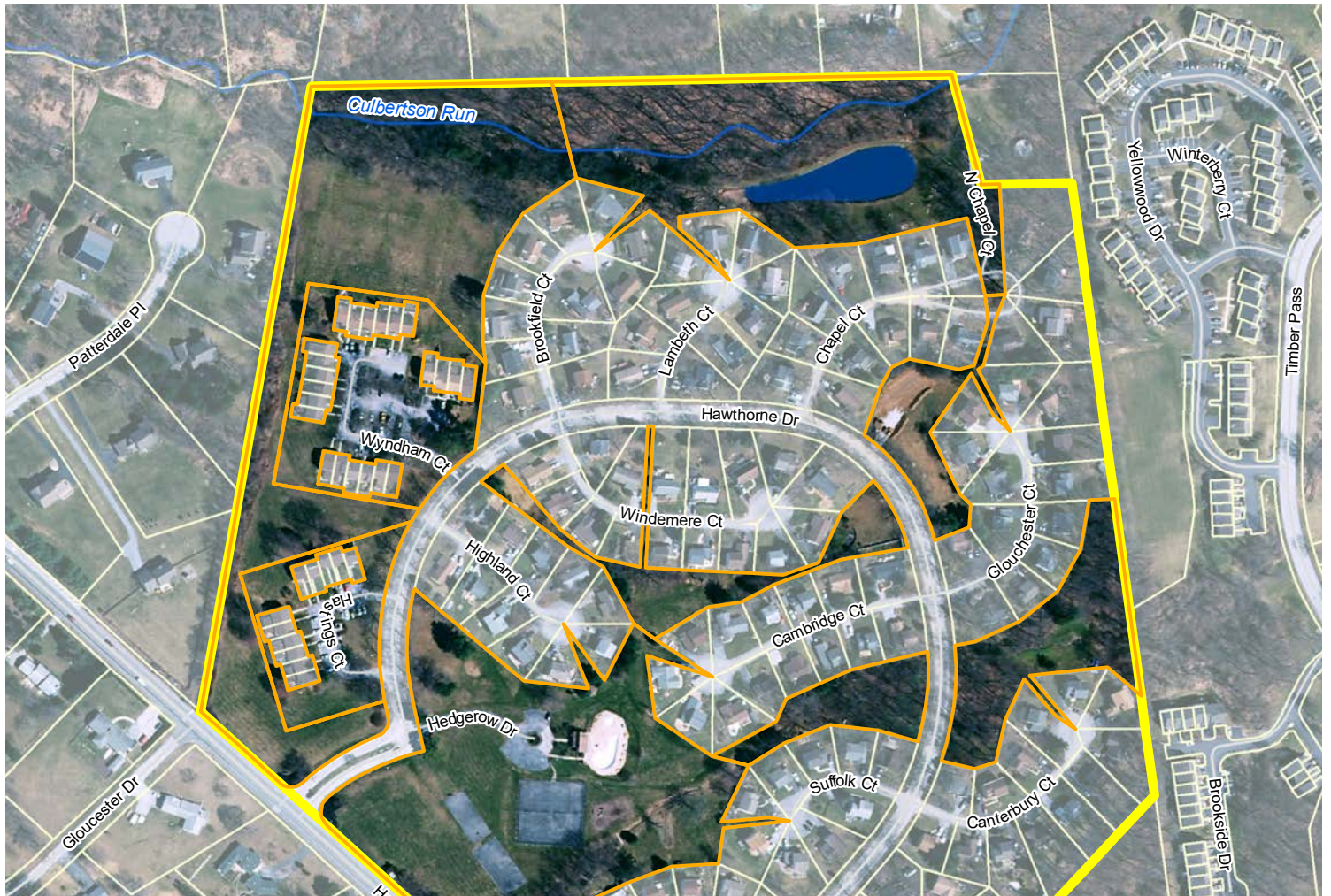


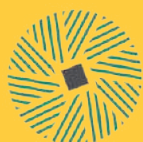


Hedgerow/Culbertson Run HOA

EAST BRANDYWINE TOWNSHIP, CHESTER COUNTY, PA

stormwater management assessment & recommendations

June 2020



BRANDYWINE
CONSERVANCY



Natural
Lands

background

Scott Piersol, Manager of East Brandywine Township, was contacted by the Hedgerow Culbertson Run HOA regarding concerns regarding stormwater runoff and flooding on their property. Natural Lands and Brandywine Conservancy visited the site the evening of August 13th, 2019. The property was toured with Mike Mize, the HOA President, Scott Piersol, and others from the HOA Board. Natural Lands submitted a proposal for site assessment and recommendations, which was approved by the HOA in October 2019. Natural Lands again visited the site in January of 2020 during a significant storm event to observe runoff patterns and issues. This report is based on the items as stated in the proposal, as well as the results of discussions, mapping and site visits.

field assessment & mapping

Natural Lands conducted two field visits in August of 2019 and January of 2020 in order to assess existing site conditions. Specific observations included the following:

- Property boundaries
- Runoff and drainage patterns
- Existing vegetation

The entire property was mapped, including topography, hydrology and soils, and existing conditions and structures. These are included within the drawing set (**see Maps**).

The development site slopes steadily and in some case steeply to the north, with the majority of site runoff draining towards Culbertson Run, although in the eastern portion of the site, runoff is collected in a swale that drains into



an unnamed dry detention basin just north of Canterbury Court which then drains off-site. The also site collects water from adjacent properties and roads.

Soils are primarily considered impermeable urban land (UrmB type) but along the east and northern boundary of the site there are Gladstone (GdB, GdC and GdD) and Cokesbury (CaB) type soils which are considered to be well-draining.

While much of the public areas are mown grass, there are woodland areas. The majority of woodlands in public areas contain invasive species: trees, shrubs, and groundcover/ grasses.

issues identified

- During significant storm events, many areas of the development experience significant issues with stormwater runoff, including flowing water channels, sheet runoff, and flooding. Due to existing site topography, individual homeowners attempting to solve runoff issues on their own property often affect properties below. The majority of runoff collects in either the non-functional dry detention basin to the east, or the Chapel Court wet retention basin to the north.



- An existing swale running through the property from Route 322 no longer effectively directs water flow through the HOA site. Water is forming new runnels and channels and saturating the rear yards of individual properties and flooding the existing woodland area at the eastern boundary of the development, **photo 1** and **photo 2**. A non-functioning dry basin adjacent to the far east boundary of the property collects most of this runoff, leading to issues with standing water, saturated soils and insects, **photo 3**. Observation of damp soil and ruts from attempted mowing around and within the basin show evidence of difficulty with ongoing maintenance.
- The lawn area and communal space between Route 322 and the HOA Clubhouse, to the south of the entrance, is underutilized, with drainage issues and standing water adjacent to the tennis courts, **photo 4**.
- The Chapel Court Basin to the north end of the property is in need of maintenance, **photo 5**.
- Excess runoff from properties above the Chapel Court Basin contribute to flooding and wet soils around the basin area.
- The development is affected by runoff from adjacent roads and non-HOA properties.



- The large open space area north of Wyndham Court in the northwest of the development is underutilized and requires planning (*not addressed in this plan*).
- Many homes experience runoff issues from the roadways throughout the HOA (*currently being addressed by others*).

recommendations

entire development site

on-site management/education – introduce educational program and potential rebate program for homeowners in order to promote on-site stormwater management on individual properties. The purpose of on-site practices is to help reduce the volume and peak of stormwater runoff at its source, improve water quality by filtering runoff, and increase the infiltration of rainfall by retaining stormwater to slow its discharge into sewer systems, nearby waterways, and adjacent properties. Costs can range from \$3–10 per square foot. Placement and design are important elements that will influence effectiveness of these elements. The

more that stormwater is mitigated on individual properties, the less will be running through the development and causing flooding or other issues. Examples of recommended practices are as follows:

rain gardens – planted landscape depressions that retain and filter stormwater in order to allow rainwater runoff from impervious areas such as roofs, driveways, walkways, patios and compacted lawn areas to be absorbed and infiltrated. Landscaping can be designed to be beneficial both aesthetically and ecologically, **photo 6**.

bioswales – swaled drainage courses with gently sloped sides filled with vegetation, compost and/or rip-rap, designed to maximize the time water spends in the swale. This aids in the trapping of pollutants and silt from adjacent impervious areas, and encourages infiltration. Landscaping can be designed to be beneficial both aesthetically and ecologically, **photo 7**.

disconnected downspouts – in many developments downspouts from individual homes are connected directly to a collective storm sewer system. During major storm events, these systems can overflow and contribute to flooding. Downspouts can be connected to rain barrels



to provide onsite water storage for later use. They help conserve water, reduce discharge into storm sewers, and they provide free water for the landscape. Downspouts can also be disconnected entirely and allowed to discharge over pervious land areas which will allow the rainwater to infiltrate. Although this will contribute to more runoff water on the property, the use of a rain garden will mitigate these effects.

permeable paving materials – Using permeable paving materials to replace impervious driveways, patios, and walkways is likely to be the most expensive option. There are several options ranging from gravel to porous concrete to interlocking pavers, based on budget and aesthetic preference. Pervious paving allows for water infiltration on what would otherwise be an impervious surface, such as drives, walkways or patios, **photo 8** and **photo 9**.

meadow conversion – Typical lawn areas do not infiltrate water as well as meadow-type plantings. Underutilized lawn areas could be converted to meadow.

off-site management – from observation, it appears that significant stormwater runoff is entering the site from off-site sources. It is recommended that the HOA speak with East Brandywine Township about potential reduction of off-site stormwater entering the site from 322 and other adjacent properties. If possible, the same residential stormwater management education as suggested earlier could be offered to adjacent homeowners.

existing swale

The existing swale that runs northeast through the site no longer adequately channels stormwater through the site and to the intended dry detention basin just north of Canterbury Court. Historically, there was a channel running through the grassy area, leading northeast from 322 to the wooded area below. Residents recall that its banks were planted and the channel itself was rock-lined. Over time, runoff has increased and sedimentation has all but eradicated the channel. Stormwater runs downhill via a myriad of naturally forming channels through a mowed lawn area which affords little means of slowing or infiltrating runoff. The length of the swale is divided into several specific zones, with associated recommendations (**see Concept Plan**).



Image source: Stormwater Commission, Lake County, IL



Image source: Houzz.com



Image source: Belgard Pavers

upper open grass area

For the upper open grass area, several solutions are recommended:

- **installation of weirs** – weirs (ornamental landscape stone or riprap) will allow more space for slowing flow rates and increasing retention and potential infiltration of runoff, reducing the amount and rate of flow downstream, **photo 10**, **photo 11**, and **photo 12**. Ponded areas behind the individual weirs can be landscaped to increase aesthetic and ecological value for the landscape within the development, and also to help manage runoff (*no image available*).
- **native riparian buffer planting** – the existing turf the stormwater runs through and across has no ecological or stormwater management value. Replacing some of the adjacent turf areas with planted native riparian buffers will serve to increase aesthetic and ecological value, as well as provide further ability to treat stormwater runoff, **photo 13**.
- **expanded swale depth and width** – in addition to weir installations, the swale needs to be widened, with gently sloping banks planted with native riparian shrubs, grasses and trees, **photo 14**.



- **invasive species management and removal** – the heavily overgrown area adjacent to 322 should be cleared of invasive plant material and replanted with appropriate native material if possible. The area should be regularly monitored and managed for invasives.
- **meadow conversion** – where not required/desired, turf areas can be converted to lower maintenance, more ecologically beneficial meadow areas. Meadow grass areas are better able to slow and infiltrate stormwater and will reduce the amount of runoff running into swaled areas and into the property from 322, **photo 15**. They also require less frequent mowing.

- **installation of raingardens/raingarden plantings in key areas** – flooding, standing water and saturated soils can be problematic in areas adjacent to the tennis courts and playground. By treating these areas as what they are—natural basins—they can be seen in a different light. Wet areas can be sloped and planted with wetland grasses and perennials, creating areas that are more ornamental, better able to manage and infiltrate stormwater, and are more beneficial to the environment in terms of water purification and wildlife habitat, **photo 16**.

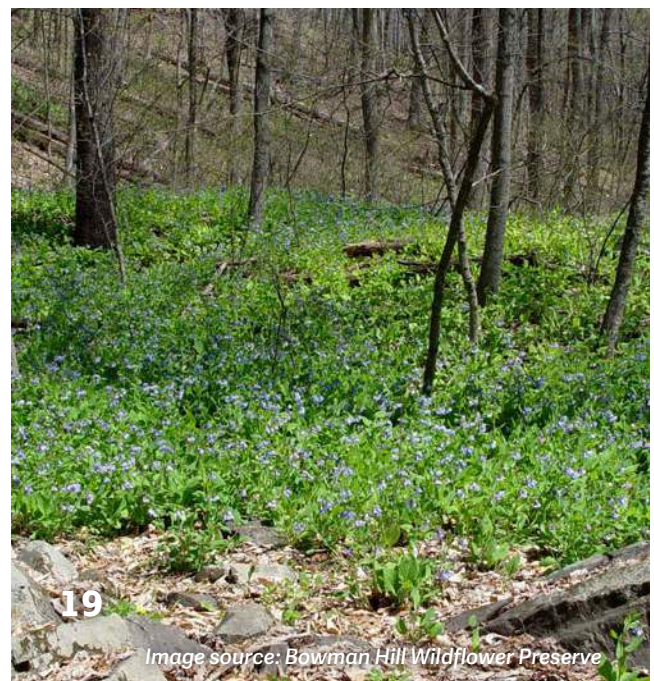




lower woodland area

During storm events, the woodland area becomes flooded, with a series of meandering channels running through it, culminating in a culvert running under Hawthorne Drive and down into a neglected and inadequate stormwater basin. Flooding of this area extends into the rear yards of adjacent properties, causing saturated soils and rendering the yards virtually unusable, **photo 17** and **photo 18**. While improving conditions upstream will help reduce stormwater flow in this area, several additional solutions are recommended:

- **channel restoration** – where possible without excessive tree removal, water flow should be directed into a wider meandering channel with shallow banks heavily planted with native riparian shrubs, grasses and trees.
- **supplemental planting** – this entire forested area could be treated as a wet forest, and seeded with an appropriate seed mix, as well as supplemental plantings of appropriate native woodland grasses, shrubs, and trees in order to help absorb and slow stormwater flow, **photo 19**.
- **invasive species management and removal** – invasive plant material should be removed and replanted with appropriate native material if possible. The area should be regularly monitored and managed for invasives.



dry detention basin area

The detention basin just north of Canterbury Court appears inadequate due to sedimentation and lack of maintenance. Banks are steep and planted with turf grass, which creates issues with maintenance and management, **photo 20**. The following potential solutions are recommended:

- **evaluation of existing basin structures** – the built features of this basin (outlet, riser, etc.) should be evaluated by a professional and cleared/unclogged/repared if necessary to ensure functionality (*see Recommended Contractor List*).
- **enlarged basin** – in order to better treat stormwater and reduce maintenance, retrofitting this dry basin into a natural ecosystem should be considered. The basin footprint could be enlarged to allow for more gradual slopes for ease of maintenance and access.
- **basin and buffer planting** – any area not owned by the adjacent property owner should be converted to a type of landscape better suited to stormwater management. Turf grass can be converted to meadow which is more ecologically beneficial, and better able to slow and infiltrate stormwater flow. The basin itself can be planted with appropriate native trees, shrubs and grasses for habitat and stormwater mitigation, and to cut down on the need for regular mowing, **photo 21**.

- **invasive species management and removal** – invasive plant material should be removed and replanted with appropriate native material if possible. The area should be regularly monitored and managed for invasives.

Refer to Table - Planting Recommendations, Table - Maintenance Recommendations, Stormwater Mitigation Estimates and Concept Plans for additional information.



Image source: David Brandes, Lafayette College

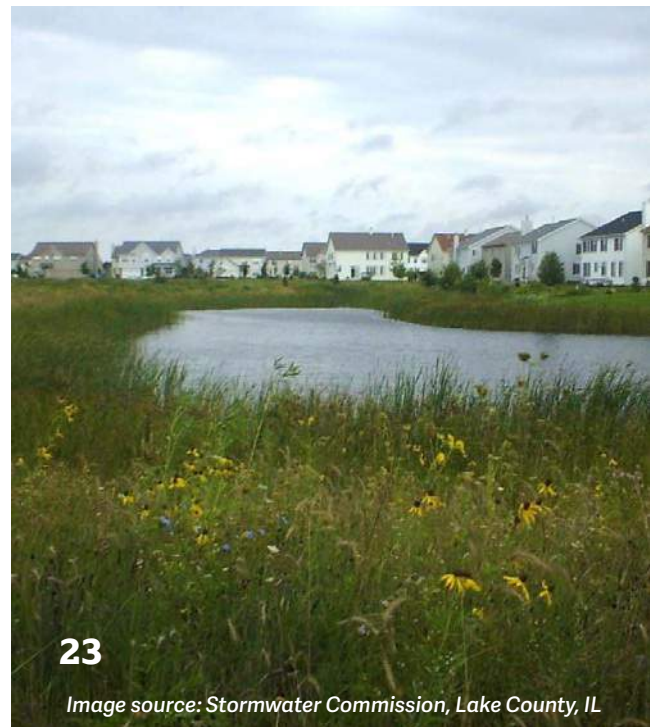
Chapel Court basin

The existing wet retention basin is located below the development, and collects significant runoff from the development. The areas around the basin are turf, with evidence of saturated soils and puddling, particularly to the east. The basin lies within the 100-year floodplain of Culbertson Run, which runs just north of the basin area. It also overlaps a designated wetland area to the north. Significant runoff flows down the gravel/asphalt drive (North Chapel Court Road, which leads to what appears to be a utility building). This untreated runoff floods the base of the road, either entering the basin or flowing directly to Culbertson Run, which then runs directly to the East Branch of the Brandywine Creek (*see Concept Plan*).

retention basin area

The basin is not functioning as intended. The basin appears inadequate due to sedimentation and lack of ongoing maintenance. Banks are shallow and planted with turf grass, which does little for safety and does little in terms of stormwater management, wildlife habitat or aesthetics, *photo 22*. The following potential solutions are recommended:

- **evaluation of existing basin and structures** – the basin and built features of this basin (outlet, riser, etc.) should be evaluated by a professional and dredged/cleared/unclogged/repared if necessary to ensure functionality (*see Recommended Contractor List*).
- **enlarged basin** – in order to better manage stormwater runoff volume, expanding the basin to the south and planting with native wetland species is recommended.
- **basin and buffer planting** – any area not owned by the adjacent property owner should be converted to a type of landscape better suited to stormwater management. Turf grass can be converted to riparian meadow or forested buffer which is more ecologically beneficial, and better able to slow and infiltrate stormwater flow. The basin banks can be planted with appropriate trees, shrubs and grasses for habitat and stormwater mitigation, and to cut down on need for regular mowing, *photo 23*.
- **invasive species management and removal** - invasive plant material should be removed and replanted with appropriate native material if possible. The area should be regularly monitored and managed for invasives.
- **on-site management/education** – refer to *Recommendations - Entire Development Site section*.

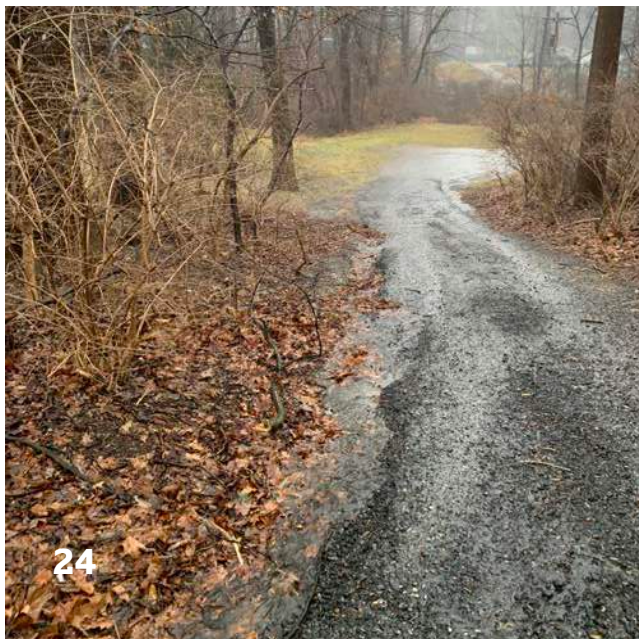


gravel road management

North Chapel Court Road acts as a direct channel of untreated runoff (sediment and potential pollutants such as oil and fertilizers/pesticides) into the basin and Culbertson Run, **photo 24**. Simple water diversion interventions could be installed to better manage runoff from the neighborhood above, such as:

- **adjacent swales** – installation of planted depressed areas to the sides of the drive could serve to collect, slow and infiltrate water, as well as directing it towards specific areas instead of allowing it to fan out at the bottom of the hill. Swales could be directed towards “lead-offs” which surface drain into planted or forested areas, or to designed “sumps” which are dug depressions that are planted or filled with rock and can serve to detain water and act as sediment collectors. Swales can also incorporate rock or timber check-dams to further slow water, **photo 25**.
- **water bars** – Often installed on steep trails, these are barriers of stone, wood, or other materials embedded in order to divert water into adjacent planted or forested areas, which can better act to slow and infiltrate water than the drive’s impervious surface, **photo 26** and **photo 27**.

Refer to Table - Planting Recommendations, Table - Maintenance Recommendations, Stormwater Mitigation Estimates and Concept Plans for additional information.





**BRANDYWINE
CONSERVANCY**

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brandywine.org



**Natural
Lands**

Hildacy Preserve
1031 Palmers Mill Road
Media, PA 19063
610-353-5587
natlands.org

HEDGEROW/ CULBERTSON RUN HOA East Brandywine, PA

CONCEPT PLAN



CHAPEL COURT BASIN - recommendations include professional evaluation, enlargement of basin, buffer plantings, invasive species removal and management, as well as environmental education

GRAVEL ROAD - recommendations include installation of adjacent swales and/or water bars

ENTIRE DEVELOPMENT SITE- recommendations include environmental education for residents regarding the benefits of green stormwater management practices, and installation of those practices throughout the HOA site as well as on individual residential properties

LOWER WOODLAND AREA - recommendations include channel restoration, supplemental woodland plantings, and invasive species management and removal

DRY DETENTION BASIN AREA - recommendations include professional evaluation, basin enlargements, buffer plantings and meadow conversion, and invasive species management and removal

UPPER OPEN GRASS AREA - recommendations include bioswale plantings

UPPER OPEN GRASS AREA - recommendations include rain garden plantings in key wet areas, including by tennis courts and playground area

UPPER OPEN GRASS AREA - recommendations include meadow conversion

UPPER OPEN GRASS AREA - recommendations include invasive plant removal, installation of weirs, expanded swale length and width, and native riparian buffer planting

UPPER OPEN GRASS AREA - recommendations include invasive plant removal and installation of roadside buffer plantings

HEDGEROW/ CULBERTSON RUN HOA

East Brandywine, PA

SITE ASSESSMENT

-  Property Boundary
-  Mown Lawn Areas
-  Woodland Areas
-  Wet/Flooded Areas
-  Ponds/Basins
-  Streams/Swales
-  Direction of Storm-water Runoff



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1. Aerial photography from DVRPC (2015).
2. Roadways and waterways from Chester County (2016).
3. Parcel boundaries from Chester County (2017).

Compiled By: CMA 10/3/19

Disclaimer: This map is not a survey. The information imparted with this map is meant to assist Natural Lands Trust, Inc., describe the placement of certain retained, reserved, or excluded rights and to calculate acreage figures. Property boundaries, while approximate, were established using the best available information, which may have included: surveys, tax maps, field mapping using G.P.S., and/or orthophotos. Natural Lands Trust, Inc., makes no representation as to the accuracy of said property lines (or any other lines), and no liability is assumed by reason of reliance hereon. Use of this map for other than its intended purpose requires the written consent of Natural Lands Trust, Inc.





2015 Aerial Photography

Hedgerow Culbertson Run HOA

Tax ID: 30-2J-3, 30-2J-4, 30-2N-120, 30-2N-134, 30-2N-158, 30-2N-166, 30-2N-34, 30-2N-46, 30-2N-74, & 30-2N-89 (+/- 24.93 Acres)

East Brandywine Township, Chester Co., PA

 HOA Property Boundary

 Development Boundary

 Waterways

 Roadways

 Parcel Boundaries

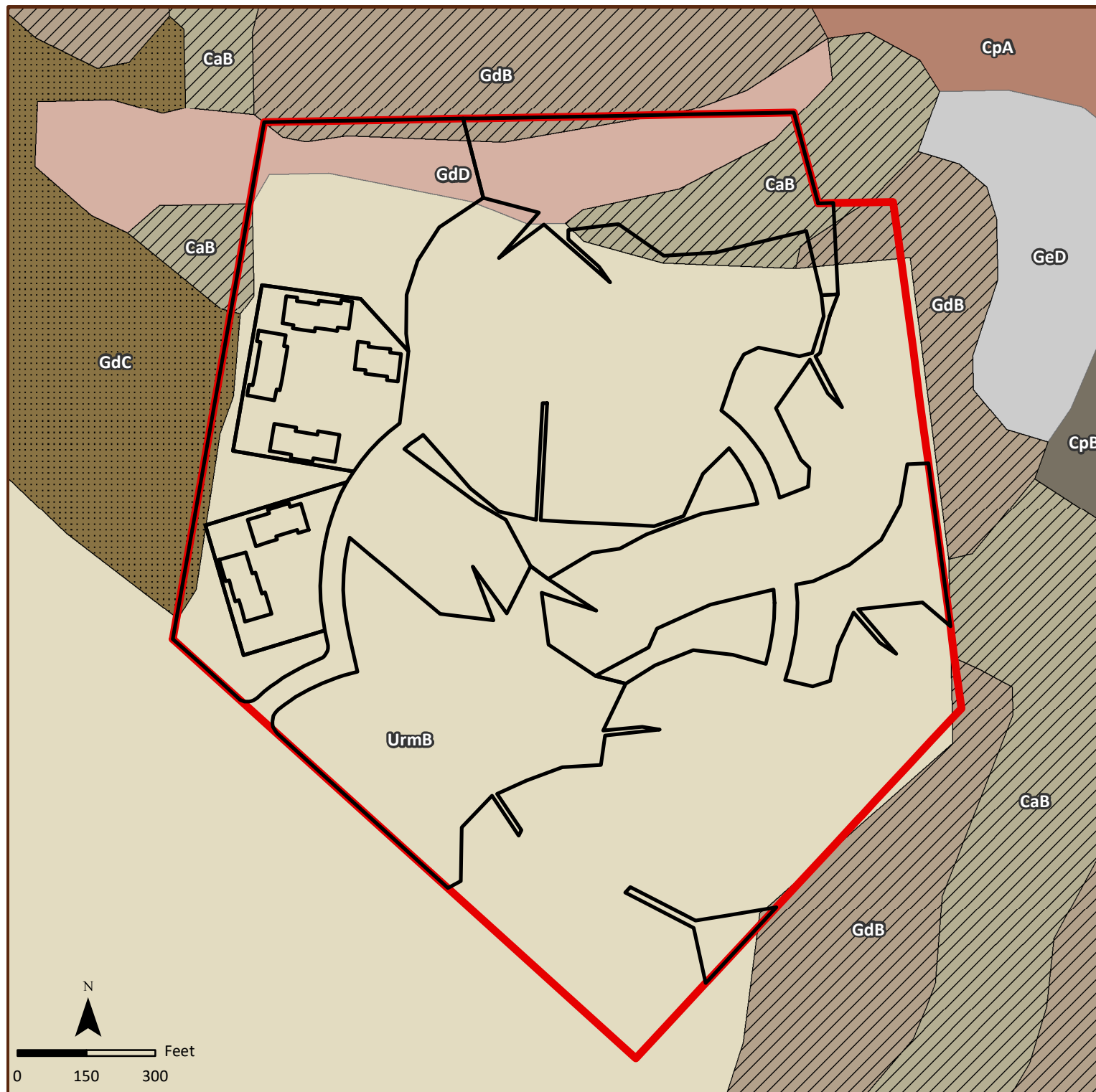


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1. Aerial photography from DVRPC (2015).
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Soils

Hedgerow Culbertson Run HOA

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East Brandywine Township, Chester Co., PA

- HOA Property Boundary
- Development Boundary
- Prime farmland
- Farmland of statewide importance

Soils

- CaB, Calton
- CpA, Cokesbury
- CpB, Cokesbury
- GdB, Gladstone
- GdC, Gladstone
- GdD, Gladstone
- GeD, Parker
- UrmB, Urban land

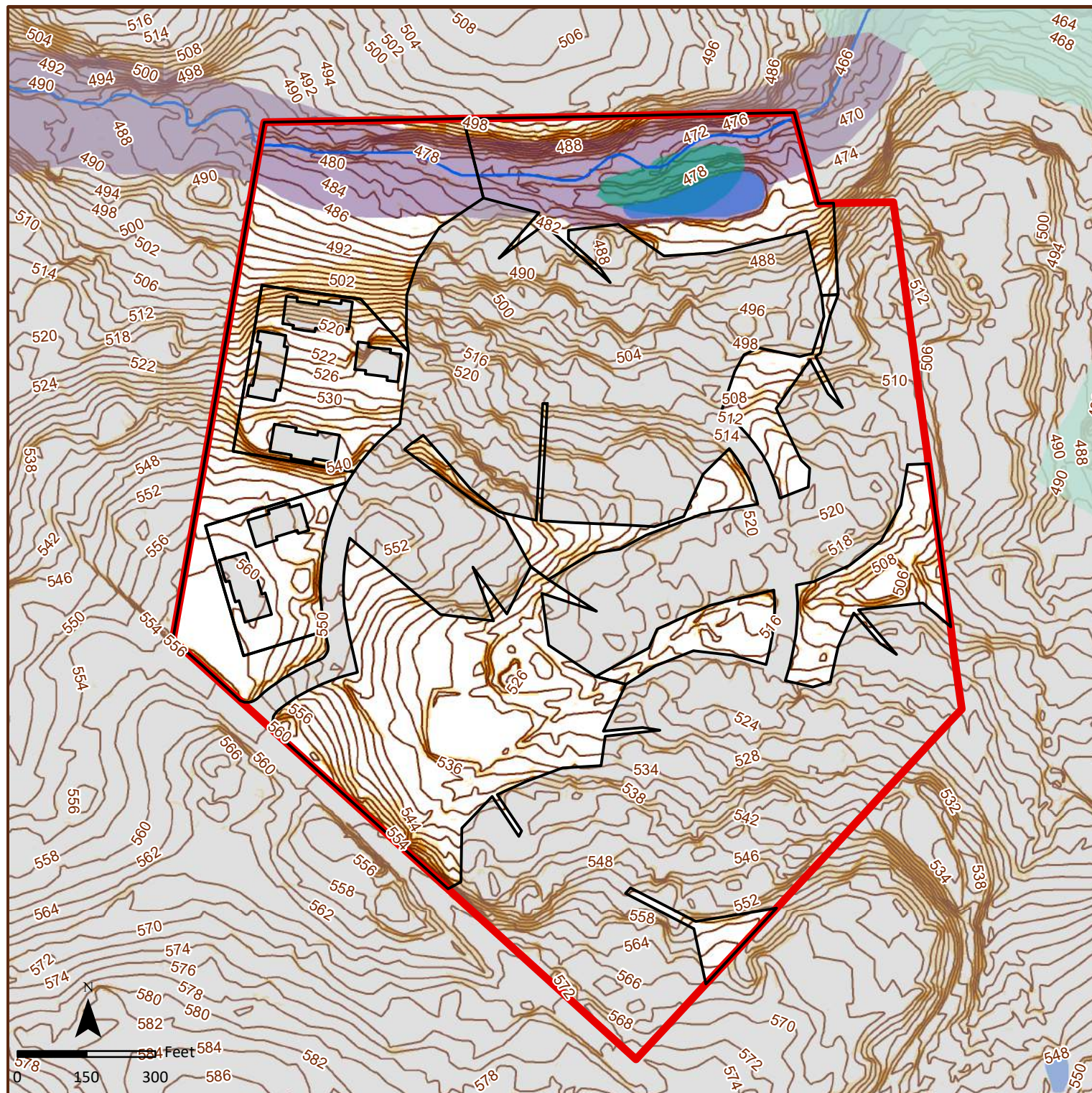


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1. Parcel boundaries from Chester County (2017).
2. Soils data from USDA NRCS.

Compiled By: CMA 9/26/19

Disclaimer: This map is not a survey. The information imparted with this map is meant to assist Natural Lands Trust, Inc., describe the placement of certain retained, reserved, or excluded rights and to calculate acreage figures. Property boundaries, while approximate, were established using the best available information, which may have included: surveys, tax maps, field mapping using G.P.S., and/or orthophotos. Natural Lands Trust, Inc., makes no representation as to the accuracy of said property lines (or any other lines), and no liability is assumed by reason of reliance hereon. Use of this map for other than its intended purpose requires the written consent of Natural Lands Trust, Inc.



Topography and Hydrology

Hedgerow Culbertson Run HOA

Tax ID: 30-2J-3, 30-2J-4, 30-2N-120, 30-2N-134, 30-2N-158, 30-2N-166, 30-2N-34, 30-2N-46, 30-2N-74, & 30-2N-89 (+/- 24.93 Acres)

East Brandywine Township, Chester Co., PA

HOA Property Boundary

Development Boundary

Waterways

Wetlands

Hydric Soils

100-Year Floodplain

Contours (2-ft)

Soils

< 15%

15% - 25%

> 25%



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1. Parcel boundaries from Chester County (2017).
2. Soils data from USDA NRCS.
3. Wetlands data from National Wetlands Inventory (2015).
4. Contours from PA DCNR (PAMAP, 2008).
5. Waterways from Chester County (2016).
6. Slopes calculated in ArcGIS using DEM from PA DCNR (PAMAP, 2008).
7. Floodplains from FEMA (2016).

Compiled By: CMA 10/3/19

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TABLE - CONTRACTOR AND VENDOR RECOMMENDATIONS

CONTRACTORS

Weeds, Inc.
Weedsinc.com
Aston, PA

William's Forestry (Christian Duffy)
<https://www.wfatrees.com>
Millville, PA

Greenweaver Landscapes
Greenweaver.com
Lenni, PA

Teti Farms (Bill Teti)
tetifarm@verizon.net

Red Tail Restoration and Land Management, LLC
www.redtailrestore.com
Glen Mills, PA

VENDORS

Kind Earth Growers
Kindearthgrowers.com
Ottsville, PA
containerized perennials

Octararo Native Plant Nursery
octararo.com
Kirkwood, PA
trees and shrubs

New Moon Nursery
NewMoonNursery.com
Woodstown, NJ
landscape plugs

North Creek Nursery
northcreeknurseries.com
Oxford, PA
landscape plugs

TABLE - LANDSCAPE MAINTENANCE RECOMMENDATIONS				
Area	Task	Means/Technique	Season	Labor
Entire Development Site - Open Space Areas	Remove existing invasives/unwanted species	Invasives should be removed mechanically, manually or sprayed with an approved herbicide by a licensed spray technician, such as glyphosate (Rodeo®), triclopyr (Garlon® 3A) or other aquatic herbicide formulation, to control undesirable shrubs, vines or other woody species.	Fall/Winter	Public Works or Contractor
	Remove existing invasives/unwanted species	1. Site should be evaluated for extent of Invasive growth and for established native plant communities. Natives should be protected and remain undisturbed if possible. Invasives should be removed mechanically, manually or sprayed with an approved herbicide by a licensed spray technician, such as glyphosate (Roundup or Rodeo®) to control undesirable shrubs, vines or other woody species, when new growth is 6" high. 2. A follow-up application may be applied 1-2 weeks later. 4. Existing turf grasses should be eliminated either by physically removing the sod diggin in small areas, plowing and disking in larger areas) or treating the area with an herbicide and seeding with a no till drill.	Fall/Winter	Public Works or Contractor
Entire Development Site - Potential Meadow Conversion Areas	Site preparation	If pervasive invasives remain or site is determined to be void of desired plant communities, a close mowing, tillage or controlled burning may be necessary.	Spring	Public Works or Contractor
	Plant 25% of area with native meadow forb and grass plugs	1. Plant as quickly after construction as possible. 2. Plant individual plugs in masses according to planting plan recommendations. 3. Irrigate after planting and weekly as needed until establishment.	Spring	Volunteer, Public Works or Contractor

Area	Task	Means/Technique	Season	Labor
Entire Development Site - Potential Meadow Conversion Areas (Continued)	Seed 75% of area with native upland meadow seed mix	1. Plant as quickly after construction as possible. 2. Seed area per planting plan and supplier's specifications via broadcast seed, hand seeding, drill seeding or hydroseeding. A non-toxic bulking agent may be used. 3. Lightly irrigate after seeding and weekly until seedlings become established.	Spring	Public Works or Contractor
	1st Year Maintenance	1. Trim vegetation to 8" height whenever it reaches 18", using string trimmer or other means (a lawn mower is not recommended). 2. Remove problem invasives or weeds by hand. 3. Monitor erosion.	Spring - Summer only	Volunteer, Public Works or Contractor
	2nd Year Maintenance	1. Prior to new spring growth, trim all plant material to 2" tall. 2. Remove problem invasives by hand or spot-sprayed with an approved herbicide. 3. Monitor erosion.	Spring - Summer only	Public Works or Contractor
	Ongoing Maintenance	1. Remove problem invasives by hand or spot-spray with an approved herbicide.	Late Winter/Spring	Public Works or Contractor
Entire Development Site - Potential Individual Residential Rain Garden, Bioswale or Porous Paving Installations	to be determined based on type of installation, as well as plant and material selections and locations	to be determined based on type of installation, as well as plant and material selections and locations	to be determined, but most likely spring	Contractor or Homeowner
Upper Open Grass Area - Swales and Riparian Buffer Plantings	Remove existing invasives/unwanted species	Invasives should be removed mechanically, manually or sprayed with an approved herbicide by a licensed spray technician, such as glyphosate (Rodeo®), triclopyr (Garlon® 3A) or other aquatic herbicide formulation, to control undesirable shrubs, vines or other woody species.	Fall/Winter	Public Works or Contractor

Area	Task	Means/Technique	Season	Labor
Upper Open Grass Area - Swales and Riparian Buffer Plantings (Continued)	Site preparation	Remove any pervasive invasives. Normal vegetation can be worked into the topsoil during site grading, which should be stockpiled until the final grade has been established.	Early Spring	Public Works or Contractor
	Plant 25% of area with native riparian zone shrubs and trees	1. Plant as quickly after construction as possible. 2. Plant individual plants according to planting plan. 3. irrigate after planting and weekly as needed until establishment.	Spring	Volunteer, Public Works or Contractor
	Plant 25% of area with native riparian zone plugs	1. Plant as quickly after construction as possible. 2. Install jute mesh over entire area using manufacturer's specifications 3. Plant individual plugs in masses through mesh according to planting plan. 4. irrigate after planting and weekly as needed until establishment.	Spring	Volunteer, Public Works or Contractor
	Seed 50% of area with native riparian zone seed mix	1. Plant as quickly after construction as possible. 2. Seed area per planting plan and supplier's specifications via broadcast seed, hand seeding or hydroseeding. A non-toxic bulking agent may be used. 3. Install jute mesh over entire seeded area using manufacturer's specifications. 4. Lightly irrigate after seeding and weekly until seedlings become established.	Spring	Public Works or Contractor
	1st Year Maintenance	1. Trim herbaceous (non-woody) vegetation to 8" height whenever it reaches 18-24", using string trimmer. 2. Remove problem invasives by hand or spot-spray with an approved aquatic herbicide. 3. Monitor sedimentation of swales and weirs.	Spring - Summer only	Public Works or Contractor

Area	Task	Means/Technique	Season	Labor
Upper Open Grass Area - Swales and Riparian Buffer Plantings (Continued)	2nd Year Maintenance	1. Prior to new spring growth, trim all plant material to 2" tall. 2. Remove problem invasives by hand or spot-spray with an approved aquatic herbicide. 3. Monitor erosion and sedimentation, removing if possible with as little disturbance to plant community as possible.	Spring - Summer only	Public Works or Contractor
	Ongoing Maintenance	1. Remove problem invasives by hand or spot-spray with an approved aquatic herbicide. 2. Monitor erosion and sedimentation, removing if possible with as little disturbance to plant community as possible.	Spring - Summer only	Public Works or Contractor
Upper Open Grass Area - Meadow Conversion	See description for Entire Development Area - Potential Meadow Conversion Areas	See description for Entire Development Area - Potential Meadow Conversion Areas	See description for Entire Development Area	See description for Entire Development Area
Upper Open Grass Area - Roadside Buffer Planting	Remove existing invasives/unwanted species	Invasives should be removed mechanically, manually or sprayed with an approved herbicide by a licensed spray technician, such as glyphosate (Rodeo®), triclopyr (Garlon® 3A) or other aquatic herbicide formulation, to control undesirable shrubs, vines or other woody species.	Fall/Winter	Public Works or Contractor
	Plant buffer zone trees and shrubs	1. Plant as quickly after site work as possible. 2. Irrigate after planting and weekly as needed until establishment.3. A 2-3" hardwood mulch layer may be applied.	Spring or Fall	Volunteer, Public Works or Contractor
	1st Year Maintenance	1. Remove problem invasives by hand or spot-spray with an approved herbicide.	Spring - Summer only	Volunteer, Public Works or Contractor
	2nd Year Maintenance	1. Remove problem invasives by hand or spot-spray with an approved herbicide.	Spring - Summer only	Volunteer, Public Works or Contractor
	Ongoing Maintenance	1. Remove problem invasives by hand or spot-spray with an approved herbicide.	Spring - Summer only	Volunteer, Public Works or Contractor

Area	Task	Means/Technique	Season	Labor
Upper Open Grass Area - Raingarden Plantings	Site preparation	Determine appropriate garden size and depth, remove existing turf or other vegetation. Add appropriate soil drainage medium and sub-drainage, if necessary.	Spring	Public Works or Contractor
	Plant 50% of area with native raingarden plugs and shrubs	1. Plant as quickly after construction as possible. 2. Plant individual plugs in masses according to planting plan. 4. Irrigate after planting and weekly as needed until establishment.	Spring	Volunteer, Public Works or Contractor
	Seed 50% of area with native raingarden seed mix	1. Plant as quickly after construction as possible. 2. Seed area per planting plan and supplier's specifications via broadcast seed, hand seeding or hydroseeding. A non-toxic bulking agent may be used. 3. Lightly irrigate after seeding and weekly until seedlings become established.	Spring	Public Works or Contractor
	1st Year Maintenance	1. Remove problem invasives by hand or spot-spray with an approved aquatic herbicide. 3. Monitor sedimentation..	Spring - Summer only	Public Works or Contractor
	2nd Year Maintenance	1. Prior to new spring growth, trim all plant material to 2" tall. 2. Remove problem invasives by hand or spot-spray with an approved aquatic herbicide. 3. Monitor erosion and sedimentation, removing if possible with as little disturbance to plant community as possible.	Spring - Summer only	Public Works or Contractor
	Ongoing Maintenance	1. Remove problem invasives by hand or spot-spray with an approved aquatic herbicide. 2. Monitor erosion and sedimentation, removing if possible with as little disturbance to plant community as possible.	Spring - Summer only	Public Works or Contractor

Area	Task	Means/Technique	Season	Labor
	Remove existing invasives/unwanted species	Invasives should be removed mechanically, manually or sprayed with an approved herbicide by a licensed spray technician, such as glyphosate (Rodeo®), triclopyr (Garlon® 3A) or other aquatic herbicide formulation, to control undesirable shrubs, vines or other woody species.	Fall/Winter	Public Works or Contractor
	Plant 25% of area with native shrubs and trees	1. Plant as quickly after construction as possible. 2. Plant individual plants according to planting plan. 3. irrigate after planting and weekly as needed until establishment.	Spring	Volunteer, Public Works or Contractor
	Plant 25% of area with native plugs	1. Plant as quickly after construction as possible. 2. Install jute mesh over entire area using manufacturer's specifications 3. Plant individual plugs in masses through mesh according to planting plan. 4. irrigate after planting and weekly as needed until establishment.	Spring	Volunteer, Public Works or Contractor
	Seed 50% of area with native transitional woodland seed mix	1. Plant as quickly after construction as possible. 2. Seed area per planting plan and supplier's specifications via broadcast seed, hand seeding or hydroseeding. A non-toxic bulking agent may be used. 3. Install jute mesh over entire seeded area using manufacturer's specifications. 4. Lightly irrigate after seeding and weekly until seedlings become established.	Spring	Public Works or Contractor
Lower Woodland Area	1st Year Maintenance	1. Trim herbaceous (non-woody) vegetation to 8" height whenever it reaches 18-24", using string trimmer. 2. Remove problem invasives by hand or spot-spray with an approved aquatic herbicide. 3. Monitor sedimentation of swale.	Spring - Summer only	Public Works or Contractor

Area	Task	Means/Technique	Season	Labor
Lower Woodland Area (Continued)	2nd Year Maintenance	1. Prior to new spring growth, trim all plant material to 2" tall. 2. Remove problem invasives by hand or spot-spray with an approved aquatic herbicide. 3. Monitor erosion and sedimentation, removing if possible with as little disturbance to plant community as possible.	Spring - Summer only	Public Works or Contractor
	Ongoing Maintenance	1. Remove problem invasives by hand or spot-spray with an approved aquatic herbicide. 2. Monitor erosion and sedimentation, removing if possible with as little disturbance to plant community as possible.	Spring - Summer only	Public Works or Contractor
Dry Detention Basin Area	Remove existing invasives/unwanted species	Invasives should be removed mechanically, manually or sprayed with an approved herbicide by a licensed spray technician, such as glyphosate (Rodeo®), triclopyr (Garlon® 3A) or other aquatic herbicide formulation, to control undesirable shrubs, vines or other woody species.	Fall/Winter	Public Works or Contractor
	Plant 25% of area with native transitional basin shrubs and trees	1. Plant as quickly after construction as possible. 2. Plant individual plants according to planting plan. 3. irrigate after planting and weekly as needed until establishment.	Spring	Volunteer, Public Works or Contractor
	Plant 25% of area with transitional basin native plugs	1. Plant as quickly after construction as possible. 2. Install jute mesh over entire area using manufacturer's specifications 3. Plant individual plugs in masses through mesh according to planting plan. 4. irrigate after planting and weekly as needed until establishment.	Spring	Volunteer, Public Works or Contractor

Area	Task	Means/Technique	Season	Labor
Dry Detention Basin Area (Continued)	Seed 50% of area with native transitional basin seed mix	1. Plant as quickly after construction as possible. 2. Seed area per planting plan and supplier's specifications via broadcast seed, hand seeding or hydroseeding. A non-toxic bulking agent may be used. 3. Install jute mesh over entire seeded area using manufacturer's specifications. 4. Lightly irrigate after seeding and weekly until seedlings become established.	Spring	Public Works or Contractor
	1st Year Maintenance	1. Trim herbaceous (non-woody) vegetation to 8" height whenever it reaches 18-24", using string trimmer. 2. Remove problem invasives by hand or spot-spray with an approved aquatic herbicide. 3. Monitor sedimentation of swale.	Spring - Summer only	Public Works or Contractor
	2nd Year Maintenance	1. Prior to new spring growth, trim all plant material to 2" tall. 2. Remove problem invasives by hand or spot-spray with an approved aquatic herbicide. 3. Monitor erosion and sedimentation, removing if possible with as little disturbance to plant community as possible.	Spring - Summer only	Public Works or Contractor
	Ongoing Maintenance	1. Remove problem invasives by hand or spot-spray with an approved aquatic herbicide. 2. Monitor erosion and sedimentation, removing if possible with as little disturbance to plant community as possible.	Spring - Summer only	Public Works or Contractor

Area	Task	Means/Technique	Season	Labor
Chapel Court Basin	Remove existing invasives/unwanted species	Invasives should be removed mechanically, manually or sprayed with an approved herbicide by a licensed spray technician, such as glyphosate (Rodeo®), triclopyr (Garlon® 3A) or other aquatic herbicide formulation, to control undesirable shrubs, vines or other woody species.	Fall/Winter	Public Works or Contractor
	Site preparation	Remove any pervasive invasives. Normal vegetation can be worked into the topsoil during site grading, which should be stockpiled until the final grade has been established.	Early Spring	Public Works or Contractor
	Plant 25% of buffer/transitional area with native plugs	1. Plant as quickly after construction/re-grading as possible. 2. Install jute mesh over entire area using manufacturer's specifications 3. Plant individual plugs in masses through mesh according to planting plan. 4. irrigate after planting and weekly as needed until establishment.	Spring	Volunteer, Public Works or Contractor
	Seed 75% of buffer/transitional area with native transitional seed mix	1. Plant as quickly after construction as possible. 2. Seed area per planting plan and supplier's specifications via broadcast seed, hand seeding or hydroseeding. A non-toxic bulking agent may be used. 3. Install jute mesh over entire seeded area using manufacturer's specifications. 4. Lightly irrigate after seeding and weekly until seedlings become established.	Spring	Public Works or Contractor
	1st Year Maintenance	1. Trim vegetation to 8" height whenever it reaches 18-24", using string trimmer. 2. Remove problem invasives by hand or spot-spray with an approved aquatic herbicide. 3. Monitor sedimentation.	Spring - Summer only	Public Works or Contractor

Area	Task	Means/Technique	Season	Labor
Chapel Court Basin (Continued)	2nd Year Maintenance	1. Prior to new spring growth, trim all plant material to 2" tall. 2. Remove problem invasives by hand or spot-spray with an approved aquatic herbicide. 3. Monitor erosion and sedimentation, removing if possible with as little disturbance to plant community as possible.	Spring - Summer only	Public Works or Contractor
	Ongoing Maintenance	1. Remove problem invasives by hand or spot-spray with an approved aquatic herbicide. 2. Monitor erosion and sedimentation, removing if possible with as little disturbance to plant community as possible.	Spring - Summer only	Public Works or Contractor
Gravel Road Area	Remove existing invasives/unwanted species within and alongside road	Invasives should be removed mechanically, manually or sprayed with an approved herbicide by a licensed spray technician, such as glyphosate (Rodeo®), triclopyr (Garlon® 3A) or other aquatic herbicide formulation, to control undesirable shrubs, vines or other woody species.	Fall/Winter	Public Works or Contractor
	Plant 50% of area with native woodland shrubs	1. Plant as quickly after construction as possible. 2. irrigate after planting and weekly as needed until establishment.	Spring	Volunteer, Public Works or Contractor
	Seed 50% of area with native transitional woodland seed mix	1. Plant as quickly after construction as possible. 2. Seed area per planting plan and supplier's specifications via broadcast seed, hand seeding or hydroseeding. A non-toxic bulking agent may be used. 3. Install jute mesh over entire seeded area using manufacturer's specifications. 4. Lightly irrigate after seeding and weekly until seedlings become established.	Spring	Public Works or Contractor

Area	Task	Means/Technique	Season	Labor
Gravel Road Area (Continued)	1st Year Maintenance	1. Trim herbaceous (non-woody) vegetation to 8" height whenever it reaches 18-24", using string trimmer. 2. Remove problem invasives by hand or spot-spray with an approved aquatic herbicide. 3. Monitor sedimentation of swale and/or water bars.	Spring - Summer only	Public Works or Contractor
	2nd Year Maintenance	1. Prior to new spring growth, trim all plant material to 2" tall. 2. Remove problem invasives by hand or spot-spray with an approved aquatic herbicide. 3. Monitor erosion and sedimentation, removing if possible with as little disturbance to plant community as possible.	Spring - Summer only	Public Works or Contractor
	Ongoing Maintenance	1. Remove problem invasives by hand or spot-spray with an approved aquatic herbicide. 2. Monitor erosion and sedimentation, removing if possible with as little disturbance to plant community as possible.	Spring - Summer only	Public Works or Contractor

TABLE - PLANTING RECOMMENDATIONS

Upper Open Grass Area (Roadside Buffer Plantings)

Containerized Trees and Shrubs

Amelanchier laevis	Alleghany Serviceberry
Chionanthus virginicus	White Fringe Tree
Ilex verticillata	Winterberry
Itea virginica	Virginia Sweetspire
Lindera benzoin	Spicebush
Magnolia virginiana	Sweetbay Magnolia
Rhus glabra	Smooth Sumac
Rhus typhina	Staghorn Sumac
Rosa carolina	Pasture Rose
Spiraea latifolia	Meadowsweet
Viburnum lentago	Nannyberry
Viburnum trilobum	American Cranberry

Upper Open Grass Area (Riparian Buffer Plantings)

Seeding

Ernst Conservation Seeds Riparian Buffer Mix

Tree Recommendations

Cercis canadensis	Eastern redbud
Amelanchier laevis	Serviceberry
Betula nigra	River Birch

Upper Open Grass Area (Meadow Conversion)

Seeding

Ernst Conservation Seeds Showy Northeast Native Wildflower & Grass Mix

Supplemental Masses Plug Recommendations for Immediate Impact

Asclepias tuberosa	Butterfly Milkweed
Aster laevis	Smooth Blue Aster
Aster novae-angliae	New England Aster
Echinacea purpurea	Purple Coneflower
Eupatorium coelestinum	Mistflower
Coreopsis lanceolata	Lanceleaf Coreopsis
Liatris spicata	Marsh Blazing Star
Monarda fistulosa	Wild Bergamot
Pycnanthemum tenuifolium	Mountainmint
Rudbeckia hirta	Blackeyed Susan
Solidago nemoralis	Gray Goldenrod
Schizachyrium scoparium	Little Bluestem

Upper Open Grass Area (Rain Garden Plantings)

Plug Recommendations

Asclepias incarnata	Swamp Milkweed
Aster novae-angliae	New England Aster
Aster umbellatus	White Aster
Baptisia australis	False Blue Indigo
Caltha palustris	Marsh Marigold
Carex vulpinoidea	Fox Sedge
Echinacea purpurea	Coneflower
Iris versicolor	Blue Flag Iris
Juncus effusus	Soft Rush
Liatris spicata	Blazing Star
Panicum virgatum	Switchgrass
Rudbeckia laciniata	Tall Coneflower
Schizachyrium scoparium	Little Bluestem
Verbena hastata	Blue Vervain

Shrub Recommendations

Cornus amomum	Silky Dogwood
Hibiscus moscheutos	Swamp Rose Mallow
Sambucus canadensis	Elderberry

Upper Open Grass Area (Bioswale Plantings)

Seeding

Ernst Conservation Seeds Retention Basin Wildlife Mix

Supplemental Plug Recommendations for Immediate Impact

Asclepias incarnata	Swamp Milkweed
Aster novae-angliae	New England Aster
Aster puniceus	Purplestem Aster
Carex vulpinoidea	Fox Sedge
Eupatorium perfoliatum	Boneset
Juncus effusus	Soft Rush
Lobelia siphilitica	Great Blue Lobelia
Verbena hastata	Blue Vervain

Shrub Recommendations

Clethra alnifolia	Sweet Pepperbush
Lindera benzoin	Spicebush
Vaccinium corymbosum	Highbush Blueberry

Tree Recommendations

Cercis canadensis	Eastern redbud
Amelanchier laevis	Serviceberry
Betula nigra	River Birch

Dry Detention Basin Area

Seeding

Ernst Conservation Seeds Retention Basin Wildlife Mix

Supplemental Plug Recommendations for Immediate Impact

Asclepias incarnata	Swamp Milkweed
Aster novae-angliae	New England Aster
Aster puniceus	Purplestem Aster
Carex vulpinoidea	Fox Sedge
Eupatorium perfoliatum	Boneset
Juncus effusus	Soft Rush
Lobelia Siphilitica	Great Blue Lobelia
Verbena hastata	Blue Vervain

Shrub Recommendations

Clethra alnifolia	Sweet Pepperbush
Lindera benzoin	Spicebush
Vaccinium corymbosum	Highbush Blueberry

Tree Recommendations

Cercis canadensis	Eastern redbud
Amelanchier laevis	Serviceberry
Betula nigra	River Birch

Lower Woodland Area

Seeding

Ernst Conservation Seeds Right-of-Way Native Woods Mix w/Annual Ryegrass

Supplemental Plug Recommendations for Immediate Impact

Asarum canadense	Native Ginger
Aster cordifolius	Blue Wood Aster
Chasmanthium latifolium	Northern Sea Oats
Mertensia virginica	Virginia Bluebells
Phlox stolonifera	Creeping Phlox
Stylophorum diphyllum	Celandine Poppy

Shrub Recommendations

Clethra alnifolia	Sweet Pepperbush
Hamamelis virginiana	Witchhazel
Lindera benzoin	Spicebush
Vaccinium corymbosum	Highbush Blueberry

Tree Recommendations

Cornus alternifolia	Dogwood
Magnolia virginiana	Sweetbay Magnolia
Sassafras albidinum	Sassafras

Gravel Road Area (swales)

Seeding

Ernst Conservation Seeds Right-of-Way Native Woods Mix w/Annual Ryegrass

Shrub Recommendations

Clethra alnifolia	Sweet Pepperbush
Lindera benzoin	Spicebush
Vaccinium corymbosum	Highbush Blueberry

Chapel Court Basin Area

Seeding

Ernst Conservation Seeds Retention Basin Wildlife Mix

Supplemental Plug Recommendations for Immediate Impact

Asclepias incarnata	Swamp Milkweed
Aster novae-angliae	New England Aster
Aster puniceus	Purplestem Aster
Carex vulpinoidea	Fox Sedge
Eupatorium perfoliatum	Boneset
Juncus effusus	Soft Rush
Lobelia Siphilitica	Great Blue Lobelia
Verbena hastata	Blue Vervain

TABLE - STORMWATER MITIGATION COST ESTIMATES			
Area	Activity	Approx. Area	Approx. Cost
Entire Development Site	On-site management/education	N/A	No cost - provided by Natural Lands and Brandywine Conservancy
	Raingarden installation	variable	\$3-\$5 per sf
	Bioswale installation	variable	\$3-\$5 per sf
	Disconnected downspouts	variable	roughly \$250 for cost of rainbarrel and installation
	Permeable paving install	variable	\$8-\$10 per sf
	Meadow conversion	variable	\$3,000-\$10,000 per acre
Existing Swale - Upper Open Grass Area	Expanded swale, buffer plantings, installation of weirs	1.2 acres	\$250,000-\$500,000
Existing Swale - Lower Woodland Area	Channel restoration, supplemental plantings, invasive species management and removal	1.3 acres	\$150,000-\$250,000
Canterbury Court Dry Detention Basin Area	Evaluation, basin enlargement and re-grading, buffer plantings, and invasive species management and removal	0.5 acre	\$50,000-\$150,000
Chapel Court Basin - Retention Basin Area	Evaluation, basin enlargement, buffer plantings, and invasive species management and removal	1.5 acres	\$250,000-\$500,000
Chapel Court Basin - Gravel Road Management	Installation of adjacent bioswales and/or water bars	.25 acre	\$25,000-\$50,000