# EXHIBIT 5
# GEOLOGIC TIMETABLE

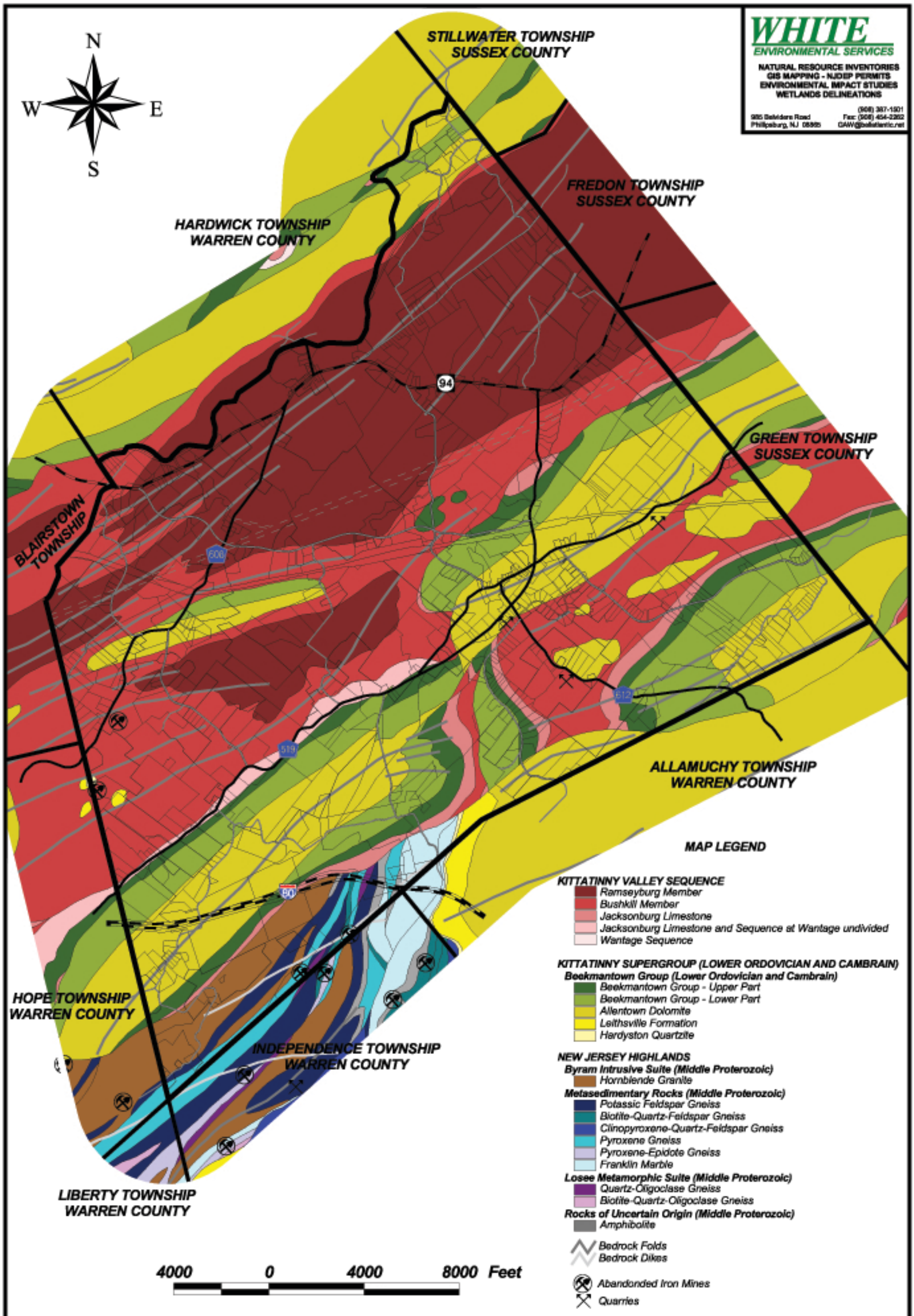
| ERAS | PERIODS | EPOCHS | MILLIONS OF YEARS DURATION | MILLIONS OF YEARS BEFORE THE PRESENT |
|---|---|---|---|---|
| CENOZOIC | Cenozoic | Pleistocene | 1,000,000 | |
| | | Pliocene | 12,000,000 | |
| | | Miocene | 12,000,000 | |
| | | Oligocene | 11,000,000 | |
| | | Eocene | 22,000,000 | |
| | | Paleocene | 5,000,000 | 63,000,000 |
| MESOZOIC | Cretaceous | | 72,000,000 | |
| | Jurassic | | 46,000,000 | |
| | Triassic | | 49,000,000 | 230,000,000 |
| PALEOZOIC | Permian | | 50,000,000 | |
| | Pennsylvanian | | 30,000,000 | |
| | Mississippian | | 35,000,000 | |
| | Devonian | | 60,000,000 | |
| | Silurian | | 20,000,000 | |
| | Ordovician | | 75,000,000 | |
| | Cambrian | | 100,000,000 | 600,000,000 |
| | Precambrian time | | | |

Oldest rocks dated 3,000,000,000 years

Origin of earth 4-5,000,000,000 years

# GEOLOGIC TIMETABLE

# EXHIBIT 6
# BEDROCK GEOLOGY AND MINES

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**REFERENCES & NOTES:**

*Property boundaries were taken from a composite tax map of FrelinghuysenTownship and adjusted accordingly.*

*Bedrock Geology based upon NJGS GIS database "The Bedrock Geology of New Jersey", 1999.*

*This map has been prepared as a guide for the Frelinghuysen Township Master Plan. Data on this map should not be relied upon for individual lot planning.*

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# Bedrock Geology

**Municipal Master Plan**
**Township of Frelinghuysen**
**Warren County, NJ**

Scale: 1" = 4000' Date: 11/19/03


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Within the Valley and Ridge Province there can often be ten members of the Kittatinny Limestone Supergroup. They can also be divided in terms of their solubility. From a planning standpoint, this is of far greater importance as the more soluble formations yield greater quantities of water, are most susceptible to pollution and also exhibit karst features such as sinkholes, disappearing streams, and caverns. The least resistant formations include the Leithsville and Allentown Dolomites. These areas lie in the central valley running generally from Dark Moon Road at the Green Township boundary to Interstate 80 at the Hope Township boundary along with pockets along the Allamuchy Township boundary and a small portion adjacent to Stillwater Township are bounded by the more extensive Ramseyburg, Beekmantown Members. Portions of the Wantage Sequence and Jacksonburg Limestone and sequence may also be found.

In the 1970s and 1980s bedrock geology was considered a critical element in determining appropriated densities for development based on their presumed safe sustained yield of water supplies. Earlier studies, such as the Land Oriented Reference Data System (LORDS), prepared in 1974, stated as follows:

> "Realization a few years ago that the earth was a space ship with finite resources started a surge of interest in what may loosely be called "environmental" and ecology." The factors and interrelationships of these two disciplines, while known and studied for years by a few, now became matters of general interest. Two deficiencies then became apparent; there was a singular lack of specific data, particularly for the smaller areas and information sources available lacked the flexibility needed for quick recovery of information, rapid update of facts and changing emphasis of use.
>
> The problem is particularly acute in that part of the earth known as New Jersey. With an average population density of 1,008 people per square mile only 19% is urban, nearly 45% of the state is forested, 9% is lakes, and 27% is suburban or agricultural, with a per acre dollar value for crops produced which for years has ranked either first or second in the nation. On the one hand, one municipality has over 10,000 people per square mile while another has less than four people per square mile. In rural New Jersey, 16 townships encompassing over 1,000 square miles, nearly 1/7 of the land surface of the state, has a population density of less than 100 people per square mile. Half of these townships have population densities of less than 50 people per square mile. There is an intense competition for land use of whatever kind whether for open space or urban, suburban or agriculture. Whether the open spaces shall be preserved or suburbs built has become an increasingly difficult decision for local officials.
>
> The various national environmental protection laws have accentuated the need for factual data that is not only available but also relevant, adequate, and current. To meet this need, various public and private, national and state organizations have turned to the data bank and computer program as

a possible means of providing the vast amounts of factual data required for the wide variety of land use and environmental decisions which must be made.

Before discussing the development of the New Jersey Land Oriented Reference Data System, hereafter referred to as LORDS, four relationships with respect to the development of land use and environmental program should be emphasized. First, people attract people; second, geology, topography and climate determine where people will settle and what, in a general way, they may do; thirdly, the activity of people in the physical environment determines the character of the biosphere or the ecological conditions, and finally, many little wrong or adverse decisions may result in undesirable environmental, ecological, or socio-economic conditions beyond recovery."

The LORDS study provided for minimum lot size where well and septic were used based on geology. Those minimum lot sizes were as follows:

| | |
|---|---|
| Precambrian gneiss | 3.0 – 4.0 acres |
| Franklin Limestone | 1.5 – 3.0 acres |
| Kittatinny Limestone | 1.5 – 3.0 acres |
| Martinsburg Shale | 3.0 – 4.5 acres |
| Jacksonburg Limestone | 1.5 – 3.0 acres |
| Triassic Diabase | 2.5 – 3.0 acres |
| Quaternary Stratified and Unstratified Drift | 1.0 – 1.5 acres |

Accordingly, zoning during that timeframe utilized this environmental data in an attempt to bring natural systems and population/economic development into some degree of balance.

During the 1980's, the Planning Board spent a considerable amount of time and provided expertise in the area of natural resources. From the discussions comes the following:

Frelinghuysen also has significant areas of glacial sediments (see Exhibit 7, Glacial Sediment Deposits) located generally along Allamuchy Johnsonburg Road and within the Village of Johnsonburg itself. Note that the recommended densities at that time were for 1.0 to 1.5 acres per unit.

Recently, however, the New Jersey Department of Environmental Protection and specifically the New Jersey Geologic Survey, have put a great deal of effort into an analysis of the recharge capabilities for various areas within the state basing the safe sustained yield of water for consumption on the amount so water which actually infiltrate the soils and could be expected to reach the aquifer for later withdrawal. This is being coupled with a renewed understanding and concern of

potential pollution of these subsurface aquifers (see Exhibit 8, Groundwater Recharge Rates and Exhibit 9, Aquifer and Public Wells).

Soil is the product of a living environment and a vital factor in the productivity and sustainability of any region. Soil, along with water and air, are the precious commodities that give life to our planet. Soil purifies our water, it sustains green plants which are at the foundation of our food chain, and which provide oxygen and filter pollutants from the air. Though it can take a thousand years for decomposing leaf litter to produce one inch of topsoil, and many thousands of years of weathering processes on rocks to fragment soil particles to soil size, the leaching and erosion tendencies of soils can deplete an area of nutrients and materials in a matter of a few seasons. This points out the need for careful management and protection of soils; once depleted or eroded, soils will not regenerate in a lifetime.

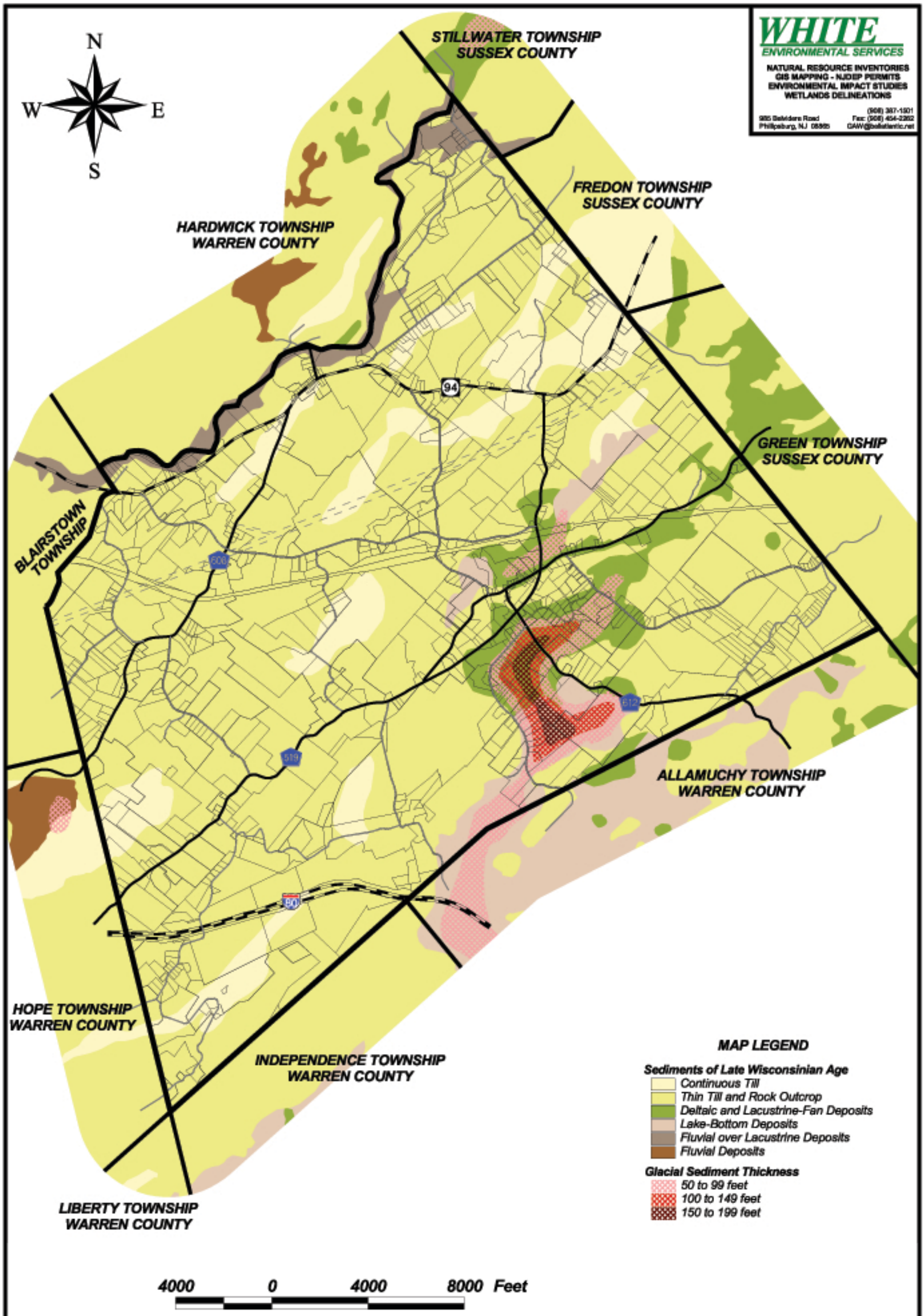
Soil types control natural drainage, stoniness, soil erodability, engineering properties such as the ability to support the weight of buildings and roads, available water capacity, runoff potential, and natural fertility. It is more effective and more economical in planning to pay attention to the natural limitations imposed by different soils than to try to attempt to modify soils or remedy problems created by improper land use. Since experience has shown that most problems from erosion occur during the initial stages of the development process, the Planning Board should ensure that all subdivision and site plans contain adequate designs to minimize damage from soil erosion and sedimentation.

Freshwater wetlands play an integral part in maintaining the quality of life by providing a natural means of flood and storm damage protection, serving as a buffer zone to prevent erosion of sediments to streams, and by providing essential breeding, spawning, nesting and wintering habitats for a major portion of the township's fish and wildlife, including migrating birds, endangered species, and commercially and recreationally important wildlife.

Wetlands are scattered throughout the township, including large areas along some of our major waterways such as Bear Creek and Trout Brook. The Frelinghuysen Township Planning Board and Committee recognized the value of freshwater wetlands to the quality of life by incorporating a wetlands ordinance into the revised Land Development Ordinance, adopted in May 1987. As of May 16, 1988, freshwater wetlands are protected and regulated by law in New Jersey (N.J.A.C. 7:7A).

The United States Department of Agriculture Soil Conservation Service in the early 1970s prepared a soil survey of Warren County (see Exhibit 10, Soils Survey). This information first thought to be particular useful farmers and is somewhat ancillary value to developers has received much greater attention in recent years. A general description of the various soils in Frelinghuysen Township is provided in Appendix A.

# EXHIBIT 7
# GLACIAL SEDIMENT DEPOSITS

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**MAP LEGEND**

**Sediments of Late Wisconsinian Age**
- Continuous Till
- Thin Till and Rock Outcrop
- Deltaic and Lacustrine-Fan Deposits
- Lake-Bottom Deposits
- Fluvial over Lacustrine Deposits
- Fluvial Deposits

**Glacial Sediment Thickness**
- 50 to 99 feet
- 100 to 149 feet
- 150 to 199 feet

**REFERENCES & NOTES:**

*Property boundaries were taken from a composite tax map of FrelinghuysenTownship and adjusted accordingly.*

*Glacial Deposits taken from NJGS GIS database, "Glacial Sediments of New Jersey", 2003.*

*This map has been prepared as a guide for the Frelinghuysen Township Master Plan. Data on this map should not be relied upon for individual lot planning.*

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## Glacial Sediment Deposits

**Municipal Master Plan**
**Township of Frelinghuysen**
**Warren County, NJ**

Scale: 1" = 4000' Date: 11/19/03

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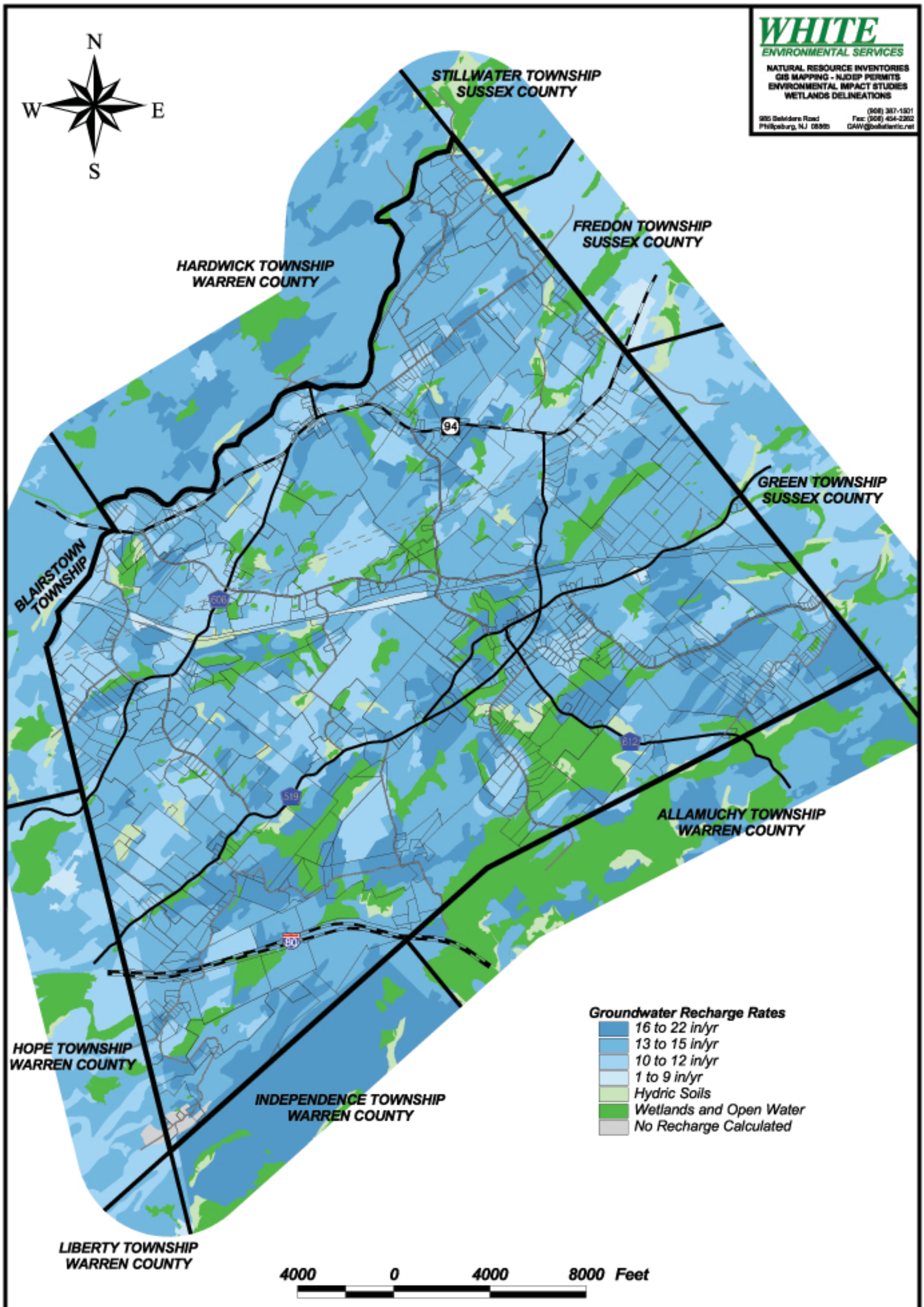
# EXHIBIT 8
# GROUNDWATER RECHARGE RATES





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**REFERENCES & NOTES:**

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*Groundwater Recharge Rates based upon NJGS GIS database " DGS02-3: Ground-Water Recharge for New Jersey", 2002.*

*This map has been prepared as a guide for the Frelinghuysen Township Master Plan. Data on this map should not be relied upon for individual lot planning.*

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# Groundwater Recharge Rates

**Municipal Master Plan**
**Township of Frelinghuysen**
**Warren County, NJ**

Scale: 1" = 4000' Date: 11/19/03


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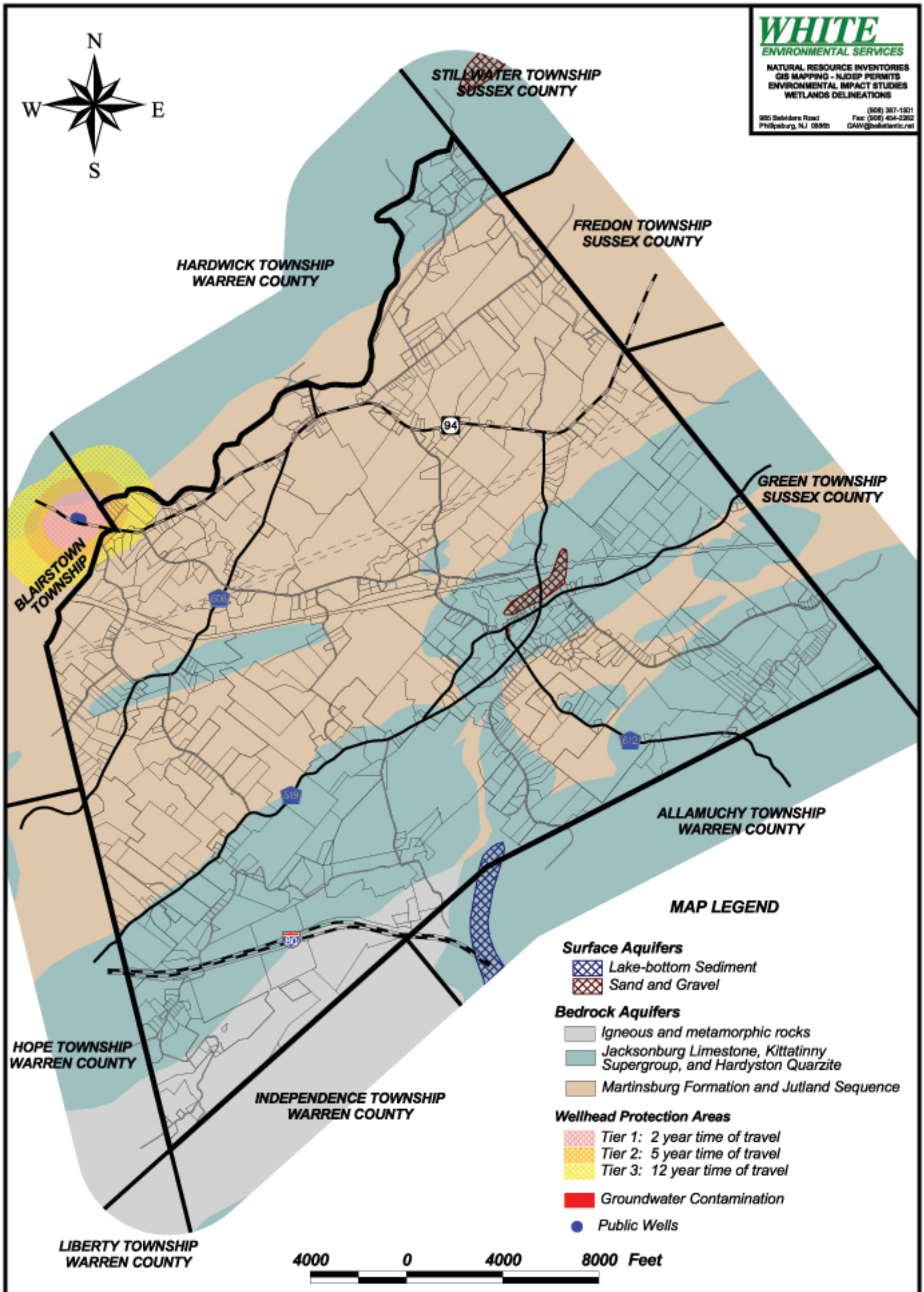
# EXHIBIT 9
# AQUIFER AND PUBLIC WELLS




**REFERENCES & NOTES:**

*Property boundaries were taken from a composite tax map of FrelinghuysenTownship and adjusted accordingly.*

*Bedrock and Surface Aquifers based upon NJGS DGS98-5 "Aquifers of New Jersey", 1998.*

*Public Wells and Wellhead Protections Areas based upon NJGS "DGS02-2 Geographic Information System Coverages of Public Community Water Supply Well Head Protection Areas for New Jersey", 2002.*

*Groundwater Contamination Areas based upon "NJDEP Currently Known Extent of Groundwater Contamination (CKE) for New Jersey", 2001*

*This map has been prepared as a guide for the Frelinghuysen Township Master Plan. Data on this map should not be relied upon for individual lot planning.*

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# Aquifers & Public Wells

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**Township of Frelinghuysen**
**Warren County, NJ**

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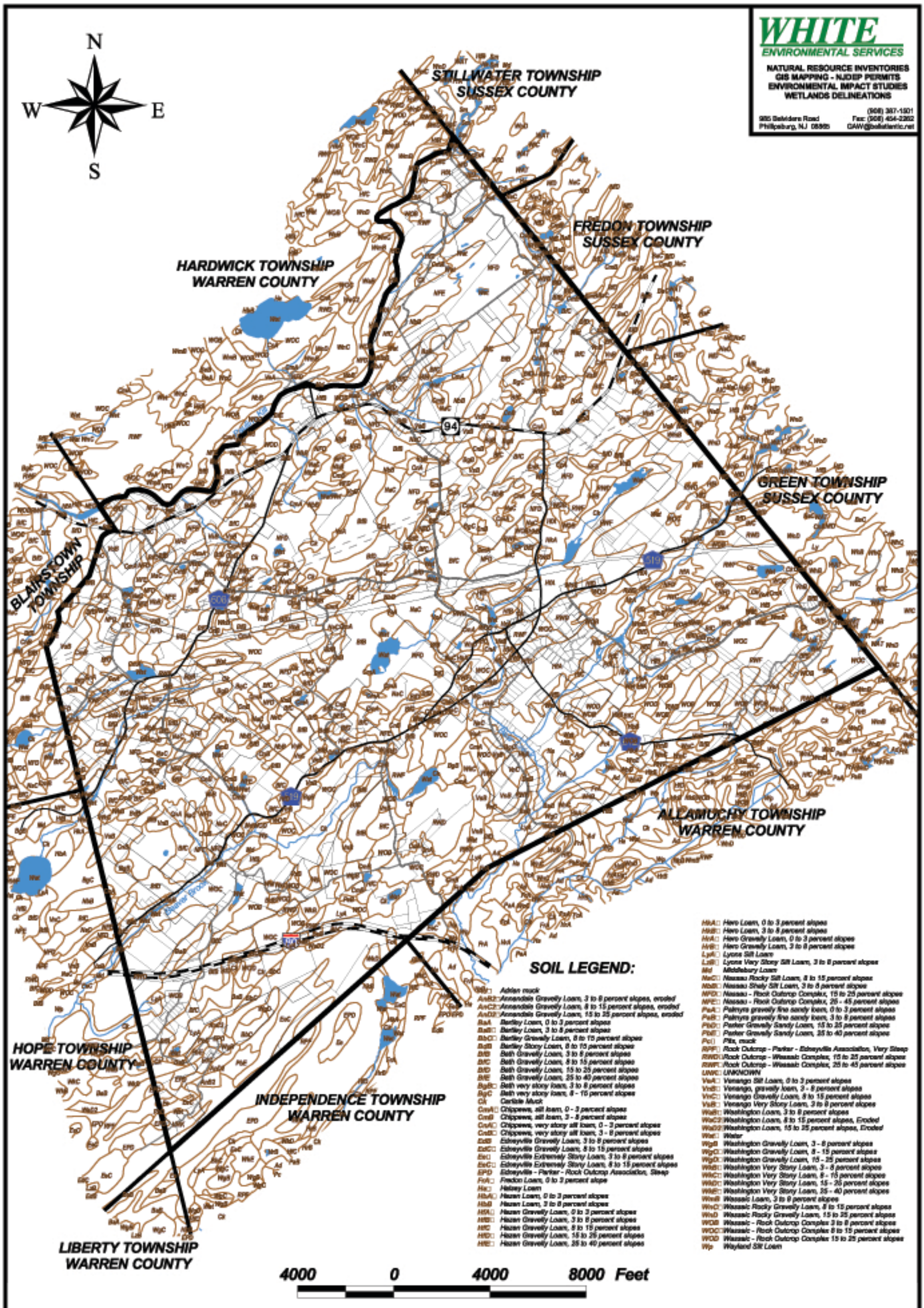
# EXHIBIT 10
# SOILS SURVEY




**REFERENCES & NOTES:**

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*Soils Series mapping based upon NJDEP GIS mapping of the Warren County and Sussex County Soils Surveys.*

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## Soil Survey

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**Township of Frelinghuysen**
**Warren County, NJ**

Scale: 1" = 4000' Date: 11/19/03


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An understanding of the natural physical setting in Frelinghuysen is important in determining the capability of the land in the township to support development. Natural processes which continually change the surface of the earth have occurred since the beginning of time and will continue to do so, with or without our presence. Hazards to safe and economic development may result from preexisting natural conditions or they may occur as a direct result of human activities.

The geologic processes that formed the rock formations which occur in the area have produced an environment with great variety, and one that shaped human habitation of the region. Deep, rich limestone soils; steep, rocky, cavernous limestone outcrops; cool springs and perennial swamps; and rolling, thinly veneered hills of shale are all the product of the township's unique geologic history. Each one of these environments presents "built-in" limitations to human exploitation.

For planning in rural areas, the most important aspects of geology include the stability of geologic formations and the availability of ground water. Soils, rocks, climate, vegetation, elevation and slope all affect hydrology, the movement and presence of water above and below the surface in the township. Land use affects the flow of water through a watershed - whether above or below ground - and its quality. A stream that drains an undeveloped watershed or one which has been carefully developed will be in balance with normal amounts of rainfall and flood only occasionally. Changes in drainage patterns brought about by improper development can create downstream flooding and ponding in areas previously dry. Diverting streams, draining wetlands and paving for roads and parking lots, changes the location and amount of water absorption and eventually the recharging of the aquifer.

Frelinghuysen is host to deposits of cavernous limestone, which bring with them unique planning challenges. The limestone formations are prolific aquifers and have a great number of caverns, sinkholes, springs, bedrock pinnacles and other "karst" features thereby making limestone valleys a very sensitive environment. Land subsidence which may occur in areas of limestone. Sinkholes are of concern because their collapse usually happens suddenly, often causing property damage and, sometimes injuries or even death to humans and animals.

## BEDROCK GEOLOGY AND LAND USE

Bedrock is a general term for the rock which is usually solid and underlies the soil or other unconsolidated surface material. If it is exposed on the surface, it is referred to as “outcrop”. Basic rock strata that can be separated from other types by their age and composition are usually named after the locality where they are first found, such as the Allentown Formation, first identified in Allentown, Pennsylvania.

Exhibit 6, Bedrock Geology also shows faults, a structural characteristic of rocks that is formed when breakage and movement occur. There are many faults in Frelinghuysen, most of which are inactive at this time. Active faults are found in

the region though, as evidenced by the many small earthquakes recorded in the surrounding areas, such as near Tranquility to the east.

In terms of land use, bedrock geology is important in that it controls where ground water occurs and determines stability of the environment. For instance, there are many unstable features associated with the Kittatinny Limestone, such as sinkholes and caves, that are the result of chemical and physical weathering. Bedrock geology thus helps us plan where to locate wells for water supply and where to exercise caution in undertaking construction.

The chemical characteristics of the various bedrock types are important because they control the quality of the ground water found in them, and other important factors such as the occurrence of radon gas. The latter is usually associated with Precambrian granitic rocks, but is known to occur in the limestone and shale in other areas of New Jersey.

PLEISTOCENE SURFICIAL DEPOSITS

The bedrock surface of the township has been modified by glaciation, as described above, Exhibit 7, Glacial Sediment Deposits, shows the various types of glacial drift left by the advance and retreat of the last glacier to occupy New Jersey, the Wisconsin Ice Sheet.

Glacial deposits, or drift, are categorized on the basis of their dominant texture which are a function of the processes that formed the deposits. Meltwater carrying rock particles from the retreating glacier deposited coarse sediments, known as stratified drift, in high-energy environments such as streams and deltas, and fine-grained sediments in low-energy environments such as lakes, ponds and swamps. Deposits laid down directly by the ice in the absence of meltwater are heterogeneous and are labeled glacial till.

Stratified drift deposits are well sorted, tend to lack clay and silt, and are well drained. These deposits form prolific aquifers where they are sufficiently thick. Stratified drift permits good infiltration of water and serves to store ground water, often contributing large volumes of high quality recharge to underlying bedrock aquifers. The well drained soils in the township are most often developed atop stratified drift deposits. The water table is often moderately deep in these deposits. The most significant deposits of stratified drift are found in the Paulins Kill Valley, and in the central part of the township in the vicinity of Johnsonburg, where they overlie limestone.

Poorly drained glacial drift includes glacial lake-bed deposits, glacial till and swamp deposits. Glacial lake-bed sediments are deposited downstream of melting ice, in low-energy environments where the fine silt and clay were permitted to settle out. These fine lake-bed sediments often underlie better drained stratified drift deposits, which often cause springs to form at the base of

the sand and gravel deposits. The fine sediments also underlie the larger swamps in the region. Although thick in places, glacial lake-bed deposits do not constitute prolific aquifers but may supply water to some wells. Ground water in these sediments is often of objectionable quality due to a high content of organic material as well as high iron and sulfur concentrations in lake-bed sediments.

Glacial till is material deposited by gravity from the glacier as debris. Till deposits in the township are usually thin, although, in places, till may reach 25 feet in thickness. Till generally has a high clay content and, usually, a high percentage of gravel. The high clay content and poor grain-size sorting within the till reduce its permeability. This causes poor internal drainage and, often, a shallow seasonal water table within a few feet of ground surface.

| **Unit** | **Description** | **Hydrologic Characteristics** |
|---|---|---|
| Qsd | Glacial outwash, deposited mostly as deltas in glacial lakes (glaciolacustrine deltas), or between the glacier and the valley walls, (kame terraces) or in channels within the glacier. Consists of cobbly pebble gravel, pebble gravel, pebble sand, coarse sand and, sometimes, silty sand. Usually well-sorted and stratified. Generally 20 to 50 feet thick, may reach thicknesses of up to 100 feet. Forms significant terraces in Paulins Kill alley. Forms isolated moderate to low profile landforms elsewhere. Often deposited atop finer glacial lake bed sediments (Qlb below). | High to moderate permeability. Constitute aquifers suitable for community and/or domestic needs where significantly thick. Provide significant storage and recharge for underlying bedrock aquifers. |
| Qlb | Glacial lake bottom deposits, composed of laminated sand, silt and clay. Very flat surfaces, generally covered by peat. Generally 30 to 50 feet thick, but may exceed 100 feet in places | Very low to low permeability. Constitute confining bed for underlying aquifers. Suitable for domestic needs on very limited basis, but few wells finished in this unit. |
| Qt | Glacial till, interpreted to be basal till, deposited directly by ice. Moderately to highly compacted. Low to moderate content of cobbles and boulders. Silty to silty sand matrix. Clasts and matrix derived primarily from the local bedrock. Usually occurs as a veneer up to 10 feet thick. | Moderate to low permeability. Generally too thin and discontinuous to form notable confining bed. |

| Unit | Description | Hydrologic Characteristics |
|---|---|---|
| Qs | Swamp and bog deposits, consisting of peat and muck with silt and clay. Generally 5 to 20 feet thick, but may be thicker in some glacial lake basins. | Highly impermeable. Water table at surface, or local ponding above regional water table. |
| Qal | Alluvial deposits left by modern streams, consisting of silt, sand and boulder gravel, with peat and other organic matter on flood plains and along small streams. May contain minor amounts of swamp (Qs) deposits. Generally less than 10 feet thick. | Moderate to very low permeability, depending on organic content. Too thick to constitute aquifer or confining bed. Water table at or near surface most of the year. |
| Qc | Colluvial deposits on slopes, left by mass wasting of tills, alluvium, or glaciofluvial outwash aquifers. May aid aquifer recharge, where permeable, especially over poor aquifers or where other surficial deposits are thin or absent | Moderate to very low permeability, depending on clay content. Too thin and discontinuous to constitute aquifers may aid aquifer recharge where permeable, especially over poor aquifers or where other surficial deposits are thin or absent. |

Other important surficial deposits within the township include post-glacial (or "Recent") stream alluvium and swamp deposits. The alluvial deposits are sediments laid down in modern stream valleys. Alluvium has a variable composition depending on the terrain being drained by the stream. Alluvium may have a high silt content or a high percentage of organic material – both of which reduce permeability of the alluvial deposit. In most cases, the water table occurs at shallow depths within the alluvium. The deposits are usually thin.

Swamps are the remnants of glacial lakes and ponds caused by the melting of the glacier. Underlying glacial lake-bed sediments and/or impervious bedrock entrap surface drainage and form the swamp. The swamp deposits contain a very high percentage of organic material and the water table is at, or near, the surface most of the year.

From the realization that recharge and the vulnerability of aquifers to pollution are of great importance to the safe sustained yield subsurface water supply, an entirely new approach to evaluating appropriate development densities has been crafted and is now the recommended approach by the New Jersey Department of Environmental Protection.

This model, the Modified Nitrate Dilution Model, is based on the ability of soils to accept recharge and in that context to dilute the nitrate contained in human septic effluent. The Nitrate Dilution Model offers a method of establishing a carrying capacity of safe densities for development. As part of this Master Plan update, the Hydro-geologic Group of Maser Consulting prepared a nitrate dilution based carrying capacity assessment for Frelinghuysen Township.

Nitrate (NO3) is a highly stable and mobile anion in shallow aquifer conditions. Namely, it tends to not readily decompose into other compounds and furthermore, is not readily bound by soil as are many other contaminants. Consequently, it has the ability to be long lived and travels at a similar velocity as that of the groundwater in which it is present. In undeveloped areas, nitrate concentrations are typically low (less than 1 mg/1) and serve as an excellent general indicator of human impact to natural resources.

Typical septic system discharges contain approximately 10 pounds of nitrate per person per year per system. At locations where housing densities exceed the capability of the environment to sufficiently dilute the concentration of septic discharged nitrates, potential health impacts can arise where domestic wells are employed as potable water sources.

As a result of the potential health impacts of excess nitrate in drinking water (e.g., methemoglobinemia commonly know as blue-baby syndrome), the U.S. EPA and has set a maximum contaminant level (MCL) of 10 mg/1 for nitrate in potable water supplies.

Traditional methods used to assess domestic septic system suitability are effective tools to evaluate the ability of a specific site to hydraulically support an individual septic system. However, these methods do not address the cumulative effect of multiple septic systems to the local or regional groundwater quality. Thus, groundwater quality may potentially be degraded in areas having a high density of approved, properly functioning septic systems.

The objective of the Maser study was to utilize a nitrate dilution model in order to provide the Township with technical information for the Township's review and furthermore to act as technical justification for the possible development of residential density guidelines by the Township to mitigate potential groundwater degradation in non-sewered areas.

The New Jersey Geologic Survey adapted a technique to estimate carrying capacities based on septic system discharged nitrates. The technique requires inputs consisting of the soil type, the population density (residents per household), nitrate loading rate, and a target nitrate concentration that represents the maximum concentration of nitrate deemed to be acceptable by the governing body. Maser employed this technique to assess the carrying capacity of the

Township using a population density of 3.5 residents per household (the average density of a new single family detached residential unit for the State of New Jersey) and a target nitrate concentration of 2.0 mg/1.

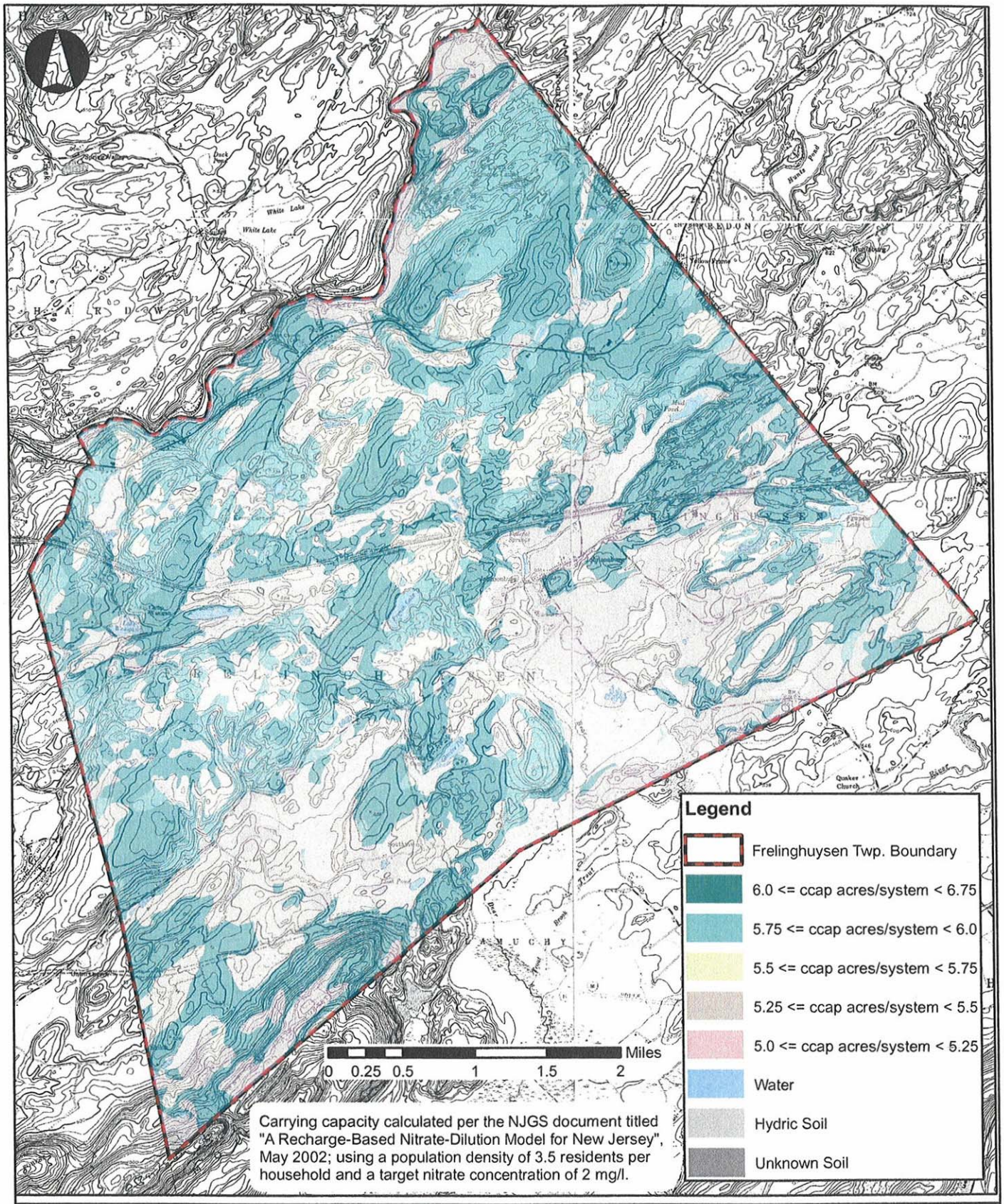
The results of the study indicate that the carrying capacities of the Township range from a low of 5.0 acres per septic system to a high of 6.2 acres per septic system, with an area weighted average carrying capacity of 5.8 acres per septic system. (see Exhibit 11 & 12)

Land use densities are only one of a number of issues that may be evaluated using this information. Exhibit 9, Aquifer and Public Wells, also indicates the specific location of aquifers within the Township and wellhead protection areas including the three tier time of travel spectrum proposed by the NJDEP. There are no public wells within Frelinghuysen Township. However, it is well to be aware that development in the vicinity of public wells or concentrations of private wells must be carefully considered so as to avoid the degradation of those supplies.

The Kittatinny Valley, through which run the Pophandusing and the Pequest Rivers, is generally broad and flat. Available water is located not only within the underlying limestone aquifers but also within the overlying glacial deposits. Water supply from these formations varies widely, the greatest productivity being found in the most highly soluble limestones and in the sand and gravel aquifer.

The availability of water within the aquifer is not the only issue of concern relating to geology. With greater availability comes greater vulnerability to pollution. Water within the Pre-Cambrian Crystallines may move at rate of a few inches a day. In the highly productive sand and gravel and limestone aquifers, water may move at a rate of hundreds of feet per day. The rate of movement relates directly to the degree to which pollutants may be disseminated throughout the aquifer and the extent of the impact on the aquifer of a given pollution event.

# EXHIBIT 11
# CARRYING CAPACITY AND TOWNSHIP AREA




MASER CONSULTING P.A.

Consulting, Municipal & Environmental Engineers
Planners ▪ Surveyors ▪ Landscape Architects

Figure No. 3

Nitrate Dilution Based Carrying Capacity
Frelinghuysen Township, Warren County, NJ

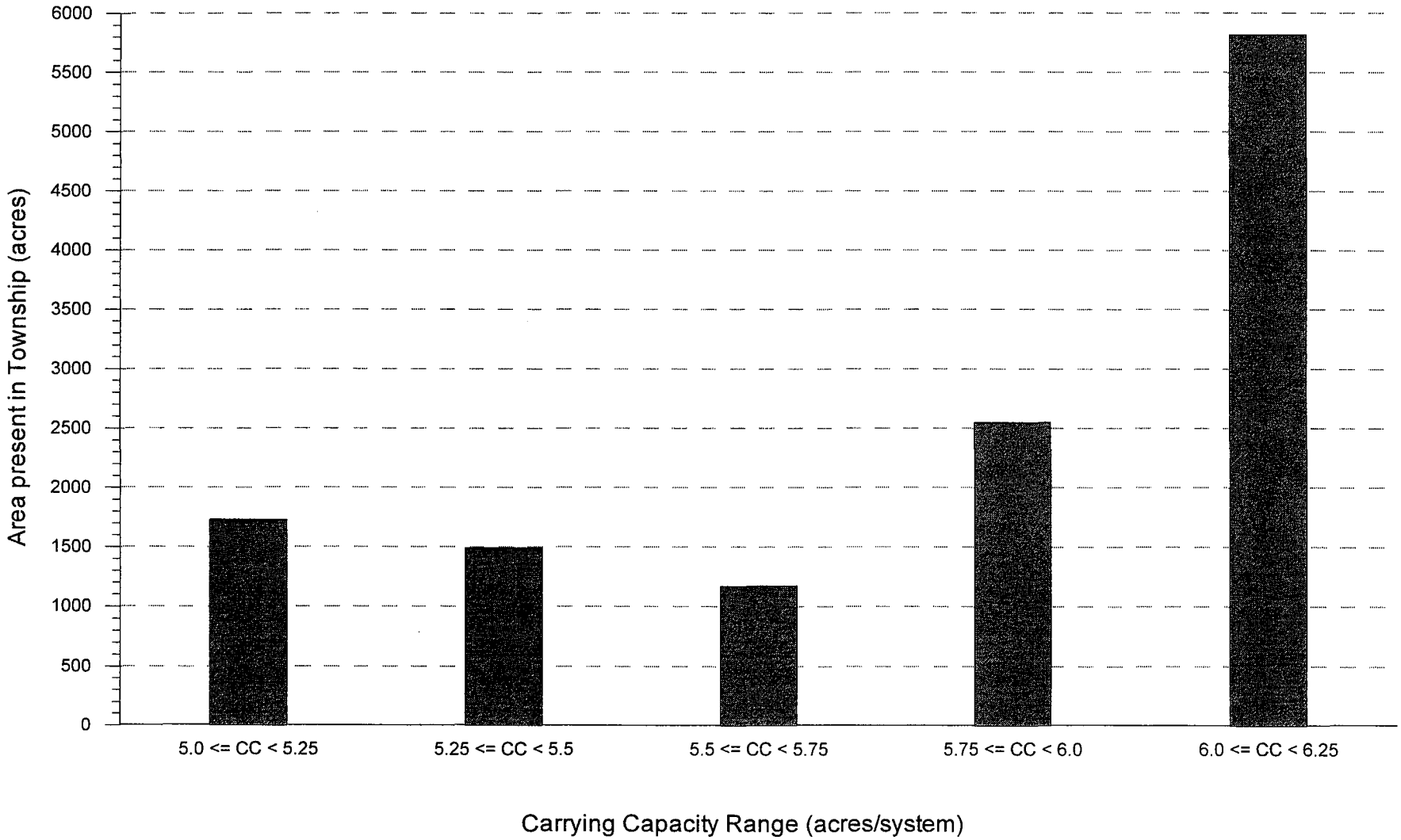
This map was developed using geographic information system digital data developed under the auspices of the Department of Environmental Protection Geographic Information System, but this secondary product has not been verified by NJDEP and is not State-authorized.

MC Project No. FRB-005

# EXHIBIT 12
# CARRYING CAPACITY MAP

Frelinghuysen Township, Warren County, New Jersey

**Carrying Capacity and Township Area**




Note: Area weighted average carrying capacity = 5.8 acres per system.

P:/Frelinghuesen_NO3/CCAP_vs_TwpArea_barplot.grf

Figure No. 2

**Surface Hydrology**

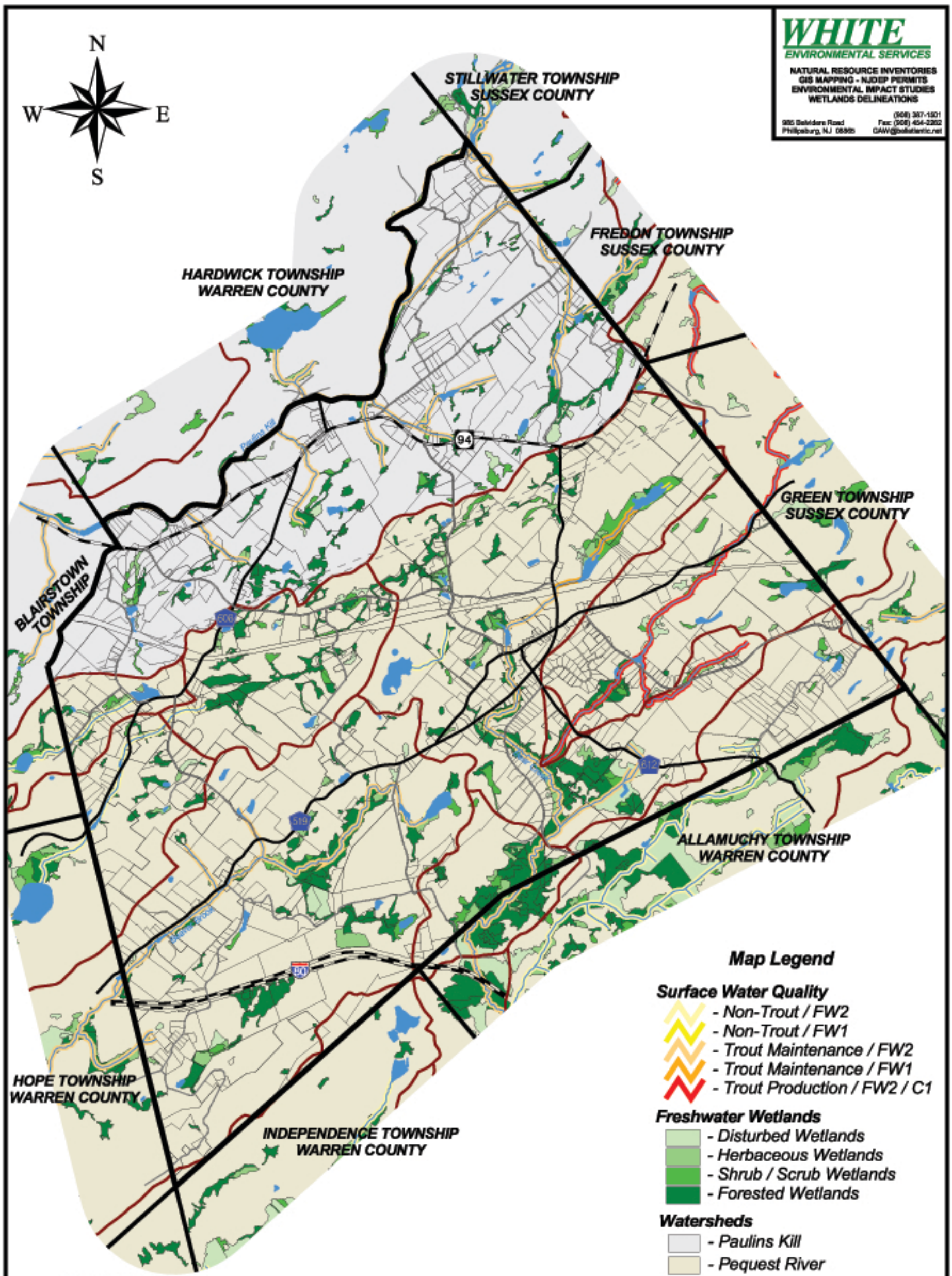
Frelinghuysen is home to numerous streams, ponds, and lakes along with the wetlands associated with those water features. Exhibit 12, Surface Hydrology, indicates that these features are present throughout the Township, are often associates with substantial wetlands.

The Township is subdivided into two watersheds, the Paulinskill and Pequest Watersheds. The Pequest comprises approximately three quarters of the Township while the Paulinskill occupies the northwestern quarter of Frelinghuysen adjacent to Hardwick and Blairstown Townships in Warren County and Stillwater and Fredon Townships in Sussex County. A watershed is defined as that area from which water falling runs to a particular stream. Consequently, activities within each watershed should be addressed on their potential impact to downstream areas.

A subset of the surface water features within the Township are the flood hazard areas as shown on Exhibit 13. However, the principal issue related to surface hydrology is that planning in large part has moved from planning based on municipal or county boundaries to planning based on natural boundaries and particularly on watersheds. As may be seen from Exhibit 13, the surface hydrology of Frelinghuysen Township, the Pequest and Paulinskill watersheds originate elsewhere and flow into other municipalities. Activities undertaken in Frelinghuysen Township, effect residents of Hope Township, Blairstown Township and Independence Township. Whereas activities in Green, Fredon and Stillwater Townships in Sussex County effect those in Frelinghuysen.

The NJDEP has actively encouraged watershed planning, designating watershed management areas. The Township of Frelinghuysen lies within WMA 1, the Upper Delaware Watershed Management Area. This area comprises those watersheds in subwatersheds which flow to the Delaware River in northwest New Jersey.

# EXHIBIT 13
# SURFACE HYDROLOGY

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**REFERENCES & NOTES:**

*Property boundaries were taken from a composite tax map of FrelinghuysenTownship and adjusted accordingly.*

*Freshwater Wetlands based upon the NJDEP Freshwater Wetlands Inventory, 1986.*

*Lakes and Streams based upon NJDEP GIS database.*

*Drainage Basins and Watersheds based upon NJDEP GIS Database, HUC14.*

*This map has been prepared as a guide for the Frelinghuysen Township Master Plan. Data on this map should not be relied upon for individual lot planning.*

*This map was developed using NJDEP & NJGS Geographic Information System digital data, but this secondary product has not been verified by the NJDEP or NJGS and is not State - authorized.*

## Surface Hydrology

**Municipal Master Plan**
**Township of Frelinghuysen**
**Warren County, NJ**

Scale: 1" = 4000' Date: 11/19/03

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**Wildlife Habitat**

Much has been made of the concern that the natural resource base be able to sustain the impact of development by human settlement. However, there is another substantial group of organisms affected by human activities and that is the plant and wildlife communities. Exhibits 16, Critical Wildlife Habitat and Exhibit 15, Natural Heritage Priority Sites indicate that Frelinghuysen is the home of State and Federal threatened and endangered species. These tend to be associated with surface water systems and the map in question is designed to provide general information to suggest that species of concern may lie within these areas. The State Natural Heritage Priority Sites and the mechanism of tracking of threatened and endangered species is general. In the case of wildlife, although it can be more particular in the case of plant life which is fixed.

The Natural Heritage Priority Sites located within Frelinghuysen are the Great Meadows Macrosite, Luse Pond, South Town Sinkhole, Bear Creek, Glovers Pond, Greendell Ridge, and various areas within the vicinity of Johnsonburg. It should be noted at this point that the Nature Conservancy has been active in securing the development rights to areas of particular concern, most particularly in the Johnsonburg areas so as to protect the limestone forest habitat.

## NATURAL COMMUNITIES

Wildlife protection is of importance not only to Frelinghuysen Township and its immediate environs but also to the State of New Jersey. Exhibit 14, Critical Wildlife Habitat indicates that, within Frelinghuysen Township, there are various locations where threatened or endangered species are resident. Development of any kind within the Township will have an impact on wildlife populations.

## VEGETATION

In an area as large as Frelinghuysen, it is not practical to map the highly variable plant and animal communities found within the Township. Accordingly, a more generalized approach is taken in this document. It is recommended that language be included in subsequent development regulations include the requirement that concentrations of particularly important and protected species be shown in conjunction with development applications. The following are a series of habitat designations, with the plant species generally associated with them.

# EXHIBIT 14
# CRITICAL WILDLIFE HABITAT