and domestic solid waste which is generated and collected in Sussex County is disposed of at a landfill in Lafayette operated by Hamm's Sanitation Incorporated[14]. The municipalities of Sparta, Hopatcong, Hardyston and Stillwater operate their own landfills, but only Hopatcong performs collec-

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14. Sussex County Solid Waste Master Plan, page 4-26

tion services as well. None of these landfills have liners or leachate collection systems which precludes them from qualifying as "sanitary landfills". As a result there exists no adequate barriers to groundwater contamination at any of these facilities. These design mechanisms along with monitoring wells and other pollution abatement and detection systems are now required of all newly constructed landfills under the Resource Conservation Recovery Act (RCRA). In the Sussex County '208' Plan, the Sparta Landfill was cited as being a possible source of contamination of the Germany Flats aquifer.[15] Hamm's landfill, though not positively linked to groundwater pollution, is cited in the 208 plan as a contributor to surface water pollution. Many landfill or "dump" related groundwater contamination problems stem from the fact that historically landfills were improperly sited.

The Sussex County Board of Chosen Freeholders, as mandated by the State of New Jersey, and with the aid of professional consultants, are presently searching for a site or sites for a "state-of-the-art" sanitary landfill that would serve the future solid waste disposal needs of County residents. The success of such a facility will greatly influence the impact of landfill leachate from landfills on groundwater supplies in the years to come.

Spills

Although there is no way to quantify the frequency of accidental or intentional spills of harmful materials in Sussex County, the fact that it occurs can not be ignored. The Sussex County Health Department, which is the agency directly concerned with health hazards resulting from spills, relies upon reports from operators/transporters and concerned citizens to monitor violations.

Improper Disposal/Storage of Hazardous Waste:

As in the case with spills, it is difficult to gauge the degree to which illegal or improper disposal of materials classified as hazardous waste occurs in Sussex County. The combination of vast amounts of open space and the considerable truck traffic passing through the County to and from New York, Pennsylvania, and southern portions of New Jersey as well as the increasingly exorbitant cost to legally dispose of most hazardous waste creates the temptation to discharge unwanted loads of hazardous waste in secluded areas. A law which is rarely abided by requires haulers to notify appropriate authorities in advance whenever hazardous wastes are transported through Sussex County.

A federal and State manifest program to track all hazardous waste from "cradle to grave" has been initiated within the last two years.

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15. *Water Resource Study in Germany Flats Area, Prepared for Sparta Township by Harold E. Pellow Assoc., Inc., Dec. 1975.*

TABLE III

DESCRIPTION OF EXISTING MAJOR MUNICIPAL TREATMENT FACILITIES

Facilities	Treatment Level	NPDES Permit Number	Discharge Point	Basin	Flow (MGD)
Newton	Secondary	N.J. 0020184	Moore's Brook	Paulinskill	1.0
Sussex	Secondary	N.J. 0021857	Clove Brook	Wallkill (Papakating)	0.25
Franklin:					
Hemlock Junction	Primary	N.J. 0022055	Wallkill River	Wallkill	0.20
Main Street		N.J. 0029220	Wallkill River	Wallkill	
Water Supply-back wash		N.J. 0031038*	Wallkill River	Wallkill	
MSA	Secondary	N.J. 0027821	Wills Brook	Musconetcong	1.0

* Application filed and number assigned but permit not yet issued.

Source: Sussex County 208 Water Quality Management Plan, April 1979.

Non-Point Sources

Wastewater Disposal

Traditionally residential wastewater disposal, is the element of residential development which has received much attention as a contributer to groundwater contamination. The following section presents a scenario for future residential development as related to the need for on-site wastewater disposal systems and the increasing pressure that they will impose on groundwater resources.

Future Wastewater Disposal Needs:

Using 1980 U.S. Census information on population and population density, a general notion as to the number of households, and thus the number of septic systems that will be added to each municipality can be estimated. The figures are derived by taking each municipality's percentage of 1980 Sussex County population and applying them to the Planning Department's 1990 population projections. These projections were felt to be the most accurate of those currently in existence. The 1990 projection was extrapolated from a 1975 base population which was arrived at using historical trends, building permits, and school enrollment data. It is assumed that, because of the rural nature and dispersal of households in Sussex County and the expected continuation of this trend, that each new unit will require an on-site wastewater disposal system unless already existing sewer capacity is available. Cluster housing or PUD development would also be exceptions to this assumption.

By applying the 1980 percentages to the 1990 projections, it is assumed that the 1980 growth trends will continue into 1990. Because of the slackening of growth rates in the 1970's and the current stagnant market, this assumption appears realistic.

Sussex County municipalities will be analyzed in alphabetical order.

Andover Borough

Andover Borough has a 1980 population of 892 people on two square miles, resulting in a gross density of 446 persons per square mile. Applying the 1980 percentage of County population, (0.7%) to the 1990 projection (158,075) renders an estimated 1990 population of 1,214 people in Andover, an increase of 322 people. Applying the Sussex County average household size of 3.4 persons to the population increase produces a figure of 95 households or 47.5 per square mile in the Borough by 1990. Reverting back to the statement made in Chapter One that on-site septic systems will continue to dominate in the future, Andover Borough can possibly anticipate 47.5 more septic systems per square mile by 1990.

Andover Township

Andover Township is located in the south-central portion of the County and occupies 20.4 square miles of land area. This land currently supports a population of 4506 people at a density of 221 persons per square mile. By 1990, if County population grows at the same rate as from 1970 to 1980, Andover Township will have around 6,100 people at a density of 301 persons per square mile. The increase in density from 220 to 301 persons per square mile will result in an additional 24 households per square mile in 1990, based on the 3.4 persons per household parameter.

Following the previous assumption, 24 more septic systems per square mile may be expected in the Township by 1990.

Branchville Borough

Branchville, the smallest municipality in land area (0.5 square miles), contains 870 residents, making it the fourth most densely populated area in the County (1740 persons/sq.mile). Branchville actually lost 41 people between 1970 and 1980 and is not expected to experience significant future growth. Branchville residents should be alert to growth trends in Frankford Township, which envelopes the Borough, which may have an affect on their water supplies.

Byram Township

Byram Township, located in the southwestern corner of the County, occupies 20.6 square miles. Byram supports 7,502 people at a density of 364.2 persons per square mile. Using the interpolative method described earlier, a 1990 population of 10,200 people results. The 1990 population will reside in Byram at a density of 496 persons per square mile. Thus it can be assumed that around 40 more septic systems per square mile will be added to Byram Township by 1990. It is also assumed that the proposed Musconetcong Utilities Authority Sewage Treatment Plant (STP) expansion will not extend service to Byram Township.

Frankford Township

Frankford Township, located to the west of central Sussex County, occupies 34.8 square miles and contains 4,654 people. The 1990 population in Frankford is calculated to be 6,335 people, increasing the density from the present 134 to 308 persons per square mile. This increase in population density should produce a need for 51 additional septic systems/sq. mile by 1990.

Franklin Borough

Franklin Borough is a small rural center of around 4.4 square miles located in east central Sussex County. The Borough has 4,486 residents living at a density of 1,020 persons per square mile. 1990 population is calculated at 6,106 people resulting in a density of 1283 persons per square mile. If all of the households created by the expansions in populations were to use on-site disposal systems, an additional 108 systems per square mile will be necessary by 1990. However, the completion of the Upper Wallkill STP will preclude the need for on-site systems.

Fredon Township

Fredon Township is located just south of the eastern tip of Susex County and encompasses 18.3 square miles. The 1980 population is estimated at 3,725 people. The population density per square mile increases from 125 to 204 based on the population numbers. This increase in density will create the need for approximately 23 more on-site systems per square mile.

Green Township

Green Township neighbors Fredon to the southeast and is similar in size and population. Green has 2,450 people on 16.5 square miles and a corresponsing density of 148 persons per acre. In 1990, the Township may have 3,335 people with a density of 202 persons per square mile. The result is a need of approximately 16 more septic systems per square mile.

Hamburg Borough

In 1980 Hamburg Borough contained 1,832 people on 1.2 square miles. The population density of 1,526 persons per square mile could increase to 2,078 persons per square mile if the population increases to 2,493 by 1990. With a population increase such as this, the Borough may anticipate a possible addition of 162 households. This would amount to approximately 162 more septic systems per square mile by 1990. However, the Upper Wallkill STP is expected to provide service to any new housing in the Borough.

Hampton Township

Hampton Township lies to the southwest of the central point in the County. As of 1980, 3,916 people live on 24.7 square miles, producing an overall density of 159 persons per square mile. Hampton's share of the County population in 1990 should be 5,330 people, increasing the density to 216 persons per square mile. The increase in density should create the need for 17 more septic systems per square mile in Hampton Township.

Hardyston Township

Hardyston is located on the eastern boundary of central Sussex County. Its 32.8 square miles support 4,553 people at a density of 139 persons per square mile. If the original proportion of total County population remains constant through 1990, Hardyston should have around 6,200 people living at a density of 190 persons per square mile. The average household size of 3.4 persons yields an additional household density of 15 per square mile by 1990. Assuming that the majority of Hardyston will remain unaffected by the Upper Wallkill STP, an additional 15 septic systems per square mile or a total of 492 systems may be required by 1990.

Hopatcong Borough

Hopatcong Borough is the southeastern most tip of Sussex County. There were 15,531 people contained on 10.8 square miles of land in Hopatcong in 1980. The consequential density of 1,438 persons per square mile increases to 1,960 persons per square mile in 1990, based on the assumptions made previously. The additional 153 households per square mile will require either septic systems or sewers depending on the development of the Musconetcong Sewage Authority. It is doubtful at the writing of this document that MSA will expand to include Hopatcong Borough.

Lafayette Township

Lafayette, the central most municipality, has a 1980 population of 1,614 on its 18.3 square miles. The population of 88 persons per square mile is one of the lowest in the County but may grow to 120 persons per square mile by 1990. This increase would necessitate the creation of 9 more households per square mile by 1990. The households will more than likely be serviced by on-site wastewater systems.

Montague Township

Montague Township is the northwest tip of Sussex County. Its 44.6 square miles are sparsely populated with 2,066 people. The resulting population density is the third lowest in Sussex County, 46.3 persons per square mile. Even though nearly two-thirds of Montague is either state or Federal Parkland, it is expected that the municipality will experience a share of overall County population growth between 1980 and 1990. This increase in population will produce 5 more households per square mile, which will almost definately require on-site wastewater systems.

Newton

The Town of Newton, the County Seat, is centrally located in the southern half of Sussex County. In 1981, 7,748 people were residing on 3 square miles, creating the second most densely populated municipality in Sussex County. Its population is expected to increase nonetheless. By 1990 Newton's share of County population should amount to approximately 10,550 people. A population increase of this magnitude will necessitate the accomodation of around 275 households per square mile assuming available developable land and allowance for that land use in addition to the 760 households per square mile (1.18 per acre) that were in place in 1980.

Ogdensburg Borough

Ogdensburg, lying immediately south of Franklin Borough, is inhabited by 2,737 people on 2.1 square miles. Its population density of 1,303 persons per square mile is calculated to increase to 1,774 persons per square mile by 1990. The creation of around 140 new households per square mile will result from that population increase, assuming available land and allowance for that land use.

Sandyston Township

Sandyston Township, located west of Frankford and south of Montague, is populated at a lower density than Montague (35. 3 persons per square mile), and is about three-quarters state and federal parkland. The Township, however, can anticipate steady population growth in the privately owned portion. In 1990, the Township may have a population density of 48 persons per square mile and an additional 13 households per square mile.

Sparta Township

Sparta Township is located southeast of Lafayette Township and southwest of Hardyston Township. The Township has the third largest population (13,333) and the fifth largest land area (38.8 square miles). By 1990, Sparta's population could reach 18,150 people at a density of 467 persons per square mile. The additional burden that the land will have to bear will then be approximately 37 households per square mile.

Stanhope Borough

Stanhope occupies the southern most tip of Sussex County. It is a municipality of 2 square miles and supports 3,638 people. This little Borough is the third most densely populated municipality in the County. It's 1819 people per square mile could increase to 2,476 persons per square mile by 1990. The result would be 193 more households per square mile by 1990 assuming available land. There is a strong possibility that additional households will be sewered, depending on the capacity of the Musconetcong Utilities Authority over the next ten years.

Stillwater Township

Stillwater Township lies northwest of Fredon. In 1980 its 29 square miles contained 2,887 people. The population projection for 1990 is 5,291 people at a density of 182 persons per square mile. This density will increase the number of households per square mile by 14. Chances are that most or all of these additional households will have on-site wastewater systems.

Sussex Borough

This tiny Borough lies within the southeast quadrant of Wantage Township. Its 0.9 square miles harbors 2,418 residents at the highest population density in the County. Currently the Borough is serviced by a municipal waste water collection treatment facility. The population of Sussex Borough may increase or decrease, depending on market forces and housing trends.

Vernon Township

Vernon Township, located in the northeast corner of Sussex County is the fastest growing municipality in the County, jumping from 6,059 to 16,302 between 1970 and 1980. It now has the largest population in the County and still has plenty of room to grow, being the largest (along with Wantage) in land area as well. It is projected that its 67.9 square miles may contain 22,192 people by 1990 at a density of 326 persons per square mile. Although the additional number of households per square mile that this density represents (25.5) may seem insignificant over ten years, an estimated 1,732 additional households by 1990 will need on-site wastewater treatment systems.

Walpack Township

Walpack has become almost entirely absorbed by State and Federal Parkland. There will be little or no need for additional on-site wastewater disposal in Walpack in the forseeable future.

Wantage Township

Wantage Township, located just east of Montague, has 67.9 square miles as does Vernon. In 1980, 7,268 people resided there at a density of 107 persons per square mile. That density will increase to an estimated 150 persons per square mile by 1990. The result of that increase will be an additional 11 households per square mile, all of which will need on-site wastewater disposal.

From the above projections, it can be seen that the total additional load on the County by 1990 could amount to over 9,500 individal on-site wastewater systems. The probability of this occuring lends credence to the concept of septic system management and programs which are finally receiving attention as a necessary management

technique to ensure prolonged use and system efficiency.

The preceding analysis has tried to illustrate the need for careful identification and protection of groundwater and critical recharge areas. Wastewater disposal and stormwater runoff from residential and agricultural areas have a dominating impact on County groundwater systems and thus have been more thoroughly discussed, but residential development, business and industry, agriculture, surface mining and silviculture operations are also contributors.

Residential Development

One nonpoint source of groundwater pollution which will undoubtedly increase in Sussex County is residential stormwater runoff. Factors which have made Sussex County one of the fastest growing counties in the state are: 1) it is within affordable commuting distance of the New York metropolitan area and other urban and suburban employment centers and, 2) the price of land is relatively low compared to the rest of the state. While high interest rates on mortgages have slowed residential growth at present, the trend is expected to be temporary and it is anticipated that the growth rate will increase rapidly when homes become readily financible again.

Current population is clustered in the rural centers of Newton, Stanhope Borough, Andover Borough, Branchville Borough, Ogdensburg Borough, Franklin Borough, Hamburg Borough, and Sussex Borough, as well as around lakes; the most notable being Lake Hopatcong and Lake Mohawk. These populations are expected to increase in the future, and additional development will most likely be attracted to the Route 517 - Route 23 - Route 94 corridor. Vernon Township is the fastest growing municipality and is expected to remain so due to its recreational attractions.

Given this outlook for the future, concern is raised as to how to remain in control of development in the face of increasing economic and social pressure to grow. Two of the fastest growing municipalities in the County, Vernon and Sparta, also possess the most abundant groundwater resources. Thus the threat to groundwater systems is clear and the need for immediate land use control and BMP enforcement is critical.

Business and Industry

At present, the overall threat to groundwater systems from business and industry can be considered within control. There have been a number of localized instances in the recent past, however, where industrial wastes have encroached upon the water supply. Two examples of this are a discovery of tetrachloroethylene (TCE) in municipal wells near a chemical plant in Franklin Borough, and formaldehyde in private wells near a plant in Sparta. These incidents underline the fact that even when industrial development is minimal, there is a potential contamination problem with industries which handle potentially hazardous or toxic materials are located in critical areas. Even industries that are not sited in or near critical areas should exercise proper techniques of handling potentially hazardous materials.

Due to its position in the path of industrial migration away from urban areas, Sussex County has shown one of the fastest industrial growth rates between 1970 and 1975.[16] Growth in employment is expected to continue into the year 2000 with nonmanufacturing jobs, primarily in service and government contributing the lion's share (see Figure 11).

It is conceivable that the danger from toxic industrial wastes to groundwater will be minimal, or at least more preventable in Sussex County if proper action and planning is engaged at an early stage. Surveillance of industrial operations should never be down-played, and a golden opportunity exists in Sussex County to guide industrial development to suitable areas and require state-of-the-art wastewater treatment processes either within the plant, on the site, or possibly on a cluster basis in an industrial park development.

Agriculture

Agricultural activity takes place on a large scale in Sussex County. The Census of Agriculture statistics show a very stable agricultural community which has been increasing in number of farms steadily over the last five years, although total acreage in farming has fluctuated. In 1978, 28.1% of all land in Sussex County was being farmed. In 1980, the percentage of land in farms dropped to 23.8%. Data for 1981 shows an increase in acreage by 1,333 acres or 1.7% over 1980. Total number of farms has increased from 539 in 1978 to 660 in 1980. That number has increased to 747 farms in 1981, a rise of 13.18% (87 farms) from the 1980 total.[17]

To give another perspective on how prevalent the use of land in the County is for farming; the combined percentage of the total land in state and federal parkland, water bodies, and farming amounts to 47.11%, or about half of the County. This means that the other half of the County is divided up among all of the other possible land uses and also includes vacant land.[18]

The vast majority of the farms in Sussex County are located in the valleys between the Kittatinny Ridge in the west and the Highlands in the east, and lie along a belt that bisects the County from northeast to southwest.

Dairy farms predominate in the County with 307 farms raising 11,194 head of cattle in 1981. Although there are 46,453 acres in cropland compared to 18,292 acres in pasture in 1981, it must be pointed out that there is overlap here as the Dairy operations also grow their own feed to support their livestock. There is also overlap as some dairy farmers raise other livestock as well as feed crops and vegetables. A ranking of different types of farms and their

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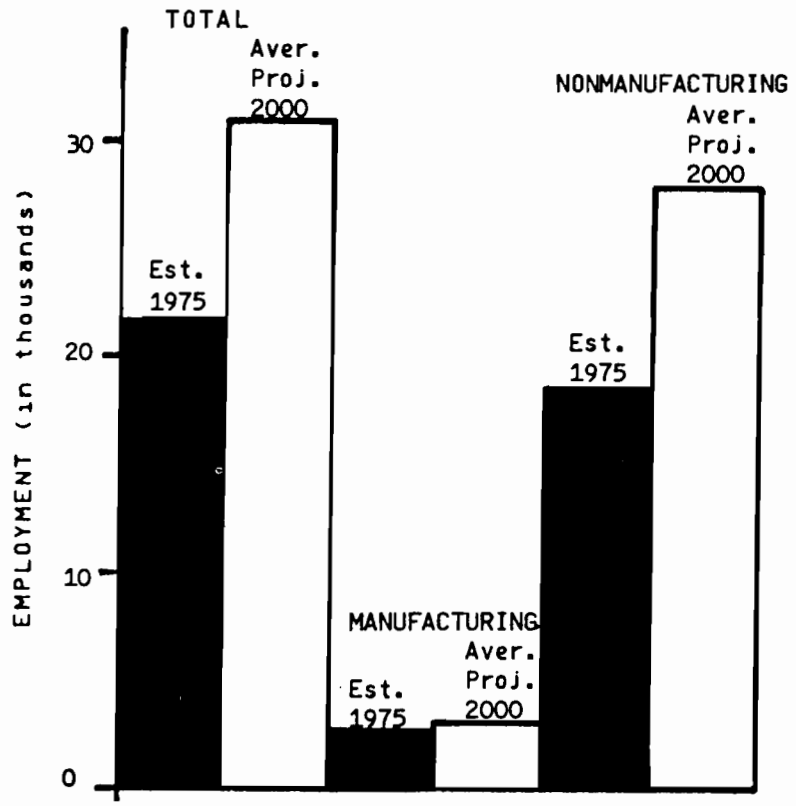
16. *Michael Greenberg, Connie Michaelson, New Jersey Toward the Year 2000: Employment Projections (New Brunswick: Center for Urban Policy Research, 1978), pg. 172.*
17. *Computer Printout, source: U.S. Department of Commerce, Bureau of Census, 1981 Census of Agriculture.*
18. *Source: Information compiled and plotted by Sussex County Co-operative Extension Service, Warren Welsh: Senior County Agent.*

Photo: Courtesy of Kniep Associates, Randolph, N.J.

Many industries have incorporated wastewater treatment processes into their plants and recycle the water back into productive use. Shown above are flash mixers and settling tanks, which are part of the overall wastewater treatment and recycling process at the Custom Alloy plant in Califon, New Jersey.

FIGURE 11

SUSSEX COUNTY 1975 ESTIMATES OF AND 2000 AVERAGE* PROJECTED TOTAL, MANUFACTURING AND NONMANUFACTURING EMPLOYMENT



Source: Greenberg & Michaelson, New Jersey Toward The Year 2000 Page 173.

Acreages follows. Farms that raise strictly vegetable crops are not included because of the difficulty in monitoring the constant change in their size and crop composition.

Farm Type	# Farms	# Head	# Acres
Dairy (Young & Mature)	307	11,194	
Horse & Pony	229	1,436	
Beef	217	3,404	
Swine	115	2,978	
Tree & Shrub	46		847
Apple Orchard	36		340
Strawberry	19		81
Peach Orchard	16		78

Source: 1981 Census of Agriculture

To illustrate how Farmland is distributed throughout the County, data from the 1981 Census of Agriculture will be used to rank Sussex County municipalities according to the number of farms which are located in them. The top ten municipalities are as shown in the following table:

Table IV

Comparison of Municipalities Possessing

Farms and Groundwater Resources

Rank	Municipality	# of Farms	Rank	Municipality	Acres of Minor & Major Stratified Drift Aquifers	Municipality	Acres of Carbonate Rock Aquifer	Rank
1	Wantage	175	1	Sparta	3860	Vernon	8500	1
2	Frankford	92	2	Green	3350	Green	6880	2
3	Lafayette	78	3	Vernon	2866	Stillwater	5900	3
4	Hampton	66	4	Wantage	2845	Sparta	5100	4
5	Stillwater	62	5	Hardyston	2740	Lafayette	4896	5
6	Fredon	52	6	Lafayette	2360	Hardyston	4762	6
7	Hardyston	46	7	Andover Twp.	2310	Hampton	4704	7
8	Green	45	8	Frankford	1600	Wantage	3630	8
9	Vernon	42	9	Hampton	1600	Fredon	2022	9
10	Sandyston	41	10	Hamburg	600	Frankford	1165	10

Reference to the groundwater map in the back insert of the manual will show that these are the municipalities which lie in the valleys between the Kittatinny Ridge and the Highlands as was described earlier.

Table IV also shows that the top four municipalities in numbers of farms fall into the top ten municipalities in major and minor aquifer acreage. In fact seven municipalities are ranked in the top ten in both categories, and all of these seven lie wholly or partially in the northeast-southwest running valley.

Surface Mining:

Surface mining was mentioned in Chapter Two as a potential non-point source of groundwater pollution, and because it is practiced to a large degree in Sussex County it will be discussed here.

The surface mining industry patterns in Sussex County is not expected to experience much change in the future, and probably will employ less people than the 700 that worked in 1975.[19] There are eleven (11) large commercial surface mining companies in the County at present.[20] Two of these operations are located in Sparta, two in Lafayette, two in Vernon, two in Franklin, and one each in Newton, Andover Township, and Stillwater. Of these municipalities, Sparta, Vernon, Lafayette, and Andover Township are four of the ten in the County with the most plentiful groundwater resources.

In addition to large commercial surface mining operations there are hundreds of small private sand and gravel pits scattered around the County which are operated by private landowners.[21] Although the surface mining is done at a small scale and may be merely a supplementary enterprise to support a primary use of someone's land (e.g. farming), soil erosion plans are still required by the Soil Conservation District, and other standard environmental safeguards should be applied to thes small operations as well. It is entirely possible and highly recommended that municipalities enact surface mining ordinances that hopefully will provide the "teeth" for enforcement of environmental safeguards and Best Management Practices.

Silviculture:

Silviculture, or woodland management and cultivation was mentioned in Chapter Two as a potential source of groundwater contamination. In Sussex County, where woodlands and forests occupy 100,000 acres,[22] there are 46 farms which cultivate trees on 847 acres of land.[23]

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19. *Greenburg & Michealson, New Jersey Toward the Year 2000: Employment Projections, pg. 174*
20. *Sussex County Economic Development Commission, 1981 Industrial Directory, pg. 25*
21. *Telephone conversation: Phyllis Anderson, Manager; Sussex County Soil Conservation District*
22. *Information compiled and plotted by Sussex County Cooperative Extension Service, Warren Welsh: Senior County Agent.*
23. *Computer printout: U.S. Department of Commerce, Bureau of Census, 1981 Census of Agriculture.*

Stillwater Township contains 469 of those acres. It can be surmised, then, that although tree farming is a relatively insignificant segment of the total agricultural composition, it warrants attention as a non-point pollution source with an impact that can be minimized by employing Best Management Practices.

Water Quantity

Over Taxation of Groundwater Systems

The Sussex County "208" Water Quality Management Plan includes estimates from the N.J. Bureau of Geology, concerning relative yields of stratified drift deposits and the Kittatinny limestones. The following table is taken from the "208" plan and summarizes those estimates.[24]

Table V

Total Groundwater Yield Estimates

Formation	Yield (GPD/Mi^2)	Total Yield (MGD)
Stratified Drift	500,000	16.7
Kittatinny		
Leithsville	500,000	6.4
Allentown, Rickenbach, & Epler	250,000	11.1
Ontelaunee	100,000	
*Undifferentiated		9.4
Total	1,350,000	43.6

* Assuming 25% Leithsville and 75% Allentown, Rickenbach, and Epler

Assuming measures are taken to manage and preserve the quality of existing groundwater resources, the "208" plan projects an adequate future supply for those areas of Sussex County overlying stratified drift or Kittatinny Limestone, including the 12MGD needed to supply the water needs of the concentrated development centers in Sussex County to the year 2000.[24a] Areas of the County underlain by Martinsburg Shale or Precambrian gneisses (i.e. most of the remainder of the County) should be especially wary of overtaxing groundwater supplies. An example of the above is the upper Musconetcong drainage basin (Stanhope, Hopatcong, Netcong, etc.) where the estimated yield of 100,000 GPD/Mi^2, when applied to the 21 square mile drainage area of the lake, produces about 2.1 MGD of groundwater. This output is barely satisfying existing demands.[24b]

24. a, b. - The Sussex County "208" Water Quality Management Plan, April, 1979, pg. X31.

TABLE VI

WATERSHED TOTAL GROUNDWATER BUDGET ACCORDING TO ROCK TYPE UNDER BOTH NORMAL AND DROUGHT CONDITIONS

Watershed	(A) Total Ground Water Budget During Normal Precipitation Gal/day sq/mi	(B) Gal/day /acre	(C) Total Ground Water Budget During Periods of Drought Gal/day sq/mi.	(D) Infiltration or dry yield rate per acre gal/acre/day	Geologic Formations in the Watershed PC**	ϵO_k**	Omb***	Ssq/Don**	Qsd**	Range for Minimum lot size Dry Year	(acres) Normal Year
Flatbrook	350,000	550	240,000	380				X	X	2.4	1.6
Paulins Kill	650,000	1,000	220,000	340		X	X		X	2.7	1.0*
Paulins Kill	350,000	550	250,000	390			X		X	2.3	1.6
Wallkill	*200,000	310	*100,000	160	X					5.6	2.9
Wallkill	680,000	1,100	250,000	390		X			X	2.3	1.0*
Wallkill	350,000	550	250,000	390			X			2.3	1.6
Musconetcong	*200,000	310	*100,000	160	X				X	5.6	2.9
Pequest	*200,000	310	*100,000	160	X					5.6	2.9
Pequest	650,000	1,000	220,000	340		X			X	2.7	1.0*
Pequest	350,000	550	250,000	390			X		X	2.3	1.6

* Vecchioli, J., 1973 as reported in Miller
**PC Precambrian Crystallines - (Eastern Sussex County)
**PC_k Kittatinny Limestone
**Omb Martinsburg Formation (shale)
**SSg/Don Shawangunk and Onondaga Formations - (Western Sussex County - Kittatinny Ridge)
**Qsd Stratified Drift

(Reprinted from Sussex County "208" Water Quality Management Plan, Chapter VIII, P.64

*rounded off

The possible over-taxation of groundwater supplies by a steadily increasing population provides the impetus for the concept of "carrying capacity". A manual which applies carrying capacity to Sussex County has been prepared by the Sussex County Planning Department/208 Water Quality Management Program. The manual approaches the problem of supporting a growing population with a fixed groundwater supply by applying measures of groundwater availability under normal and drought conditions to the various water-bearing geologic formations in each basin. A range of acceptable lot size for areas over those formations is then derived based on the amount or recharge necessary to dilute septic effluent to the allowable nitrate concentration. Table VI, taken from the carrying capacity manual, displays the results of the analysis described above and can be cross referenced to the "Groundwater Management Map" for graphic representation. *

Impedence of Groundwater Recharge

While the impedence to groundwater recharge is not a significant problem in predominantly rural Sussex County, there is nothing to prevent it from becoming one in the suburban Sussex County of the future. If present patterns of residential and industrial land use development persist into the future, valuable acres of aquifer recharge areas could be covered over with impervious surface, adversely affecting the groundwater budget. Inter-basin transport of groundwater could also adversely affect aquifer replenishment. Sussex County municipalities have a golden opportunity to take steps now to avoid the water supply dilemmas of the more urban New Jersey counties. The key is in knowing where the critical areas are and using common sense practices to maintain their quality and quantity.

Concentration of Natural Salts

The threat to groundwater posed by the concentration of natural salts has a great deal to do with the maintenence of the groundwater budget, and thus with over-taxation and impedence of recharge. As long as supplies can be naturally replenished while the water demand is kept within the limits of the system, the natural salt concentration has minimal threat to Sussex County water supplies. A problem may arise, for example, if fertilizers are applied to agricultural lands in quantities that crops cannot assimilate and are allowed to accumulate in the soil. The high cost of fertilizer is a built-in deterrent to their over application, however, and successful farmers measure quantities very precisely for each crop to maximize efficiency.

Groundwater Identification

The locations of major and minor aquifers will be described by towns in alphabetical order. This information is illustrated on the Groundwater Management Map which identifies recommended levels of groundwater management for groundwater resource areas in Sussex County and is inserted in the back cover of this document. Only municipalities with groundwater areas appearing on the map will be

*NOTE: The establishment of minimum lot size requirements based on estimates of regional groundwater recharge is a difficult undertaking, especially in regions where consolidated rock aquifers are the principal source of water supply. This Table is merely a beginning pending further in-county research in geo-hydrology and on the impact of development on groundwater. Final on-site evaluation should be made in accordance with the results of aquifer pump-tests.

discussed. Aquifers will be described in two major categories: stratified drift and carbonate rock. It is important to note that the delineation of these aquifer boundaries is based on existing geologic data which currently is not extensive enough in nature to be used for precise boundary determination. Therefore, these boundaries must be regarded to some degree as educatively speculative and are possibly subject to revision. The delineation and justification of groundwater management areas on the groundwater management map however, is less subject to controversy and question than are specific aquifer boundaries, (i.e. uses less speculation) since actual well log, well yield and other physical data was used to derive these areas and document the general geological trends in Sussex County which dictate them.

Stratified Drift Aquifers

Andover Borough

Approximately the northern third of Andover Borough lies over a major aquifer containing thick unconfined sands and gravels of high yields. The major finger of the aquifer borders U.S. Route 206 and extends northeastward into Andover Township. A secondary finger bisects the northwest tip of the Borough and also travels into Andover Township. The formation covers 345.6 acres.

A minor aquifer consisting of thin unconfined sands and gravels, extends from the major aquifer into the southwest corner of the Borough. This aquifer covers a little over 100 acres (0.16 square miles).

Andover Township

Andover Township contains two areas of major aquifers with associated minor aquifers. The larger of the two major aquifers is a continuation of the Germany Flats aquifer which enters Andover via Sparta and Lafayette Townships and bisects the Township before it enters Andover Borough. This portion of the Germany Flats aquifer in Andover Township encompasses approximately 900 acres (1.4 square miles). The other major aquifer lies along the western border of the Township where it abuts Fredon Township. This aquifer occupies about 410 acres (0.64 square miles). Minor aquifers are associated with major aquifer locations in Andover Township. Total land area occupied by minor aquifers in the Township amounts to nearly 1000 acres (1.6 square miles).

Branchville Borough

Of the 0.5 square miles in Branchville, slightly over half is overlaying a minor aquifer formation. The minor aquifer, which is the northern most extension of a huge major aquifer formation comprising thousands of acres in Hampton, Frankford, and Lafayette Townships, covers about 200 acres in the eastern half of Branchville Borough.

Byram Township

There are two significant minor aquifers located in Byram Township which are isolated from any major aquifer. The prominent formation is a combination of isolated minor and possible confined aquifers which run along the border with Hopatcong. The secondary formation is an isolated minor aquifer which lies along Route 206 near the center of the Township. There is an estimated area of 614.4 acres of possible confined aquifer and 1305.6 acres of isolated minor aquifer in Byram Township.

Frankford Township

Along with the substantial minor aquifer mentioned in the Branchville discussion (+ 1000 acres), there is a large major aquifer band which runs northeast-southwest along the Frankford-Lafayette border which totals close to 1600 acres (2.4 square miles). There is also an isolated minor aquifer which is pocketed by what is termed on the groundwater map a "possible confined aquifer". A confined aquifer is defined on the map as sand and fine sand of low yield, possibly underlain by sand and gravel of high yield. These aquifers are located near the northeast boundary of Frankford, just east of County Route 629 (Wykertown Road).

Franklin Borough

A small portion of a major aquifer stretches into Franklin Borough from Hardyston Township and a minor aquifer protrudes from it into the northern half of the municipality. The major aquifer underlies about 250 acres of land in Franklin, while the minor aquifer exists under about 275 acres. There is also an isolated minor aquifer which runs along the southeast boundary between Franklin and Hardyston. This aquifer is present under 375 acres of land.

Fredon Township

A corner of the major aquifer described earlier in the western edge of Andover Township crosses into Fredon Township. Although this corner occupies only about 50 acres, its associated minor aquifer continues into the Township, underlying around 475 acres of land. There are small, scattered pockets of unassociated minor aquifers in the western portion of Fredon Township which total around 500 acres. The largest of the unassociated minor aquifers runs along the length of County Route 614.

Green Township

The aquifer formation in Green Township, includes a minor aquifer of approximately 950 acres. This aquifer is traversed by County Route 608 in its northern half and County Route 519 in its southern half. There is also a very large minor aquifer of nearly 2,400 acres (3.8 square miles) that runs northeast-southwest in two parallel finger-like extensions. The larger and smaller minor aquifers merge at the southwest border of the Township. There is also an

an area of confined aquifer that reaches from the original minor aquifer eastward into Fredon Township.

Hamburg Borough

The Borough of Hamburg is almost entirely situated above part of a massive integrated aquifer system which appears on the map as a melange of associated and unassociated major and minor aquifers. A major aquifer occupies around 200 acres in the Western third of the Borough, and an associated minor aquifer underlies most of the northern half and south central portion of Hamburg. This amorphous formation covers an area of approximately 400 acres.

Hampton Township

There are three large minor aquifer systems in Hampton Township; one which is associated with the large major aquifer in Frankford and two which are unassociated. The associated minor aquifer consists of an area of 1600 acres in the northeast corner of the Township. The smaller aquifer occupies around 475 acres underneath Hampton Township and also runs under its southwest border into Stillwater Township.

In addition to the three aquifers just discussed, there are two areas of possible confined aquifer that should be mentioned. The first underlies 700 acres along the southeast border of the Township adjacent to Andover Township. The second area is situated under around 275 acres in the northwestern sector of Hampton. The addition of these aquifers creates a total of approximately 7.3 square miles of water carrying formations in Hampton Township.

Hardyston Township

Hardyston Township possesses a huge major aquifer association, part of which overlays Hamburg Borough. The major and minor aquifers gradate into each other as the thicknesses of the unconfined sand and gravel deposits vary. The most extensive major aquifer begins at the Hardyston-Wantage border, about a mile west of Hamburg Borough, and curves westward through the township in a configuration covering about 1500 acres (2.34 square miles). There are two additional major aquifer formations; one of 350 acres which juts out from the northeast corner of Hamburg, and one of 250 acres which originates at the southeastern edge of that Borough.

Associated with the two aquifers mentioned in the previous paragraph are three minor aquifers. One of the minor aquifers follows a portion of County Route 517 and covers about 190 acres. The other two minor aquifers lie on opposite sides of the major aquifer which is adjacent to the northeastern corner of Hamburg. The aquifer on the north side occupies about 150 acres and the aquifer on the south side covers 300 acres in area.

There are a few scattered unassociated minor aquifers which also appear on the groundwater map. One near the Township's eastern border covers 245 acres in area. Another narrow strip of about 105

acres extends down from the northern-most point in Hardyston. The total area occupied by aquifers of very high and high susceptibility to contamination and high yields amounts to around 2740 acres or 4.28 miles under the ground.

Hopatcong Borough

Hopatcong Borough has a small minor aquifer of about 200 acres in area. The aquifer is unassociated with any other major or minor aquifer, and there are none other in the Borough.

Lafayette Township

Lafayette Township contains aquifer locations in four main areas. Two intrusions of the Frankford major aquifer, one of 200 acres and one of 50 acres, occur along the western border of Lafayette. Another system of associated and unassociated major and minor aquifers orients northeast-southwest from the Hardyston Township border. An arm of the Germany Flats aquifer in Sparta Township crosses into Lafayette near the merger of U.S. Routes 94 and 15, where an associated minor aquifer then links it with the Frankford systems. Unassociated minor aquifers separate that arm from the main stem of the Germany Flats aquifer system which flows beneath the Township at its southern most point. The breakdown in area occupied by each type of aquifer is as follows:

Major Aquifer	780 ac	1.20 sq.miles
Associated Minor Aquifer	1580 ac	2.46 sq.miles
Unassociated Minor Aquifer	840 ac	1.31 sq.miles
Possible Confined Aquifer	1100 ac	1.71 sq.miles

Montague Township

There are two areas of isolated minor stratified drift aquifers in Montague which run in parallel bands along the Delaware River. The larger of the two follows the river at the Northwestern edge of the Township and occupies 4,378 acres. The second band, further to the southeast, occupies 3,610 acres. Montague has a total of 7,987 acres of potential water holding stratified drift formations.

Newton

In Newton there is a pocket of about 130 acres of unassociated minor aquifer which lies about 3/4 of a mile south of the town center along U.S. Route 206. There is also a possible source of water represented in about 215 acres of confined aquifer in the eastern corner of the town.

Ogdensburg Borough

The most significant aquifer formation that underlies the Borough of Ogdensburg is an unassociated minor aquifer running north-south parallel to County Route 517. The aquifer passes underneath the Borough along a path that has a termini in Franklin Borough and

Sparta Township. There are 350 acres of this aquifer of moderate yield in Ogdensburg, however. About 25 acres of an associated minor aquifer originating in Sparta lies under Ogdensburg as well.

Sandyston Township

The same two parallel bands of thin stratified drift deposits that lie under Montague Township extend into Sandyston Township as well. The larger area along the river covers an area of 3,705 acres. The thinner band that bisects the township lies under 2,899 acres of land. In addition, a long narrow tributary juts out from the thin band covering 1,165 acres. A total of approximately 7,769 acres of thin stratified drift can be found in Sandyston Township.

Sparta Township

Sparta Township is rich in groundwater resources, its boundaries encompassing the most substantial portion of the Germany Flats aquifer. Sparta's share of Germany Flats consists of 1,866 acres of major aquifer of very high yield, and 915 acres of associated minor aquifer of high yield. In the center of the Township, west of Germany Flats, is another major aquifer of 275 acres and its associated minor aquifer of 825 acres.

In addition to the associated aquifers, there are two scattered unassociated aquifers of 141 and 134 acres in the southern portion of the town. An area of 150 arces near the Ogdensburg border of unassociated minor aquifer completes the inventory in Sparta. The breakdown in areas is as follows:

Major Aquifer	2141 ac	3.34 sq.mile
Associated Minor Aquifer	1719 ac	2.80 sq.mile
Unassociated Minor Aquifer	625 ac	0.97 sq.mile
Possible Confined Aquifer	125 ac	0.20 sq.mile

Stanhope Borough

Stanhope possesses an isolated minor aquifer that basically follows beneath the configuration of Route 206 in the southern portion of the Borough. This deposit of thin stratified drift occupies an area of slightly more than 213 acres in Stanhope Borough.

Stillwater Township

Groundwater resources in Stillwater Township consist of several scattered areas of unassociated minor aquifer formations An area of 307 acres lies adjacent to the north shore of Swartswood Lake which is part of the same system that lies under Little Swartswood Lake in Hampton Township. The largest aquifer is 1,516 acres in area that lies under a portion of the Paulinskill River in the Southern most part of the Township. The remaining unassociated aquifer consists of around 500 acres near the northwestern border of the Town-

ship and proximate to Fairview Lake, Lake Kathryn, and streams that lie to the north. There are three areas of possible confined aquifer which break up the unassociated minor aquifer and which total 382 acres.

Sussex Borough

Sussex Borough, though small in land area, is fortunate enough to have a significant aquifer system partially situated beneath it. To the northeast there is a section of a minor aquifer of high yield occupying an area of 89.6 acres that is part of a large system which lies along Route 23 to the south and Route 284 to the northeast. U.S. Route 206 and County Road 642 pass over this aquifer en route to New York State. In the southern portion of the Borough there is a possible confined aquifer of 70 acres that may eventually become a potential water source.

Vernon Township

In Vernon Township there are two significant major-minor aquifer associations which follow a northeast-southwest linear path across the center of the Township. The northern most association consists of a major aquifer of 429 acres and a minor aquifer of 537 acres. The larger association which lies to the southwest consists of a major aquifer of 590 acres connected to one of 480 acres by a minor aquifer of 409 acres.

There is a large area which lies along the Wantage-Vernon border where a formation exists that may contain confined aquifers. In Vernon this area covers 2016 acres of 3.15 square miles.

The summary of groundwater resources for Vernon follows below:

Major Aquifer	1497.6 ac.	2.26 sq.miles
Associated Minor Aquifer	1369.0 ac.	2.81 sq.miles
Unassociated Minor Aquifer	1925.8 ac.	3.00 sq.miles
Possible Confined Aquifer	2016.0 ac.	3.15 sq.miles

Walpack Township

Walpack Township is almost totally contained within the Delaware Water Gap National Recreation Area, and the use of its 3,080 acres of thin stratified drift will probably never be very intensive as long as they remain within a national park. It is, nevertheless, a significant amount of land and bears mentioning.

Wantage Township

There are three significant areas of major-minor aquifer formations in Wantage. The area to the east of Sussex consists of a major aquifer of 397 acres with an associated minor aquifer of 620 acres to the north and one of 627 acres congruent to U.S. Route 23 to the south. An association to the southwest is made up of a major aquifer of 486 acres and a minor aquifer of about 100 acres. To the northwest of

Sussex, along County Route 628, there is another association consisting of a major aquifer of 250 acres and one of 70 acres, with a minor aquifer of 294 acres between them.

Other than the three areas just described, there are scattered pockets of aquifer areas, mostly of the confined type, around the Township. These areas appear on the groundwater map but the breakdown in total area follows below:

Major Aquifer	1203.3 ac.	1.88 sq.miles
Associated Minor Aquifer	1642.4 ac.	2.69 sq.miles
Unassociated Minor Aquifer	2507.2 ac.	3.91 sq.miles
Possible Confined Aquifer	3108.8 ac.	4.85 sq.miles

Concluding the preceding discussion and giving perspective to the numbers is the salient fact that Sussex County contains around 11,477 acres in area of major aquifer formations of very high yield, 16,161 acres of associated minor aquifers of moderately high yield, 29,931 acres of unassociated minor aquifers, and 8,480 acres of possible confined aquifers in glacial stratified drift formations. It would be difficult to find a better indication of the magnitude of the groundwater management task that confronts us.

Aquifers in stratified drift formations represent only part of the picture. To complete the groundwater scenario for Sussex County, the water that exists within carbonate rocks must be scrutinized. The following section will address carbonate rock aquifers in the same manner as the stratified drift aquifers were discussed above.

Carbonate Rock Aquifers

As discussed in Chapter Two, groundwater moves through and is stored in solution channels as well as in cracks and fissures in carbonate rocks such as limestone. In Chapter Three, the Kittatinny formation is described as being capable of holding and transmitting large quantities of water and therefore are potentially high yielding sources of water.

The Kittatinny Formation stretches across Sussex County from southwest to northeast in two parallel bands; the southern most band spanning the entire county while the northern most band reaches less than half of that distance. The Groundwater Management Map delineates the differentiated and undifferentiated members of the Kittatinny Formation and shows the sequence in which they can be found: (Leithsville, Allentown, Rickenbach, Epler, and Ontelaunee).

As with the stratified drift aquifers in the preceding section, the carbonate rock aquifers will be summarized by town in alphabetical order. Refer to Table IV for a comparison of the top ten municipalities containing farms, stratified drift aquifers, and carbonate rock aquifers. Extensive work is currently being finalized on carbonate rocks in the Hamburg Quadrangle (USGS Map Series) by the N.J. Bureau of Ground Water Management. This information will provide a more detailed data base for groundwater management in this area.

Andover Borough

The southern arm of the Kittatinny grazes the western edge of Andover Borough. The area is split between Hardyston and Leithsville members and occupies a total of 205 acres.

Andover Township

Andover Township is split by a linear tributary of the southernmost arm of the Kittatinny Formation. The tributary underlies 2624 acres of land and is differentiated into Hardyston, Leithsville, Allentown, Rickenbach, Epler, and Ontelaunee Formations.

Frankford Township

Differentiated Kittatinny limestone enters Frankford Township under the point where County roads 655 and 519 intersect at the Hampton boundary. It extends into Branchville and contains crossed beds of the Allentown, Rickenbach, Epler, and Ontelaunee Formations occupying 1165 acres.

Franklin Borough

Approximately 25% of Franklin Borough is underlain by differentiated members of the Kittatinny Formation. Hardyston, Leithsville, and Allentown rocks lie along both the southeastern and northwestern borders of the Borough and occupy around 704 acres.

Fredon Township

The southern most extension of Fredon covers 2022 acres of undifferentiated Kittatinny Limestone in an area which includes a state forest (part of the Whittingham Tract) and a state park.

Green Township

Nearly all of Green Township is underlain by Kittatinny Limestone. Only a narrow strip along the southeastern border and around 100 acres in the northwest corner are not over undifferntiated Kittatinny. There is approximately 6,880 acres of land which covers Kittatinny Limestone in Green Township.

Hamburg Borough

All of Hamburg except the eastern and northwestern tips lies over differentiated Kittatinny Limestone. A total of 538 acres covers the Allentown, Leithsville, and the Hardyston, although much of this land is already developed.

Hampton Township

Hampton is mostly bisected by an extensive area of undifferentiated Kittatinny Limestone that includes Swartswood State Park and underlies Swartswood Lake and Little Swartswood Lake. As the Kittatinny nears the northern border of Hampton the map shows that it becomes differentiated into Ontelaunee, Epler, Rickenbach, and Allentown formations. Clearview Lake is underlain by the Epler Formation. There are 4,704 acres in Hampton which sit above Kittatinny Limestone.

Hardyston Township

The Kittatinny Limestone in Hardyston is concentrated in the northwestern third of the Township and is well differentiated into the six member subgroups. A total of around 4,762 acres covers Kittatinny in Hardyston.

Lafayette Township

Two bands of the southern-most arm of the Kittatinny Formation lie under Lafayette Township. One band, about one mile wide, lies directly in the middle of the Township and is well differentiated. The second band crosses the southern tip of the Township and is also well differentiated. The total amount of land that covers Kittatinny Limestone in Lafayette is about 4,896 acres.

Ogdensburg Borough

A thin band of Kittatinny Limestone bisects Ogdensburg, occupying an area of around 500 acres. The deposit consists of the Allentown member sandwiched between two Leithsville members, and is around 2,000 feet wide.

Sparta Township

Sparta Township is also traversed by two parallel bands of differentiated Kittatinny. The eastern most band is an extension of the Allentown-Leithsville formation that lies under Ogdensburg. The prominent band lies under the western border, and all six subgroups are represented in it. The total amount of land lying over Kittatinny in Sparta approaches 5,100 acres.

Stillwater Township

About half of the northwestern arm of the Kittatinny Formation in Sussex County parallels the southeastern border of Stillwater Township. The deposit is entirely undifferentiated and underlies nearly 5,900 acres.

Vernon Township

There are two areas of Kittatinny Limestone in Vernon Township. A thin band of differentiated limestone underlays the entire length of Vernon's northwestern border with Wantage, which is delineated

by the Wallkill River. A bed of about 6.5 miles in length and 1.6 miles in width extends across from Vernon's northeastern border. This bed is also differentiated, although the majority consists of the Allentown member. Total land area underlain by Kittatinny Limestone in Vernon Township amounts to close to 8,500 acres; the most of any municipality in Sussex County (see Table IV).

Wantage Township

Most of the 3,630 acres of land overlying Kittatinny Limestone in Wantage Township are over a continuation of the same bed that runs under the Wallkill River composing the boundary between Wantage and Vernon Township. Another small bed of Ontelaunee and Epler members exists about a half-mile to the west of the Wallkill River in Wantage.

As a general summary, there is a total of 66,049 acres of land (103.2 sq. miles) in Sussex County underlain by water bearing stratified drift deposits and 52,130 acres (81.45 sq.miles) underlain by carbonate rock aquifers.

Both stratified drift and carbonate rock aquifers need to be recognized and protected in order to insure a continued supply of high quality groundwater for future generations. It is important to note that when stratified drift and carbonate rock aquifers are interconnected, the use of land over them is that much more critical because combined they make for the most prime aquifers in the county. The next section will discuss the consequences of ignoring these relationships

The Consequences of Inaction

The threats to Sussex County groundwater that were outlined at the beginning of this chapter cannot continue unchecked indefinitely without causing the degradation of water quality, and thus the quality of life as it presently exists in the County. Figure 12 is a matrix which details a comparison of these problems and the primary and secondary consequences that are likely if no action is taken to change current practices. Those consequences are summarized as follows:

1. Impaired groundwater as a source of potable water.
2. Prohibitive costs of groundwater rehabilitation and/or reservoir construction.
3. Loss of prime land to reservoir construction.
4. Reliance on sources outside of municipality or county, and the higher costs of importing potable water.
5. Increased danger to public health and welfare.
6. Associated use of impaired surface waters.

1. The obvious consequence of ignoring groundwater problems will be the negative impact on availability of groundwater as a source of water of sufficient quality and/or quantity to support a growing population base. Degradation of groundwater beyond potable standards means no water for drinking, cooking, washing, or bathing. The elimination of groundwater as a reliable water source will lead to other consequences when the problem of finding water becomes acute.

2. If it is decided that the best way to solve the water shortage that will result from the impairment of groundwater is to either rehabilitate the underground resource or construct surface water systems, a likely result will be a cost that will impose an unnecessary financial burden on Sussex County residents.

3. In addition to the dilemma of paying for the construction of reservoirs to replace groundwater supplies, there will be the associated consequence of sacrificing acres of prime land, which in Sussex County would be impossible to avoid, to reservoir construction. Therefore, in addition to the cost of constructing the reservoir, the cost of forgoing the opportunity to use the land for another purpose must also be considered and included.

4. If efforts to rehabilitate groundwater supplies or construct new sources of potable water within Sussex County prove fruitless, the remaining alternative is to look beyond County borders for a potable water supply. It then becomes inevitable that Sussex County residents will be paying much more for water. It is also quite possible that, in an importing situation under drought conditions, this foreign water supply could be cut off from the County or substantially reduced in favor of more immediate, higher priority customers. This became all to evident in the 1980 drought in New Jersey.

5. Different from those above, though no less significant a consequence, is the threat to public health that will exist if the use of groundwater which has been degraded persists. The consumption of contaminated water causes exposure to a plethora of bacteria and a host of harmful chemicals or substances. It will be a difficult task for health officials to prevent the use of polluted water by those who can not pay the costs of obtaining potable water mentioned above.

6. It is quite possible and often probable that contamination or depletion of groundwater will inevitably have an effect on adjacent surface water bodies which are intricately balanced as part of a dynamic, constantly changing system.

Chapter Four has outlined groundwater problems specific to Sussex County, identified the County's groundwater resources and suggested the consequences of ignoring their vulnerability. Chapter Five will present a methodology for classifying areas in critical need of groundwater management in the order of their susceptibility, managing and controlling the use of land over those areas, and implementing the controls at the local level.

FIGURE 12

SUMMARY OF POSSIBLE

CONSEQUENCES OF INACTION