Thorntown Creek Riparian Open Space Assessment and Recommendation Report For City of Bordentown, New Jersey

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Bordentown Open Space/
Thorton Creek
City of Bordentown, Burlington County, NJ

Site Assessment and Recommendations

The following summarizes the findings and recommendations based on a site visit conducted on June 17, 2005 by Delaware Riverkeeper Network staff.

A. Background

Delaware Riverkeeper Network staff was asked by the Bordentown City Environmental Commission to review open space areas along Thorton Creek to assess conditions and provide recommendations related to the stream, riparian restoration, and a planned trail corridor. The Bordentown City Open Space Plan (2005) proposed additional land acquisition along Thorton Creek (also identified as Thorntown Creek[1]) and creation of a trail within the stream corridor.

B. Site Characteristics

B.1 Watershed Area

The Thorton Creek Watershed drains about 1.5 square miles of a largely urbanized area within the Coastal Plain as shown on Figures 1-3. The creek extends about 2.5 miles from its mouth at Crosswicks Creek to the headwater agricultural area in the northern third of the watershed. The reach assessed by DRN staff lies downstream of Route 206 and extends to the confluence with Crosswicks Creek. Land cover is mainly early successional woodlands and isolated mature woodlands and represents most of the forested land cover in the watershed.

B.2 Land Ownership

As shown on Figure 4, the significant property owners along this reach include the City of Bordentown (from Route 206 to Elizabeth Street), Ocean Spray Corporation (Elizabeth Street to the railroad), and Divine Word Missionaries (Park Street to Crosswicks Creek). Of special historical significance, the Divine Word Missionaries tract occupies lands formerly part of Joseph Bonaparte's Point Breeze Estate (1815-1844). The organization has entered into an easement agreement with the State of New Jersey to protect estuarine habitat and Bald Eagle foraging areas adjacent to Thorton Creek and Crosswicks Creek. Other property owners along the stream corridor include a series of single family residences located just upstream of Park Street.

B.3 Geology

The underlying geology of the surveyed stream reach is the Magothy Formation, which consists of rapidly lensing dark clays and light-colored cross-bedded sands. The Magothy serves as the drinking water aquifer for Bordentown City and the Bordentown Township. Keyport soils are located along streambanks and consist of moderately well drained soils with a moderately fine or fine textured

[1] USGS topographic maps and other references identify this waterbody as Thorton Creek. Area residents refer to the same waterbody as Thorntown Creek. For purposes of consistency, the official USGS referenced name, Thorton Creek, is used herein.

subsoils above clay beds with varying amounts of glauconite that are exposed in the banks and occasionally the stream bottom.

B.4 Overview of Site Disturbance

Thorton Creek's prior use was primarily as recreation and open space utilized by the Bordentown Military Academy, the Bonapate estate (and successors), and local residents of Bordentown. At one time at least two impoundments on the creek served these needs. In more recent times, Thorton Creek has an extensive history of use, which throughout history, has varied in intensity. Past uses along Thorton Creek include dumping of construction debris, gravel mining, and a series of impoundments for recreation. Many of these uses and their remnants are of historical interest and may be of historical value, such as remnants of the dike created by Joseph Bonaparte for public recreation at the mouth of the creek. Other remnants of disturbance, such as debris piles and old dumps detract from the ecological potential of the area. The current informal trail system is lightly used, except in areas modified for BMX biking and paintball.

Fill material dumped in upper reach.

The upper reaches of the assessment area (from Rt. 206 to the railroad) have been disturbed over a long period of time. Above Elizabeth Street, dumping of fill material (see adjacent photo) and stormwater diversions have degraded the ecosystem on this municipal parcel. The "City Pond" dam built during the 1930's (formerly located just upstream of Elizabeth Street) was actively used for recreation until its breach in 1971 as a result of hurricane rains and jammed debris in the sluiceway. In addition, an area actively used as a BMX bike course maintains significant areas of bare soil. If the course remains intact, measures should be taken to limit any impacts to Thorton Creek. Below Elizabeth Street, an area near the railroad bridge that was also previously impounded for aesthetic and recreational purposes (visible in topo maps from 1956, see Figure 3). The "BMI Pond" (Bordentown Military Institute) was also built in 1930,s, and subsequently retrofitted. It survived the hurricane in 1971, however BMI closed shortly thereafter-in early 1970's. The impoundment disappeared sometime shortly after as dam maintenance was neglected.

Former gate to Bonaparte Estate near Park St.

Middle portions of the survey reach (from the railroad to Park Street) also show signs of recovering from previous disturbance. A portion of this section was reportedly used as a gravel washing and quarrying operation between 1910 through the 1930's. Just like the previous section, the downstream portion of this area was also formerly impounded for recreation. The current land cover consists of early successional woods with isolated old mature trees along the valley banks. A mix of residential, institutional, and commercial land uses in upland areas around the stream valley (Figure 4).

The lower portion of the watershed (from Park Street to Crosswicks Creek confluence) has also had its share of human impacts, although this section generally has had a longer recovery period than its upper reaches. This reach is historically significant in that it was once owned and managed by Joseph Bonaparte, brother of Napoleon Bonaparte. Under ownership of Joseph Bonaparte (1815-1844), the freshwater tidal marsh at the confluence of Thorton and Crosswicks Creeks was diked, creating a large impoundment (possibly up to the current head of tide) that was used for ice staking in winter by many Bordentown residents. Maps of the property from 1847 show much of the land use as mix of fragmented woodlots, open parkland, managed gardens, and small ponds. The property is now owned by the Divine Word Missionaries, which has entered into an easement agreement with the State of New Jersey to protect estuarine habitat and Bald Eagle foraging areas adjacent to Thorton Creek and Crosswicks Creek. More modern disturbance includes the straightening and armoring of the stream channel directly above Thorton Creek's head of tide just below the Park Street Bridge. The date of the channel straightening is unknown. The channel armoring (consisting of gabion baskets lining the banks and streambed) was installed several years ago following erosion from hurricane remnant rainfall.

Throughout the survey area railroads, streets, utility infrastructure, and utility right of ways that cross the stream perpendicularly or parallel it have disturbed the stream and riparian corridor.

A full history of past disturbance requires further research into local and state historical resources as a full understanding of these disturbances are not readily apparent on the surface.

C. Problem Assessment

C.1 Areas of Special Concern

A summary of plant species identified throughout the open space areas are provided on Table 1. It is important to note that this list is not comprehensive list of species present, as some species may have not been visible at the time of the survey. Due to the relatively disturbed nature of the upper reaches assessed it is unlikely that threatened or endangered species are present, however the lower reach near the Crosswicks Creek has remained relatively undisturbed since the mid 1800's and has plant communities present that are known to include rare or endangered plants. In this area, Delaware Riverkeeper Network staff identified star chickweed (*Stellaria pubera*), which is listed by the NJ Heritage Program as a state endangered species that may fall under protection regulations of the Highlands or Pinelands Commissions. This identification should be verified to confirm the presence and distribution of this species. This list should be periodically updated as additional species of plants are identified. Where possible additional biological data related to Thorton Creek and its riparian habitats should also be collected including insects, amphibians, reptiles, fish, and mammals.

C.2 Vegetation Composition and Communities

A total of fifty-two (52) native plant species, eleven (11) exotic species, and twelve (12) invasive plant species that were identified in June of 2005 (see Table 1). These plant species occurred throughout several distinct habitat types within the park. Terrestrial habitats generally include early-successional woodlands, isolated pocket of mature woodlands, and relatively undisturbed woodlands near Crosswicks Creek and tidal portions of Thorton Creek. Distinct aquatic habitats include tidal and non-tidal reaches of Thorton Creek. In general, the field survey of plant species has shown that species diversity and

richness is fair to poor along disturbed areas in the upper and middle reaches, but good to excellent in the lower reach.

In general, the riparian habitats of each reach can be summarized as containing the following communities:

Rt. 206 to Elizabeth St./Elizabeth St. to Railroad – Early successional forest dominated by green ash (*Fraxinus pensylvanica*) and box elder (*Acer negundo*). A mix of additional native, exotic, and invasive tree species are co-dominant throughout portions of this reach.

Railroad to Park Street – A fragment of mature woods dominated by American beech (*Fagus grandifolia*) with a mix of other native and exotic tree species. Judging by the intact plant community located just downstream, it is likely that this portion of Thorton Creek was potentially an "American Beech - Sweet Birch - Tuliptree - Sugar Maple Forest". Much of this reach is maintained as lawn by several private residences.

Park Street to Thorton/Crosswicks Marsh - Riparian woods appear relatively intact and form an "American Beech - Sweet Birch - Tuliptree - Sugar Maple Forest" ecological community association. This intact community transitions into what appears to be an "American Beech - Sweet Birch - (White Oak, Northern Red Oak) / Ironwood Forest" along the slope surrounding the Thorton/Crosswicks Marsh.

For more information on vegetation along Thorton Creek, see distribution maps in Figure 6.
Natureserve.org data for specific community types are available in Appendix A. Individual plant species are listed under Table 1.

C.3 Integrated Assessment Results- Habitat
Delaware Riverkeeper Network staff uses an integrated assessment to evaluate the overall health and quality of the aquatic and riparian habitats along the creek. A copy of the integrated assessment is provided in Appendix B. The habitat scores for reaches in the assessment are summarized below. As a general trend, the quality of habitats was related to the history of land disturbance. See Figure 7 for score distribution.

Stream Reach	Habitat Score[1]					Total Score[2]
	Riparian Width	Riparian Condition	In-stream Cover	Fish Barriers	Pool Variability	
Rt. 206 to Elizabeth St.	10	3	5	7	4	**29**
Elizabeth St. to Railroad Overpass	10	5	5	7	8	**35**
Railroad to Park Street	6	4	4	7	3	**24**
Park Street to Crosswicks Creek	10	7	10	8	7	**42**

[1]A maximum score of 10 is allowed for any individual scoring category.
[2]Total scores are based on a maximum score of 50 possible points.

C.3.1 – Riparian Conditions

Scores in the upper two reaches (Rt. 206 to Elizabeth St. and Elizabeth St. to Railroad) were impacted by the lack of diversity and richness in both the herbaceous (grasses and wildflowers) and shrub layers, which are severely impaired by invasive plant colonization and deer browse. Invasive species like garlic mustard (*Allaria petiolata*) have become well established and form monotypic stands in many areas upstream of the railroad. In most other areas, individual plants are scattered throughout other vegetation. Additional invasive species colonizing these areas included multiflora rose (*Rosa multiflora*) and burning-bush (*Euonymous alatum*). In addition, an informal BMX bike course constructed within the riparian area maintains bare patched of earth and had maintained significant earth disturbance within the riparian forest giving this location high potential for the import and establishment of invasive species into the surrounding riparian areas.

The "Railroad to Park Street" has only a small portion of riparian woods still intact. Unfortunately, this reach is strongly impacted by English ivy (Hedera helix), an invasive species often planted as an ornamental vine or groundcover. Anther major impact to this section's poor riparian habitat is the general lack of any riparian buffer along the private residences. Incidentally, this also adversely affects the aquatic habitat through this reach by reducing in-stream cover and pool variability (resulting from greater erosion).

Below Park Street, the riparian woods have remained relatively intact since the closure of the Bonaparte Point Breeze Estate in 1844. Continued disturbance (although relatively small) has come from persons illegally digging around the area of the former Bonaparte Estate in search of artifacts (posted as illegal activity under the NJ easement). As mentioned above, this riparian area holds two intact native plant communities, which is significant for its proximity to such an urban area. Special measures should be made to maintain the ecological health of this riparian area.

C.3.2 Aquatic Habitat Conditions

Aside from riparian habitat conditions, there are aquatic habitat concerns. In-stream habitats have been degraded by erosion. The overall size of gravel and cobble found in the streambed are small and mobile. Sedimentation has resulted in decreased pool size and depth in some sections (notably the areas with the most active erosion).

Another in-stream habitat concern are fish barriers. Structures such as dams are often recognized as fish barriers by preventing fish from freely moving to areas up and downstream. Structures like culverts, pipes, and bridges can sometimes prevent or inhibit fish passage. Two such areas along Thorton Creek included the railroad bridge and the Park Street Bridge. Both of these bridges have a concrete channel that passes flows through. At low flow, these sections of stream have little or no significant water depth to allow fish to pass up of downstream.

C.4 Integrated Assessment Results – Stability

Delaware Riverkeeper Network's intergrated assessment scores for the four reaches of Thorton Creek surveyed are summarized in the table below. This data shows that the major sources of instability are incoming stormwater and past land use in the upper reach (Rt. 206 to Elizabeth Street) and lack of

riparian buffer along residential properties in the lower middle reach (Railroad to Park St.). See Figure 8 for score distribution.

Stream Reach	Stability Score[1]					Total Score[2]
	Bank Erosion	Bank Vegetation Protection	Bank Angle	Leaning Trees	Channel Alterations	
Rt. 206 to Elizabeth St.	3	1	3	3	3	**13**
Elizabeth St. to Railroad Overpass	8	7	8	7	8	**38**
Railroad to Park Street	2	4	2	3	5	**16**
Park Street to Crosswicks Creek	9	9	9	9	8	**44**

[1]A maximum score of 10 is allowed for any individual scoring category.
[2]Total scores are based on a maximum score of 50 possible points.

Creek near BMX bike course. View downstream.

Results of Delaware Riverkeeper Network's Integrated Assessment Protocol clearly identify problem areas along Thorton Creek. In the Rt. 206 to Elizabeth Street reach, the stream seems severely impacted by stormwater (even moreso than downstream reaches), especially in areas just downstream of Rt. 206. Added stormwater has caused the stream channel to adjust to the greater water volume by downcutting and widening its channel as seen in the adjacent photo. These effects become less pronounced downstream of the BMX bike course until the area of the former impoundment (impoundment visible on historic topo map found in Figure 3). In addition, after the dam was breached, the stream downcut through the highly erodible sediments that had accumulated within the impoundment. As a result, the stream has become disconnected from the historic floodplain and became confined to an entrenched (deeper) channel with a re-established a new floodplain. In the entrenched channel however, because the entrenched condition confines the stream during higher flows, this new floodplain will not have the same energy dissipating functions of a natural floodplain.

Debris jam along Thorton Creek.

Severe erosion has caused much of the stream to downcut below the root protection zone of many trees/shrubs growing along the banks. This lack of root protection has lead to steep bank angles (which

increases bank shear stress) and the amount of leaning trees along the stream.

The next section downstream (Elizabeth Street to Railroad) appears to be in better condition than the reach upstream. Some alteration occurred during a small scale gravel quarrying and washing operation that utilized this portion of Thorton Creek, which created a series of small check dams in the upper half of this reach. These historic influences have led to additional entrenched areas similar to those described in areas upstream, although not as severe.

Another stability impact in this section includes the abundance of large woody debris. While large woody debris is considered beneficial to aquatic habitat, an excessive amount (a result of upstream erosion) of woody material has created several debris jams throughout this section. These jams have created erosion in several areas. A larger problem is the potential for braiding of the stream channel (forming more than one active channel). This appears to have happened in at least one area as a result of a previous debris jam.

Below the areas of debris jams, the remains of a large concrete dam near the railroad (the dam also reportedly doubled as a stream crossing for a neighboring military academy which operated until 1970 (dam visible on historic topo map found in Figure 3). Although the dam no longer holds an impoundment, the structure itself is still intact and causing local erosion around the structure.

Below the railroad bridge, riparian land use changes dramatically. This section (Railroad to Park St.) is the only section with private residential property along the stream. Unfortunate, this land use has led to the nearly complete loss of a riparian buffer throughout this reach except for a small wooded parcel. The effects of no riparian buffer are clearly evident in this portion of Thorton Creek. As reflected in the assessment scoring, severe bank erosion is evident and active. Without stabilization provided by trees and shrubs, many areas have scoured out leaving steep eroded banks (See picture below).

Dam remains upstream of railroad bridge.

Bank erosion along residential properties.

Below Park Street, stream flow meets the head of tide and begins the tidal influenced portion of the creek. This final reach was largely stable. The overall score was reduced slightly due to the channel armoring recently completed, which provides artificial channel stability.

D. Recommendations

D.1. Planning and Policy Recommendations

#1 Develop a restoration vision for Thorton Creek. With community-wide involvement, develop a vision for how the Thorton Creek stream corridor will be restored and used in the near and long-term future. Components of this ideal vision would include the stream corridor's future visual, environmental, ecological, public use and other amenities. The products of this process could include a vision statement, a conceptual plan (drawing), and possibly appropriate action by the City Council. Only after a vision of Thorton Creek's potential is developed can any long-term restoration or management be sustained.

#2 Organize a local conservation initiative strategy. Using the vision, develop a strategy and a timeline to achieve set goals. Elements of the timeline could include achieving desired improvements in the parklands such as a trail system, interpretive signage, or invasive species control, so that participants in the process can be part of an on-the-ground result. The strategy will set out goals and very specific objectives, provide the projected dates for milestone activities such as completion of studies, grant deadlines, volunteer and community events, and construction periods. The strategy would identify potential volunteers, detail the organizational responsibilities with participants and Bordentown staff, and provide a brief public communication plan.

#3 Purchase property or easements along riparian properties. Over 75% of the surveyed forested floodplain and creek are properties owned by private landowners. To the extent possible, the City of Bordentown should purchase these riparian properties or (at a minimum) conservation easements along these lands for long-term protection.

#4 Public use locations and design. The results of the buffer survey also have the following implications for the development of the trail system along accessible areas of Thorton Creek. Trail location, design, and construction in the forested floodplain should avoid a) mature canopy trees, b) wetland or vernal pool areas, and c) maintain several feet away from the top edge of streambanks. The highly disturbed nature of the floodplain increases the likelihood that new disturbances will be colonized by invasive plant species. The following recommendations apply both to trail location and design as well as restoration design, where bank stabilization may be required in specific areas of the floodplain forest.

- Construction specifications should identify high value habitat areas of the buffer where disturbance is prohibited and require construction practices to minimize disturbance of these areas.
- Site design should consider access points from more disturbed and low-value areas of the floodplain forest
- Restoration and trail design should consider changes in grade or drainage that may transport invasive species seed. For example, Japanese stiltgrass has been shown to follow surface drainage paths and trail edges.
- Disturbances needed for restoration and trail building such as temporary roads can take advantage of exiting disturbed areas for construction access, material stockpiles, and other needs. Removal of trash and debris should be conducted concurrently with trail construction in order to minimize disturbance. These areas could then be restored and incorporated into trail design as demonstration areas.

- ❖ Earth moving activities or collapse of banks can spread rhizomes of Japanese knotweed and other invasive plant material that can re-sprout in new areas. Specifically, the area between the railroad and Park Street has a large patch of Japanese knotweed that could be spread downstream if not properly controlled.
- ❖ Restoration projects and trail design should consider split rail or suitable fencing along trails to limit access to sensitive areas and protect plantings. Several studies have proven transport of invasive plants by foot traffic and the current distribution of invasives is already concentrated along existing trails and disturbed areas.

#4 Plan Community Events. The recommendations in this plan assume that a volunteers could be used for monitoring and maintenance as well as serve as a match for grants. Successful groups tend to hold at least two community clean-up/invasive species control workdays a year and also have fun events such as wildflower or bird walks. An ideal situation is a core group of volunteers and at least one dedicated volunteer who is responsible for organizing volunteers and some of the events.

D. 2. Stream Corridor Management and Monitoring Recommendations

#1 Invasive species control. The most effective method of controlling invasives is prevention, and therefore the primary objective is to eliminate small colonies and "new arrivals" before they get established. The eradication of the invasives once they are established is difficult and requires years of control followed by the installation of native plants to replace community diversity.

After preventing new arrivals and eliminating small colonies, control efforts can focus on larger outliers of invasive plant colonies and areas outside of the park that may spread invasive into the park by seed (upstream, uphill, upwind, drainage areas in woodlands) or actual plant material placed as landscape wastes within park boundaries. Control efforts will require follow-up on areas where maintenance activities have been conducted and inspection of any newly disturbed areas. In areas of well-established populations where control is difficult, first control reproductive capacity and work from the outside in. Focus last in areas with large monotypic infestations that are subject to continual re-invasion by continued sources of seed.

#2 Bank stabilization. Severely eroded and unstable areas should be stabilized using ecologically sensitive approaches such as bioengineering or natural channel design techniques. Priority areas include severely eroded banks along private residential property and entrenched areas within former impoundments.

#3 Develop and implement conservation plan. A conservation plan ensures that management actions are focused on the defined goals including but not limited to: *stabilizing and returning function to riparian corridors, maintaining mature forested floodplain, enhancing floodplain and aquatic habitat, and preserving native plant communities*. It's easy to focus too much on eliminating invasive plants or providing for a particular park use, rather than the whole picture of what makes the recreational area special. The management plan will inventory and assess conditions, set maintenance priorities and schedules, and spell out maintenance tasks, methods and resources.

#4 Encourage changing private residence riparian practices. The creation of no-mow areas along the banks and re-establishing a vegetated buffer with attractive native species would improve the stability of banks along eroded residential properties. Mowing or placement of fill, lawn clippings, or horticultural debris on the banks should be avoided as this inhibits the establishment of plants that could help stabilize the banks. In some areas simply not mowing will allow vegetation to reestablish naturally, in other areas invasive species may be controlled prior to supplemental planting of native species.

#5 Install Bank Monitoring Pins. A series of monitoring points should be established to monitor erosion rates in actively degrading areas. The monitoring program should also collect baseline information on variables that could influence the rate of erosion. These include measuring the current bank angle and height, type of bank material, vegetative cover, root protection, and the position of the monitoring point relative to the channel geometry. More detailed evaluation will be needed for any restoration design and permitting.

#6 Recruiting and Retaining Park Volunteers. DRN has met many volunteer groups that are made up of locals, neighbors, or "friends of the park" who are highly trained and effective maintenance partners. More and more private and public schools are adding service components to their curriculum. Several schools have adopted DRN projects to work on aspects from planting to maintenance. These and other service-oriented programs can be found in social groups such as scouts, garden clubs, environmental clubs, religious groups, and even private companies.

Retaining volunteers requires appreciation and remembering that there are many reasons why people want to volunteer. One of the keys to retaining a volunteer is understanding and emphasizing the rewards they get out of it. Some people may be avid birders, some gaining work experience, maybe "required" to be there for a service project, are using the site for school field trips, or may simply want a place where their kids could see a frog or two. Tapping into the personal reasons and allowing people to feel ownership are two good ways to keep a volunteer. Most volunteers are also attracted to the educational or recreational aspects of natural areas. Volunteers who aren't fit or interested in physical labor can contribute by keeping records, making calls, starting a newsletter, and even writing grants for funding.

E. 3. Potential Funding

Some possible funding sources are provided in a general overview here. For more information on each funder, their grant rounds, and application guidelines, please contact them directly as listed:

Delaware Riverkeeper Network Restoration Assistance Provider Project
Delaware Riverkeeper Network, with funding from the National Fish and Wildlife Foundation, can provide technical assistance to complete restoration projects within the Delaware Estuary. Restoration projects include activities such as invasive species control, bank stabilization, stream restoration, riparian buffer planting, and more.

USFWS Partners for Conservation

The New Jersey office of USFWS, located in Pleasantville, NJ provides technical assistance to complete restoration projects that meet USFWS criteria. For more information contact Eric Shrading at Eric_Schrading@fws.gov or (609) 383-3938 x46.

NRCS WHIP

The USDA Natural Resource Conservation Service funds restoration projects through the Wildlife Habitat Incentives Program. Contact the nearest NRCS office for application and details or see http://www.nj.nrcs.usda.gov/programs/ for additional funding opportunities.

NFWF Delaware Estuary Grants

The National Fish and Wildlife Foundation funds habitat restoration projects throughout the Delaware Estuary. Applications are generally due in June, annually. Refer to www.nfwf.org/programs/delaware.cfm for more details on the foundation and the grant application process.

NJDEP 319h Grants

NJDEP funds watershed planning and restoration implementation through its 319 Non-Point Source Pollution Control Program.
Refer to http://www.state.nj.us/dep/grantandloanprograms/eps_nspc.htm for application details.

Feel free to contact Delaware Riverkeeper Network with any questions or comments regarding this assessment and its recommendations: dan@delawareriverkeeper.org or 215.369.1188.

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Delaware Riverkeeper Network assistance is funded through a Delaware Estuary Grant provided by the National Fish and Wildlife Foundation. The views and recommendations expressed here are not necessarily those of the Foundation.

FIGURE 1.
1994 USGS Topographic Map – Thorntown Creek Watershed

FIGURE 2.
1906 USGS Topographic Map – Thorntown Creek Watershed

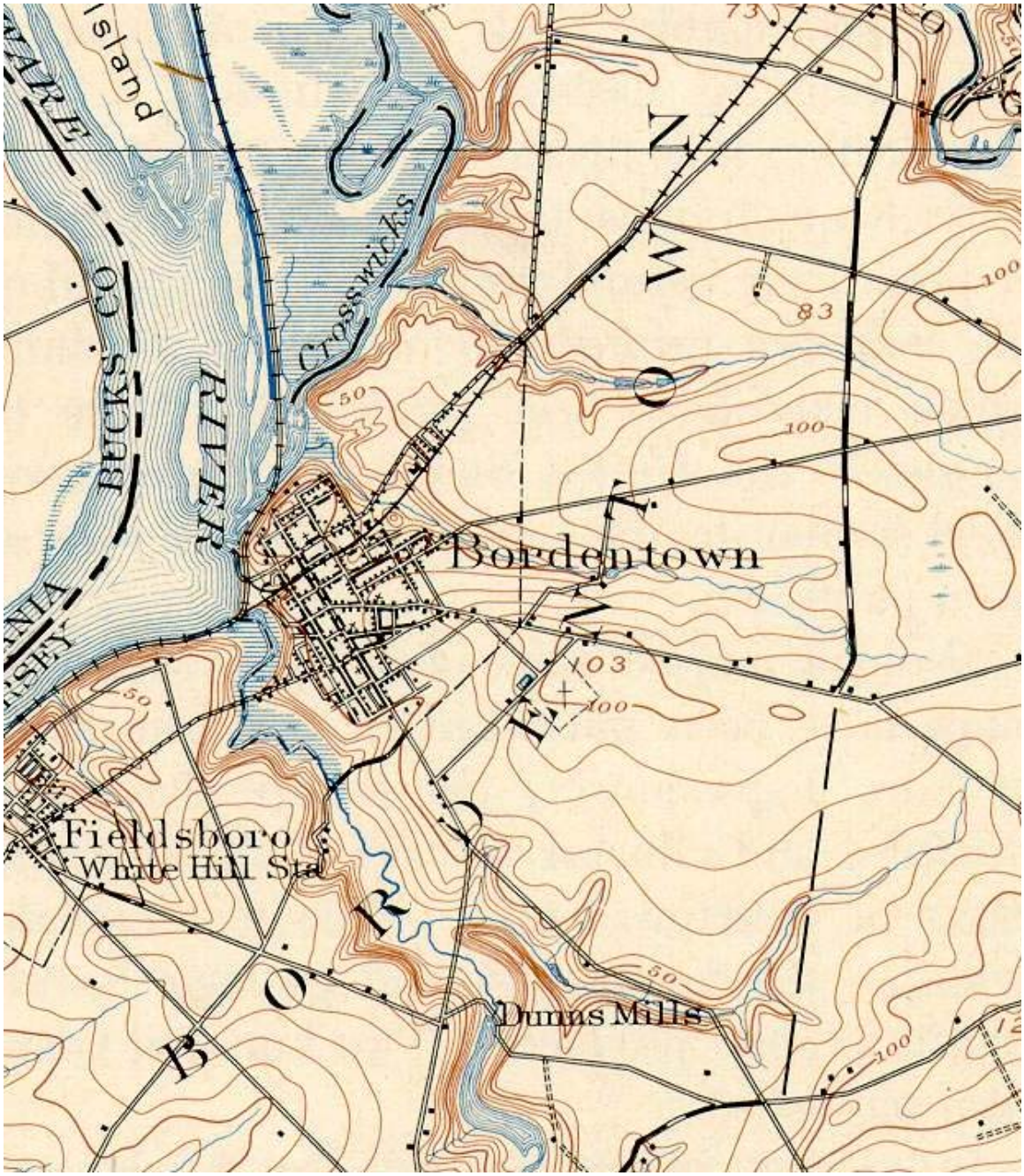
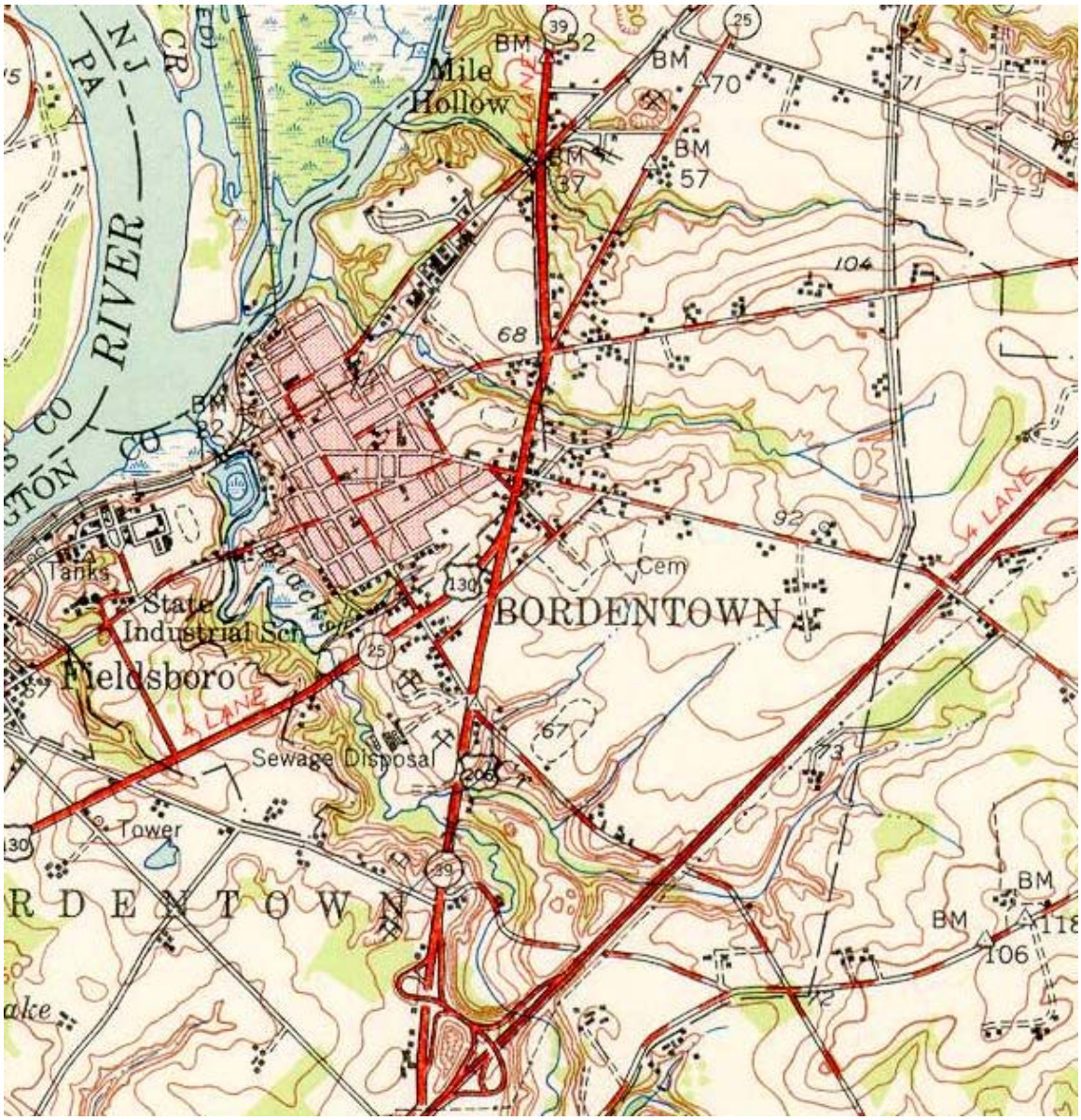


FIGURE 3.
1956 USGS Topographic Map – Thorntown Creek Watershed



Appendix A.
Ecological Community Association Summaries
(Data and descriptions directly from Natureserve.org)

Thorton Creek Riparian Woods between Park Street and Thorton/Crosswicks Marsh

Fagus grandifolia - Betula lenta - Liriodendron tulipifera - Acer saccharum Forest

Translated Name: American Beech - Sweet Birch - Tuliptree - Sugar Maple Forest
Common Name: Tuliptree - Beech - Maple Forest
Unique Identifier: CEGL006296
Classification Approach: International Vegetation Classification (IVC)

Summary: This mid- to lower slope deciduous forest of the mid-Atlantic region occurs on deep soils that are not strongly acidic. The tree canopy is characterized by a mixture of *Liriodendron tulipifera, Fagus grandifolia, Acer saccharum, Betula lenta*, and other associated species, including *Acer rubrum, Nyssa sylvatica*, and *Carya alba (= Carya tomentosa)*. The subcanopy is characterized by *Carpinus caroliniana, Cornus florida*, and *Ostrya virginiana*. *Magnolia acuminata* may occur in the western portion of the range. Common species of the shrub layer include *Hamamelis virginiana* and *Lindera benzoin*. The herbaceous layer is characterized by *Podophyllum peltatum, Sanguinaria canadensis, Botrychium virginianum, Dicentra cucullaria, Dicentra canadensis, Allium tricoccum*, and *Claytonia virginica*.

Riparian Woods along slope surrounding Thorton/Crosswicks Marsh

Fagus grandifolia - Betula lenta - Quercus (alba, rubra) / Carpinus caroliniana Forest

Translated Name: American Beech - Sweet Birch - (White Oak, Northern Red Oak) / Ironwood Forest
Common Name: Northern Piedmont Mesic Oak - Beech Forest
Unique Identifier: CEGL006921
Classification Approach: International Vegetation Classification (IVC)

Summary: This mesic hardwood forest occurs in the northern Piedmont of New Jersey, Delaware, and is likely to occur in Maryland. This association occurs on gently sloping sites, and soils may be rocky. The canopy is characterized by *Fagus grandifolia, Liriodendron tulipifera*, and *Betula lenta*, with associated species including *Quercus alba, Quercus rubra, Nyssa sylvatica, Fraxinus americana*, and *Carya* spp. The shrub layer is dominated by *Carpinus caroliniana*, with lesser amounts of *Cornus florida, Hamamelis virginiana*, and *Lindera benzoin*. Other shrub associates include *Viburnum acerifolium, Vaccinium pallidum, Viburnum dentatum*, and *Hamamelis virginiana*. The herbaceous layer is characterized by *Polystichum acrostichoides, Arisaema triphyllum, Thelypteris noveboracensis, Mitchella repens, Medeola virginiana, Polystichum acrostichoides, Parthenocissus quinquefolia, Polygonatum biflorum, Galium circaezans, Botrychium virginianum*, and *Amphicarpaea bracteata*.