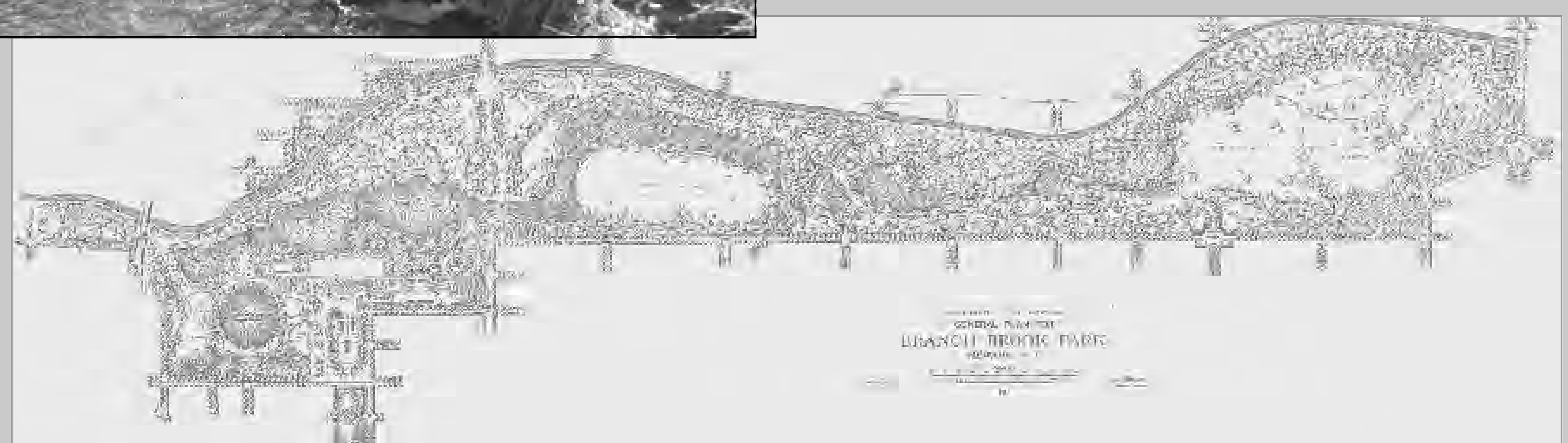
# Part II - Analysis of Hydrology, Utilities, Circulation, and Park Use



# INTRODUCTION TO CHAPTERS 5 THROUGH 9

The following sections document, analyze and present recommendations for Branch Brook Park's hydrology system (lake, ponds and connecting streams), utilities (gas, water, electric, storm water sewer, sanitary sewer, cable and telephone) and vehicular circulation (including parking). Research was conducted to gather available existing information from Essex County, local municipalities, New Jersey Department of Environmental Protection, New Jersey Geologic Society and the U.S. Environmental Protection Agency. This information was added to the Branch Brook Park survey that was completed earlier in the Cultural Landscape Report (CLR) study. Field work ensued to verify the research information and to inventory existing site conditions. Interviews were conducted with Essex County administrative staff and Department of Parks Recreation and Cultural Affairs staff to gain an understanding of the uses within the park. Interviews were also conducted with individual facility managers for the same purpose.

This information was synthesized and analyzed against previously gathered information and concurrent planning and analysis being completed in the CLR study. Recommendations are presented for the hydrologic system, utilities and vehicular circulation. The following is a summary of the recommendations. These recommendations are discussed in greater detail in the respective sections that follow.

## The Hydrologic System

The hydrologic system evaluation documents water quality and quantity information from existing sources such as Essex County Department of Parks, Recreation and Cultural Affairs (Essex County Parks), the New Jersey Department of Environmental Protection (NJDEP) and the United Stated Geological Service (USGS). Using visual survey methods, the condition of 1.3 miles of the bank of the Second River, .75 miles of the stream banks, and 1.6 miles of pond and lake shoreline were inventoried and documented including published floodplain limits and areas of erosion and siltation. A character assessment of the aquatic vegetation and plant material along the banks of the water bodies was also conducted.

In addition to the natural systems mentioned above, the manmade stormwater system is an integral part of the hydrology of this urban watershed. The stormwater is identified as follows:

- Surface runoff that contributes directly to the surface water storage (lakes, ponds and connecting streams) in the park.
- Surface runoff conveyed through structural means that contributes directly to the surface water storage.
- Surface runoff conveyed through structural means, connected to the combined storm/sanitary sewer that runs through the Middle and Southern Divisions and discharges into the Passaic River.

Contaminated sites as identified by NJDEP have been identified and a discussion of those near the park is included. Of note is a contaminated site within the Branch Brook Park boundary associated with underground storage tanks at the Essex County park maintenance facility that were removed prior to the completion of this study.

### Summary of Recommendations

#### Immediate Tasks

1. *Install additional soil erosion and sediment control measures and maintain until eroded areas are stabilized.*
2. *Revegetate shorelines recently denuded of vegetation in the Southern Division.*
3. *Complete the Remedial Action Workplan (RAW) for the soil and groundwater contamination by the maintenance building.*
4. *Restore riparian buffers along all water edges to the maximum width practical and historically correct, preferably between 75' and 100'.*

#### Short-term Tasks (within 2 years)

*Public Support Programs*

1. *Lobby NJDEP to include Branch Brook Lake in an amendment to the existing EPA MOA listing Branch Brook Lake on the 303(d) list.*
2. *Participate in Watershed Management 4 (WMA 4) Planning Process.*
3. *Notify NRCS when any excavation is occurring within the park.*
4. *Develop a fundraising strategy for anticipated projects.*
5. *Enlist volunteer groups for improvement projects, water quality testing, and continued trash pick-up.*
6. *Educate the public, Essex County Administration, and maintenance staff on how the stewardship of Branch Brook Park and Belleville Park fits within the regional watershed.*

*Management and Maintenance Programs*

1. *Implement a long-term water quality monitoring program.*
2. *Develop and implement a forestry management plan with a special component to address the life and health of the cherry trees.*
3. *Develop and implement a turf management program.*
4. *Include within the Maintenance and Treatment Plan the maintenance of riparian buffers.*
5. *Develop Best Management Practices (BMPs) that address water quantity and quality concerns specific for Branch Brook and Belleville Parks and an implementation program.*
6. *Develop an invasive species removal program.*

*Feasibility Studies*

1. *Complete a feasibility study to determine if it is possible dredge the water bodies within Branch Brook Park to their original designed depth or deeper (if studies indicate feasibility).*
2. *Develop a baseline for environmental indicators.*

### Ongoing / Long Term Tasks (Ongoing / within 10 years)

1. *Commission the completion of a flood limit study that would delineate the flood hazard boundary specific to Branch Brook Park.*
2. *Rebuild all catch basins to include trash hoods and sediment sumps.*
3. *Continue to lobby NJDEP to include Branch Brook Lake in an amendment to the existing EPA MOA listing Branch Brook Lake on the 303(d) list until accomplished.*
4. *Continue to develop and modify a fundraising strategy for anticipated projects.*
5. *Continue to inform NRCS when any excavation is occurring within the park.*
6. *Continue long-term monitoring program.*
7. *Continue to implement the dredging program if it was determined to be feasible.*
8. *Continue relationships with volunteer groups.*
9. *Continue to educate the public, Essex County Administration and maintenance staff.*
10. *Continue pro-active drainage structure cleaning and maintenance program.*
11. *Continue street sweeping program.*
12. *Continue long term water quality monitoring program.*
13. *Continue to implement forestry management plan.*
14. *Continue to implement a turf management program.*
15. *Continue implementation of Best Management Practices (BMPs) as capital improvements are planned for Branch Brook Park and Belleville Park.*
16. *Implement reconfiguration of stormwater system if it was determined feasible.*

## Utilities

The utility evaluation documents existing utility information within Branch Brook Park and Belleville Park and those immediately adjacent systems that connect to systems within the parks. This information included gathering existing information from Essex County, City of Belleville, the City of Newark and Verizon. Sanitary and stormwater systems, gas, electric, cable and water services were delineated on utility maps. The systems were visually field verified to the extent possible with the locations of structures and conditions noted from observed field conditions.

The following is a summary of utiltiy recommendations. These recommendations are discussed in greater detail in the body of this report.

### Summary of Recommendations

### Short-term Tasks (within 2 years)

1. *Remove sediment and debris from existing clogged drainage structures.*
2. *Implement a pro-active drainage structure cleaning and maintenance program.*
3. *Implement a street sweeping program.*
4. *Complete a feasibility study to determine costs and benefits of reconfiguring the Branch Brook Park stormwater system within the park.*
5. *Include within the Maintenance and Treatment Plan the maintenance of stormwater and sanitary sewer systems.*

### Intermediate Tasks (within 5 years)

1. *Connect catch basins to dry wells.*

### Ongoing / Long Term Tasks (Ongoing / within 10 years)

1. *Rebuild all catch basins to include trash hoods and sediment sumps.*
2. *Continue to develop and modify a fundraising strategy for anticipated projects.*
3. *Continue pro-active drainage structure cleaning and maintenance program.*
4. *Continue street sweeping program.*

## Vehicular Circulation and Parking

The vehicular circulation system evaluation consists of the inventory and documentation the vehicular circulation system within and surrounding Branch Brook Park. The general directions of travel on the interior park roads and adjoining neighborhood streets are noted. The roads that were evaluated included the internal Branch Brook Park loop road, Park Avenue, Bloomfield Avenue, Heller Parkway, Franklin Avenue, Lake Street, Clifton Avenue, Mill Street, Bellville Avenue, Union Avenue, and Washington Avenue. On site parking opportunities were noted for each division indicating on street and off street parking locations and number of spaces. On-street parking opportunities on adjacent city streets were also inventoried.

An inventory of land within a ¼ mile of Branch Brook Park and Belleville Park was conducted to identify possible lands to be utilized for off-site parking. Mass transit locations (NJ Transit bus and rail and Newark City Subway) were identified. The majority of vacant parcels are limited in size and not feasible for development as a surface parking lot. One parcel, a vacant 66,000 s.f. industrial site located at Block 1951, Lot 22, is large enough to accommodate parking.

An evaluation of the number of cars traveling into and through the park was completed in the spring of 2003. This information in conjunction with the evaluation of the facility managers interviews, permit users and mass transit locations will be utilized to evaluate the parking demands within the park. Parking availability is included in this report. Analysis and recommendations will be forthcomming.

# CHAPTER 5: DEVELOPMENT OF THE WATERWAYS IN BRANCH BROOK PARK

Water has played a historic role in the area now known as Branch Brook Park. Natural swamps, now drained, were once part of the site, and water stored in reservoirs was used as a power source and for commerce to bring goods from Pennsylvania to the Newark Bay. During the park's development the old reservoir holding ponds were shaped into Branch Brook Lake, Clark's Pond was incorporated into the waterway design and Blue Jay Swamp, and the associated headwaters for the First River, were excavated to form Edgewood Pond, Midwood Pool, the Upper Pool and connecting waterways.

Challenges were encountered and concerns expressed by the Olmsted firm, the park designers, during the development of Branch Brook Park's water features. The depth of Branch Brook Lake and the source of the water in the remainder of the park for the water features were constant concerns for the designers. The Olmsted's intent was to have the depth of Branch Brook Lake be a uniform 8' with a shallower margin. This was not possible due to the previous use of the site as a quarry and the fears of the possible loss of water due to opening of fissures in the bedrock. Against the designer' preferences the water depth was kept at a constant depth of 3'. This shallow depth lead to chronic algae blooms which continue today.

Natural springs were located in the Middle Division. Initially, they were under private ownership and it was therefore felt they could not be relied upon as a water source for the park and city water was purchased. When the cost of purchasing became too high the designers suggested a well be dug as a source of water. Once the land was purchased for the Middle Division the amount of water for the water features in this area was believed to be adequate. Further complications arose when the Morris Canal was drained and the water levels within the park dropped.

The existing narrow natural brooks were excavated to form the watercourse in the Northern Division. This division did not have ample water to supply the water features. In addition to the use of underdrains from the meadow, a method was devised to recirculate the water in the Middle and Southern Divisions back to the Northern Brook. This system was to ensure that the intended design effect of the rills and falls could be experienced throughout the year and to lessen the growth of algae. In 1909 approximately 1,000,000 gallons a day was being pumped from the lake and Clark's Pond into the brook system. In this area of the park it was the design intent to allow the watercourse to overflow its banks in the event of a heavy rain. When the Morris Canal was drained and the water level dropped, additional water was pumped from the well. Over the long term this was not a thorough solution and it appears that no other was devised that adequately addressed the challenge of the source of water for the Northern Division. Today, this situation persists, and in adequate water flow characterizes the existing water course.

The Second River ran through the lands acquired for the Extension. Due to the limited width of the park in this area, the design intent to devise a scenic parkway along the river and the steeply sloping banks, necessitated channelizing the river. The construction of terraced banks supported by concrete walls was carefully designed to handle potential flash flooding as well as to be aesthetically pleasing.

The text in Chapter 7 evaluates the current conditions of Branch Brook Park's lake, ponds and watercourses and develops possible solutions to improve the health and restore the original designers' intent of these features. The park is part of a larger ecosystem and the effects on this system must be evaluated when determining an approach to treat improvements in Branch Brook Park.

# CHAPTER 6: GEOLOGY AND SOILS

Surficial geology (bedrock), associated reservoirs (aquifers), and the overlying soils have a direct relation to how fast the water drains from the land surface, how saturated (soggy) the soil gets and how long it stays that way. New Jersey is divided into four geological provinces with Branch Brook Park located within the Piedmont Physiographic Province (Figure 8). (Nichols, 1968).

## Geology

Branch Brook Park lies over the Brunswick Formation of the Newark Group from the Triassic age (Figure 9). This formation is predominantly shale and sandstone but also includes minor amounts of conglomerate. Overlaying the rocks of the Newark Group are unconsolidated clay and gravel deposited during the Pleistocene and recent epochs. Pleistoncene deposits are the most widely spread and are found throughout Essex County (Nichols, 1968). Bedrock elevations as reported by the State of New Jersey Division of Water Policy and Supply Special Report 28 (Nichols, 1968) indicate bedrock elevations ranging from approximately 60' above mean sea level to over 150' above mean sea level (Figure 10). Topographic elevations within Branch Brook Park in datum NJVD 1929, with the same base 0 elevation, range from 90' to 110' in the same area noted in SR 28 from the southern most point to the Midwood Pool. There is not an abundance of rock outcropping on site and thus an inconsistency between the two data. The conclusion is no definitive depth to bedrock can be determined from this information and soil borings will have to be completed to ascertain depth to bedrock.

Site investigations were conducted in Branch Brook Park in 1998 – 2001 by Remedial Technology and Engineering of the PMK Group; Cranford New Jersey, in conjunction with the environmental remediation of previous underground storage tanks (see the Contaminated Sites section of this report for more detail). The area investigated is located near the maintenance facility. Site-specific geologic information was gathered. Within this area the park is underlain by approximately 13 feet of fill material, consisting of brown gravel with some coarse to fine sand, and varying amounts of fragments of brick, concrete and asphalt. The fill is underlain by glacial till deposits consisting of reddish brown coarse to fine sand, silt and clay, with varying amount of coarse to fine gravel and occasional cobbles. Beneath the glacial till, highly weathered reddish brown decomposed shale and siltstone is found typically beginning at 20 feet below surface grade (PMK, 2002).

## Soils

Currently there is no soil survey available for Essex County. The NRCS (Natural Resource Conservation Service) has completed the fieldwork and has compiled all of the mapping and information. Quality control is currently underway, after which printing will be completed. The scheduled release of the completed soil survey is April/May 2003. General soils information is available from this work effort as described below in Branch Brook Park Soils. Specific information will be released

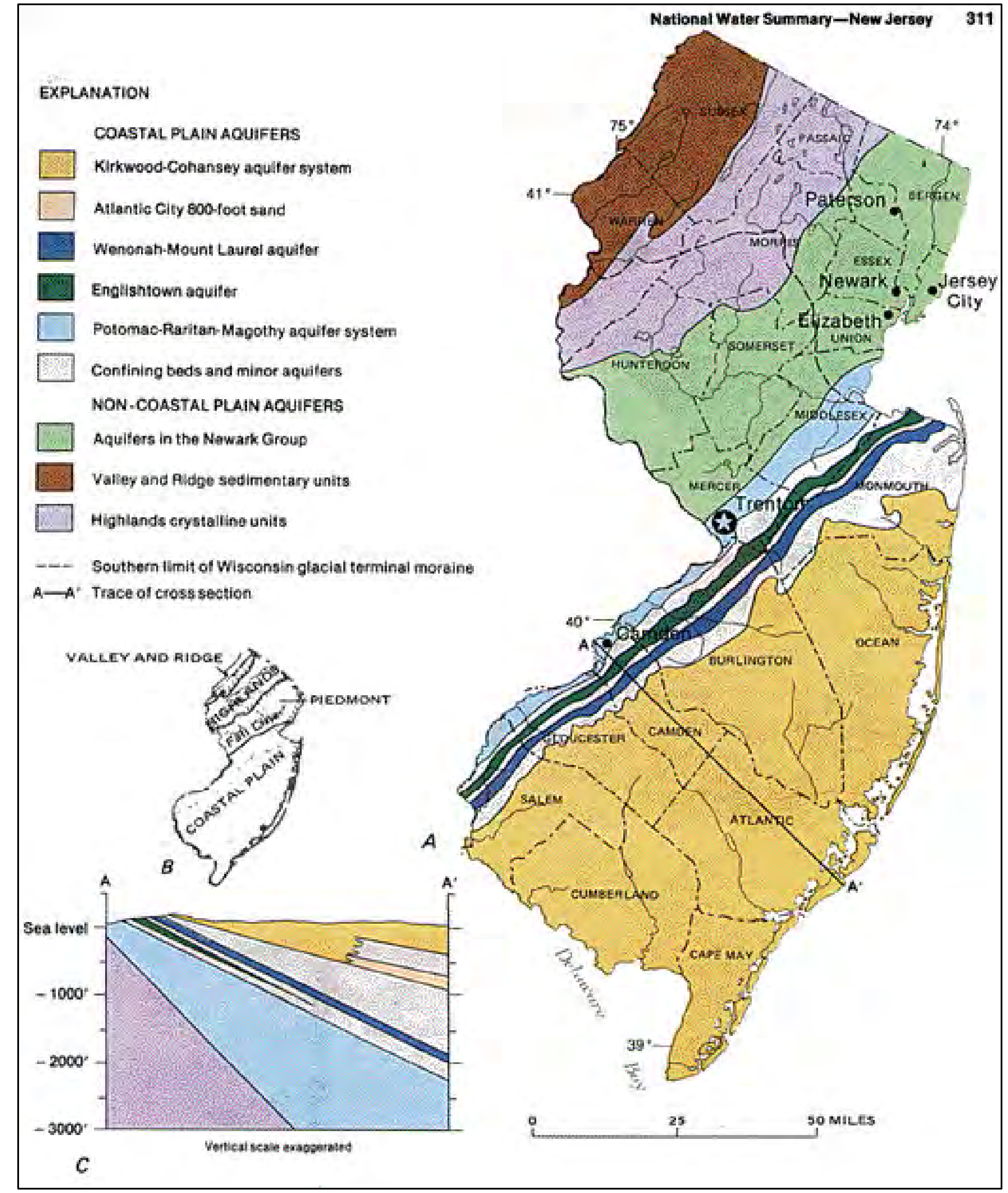



*Figure 8: Principal Aquifers in New Jersey with Physiographic Diagram and Divisions (NJDEP NJGS, 1999).*

when the quality control process is complete and the report is printed.

Note: Until the new soils information is released, data from a historical engineering soil survey completed in January 1951 by Rutgers University jointly with the New Jersey State Highway Department (Report no. 2, Essex County) and authored by Rodgers et al. will be used for soils information. A description of the soils from this report can also be found below in Branch Brook Park Soils.

## Branch Brook Park Soils

The general soils information available identifies the soil associations (map unit) in Essex County. Each association identifies a unique natural landscape with a distinctive pattern of soils, relief, and drainage. Three or more major soils and some minor soils comprise a soil association. Branch Brook Park is located within two soil associations; Urban Land- Dunellen-Riverhead and Urban Land – Boonton – Wethersfield. The following are descriptions of these associations from the USDA-SCS (1993).

### Urban Land- Dunellen-Riverhead (NJ012)

Nearly level to strongly sloping, deep and very deep, well drained gravelly, sandy loams. These soils formed in sandy, stratified glacial outwash on outwash plains and terraces and on river and stream terraces. Hydrologic group B. These soils are non-hydric.

### Urban Land – Boonton – Wethersfield (NJ013)

Gently sloping to moderately steep, well drained and moderately well drained, very deep and deep gravelly loams formed in acid, reddish sandstone, shale, basalt and conglomerate glacial till over shale and basalt bedrock. These soils occur on upland glacial till plains and ridges. Hydrologic group C. These soils are non-hydric.

The soils within Branch Brook Park and Belleville Park, according to the historic soils engineering report completed in 1951 (Rodgers, et al.), fall within three different soil groups, (1) GM and GM42i over Ss, (2) GS12i and (3) GM42i over Ss. (There are no names given to these soil groups.) The area between I-280 and Heller Parkway is a combination of GM and GM42i over Ss. The area between Heller Parkway and just north of the infield of the baseball field to the north of the Visitors Center is soil group GS 42. The remainder of Branch Brook Park and Bellville Park is GM 42i. A description of these soil groups follows:

GM and GM42i are present at the ground surface and are intermingled in a pattern too complex to allow separate mapping. The GM soils are a silty-loam and sandy-silts with varying amounts of pebbles, gravel, and boulders. Below depths of three to four feet, the material may tend more towards silty-sand. These soils usually exhibit poor internal drainage, with intermediate to very poor surface drainage depending on surface slope. Where the texture of the soil is more granular than average the drainage may be better but even in these cases internal drainage is sluggish. GM42i soils are generally moderately heavy to heavy textured with the consequent low permeability, create an imperfect and often poor, drainage condition and, hence, the water table will usually occur at

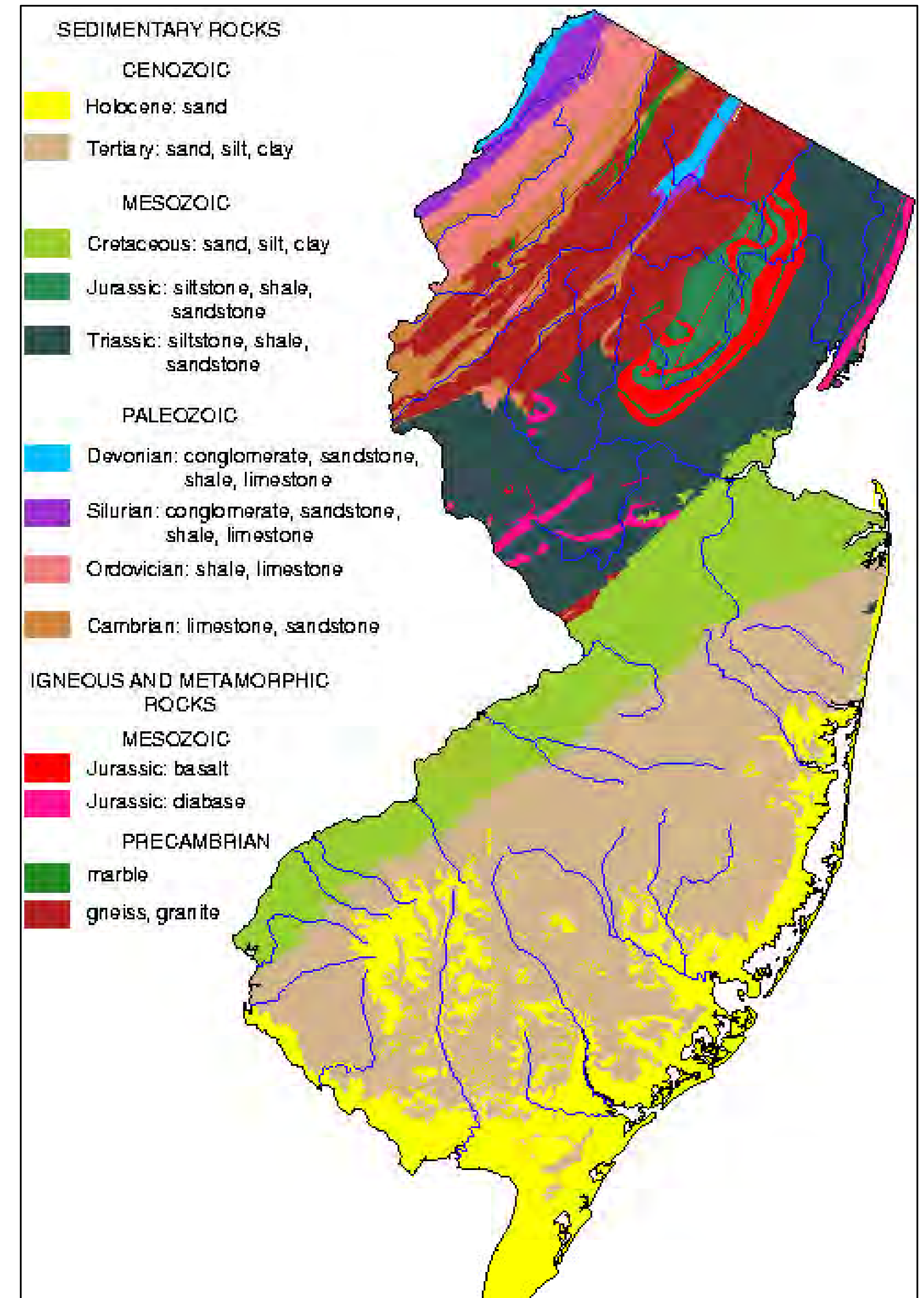



*Figure 9: Geological Map of New Jersey (NJDEP NJGS, 1999).*

relatively shallow depths. The exact position of the water table depends primarily on the magnitude and detail of local relief. Ss identifies red sandstone (Triassic age) that is the Brunswick Formation. GS 12i are silty sands, silty gravels, sandy gravels and gravelly sands. The open texture of this soil group material indicates that capillarity will usually be negligible and drainage, down through the natural profile, rapid. However, in seasons of heavy rain, inadequate surface runoff may cause temporary saturation (Rodgers et al., 1951).

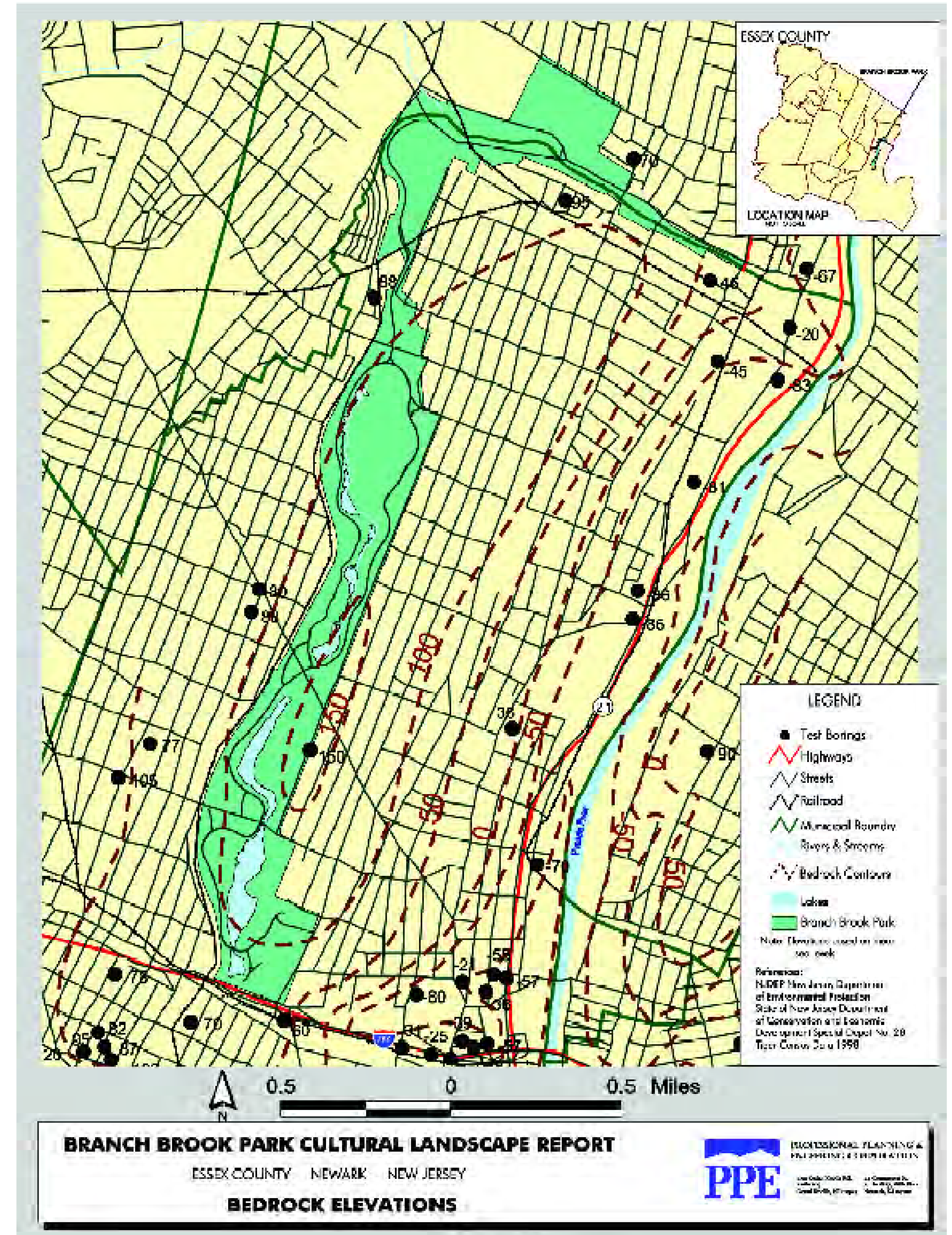



Figure 10

# CHAPTER 7: THE HYDROLOGIC SYSTEM IN BRANCH BROOK PARK

## Climate

The normal annual precipitation in New Jersey is 47.7 inches, varying from 46.6 inches on the seacoast to 49.1 inches in the Highlands and the Kittatinny Valley. Precipitation is 1 to 3 inches greater in the summer than in the other seasons. The average amount of rainfall the rest of the year is fairly consistent. From December to March, inclusively, part of the precipitation is in the form of snow. In the summer, thunderstorms are frequent, but are generally localized, and are much more common in the afternoon and early evening than in the morning (Office of the New Jersey Climatologist, 2002).

New Jersey has been in the midst of a drought since August 1999. Especially of note is that New Jersey experienced below average precipitation for 37 of the past 53 months. The above normal rainfall and snow during the fall of 2002 and early winter of 2002-2003 added enough precipitation to the yearly totals to effectively end that drought for the short term. Thus, over a 12-18 month period, the major precipitation deficits that accrued over the fall 2001 through winter 2002 period, and later during July and much of August 2002, have been replaced with near normal annual and recent above normal perception (Robinson, 2002).

Historically, there have been 7 seven recorded droughts during the 1900's. The rainfall deficit ranged from –20" (for the most recent drought) to –44" in the 1964-1968 drought. Table 1 below lists the drought periods and deficit levels.

| Period | Deficit | Time to next drought |
|---|---|---|
| 1908-1912 | -25" | 4 years |
| 1916-1920 | -30" | 3 years |
| 1923-1927 | -31" | 2 years |
| 1929-1933 | -35" | 31 years |
| 1964-1968 | -44" | 12 years |
| 1980-1984 | -25" | 15 years |
| 1999-2002* | -20" | |

*All reporting periods are for the period of the drought and two years following.

Table 1 : NJ Historical Droughts

From this information is can be seen that the drought from which New Jersey emerged from in the spring of 2003 is the least severe of the previous drought periods noted. The current urbanization of New Jersey and the high population density places significantly higher stresses on the water resources than during previous periods of drought. The significance of this information is that during the planning for the improvements to Branch Brook Park and Belleville Park the overall impact of utilizing water resources for park purposes should be evaluated to include not only natural systems but also the potential to reuse collected water as stormwater.

## The Hydrologic Cycle

There is a limited amount of water on earth. Water travels through a constant cyclic movement from the ground to the atmosphere and back to the ground and in a sequence called the hydrologic cycle (Figure 11). The hydrologic cycle includes evaporation, transpiration, evapotranspiration), condensation, transport, precipitation, infiltration, percolation, surface runoff, interflow, and groundwater flow.

Water travels from storage in the ground (aquifers) through interflow, ending up in freshwater lakes, rivers and streams and oceans. From these sources the water evaporates and is temporarily stored in the atmosphere. Vegetation contributes to atmospheric water through transpiration. Atmospheric water is released as precipitation in the form of rain, snow, fog or a combination thereof, and makes its way back to storage areas on earth via surface runoff to lakes, rivers, streams and oceans, or infiltration into the groundwater. The process then begins again.

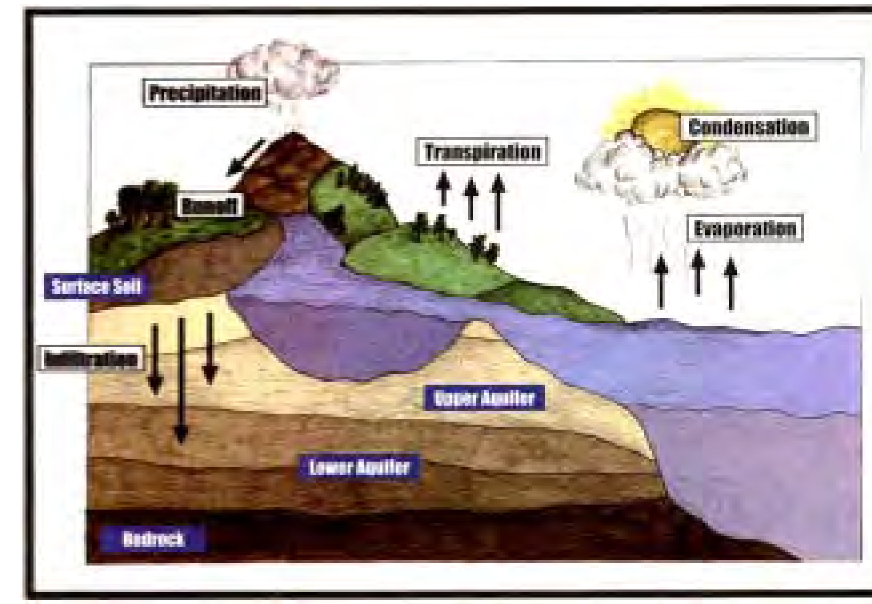



Figure 11: Hydrologic cycle (NJDEP, n.d.).

## Changes in the Watershed System as a Result of Urbanization

Urbanization has significant effects on the hydrologic cycle. When existing vegetation is removed, topography modified, and land cover changed from porous humus or soil layers to impervious pavements or eroded surfaces, the amount and rate of stormwater runoff increases substantially. These all affect the watershed hydrology, stream geometry, and aquatic ecosystems.

In an urban system the balance of the hydrologic cycle is changed with a high rate of surface runoff relative to the rest of the hydrologic cycle. By removing vegetation the uptake/transpiration portion of the cycle is greatly reduced or eliminated. By altering the land form natural areas for ponding are eliminated. There areas are where water previously had a chance to percolate back into the groundwater (groundwater/aquifer recharge) or be utilized by vegetation. Altering the landform also removes the humus layer reducing the amount of storage capacity the soil has for those same uses (Schueler, 1987). Figures 12a and 12b show the effects of urbanization on a watershed are increased surface runoff and decreased groundwater recharge. Increases

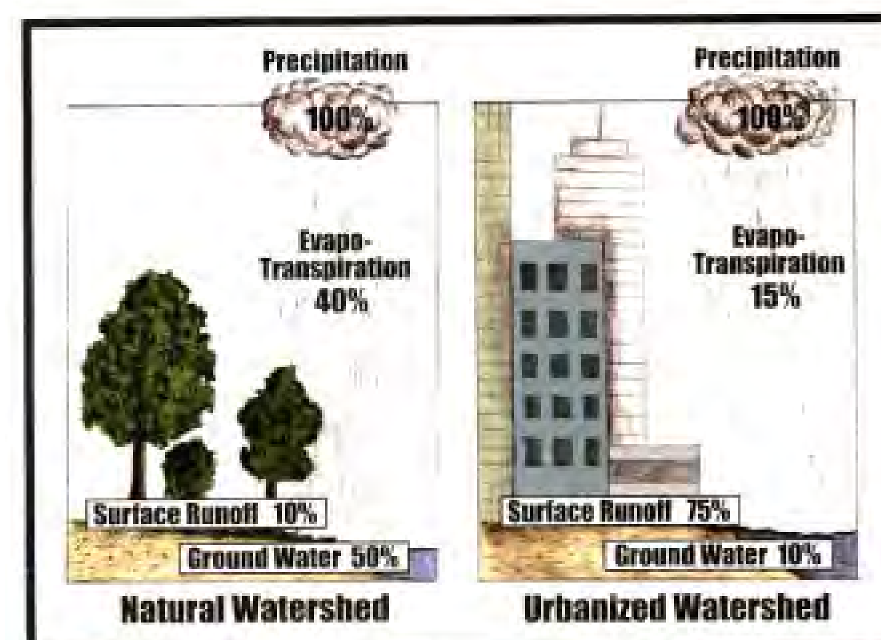



Figure 12a: Natural and urban water balance system (NJDEP, n.d.).

in surface runoff negatively impact streams, rivers and lakes through increased erosion and siltation.

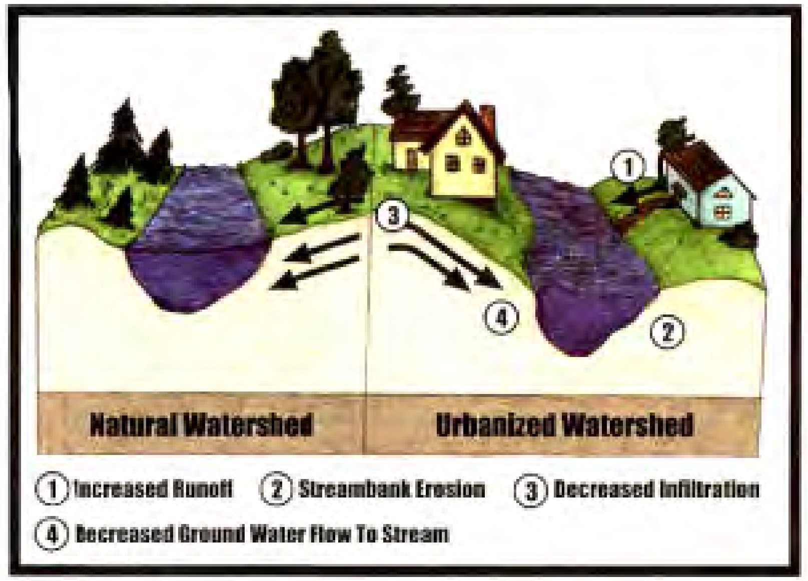



*Figure 12b: Natural and urban water balance system (NJDEP, n.d.).*

The geometry of streams and their floodplains are influenced and formed by rainfall and runoff. After urbanization (development) more rainfall is transferred into runoff, and the geometry of both the stream and the floodplain changes. The greater volume of water typically causes stream channels and floodplains to widen. Other occurrences are an increase in the elevation of the stream's floodplain, the undercutting and slumping of the streambanks into the channel due to lack of vegetation, and large quantities of sedimentation further reducing the ability of the stream to carry the surface runoff (Schueler, 1987).

As the natural stream system is changed to an urban system the habitat for fish and other biota, such as benthic macroinvertebrate communities, are reduced. The fish species become less diverse and become comprised entirely of fish that are tolerant to pollution. In addition, the overall number of fish in an urbanized stream is usually reduced from that which would be expected in a natural stream. The benthic macroinvertebrates rely on leaf litter and organic matter for food. Changes from urbanization such as change in water temperature, oxygen levels and substrate composition can further reduce the diversity and abundance of these species. These species also are a food source for the fish in the stream. (Schueler, 1987).

## Surficial Hydrologic System

The surficial hydrologic system for Branch Brook Park has a boundary called a watershed. A watershed is an area of land defined by topography from which rainwater or snowmelt drain into a particular river stream, river, lake, bay or ocean. Watersheds are separated from one another by high points or ridge lines such as hills or slopes. The watershed includes not only the waterway itself but also the entire land area that drains to it. The New Jersey Department of Environmental Protection (NJDEP) has identified 20 regional watersheds within New Jersey as Watershed Management Areas (WMA). Branch Brook Park is located within Watershed Management Area 4 (WMA 4) (Figure 13).

Two watersheds comprise WMA4: the Lower Passaic River Watershed and Saddle River Watershed. Figure 3 shows the boundaries of WMA4 and the two watersheds. The Lower Passaic River Watershed, of which Branch Brook Park is a part, originates at the confluence of the Pompton River downstream to the Newark Bay. This 33-mile section meanders through Bergen, Hudson, Passaic,


Figure 13

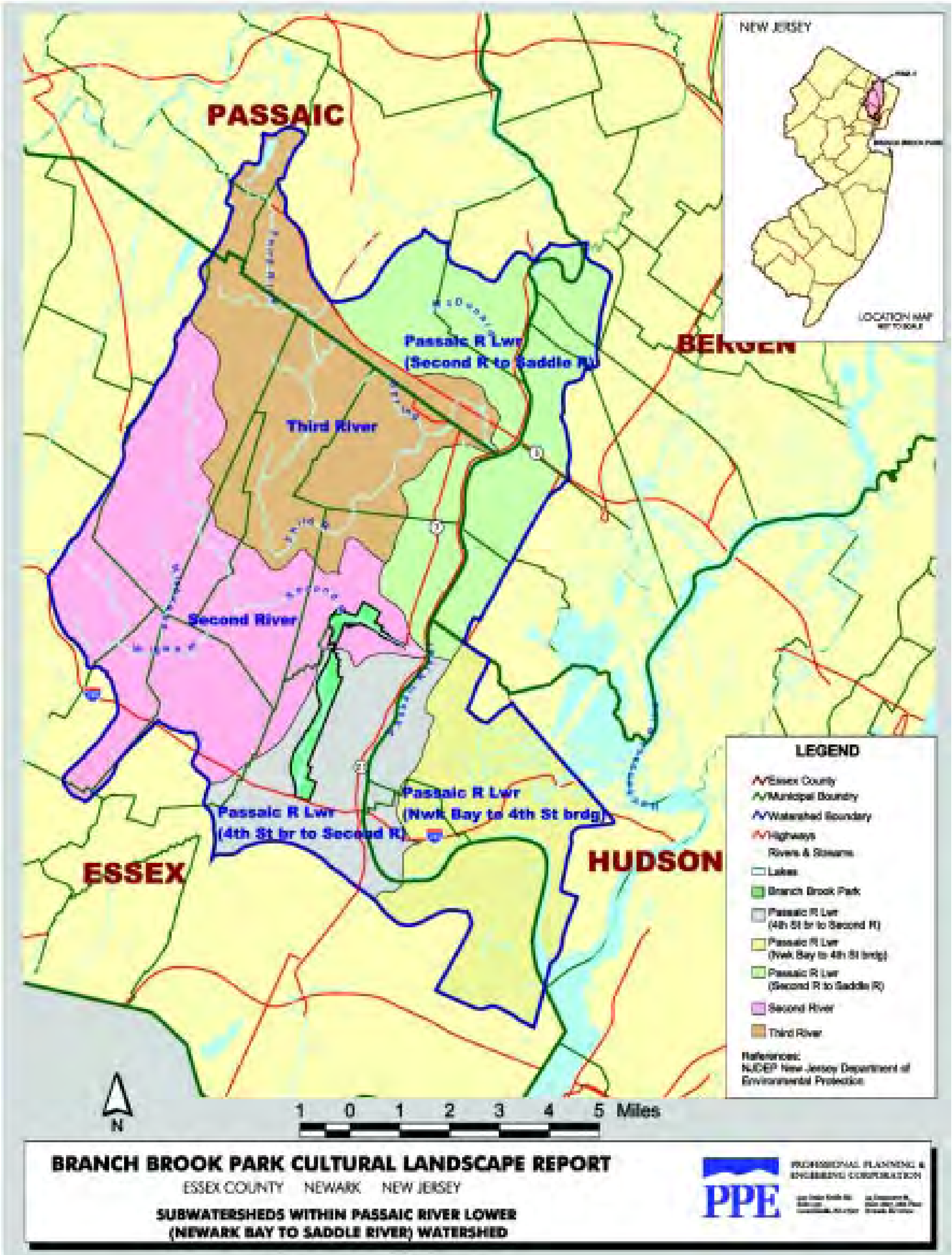


Figure 14

and Essex Counties and includes a number of falls, culminating with the Great Falls at Paterson. WMA4 has a drainage area of approximately 129 square miles. The major tributaries to this section of the Passaic River are the Saddle River, Preakness Brook, Second River and the Third River (NJDEP Division of Watershed Management, 2002).

The headwaters for the First River are located within Branch Brook Park and thus are a significant contributor to the water quality and quantity of the Passaic River.
The First River (commonly called Branch Brook) is a lower class river and thus not classified as a major contributor to the Passaic River Lower (Newark Bay to Saddle) subwatershed.

The Lower Passaic River Watershed is further divided into subwatersheds and subsubwatersheds. Branch Brook Park is primarily located within the Passaic River Lower (Newark Bay to Saddle) subwatershed, and the Passaic River Lower (4$^{th}$ St. bridge to Second River) subsubwatershed (Figure 14).

The northern portion of Branch Brook Park Extension and Bellville Park are situated within the Passaic River Lower (Newark Bay to Saddle) subwatershed and the Second River subsubwatershed (Figure 14).

## Review of Existing Data and Reports

Existing data and reports were gathered from the USEPA, USGS, NJDEP and Essex County for review and analysis.

### Watershed Characterization and Assessment Report

The Watershed Management Division of the NJDEP was officially restructured January 1, 2003 and the watershed management process restarted. Watershed Management Area 4 currently has limited information available. The NJDEP received the Geographic Information System (GIS) data sets for the watershed and provided this information to the WMA4 Technical Advisory Committee at the end of January 2003. This information has not yet been made available to WMA4 stakeholders, including Essex County. It is anticipated that even with the availability of the overall watershed information, detailed data relating to groundwater contamination and recharge areas will not be available. At this time there is no current soil survey available for Essex County. The USGS is currently completing the quality control for the mapping of the soil units found in Essex County.

Existing water quality and quantity information is available from the NJDEP, United States Geological Survey (USGS), and the New Jersey Geological Survey. A limited amount of groundwater information is available from Essex County Department of Engineering. Other potential sources investigated included the City of Newark and the City of Belleville. Neither source had information directly related to the park's hydrology. Information was available for the Second River, but little information was found for the First River (Branch Brook) and Branch Brook Lake.

### 2002 Integrated List of Waterbodies and Surface Water Quality Assessment Report

The Water Assessment Team in the Division of Science, Research and Technology in NJDEP is responsible for conducting and coordinating characterization and assessment of New Jersey's water quality and reporting. They are responsible for the development of the federally mandated Integrated Waterbodies List (303(d) list) and Surface Water Quality Assessment Report (305(b) report.) The difference between the 305(b) report and the 303(d) list is that the 305(b) report is a state-wide assessment of New Jersey's water quality programs where the 303(d) list reports only on the impaired waters of the state.

Waters placed on the 303(d) list require the preparation of Total Maximum Daily Loads (TMDLs), a key tool in the work to clean up polluted waters. A TMDL is developed as a mechanism for identifying all the contributors to surface water quality impacts and setting goals for load reductions for specific pollutants as necessary to meet surface water quality standards. TMDLs identify the maximum amount of a pollutant (carrying capacity) that the water body can mitigate or absorb and still be able to be utilized for the uses identified, such as recreation.

In May 1999, the New Jersey Department of Environmental Protection and USEPA Region 2 entered into a Memorandum of Agreement (MOA) including an 8-year schedule to produce TMDLs for all water quality limited segments remaining on the 1998 Section 303(d) List of Water Quality Limited Waterbodies in New Jersey or provide information necessary to remove waterbodies from the list. That MOA was amended in March 2000 to refine the schedule for the Whippany River Watershed and the NY/NJ Harbor Estuary. A new MOA was entered into in September 2002 with amendment that followed correcting missing or incorrect information in the September MOA.

Branch Brook Park Lake is listed on the NJDEP 1998 Integrated List of Water Bodies as a Category 3 water body due to its nutrient status (eutrophic). Category 3 waterbodies lack sufficient data to determine the status of standards compliance (TMDL) or degree of use support (water source, recreation use, etc.). The eutrophic status was determined as a part of the NJDEP Clean Lakes program as an intensive study in 1979. According to the U.S. EPA records Branch Brook Lake (List ID: NJ-LM2808) is impaired due to algae and macrophytes with the parent impairment listed as algal growth/ Chlorophyll A. The NJDEP was due to submit TMDLs for these impairments on December 31, 2002 (USEPA, 1998).

Branch Brook Park Lake is not listed as part of the September 16, 2002 MOA between the USEPA, Region 2 and the NJDEP. It is also not listed in the addendum to the list. This is significant as funding priorities are to address impaired waters on the 303(d) list. The Second River is not listed on the Integrated List of Water Bodies. The Passaic River is listed on the 2002 303(d) list as a Category 5 water body. Category 5 waterbodies fail to attain all water quality standards and/or fail to support all designated uses, or has been classified as threatened. These waterbodies require a TMDL for the parameters indicated. TMDL levels have been set for fecal coliform and temperature to be completed by 2004.

### Ambient Stream Monitoring (AMNET) Program

The USEPA has recognized that a thorough program of monitoring aquatic biota can be a cost-efficient means of gauging the quality of water and watershed areas. For lotic (running water) systems, analysis of benthic macroinvertebrate communities provides the principal means of gauging water quality. The present Ambient Biomonitoring Network (AMNET) program was developed to monitor and analyze benthic macropinvertebrate communities and provide NJDEP with the greater resolution of baseline data now necessary to support sound policy decisions in water quality/watershed management, and to direct regulatory, or "permit," activities (NJDEP Bureau of Freshwater and Biological Monitoring, no date).

Branch Brook Lake is not a studied water body for New Jersey's ambient biomonitoring network (AMNET) program. There is, therefore, little historical data to review. The Second River is a studied water body for New Jersey's AMNET. Monitoring station ANO290 is located just before the confluence at the Passaic River. This station's bioassessment rating is listed as moderately impaired with no indication of chronic macroinvertebrate abnormalities. (Macroinvertebrate abnormalities are considered chronic if they appeared during both 1992/92 and 1998/99 sampling periods.)

### Water Quality Historical Reports

Branch Brook Park Lake was a part of the NJDEP Clean Lakes program as an intensive study in 1979. The report was not available for review.

### Flood Studies

No flood studies have been completed for Branch Brook. Flood hazard area delineations have been obtained from the 1980 National Flood Insurance Rate Maps (FIRM). The base planametric information utilized on these maps does not accurately reflect the current alignment of I-280 even though I-280 was constructed in the 1960's. As such the lake's southern shoreline is incorrectly delineated and extends too far to the south. The FIRM maps and the present study base mapping were aligned to the best degree possible utilizing fixed lines of the railroads and major streets (Figure 15). The flood hazard zone for Branch Brook Lake and connecting system of ponds and streams is classified as Zone A. Zone A is the area of a 100-year flood delineated without the use of base flood elevations or flood hazard factors. Review of the USGS Orange Quadrangle (7.5 minute) map confirms the evaluation of the flood hazard limit was most likely set utilizing the quad map elevations. The shape of the FIRM flood limit line corresponds to the 100 foot contour elevation on the quad map from I-280 to Edgewood Pool. The flood hazard limit line then continues along the water course up to the Upper Pool.

Evaluation of the flood limit line in relationship to existing contours shows an inconsistency between the limits indicated and the elevations within the park. The elevation of the flood hazard zone limits in the Southern Division range from 95 feet to 110 feet. The Middle Division elevations range from 92 feet to 110 feet. The flood hazard limit elevations in the Northern Division range from 97 to 115 with the majority of the area ranging between 101 feet to 105 feet. The conclusions that can be drawn from this analysis are that flooding can be expected on site, that the existing information is general at best, and that a more detailed study will have to be performed if a more accurate mapping of the site's flood limits are required.

Flood studies were completed for the Second River. Maps obtained from the NJDEP indicate the floodway limit for the Second River follows the concrete channel walls (Figure 15). The flood hazard area generally follows the line of the floodway and extends to the south of the floodway ranging from 20 feet to 40 feet. The flood hazard area on the north of the Second River generally follows the course of the river and the floodway with two exceptions. The flood hazard area between the footbridge to Bellville Park and the Mill Street bridge extends towards Belleville Park 130 feet and tapers back to 20 feet from the floodway by the time it reached the footbridge. The second area begins just before Summer Avenue and continues to Broadway Avenue. In this area the flood hazard limit extends between 200 and 300 feet from the floodway and encompasses the majority of the properties along Mill Street. The flood hazard limit extends to the north again as soon as it passes through the Broadway Avenue bridge.

# BRANCH BROOK PARK

Cultural Landscape Report
Newark, New Jersey


Figure 15 - Flood Hazard Limit

Legend FEMA ZONES

- Zone A
- Second River Flood Hazard Area
- Classification Exception Area

Sources:
- City of Newark Engineering Dept. Topographical Survey
- PPE Corp.Topographic Survey
- Federal Emergency Management Agency Flood Insurance Rate Map

January 2003

## Ground Surface Cover

The type of ground surface has a direct relation to how quickly rainwater runs off the land surface into a receiving stormwater system or waterbody. Pavement such as asphalt roadways and concrete sidewalks are impermeable. They do not allow any water through to the surface into the soil and do not allow percolation. Pavement accelerates the movement of rainwater through the watershed. Conversely, lands that are covered with vegetation are permeable and allow for groundwater recharge. Lands that are covered with vegetation slow down the surface runoff rate and increase the quantity and rate of percolation. Differing types of vegetation have a different effectiveness for slowing runoff. Grass, is the least effective and forest with a dense understory with leaf litter is the most effective at slowing the rate of surface runoff. This is due to the high water holding capacity of leaf litter, permeable/loose soils and absorption by the plants through their roots. Differing types of vegetation also have different capacities for stabilizing the soil structure. Grass roots and major fibrous feeder roots of trees and shrubs typically are found within the top six to eight inches of soil. Woody plant roots extend deeper to stabilize the plants, and knit together a larger soil area providing greater soil stabilization as well.

The type of ground surface cover (i.e. grass, forest, wetland vegetation, etc.) at the shorelines of the water bodies within Branch Brook Park were categorized and analyzed. In addition, areas within the park that showed evidence of erosion but were not located along a shoreline were inventoried and categorized. Bellville Park does not have any water bodies within its boundaries, however, areas within the park that showed evidence of erosion were inventoried and categorized.

Branch Brook Park includes 1.3 miles of the Second River, 0.75 miles of stream banks, and 1.6 miles of pond and lake shorelines. The groundcover evaluation for wetland vegetation took place in September 2002. The groundcover evaluation for erosion inventory and classification took place during several periods between September 2002 and January 2003.

Ground surface cover along the shore and banks in Branch Brook Park exists in the form of turf grass, herbaceous plants (perennials and grasses) and woody plants (trees and shrubs) along an average of 75 percent of the lake, ponds and streambanks within Branch Brook. The Southern Division has about 55 percent of cover with 80 percent grass and 20 percent woody. Approximately 10 percent of the woody material includes understory vegetation. Approximately 90 percent of the Middle Division shoreline and stream banks are vegetated. 35 percent of vegetation is in the form of turf grass with the remainder woody vegetation. Approximately 50 percent of the woody vegetation included an understory until recent clearing of vegetation by the Essex County Department of Parks, Recreation and Cultural Affairs. The Northern Division also has about 90 percent of it's shorelines and stream banks vegetated. 15 percent of the vegetation is turf grass and 85 percent is woody vegetation. The majority of this woody vegetation (80 percent) has an understory.

Herbaceous aquatic (wetland) vegetation works in conjunction with the vegetation on the shoreline and streambanks to aid stabilization at the toe of the slopes. Wetland vegetation exists in some form or another (submersed, emergent, etc.) along approximately 90% of these areas. The extent of wetland vegetation and species found is discussed in the following section and in Appendix II.

Channelization of the Second River within Branch Brook Park has changed the natural river banks and bottom to concrete. There is, therefore, no wetland vegetation growing in this area. The banks of the river, behind the channel wall, are a mix of turf grass and woody ornamental plants. On both sides of the river approximately 50 percent of the shoreline has turf adjacent to the wall, the remainder is woody vegetation. Understory exits in the majority of this area.

### Wetland Vegetation and Riparian Buffer

The type and extent of wetland vegetation is one indicator of the health of the water system. These plants are a part of a natural system called a riparian buffer. Riparian buffers include the wetland vegetation located on the edge of the water upland. Riparian buffers have several functions. As mentioned previously, the vegetation can slow rainfall to the ground and the humus soil layer can hold large amounts of water for use by plants and for groundwater recharge. Vegetation can also stabilize the soil structure with their roots. Healthy riparian buffers preserve natural breeding, foraging and resting areas for native animal and bird species, and maintain diversity of living resources.

*Example of effectiveness of different plant types in stabilizing the shore. The woody plant material in the background (with roots extending into the lawn area) is more effective than grass.*

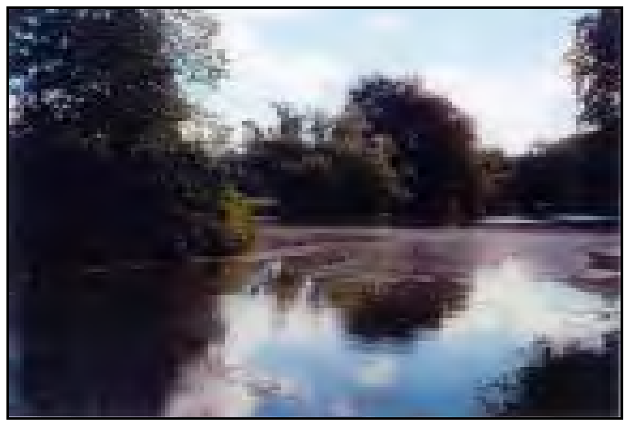
In addition, healthy riparian vegetation provides a variety of functions related to aquatic habitat. This vegetation serves as a food source for members of the aquatic food chain. Bacteria and fungi colonize leaf litter and woody debris and are in turn consumed by aquatic insects, which are eaten by other insects and fish. This leaf litter is the key energy source for every trophic level in the stream (Schueler, 1995).
The buffer also regulates light and temperature entering the water body and helps maintain balanced oxygen concentrations in water through temperature. The reduction of canopy cover has a direct relationship to the increase in water temperature (Schueler, 1995). In addition, the buffer regulates and prevents sediment from inundating water bodies that interferes with benthic habitat. Lack of groundsurface cover exposes the soil to the elements; precipitation, sun and wind, as well as foot traffic. This in turn greatly increases the possibility of erosion of the soil into the water. Trace metals found in sediment hampers the ability for benthic insects (macroinvertebrates) to process the energy in the leaf litter (Schueler, 1995). If the benthic insects are not able to thrive the overall health of the waterbody will be low.

Similar to the benthic and fish populations, there are certain wetland vegetation species that are more tolerant to pollution than others. If there is a predominance of tolerant vegetation the health of the water system can begin to be assessed as poor. Additional studies of other indicators would need to be completed to gain a complete understanding of the health of the water system, these tests will be discussed in the recommendations section of this volume. Wetland vegetation through their chemical processes can remove certain pollutants from the water to increase water quality. Thus, the inventory and assessment of wetland vegetation is a good initial indicator to utilize for water quality.

Eutrophication is a natural process during which lakes fill in with sediment and become wetlands. This process can be accelerated by human activity. Significant growths of aquatic weeds and algae are commonly found in eutrophic lakes as well as shallow depths, elevated temperatures and low dissolved oxygen conditions (NJDEP, 2001). Due to the fact that the water bodies in Branch Brook Park are shallow manmade impoundments they are highly prone to excessive inputs of nutrients and sediment. The excessive growth of algae and macrophytes can impair the lakes use for swimming and boating. In addition aquatic life may be negatively affected by periods of depleted dissolved oxygen and temperature fluctuations that can occur as a result of etrophication (NJDEP, 2001).

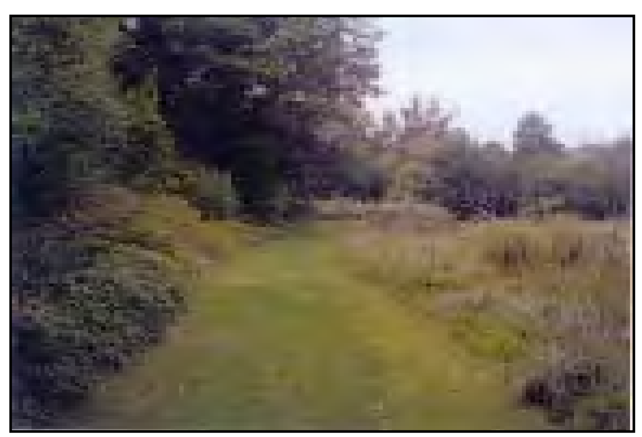
Branch Brook Park's 30 acre freshwater system is 5 miles from the Newark Bay and is located within the northeast flyway for migratory birds. It exhibits three distinct ecotypes: lacustrine (lake and ponds), riverine (river and streams), and marsh. This multiplicity of ecotypes provides a diversity of food and habitat possibilities for wildlife. Although riparian buffers are present throughout the park, lengthy sections are partially fragmented, resulting in habitat isolation, and allowing non-point pollution of the surface waters to occur. Where the buffer vegetation has been removed, trampled, or altered to other uses such as turf grass, the buffer performance is poor for water quality maintenance. Negative water quality impacts occur where there is an excess of the following variables present:

- Light penetration,
- Chlorophyll (algal abundance),
- Excess total nitrogen - causing nuisance plant growth,
- Oxygen depletion,
- Non-point pollutants (salts, oils, chemicals, refuse, etc.) from untreated, undetained stormwater runoff.



*Example of lacustrine ecotype.*

*Example of riverine ecotype.*



*Example of marsh ecotype. Butterfly garden in the Northern Division is located to the right.*

During the site investigation for the wetland plant material, the types of plants located within approximately ten feet of the shoreline in each study area were noted. In addition, species within the adjacent upland buffer were identified. Plant lists for each study area and representative photos are located in Appendix II. The plant community or wetland habitat the vegetation is associated with was also identified (Figure 16). Specific plant quantity counts were not conducted. A visual assessment was completed to determine the extent of the vegetation and the overall importance to the health of the riparian buffer and water quality in Branch Brook Park.

Overall, the type and extent of wetland and upland vegetation is in better condition in the Middle and Northern Divisions than in the Southern Division. In the Middle and Northern Divisions, the forest understory remains intact in about 50 percent of the area, while in the Southern Division, little understory vegetation remains. Similarly, the diversity of species found in the Middle and Northern Division is greater than in the Southern Division. This is most evident in the upland vegetation, with a slight increase in the diversity in the wetland vegetation in the Middle and Northern Divisions.

Negative water quality indicator aquatic open water plant species are found in all but one of the study areas. Nearly every area that has wetland vegetation has Green Algae and or Duckweed, two negative water quality indicators, that grow in the water (Table 2). (See Appendix II for specific species noted.) In addition, invasive negative indicator upland successional plant species such as Phragmities, Ailanthus and Knotweed, are found in 10 out of 27 study areas of Branch Brook Park. These species spread quickly and out compete other more

| Study Area | No. Plant Communities[1] | No. Plant Species | No. of Wetland Plant Species | % Pond Cover with Neg. Indicator | Invasives Found (Y/N) /Quantity |
|---|---|---|---|---|---|
| **Branch Brook Lake (Ponds 1-3)** | | | | | |
| Area 1A | 4 | 8 | 8 | 10 | N |
| Area 1B | 4 | 8 | 8 | 20 | N |
| Area 2A | 4 | 13 | 13 | 20 | Y/1 |
| Area 2B | 1 | 3 | 3 | 0[2] | N |
| Area 2C | 3 | 5 | 5 | 10 | N |
| Area 3A | 5 | 23 | 11 | 30 | Y/2 |
| Area 3B | 2 | 8 | 2 | 0[2] | Y/2 |
| Area 3C | 2 | 11 | 3 | 20 | Y/2 |
| Area 3D | 5 | 15 | 6 | 10 | Y/1 |
| Area 3E | 2 | 8 | 1 | 20 | Y/1 |
| **Clark's Pond (Pond 4)** | | | | | |
| Area 4A | 5 | 14 | 7 | 15 | N |
| Area 4B | 5 | 18 | 8 | 30 | N |
| Area 4C | 4 | 14 | 4 | 2 | N |
| **Watercourse 1** | | | | | |
| WC 1 | 2 | 20 | 1 | 10 | N |
| **Midwood Pool** | | | | | |
| Area 5A | 5 | 11 | 4 | 40 | N |
| Area 5B | 2 | 8 | 1 | 30 | N |
| Area 5C | 3 | 7 | 2 | 30 | N |

| Study Area | No. Plant Communities[1] | No. Plant Species | No. of Wetland Plant Species | % Pond Cover with Neg. Indicator | Invasives Found (Y/N) /Quantity |
|---|---|---|---|---|---|
| **Watercourse 2** | | | | | |
| WC 2 | 3 | 24 | 2 | 0 | Y/2 |
| **Edgewood Pool (Pond 6)** | | | | | |
| P6 | 4 | 10 | 5 | 60 | N |
| **Watercourse 3** | | | | | |
| WC 3A | 3 | 12 | 8 | 90 | N |
| WC 3B | 1 | 6 | 0 | 0[2] | N |
| **Pond 7** | | | | | |
| P7 | 4 | 6 | 2 | 0[2] | Y/1 |
| **Meadow Pool (Pond 8)** | | | | | |
| P8 | 3 | 14 | 3 | 0[2] | N |
| **Brookside Meadow (Watercourse 4)** | | | | | |
| WC 4 | 1 | 16 | 0 | 0[2] | Y/1 |
| **Upper Pool (Pond 9)** | | | | | |
| Area 9A | 4 | 5 | 5 | 90 | N |
| Area 9B | 1 | 5 | 0 | 0[2] | N |
| **Second River** | | | | | |
| SR | 1 | 12 | 0 | 0[2] | Y/1 |

[1] Five Plant Communities are possible in Branch Brook Park
[2] No submersed vegetation present

Table 2 - Wetland Vegetation Investigation Summary

# BRANCH BROOK PARK

Cultural Landscape Report
Newark, New Jersey

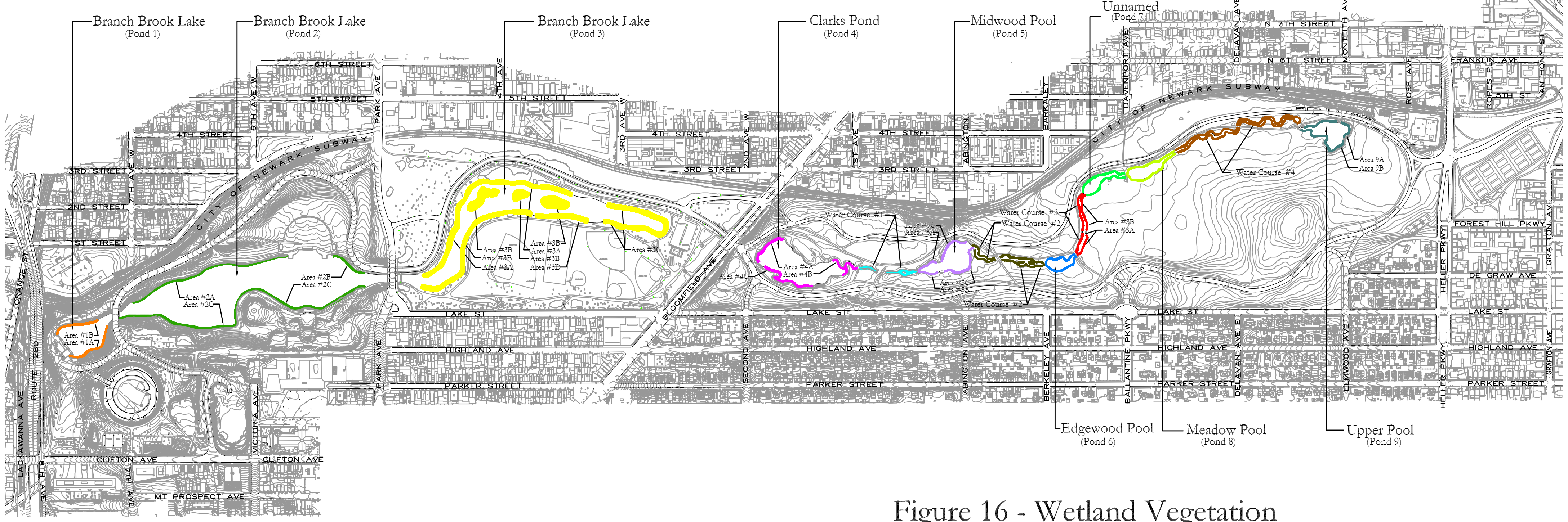



Figure 16 - Wetland Vegetation

0' 200' 500' 1000' 2000'
Graphic Scale

North

Legend

Banch Brook Lake
- Pond #1
- Pond #2
- Pond #3

Clarks Pond
- Pond #4

Midwood Pool
- Pond #5

Edgewood Pool
- Pond #6

Unnamed
- Pond #7

Meadow Pool
- Pond #8

Upper Pool
- Pond #9

Water Course #1
(Between pond #4 and pond #5)

Water Course #2
(Between pond #5 and pond #6)

Water Course #3
(Between pond #6 and pond #7)

Water Course #4
(Between pond #8 and pond #9)

Note:
No wetland vegetation exists along the Second River within Branch Brook Park.

Sources:
- City of Newark Engineering Dept. Topographical Survey
- PPE Corp. Topographic Survey
- PPE Corp. Field Reconnaissance
- North East Mapping Aerial Topographic Survey
- PK Environmental Field Reconnaissance

PPE

January 2003

desirable plant species for natural resources to survive. Phragmities is especially aggressive with its spreading rhyzomes and the added growing medium of the additional sediment in the water bodies. Invasive plant species should be removed as soon as they are identified.

Moving from south to north in the park, the amount of wetland vegetation within approximately 10 feet of the shoreline, becomes less. The watercourses generally do not have wetland vegetation due to their steep sloped design not being conducive to vegetation. In addition, the concentration of negative submersed wetland vegetation increases.

*Cattails and duckweed - two invasive plant species found within Branch Brook Park.*

*Example of cleared riparian buffer in the Southern Division. Areas of little or no riparian buffer exist throughout Branch Brook Park.*

The following are specific observations:

- Coontail (Ceratophyllum demersum) is present – Coontal is a negative indicator of water quality – Coontail has the capacity to grow at nuisance levels, but removes phosphorus from the waterbody.
- Duck weed (Wolffia, Sp.) is present – Duck weed requires high nutrients (nitrogen and phosphorus) to survive.
- Arrowhead (Sagitarria cuneata) is present – Arrowhead has a wide pH tolerance and can grow in a variety of sediments.
- Green Algae (Chlorophyceae, Sp.) is present.
- Invasive plant species are present – Phragmites (Phragmites australis), Knotweed (Tovara virginiana), Ailanthus (Ailanthus altissima) are successional invasive plant species.
- Cleared Riparian Buffers/ Turf Grass – Cleared areas allow sun tolerant, invasive successional growth species to proliferate along the waters edge. Examples of such species in clude cattails, phragmites, reed canary grass, and tickseed sunflower that are found within the park. In addition upland invasive successional growth species, such as Knotweed and Ailanthus, can end up proliferating within the riparian buffers that do exist and drive out the more beneficial native upland species.
- No positive wetland plant indicators were found in the park.

There is good diversity in the overall wetland and riparian buffer system within Branch Brook Park. The evidence, however, of Green Algae, Duck weed and Coontail at the significant coverage observed indicates that the system, which would normally filter the water entering the watercourses, is overburdened from non-point source pollution. This is occurring even though groundwater is feeding the watercourses to a degree, quantities yet unknown, but not at a high enough quantity to offset the pollution received. This overburden is most likely due to two reasons: (1) from a lack of vegetative cover which slows the water and allows percolation and uptake of water; (2) The stormwater system is bypassing the natural water filtration process and is discharging directly into the waterbody.

## Erosion

High concentrations of suspended sediment in streams cause many diverse consequences, including: increased turbidity, reduced light penetration, reduced prey capture for sight feeding predators, clogging of gills/filters of fish and aquatic invertebrates, reduced spawning and juvenile fish survival, and reduced angling success. Additional impacts result after sediment is deposited in slower moving receiving waters, such as smothering of the benthic community, changes in the composition of the bottom substrate, more rapid filling of small impoundments which create the need for costly dredging, and reduction in aesthetic values. Sediment is also an efficient carrier of toxicants and trace metals. Once deposited, pollutants in these enriched sediments can be remobilized under suitable environmental conditions posing a risk to benthic life (Gavin and Moore, 1982). Sediment is also a contributor to excess phosphorus by releasing it back into the water column, which is a contributor to algae growth.

Areas of erosion were evaluated along the banks and shorelines of the Branch Brook Park watercourses and the Second River. General areas of erosion were also noted in Branch Brook Park and Belleville Park. A classification system was utilized to differentiate the levels of erosion in to three classifications: (1) Minor, (2) Moderate, (3) Major.

*Minor Erosion Areas:* Minor erosion areas showed signs of bank undercutting, had shallow slopes and had groundcover (either turf grass or understory vegetation).

*Moderate Erosion Areas:* Moderate erosion areas include areas of steep slopes with intact geoblock reinforcing, moderate slopes with some or no understory, areas where surface runoff is contributing to the erosion, erosion of the shorelines and minor pedestrian foot traffic.

*Example of minor erosion.*

*Example of moderate erosion.*

*Major Erosion Areas:* Major erosion areas include steep slopes with no reinforcing (geoblock or understory vegetation) areas of a high concentration of foot traffic and evidence of significant amounts of surface runoff. An exception to that is in the Southern Division where the area south of the internal park drive was all considered major erosion even though some areas of geoblock are present.

*Example of major erosion.*

Approximately 45 percent of the areas identified are classified as exhibiting a major amount of erosion, 40 percent exhibit minor erosion while the remaining 15 percent exhibit moderate erosion. Areas exhibiting erosion total about 70 percent of the shoreline (Figure 17). There are several areas where silt fence is installed at the toe of the slope to try to reduce sediment into the lake and ponds, the majority of them have either failed or are installed incorrectly. Appendix III and IV are representative photographic inventories of erosion occurring within Branch Brook Park and Belleville Park.

## Shoreline Erosion

The Major areas of erosion are located in the Southern Division in the boathouse area and on both sides of the internal roadway bridge where there are steep slopes with no understory vegetation and some areas of geoblock reinforcing (Figure 17). Another area is located adjacent to the ends of the Music Court balustrades where lack of vegetation, high foot traffic, and stormwater runoff contribute to erosion. The east side of the Park Avenue Bridge embankments are very steep, have no vegetation, and have evidence high foot traffic. In the Northern Division the areas of high erosion are located on the east shoreline of Clarks Pond and the Meadow and Upper Pools. In these areas high foot traffic and evidence of surface runoff contribute to erosion. Due to siltation at the check dams the water is bypassing the check dams and eroding the banks. Water is undercutting existing geoblock reinforcing in these areas.

Moderate areas of erosion are located in the Southern and Northern Divisions (Figure 17). An area of moderate erosion is located between two areas of major erosion on the western shore in the Southern Division. At this location the shoreline is eroding, there is no understory and surface runoff, due to a non-functioning stormwater sewer system, is contributing to the erosion. There are two areas of localized moderate erosion that are occurring on Clark's Pond where geoblock is failing and the Midwood Pool where turf grass extends to the shoreline and the bank is being undercut. Two other areas of moderate erosion occur along the connecting watercourses where there are weak stands of vegetation and surface runoff contributing to erosion.

Minor erosion is occurring in all divisions (Figure 17). In the Southern Division the shoreline is eroding and the ground is saturated. In the Middle Division minor erosion is occurring on both the eastern and western banks. These areas have either no understory vegetation or turf grass extending to the shoreline. Pedestrian foot traffic to the shoreline is also apparent, along with saturated soils. Similarly, the ponds in the Northern Division exhibit eroding shorelines with the banks being undercut, a moderate stand of understory vegetation, and pedestrian foot traffic.

## General Areas of Erosion

General areas of erosion in Branch Brook Park and Belleville Park were noted and classified based on the same system used in the shoreline erosion analysis. There were areas of major and minor erosion noted in localized places throughout the parks (Figure 16). Areas of major erosion are occurring by the basketball court and along the southern top of the wall which surrounds the roller rink. The area by the basketball court appears to be due to pedestrian foot traffic while the other area most likely began as a failure of the fence footing that has been accentuated by surface runoff. Other areas of major erosion in the Southern Division occur at the pedestrian underpass abutments. At those locations there are steep slopes, little if any vegetation and pedestrian foot traffic. Major erosion is also occurring in the Extension on two northern facing slopes, one on the downhill side of the northern path encircling the Visitor Center ballfield area, the second is adjacent to the path leading across the Second River to Belleville Park. Both areas are very steep slopes with little understory vegetation and surface runoff from the nonfunctioning stormwater sewer system.

*General area of erosion at the basketball court in Branch Brook Park. Heavy foot traffic in this area has trampled any vegetation that previously existed.*

Minor erosion is occurring in Branch Brook Park primarily in areas of steep slopes with overstory and thin stand of understory (forest) vegetation. These areas are adjacent to the I-280 abutment, by the pavilion, on the Broomfield Avenue abutments and the city subway abutment just south of the greenhouses.

Belleville Park's major erosion area is due to steep slopes, lack of understory vegetation, and surface runoff (Figure 18). The moderate and minor erosion areas occur primarily adjacent to the path network. These areas are eroding due to surface runoff and lack of vegetation. In moderate areas erosion has removed the topsoil to a depth of 4" in some small areas.

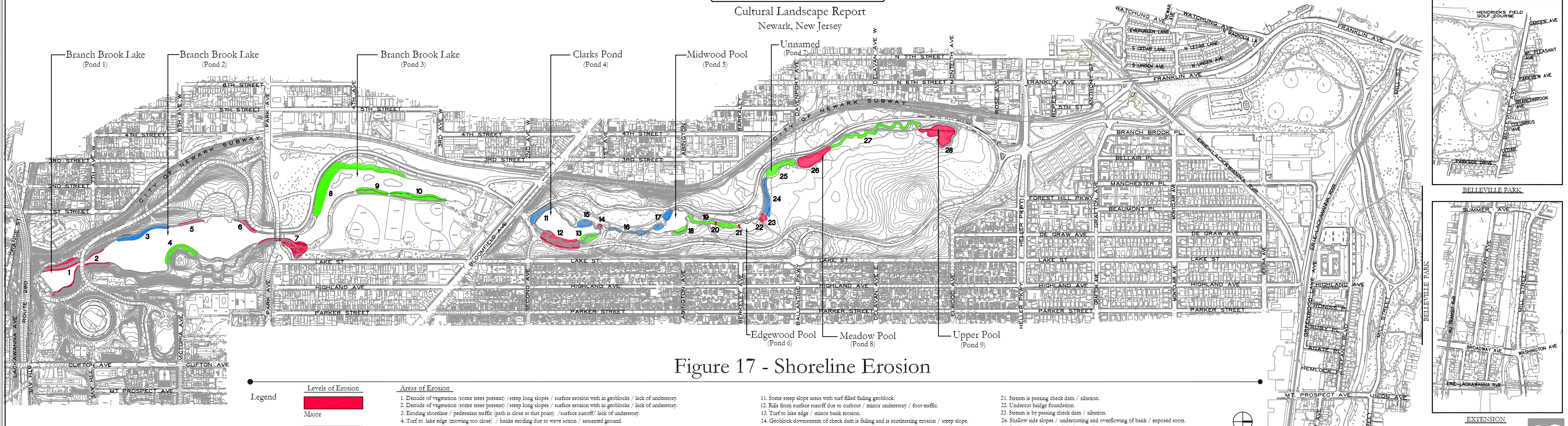
*Example of major erosion in Belleville Park.*

A significant amount of erosion is apparent within Branch Brook Park and a couple significant areas within Bellville Park. The observation of this, as well as the lack of visibility within the watercourses, leads to the conclusion that a considerable amount of soil is entering the water courses within Branch Brook Park, including the Second River. The temperature levels are being affected and thus the oxygen levels within the water and impacting the health of the aquatic biota. In addition, sedimentation was observed in the streams of the Northern Division. Sedimentation has most likely occurred in the ponds and lakes as well, but could not be observed other than directly at the shoreline due to lack of visibility in the water.

# BRANCH BROOK PARK

Cultural Landscape Report

Newark, New Jersey




## Figure 17 - Shoreline Erosion

Legend

Levels of Erosion

- Major
- Moderate
- Minor

Areas of Erosion

1. Denude of vegetation (some trees present) /steep long slopes / surface erosion with in geoblocks / lack of understory.
2. Denude of vegetation (some trees present) /steep long slopes / surface erosion with in geoblocks / lack of understory.
3. Eroding shoreline / pedestrian traffic (path is close at that point) /surface runoff/ lack of understory.
4. Turf to lake edge (mowing too close) / banks eroding due to wave action / saturated ground.
5. Area denude of vegetation / erosion rills (primarily from surface runoff and pedestrian traffic).
6. Area denude of vegetation / erosion rills (primarily from surface runoff and pedestrian traffic) /roadway runoff going through curb cut at pathway.
7. Denude of understory vegetation / erosion rills (surface runoff and pedestrian traffic).
8. Denude of understory vegetation / pedestrian traffic (desire points/access to lake shore at various points).
9. Denude of understory vegetation / pedestrian traffic (desire points/access to lake shore) .
10. Turf up to lake edge (mowing to close) / banks eroding due to wave action / saturated ground.
11. Some steep slope areas with turf filled failing geoblock.
12. Rills from surface runoff due to curbcut / minor understory / foot traffic.
13. Turf to lake edge / minor bank erosion.
14. Geoblock downstream of check dam is failing and is accelerating erosion / steep slope.
15. Geoblock is beginning to fail / shallow slope.
16. Shallow side slopes / moderate understory condition / exposed roots.
17. Turf to lake edge / bank undercutting.
18. Access point / foot traffic / denude understory.
19. Shallow side slopes / moderate understory condition / overflowing banks / exposed roots.
20. Stream is passing check dam / siltation.
21. Stream is passing check dam / siltation.
22. Undercut bridge foundation.
23. Stream is by passing check dam / siltation.
24. Shallow side slopes / undercutting and overflowing of bank / exposed roots.
25. Shallow side slopes / slight bank undercutting.
26. Rills from surface runoff / bank undercutting.
27. Shallow side slopes / overflowing banks / moderate understory condition / stable edges.
28. Denude understory / surface runoff / heavily undercut banks / exposed tree roots.

0' 200' 500' 1000' 2000'

Graphic Scale

North

Sources:

- City of Newark Engineering Dept. Topographical Survey
- PPE Corp. Topographic Survey
- PPE Corp. Field Reconnaissance
- North East Mapping Aerial Topographic Survey

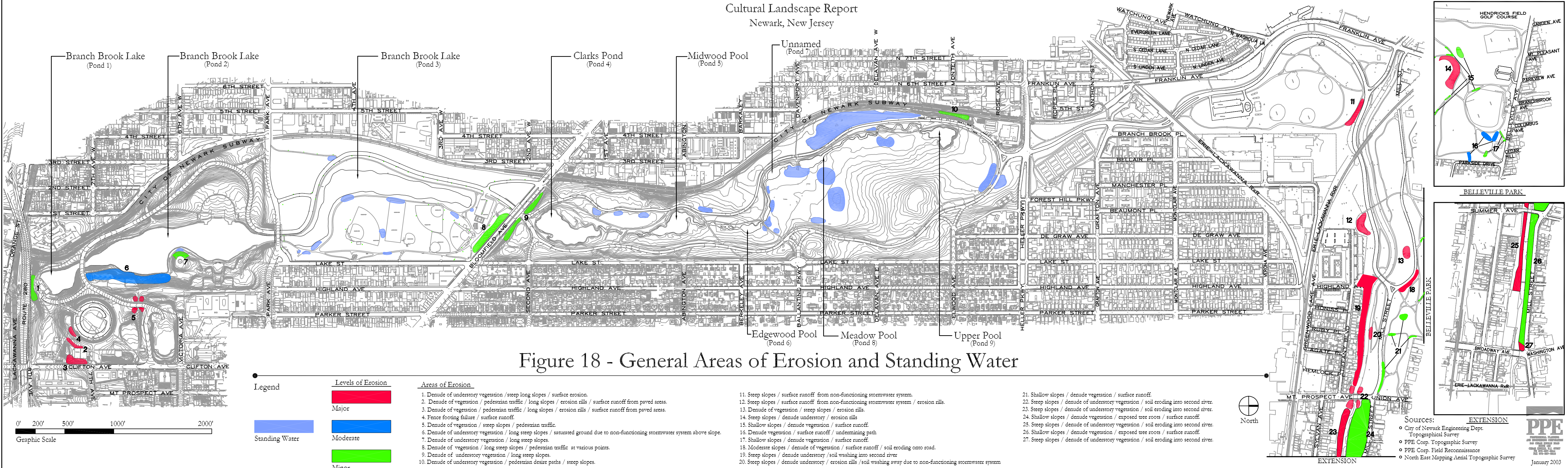
PPE

January 2003

# BRANCH BROOK PARK

Cultural Landscape Report

Newark, New Jersey




# Figure 18 - General Areas of Erosion and Standing Water

**Legend**

Levels of Erosion

- Major
- Moderate
- Minor

Standing Water

**Areas of Erosion**

1. Denude of understory vegetation /steep long slopes / surface erosion.
2. Denude of vegetation / pedestrian traffic / long slopes / erosion rills / surface runoff from paved areas.
3. Denude of vegetation / pedestrian traffic / long slopes / erosion rills / surface runoff from paved areas.
4. Fence footing failure / surface runoff.
5. Denude of vegetation / steep slopes / pedestrian traffic.
6. Denude of understory vegetation / long steep slopes / saturated ground due to non-functioning stormwater system above slope.
7. Denude of understory vegetation / long steep slopes.
8. Denude of vegetation / long steep slopes / pedestrian traffic at various points.
9. Denude of understory vegetation / long steep slopes.
10. Denude of understory vegetation / pedestrian desire paths / steep slopes.
11. Steep slopes / surface runoff from non-functioning stormwater system.
12. Steep slopes / surface runoff from non-functioning stormwater system / erosion rills.
13. Denude of vegetation / steep slopes / erosion rills.
14. Steep slopes / denude understory / erosion rills
15. Shallow slopes / denude vegetation / surface runoff.
16. Denude vegetation / surface runoff / undermining path
17. Shallow slopes / denude vegetation / surface runoff.
18. Moderate slopes / denude of vegetation / surface runoff / soil eroding onto road.
19. Steep slopes / denude understory /soil washing into second river
20. Steep slopes / denude understory / erosion rills /soil washing away due to non-functioning stormwater system
21. Shallow slopes / denude vegetation / surface runoff.
22. Steep slopes / denude of understory vegetation / soil eroding into second river.
23. Steep slopes / denude of understory vegetation / soil eroding into second river.
24. Shallow slopes / denude vegetation / exposed tree roots / surface runoff.
25. Steep slopes / denude of understory vegetation / soil eroding into second river.
26. Shallow slopes / denude vegetation / exposed tree roots / surface runoff.
27. Steep slopes / denude of understory vegetation / soil eroding into second river.

Sources:

- City of Newark Engineering Dept. Topographical Survey
- PPE Corp. Topographic Survey
- PPE Corp. Field Reconnaissance
- North East Mapping Aerial Topographic Survey

PPE
Professional Planning and Engineering Corporation

January 2003

Revised September 2003