North Branch Neshaminy Creek Phase 2 Implementation Project

Final Report



September 30, 2018

Prepared By:



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Final Report

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Pennsylvania Department of Environmental Protection

Office of Water Resources Planning Rachel Carson State Office Building 400 Market Street Harrisburg, PA 17101

United States Environmental Protection Agency

Mid-Atlantic, Region 3 1650 Arch Street, #2 Philadelphia, PA 19103

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1. Project Funding and Schedule

The North Branch Neshaminy Creek Phase 2 Implementation Project was funded by the Pennsylvania Department of Environmental Protection (PA DEP) through Section 319, the Nonpoint Source Management Program of the Clean Water Act administered by the United States Environmental Protection Agency (US EPA). The Bucks County Conservation District provided project management and technical assistance via design and construction oversight services for construction of the best management practices (BMPs). The contract between the District and PA DEP was executed on April 11, 2014, and the project was completed on September 30, 2018.

2. Project Location and Justification

The North Branch Neshaminy Creek (NBNC) watershed is a subbasin of the Neshaminy Creek and has a surface area of 15.8 square miles, of which approximately equal portions are divided among Plumstead and New Britain Townships, with significantly smaller portions in Hilltown and Doylestown Townships, Bucks County. Lake Galena is a 365-acre, county-owned impoundment and serves as the focal point of Peace Valley Park. The lake and surrounding parkland are open year-round and provide visitors with a variety of recreational opportunities and the environmental education center Peace Valley Nature Center, which offers a variety of environmental education programming to all ages.

In addition to providing regional flood control and recreational value, drinking water is drawn from the NBNC approximately two miles downstream of the Lake Galena outfall. Surface water is treated at the Forest Park water facility, which is jointly owned by North Penn and North Wales Water Authorities. The facility supplies water to about 55,000 households in Bucks and Montgomery Counties. Despite the importance of Lake Galena and the NBNC for flood control, recreation and drinking water, the lake exhibits signs of degraded water quality including algal blooms and high turbidity.

In 2002, a TMDL assessment was completed for the entire Neshaminy Creek watershed, including the NBNC and Lake Galena subbasin. As noted in this assessment, the Lake Galena watershed experienced a significant increase in residential development over the prior 5-10 years, which has been identified as an important source of sediment to the lake during this period. The lake was identified on Pennsylvania's 303(d) list as being impaired by nutrients and suspended solids from various sources, including on-site wastewater, agriculture, urban runoff/storm sewers, and other.

The objective of this North Branch Neshaminy Creek Phase 2 Implementation Project was to improve water quality by reducing sediment and nutrients entering surface and groundwater within the NBNC and Lake Galena Watershed via the implementation of nutrient management best management practices (BMPs) on two equine operations in the watershed (Figure 1). Both farms were identified in the 2011 Lake Galena & North Branch Neshaminy Creek Watershed Implementation Plan (WIP) as priorities for BMP implementation.



Figure 1. Locations of Implemented Agricultural BMP Projects North Branch Neshaminy Creek Phase 2 CAqua Link, Inc. Water Resources & Watershed Management www.aqualinkinc.com

P.O. Box 605 Doylestown, PA 18901 Ph: 215.230.9325

3. Project Overview

The primary objective of this project was to improve water quality by reducing sediment and nutrients entering surface and ground water within the North Branch Neshaminy Creek and Lake Galena watershed via implementation of agricultural best management practices (BMPs). Under this grant, agricultural BMPs were implemented on 2 equine operations in the watershed (Figure 1) that were identified in the Lake Galena & North Branch Neshaminy Creek Watershed Implementation Plan (Aqua Link and Bucks County Conservation District 2011). A final project site, Peace Valley Nature Center, was identified for design of a stormwater management BMP in summer 2018 near the grant expiration deadline.

4. Equine Facility Best Management Practice Implementation

The Bucks County Conservation District implemented agricultural BMPs on two equine operations within the NBNC and Lake Galena watershed. Best Management Practices on the equine operations were designed according to NRCS standards and specifications. The installed BMPs are discussed in the following subsections.

4.1 WIP Participant #44

WIP Participant #44 (Figure 1) is an approximately 48-acre equine facility located in New Britain Township, Bucks County. The site is an equine boarding and riding training facility and contains approximately 150 feet of an unnamed tributary to Lake Galena.

Below is a list of BMPs that were implemented to encourage proper pasture management and to prevent the mixing of surface water and groundwater with manure, thereby minimizing the transport of phosphorus and sediment into Lake Galena. The project site plan is provided in Appendix A and photos are included in Appendix B. The practices were completed between May 2014 and October 2016.

- Installed 32ft x 40ft roofed concrete stack pad with 6ft high walls to encourage proper storage of manure and prevent mixing with surface water and transport of nutrients and pathogens to groundwater
- Installed 1,480 ft of subsurface drainage and reshaped and restabilized existing grassed diversion to maintain grass cover and mitigate erosion in pastures
- Installed 4,721 ft of fencing to promote proper pasture management and exclude animal access to grassed BMPs
- Installed 30ft x 20ft infiltration bed and 30ft long rock level lip spreader at outlet of existing grassed waterway to sheetflow into wooded area along property boundary and mitigate erosion along Ferry Road
- Developed approved Forest Stewardship Plan for 23.2 acres of the property adjacent to Peace Valley County Park. The area is not used for pasture but contains an UNT to Lake Galena
- Planted 0.09 acres along UNT to Lake Galena to expand existing buffer (funded by AquaPA with TreeVitalize Watersheds funding)

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• Installed 150 ft of 10' wide stabilized access lanes for equipment and livestock movement to individual paddocks (labor and materials self-funded/provided by landowner)

Sediment and nutrient load reductions resulting from BMP implementation for this project were estimated using EPA's Region 5 Model for Feedlot Pollution Reduction, Agricultural Fields and Filter Strips and Gully Stabilization. Model output is provided in Appendix C. The model predicted a total load reductions of 24.1 tons sediment per year, 109 lbs. phosphorus per year and 909.1 lbs. nitrogen per year due to the BMPs implemented at this site.

4.2 WIP Participant #5

WIP Participant #5 is an 11-acre equine facility located in Plumstead Township, Bucks County that is designated as a Concentrated Animal Operation (CAO) according to the Pennsylvania Nutrient Management Act. The property is in the headwaters of the NBNC watershed and is bisected by two unnamed tributaries to the creek.

The farm's nutrient management plan was initially developed in 2011. The practices outlined in that comprehensive plan were designed to establish animal concentration areas to encourage proper pasture management and divert stormwater around animal concentration areas to minimize transport of phosphorus and sediment into the NBNC. To address the resource concerns on site the following practices were implemented from June 2014 to September 2018. A site map is provided in Appendix A and photos are provided in Appendix B.

- Installed a 40ft x 40ft roofed concrete stack pad with 6ft high walls to prevent manure mixing with surface water and leaching/transport of nutrients and pathogens to groundwater
- Installed system of stormwater inlet, subsurface drainage, waterways and diversions to divert stormwater around animal concentration areas, walkways and roofed stack pad
 - o 150ft x 8ft x 0.7ft parabolic grassed waterway (WW#1)
 - 100ft x 12ft x 1ft grassed diversion (Diversion #1)
 - o 140ft x 10ft x 0.8ft waterway (WW#2); 100ft of the length is rock-lined
 - o 90ft x 12ft x 1.1ft grassed diversion (Diversion #2)
 - 2ft x 2ft stormwater inlet/water control structure
 - o 403ft of 15in N-12 HDPE pipe underground outlet
 - 300 ft2 rock outlet at end of pipe to dissipate water velocity entering UNT to North Branch Neshaminy Creek
 - 105ft x 12ft x 1ft grassed diversion (Diversion #3)
 - 15ft x 10ft x 0.7ft rock-lined outlet at the base of grassed diversion #3 to outlet water to UNT to North Branch Neshaminy Creek
- Installed 2,926 ft of fencing for combination of pasture management/defining animal concentration areas and exclude animal access to grassed BMPs
- Reseeded 1.5 acres of pasture

- Updated Act 38 Nutrient Management Plan to capture changes in site BMPs during design revisions
- Planted 0.05 acres along UNT to North Branch Neshaminy Creek (funded by AquaPA with TreeVitalize Watersheds funding)

Sediment and nutrient load reductions resulting from BMP implementation for this project were estimated using EPA's Region 5 Model for Feedlot Pollution Reduction. Model output is provided in Appendix C. The model predicted a total nutrient load reduction of 168 lbs. phosphorus per year and 1,163 lbs. nitrogen per year due to the BMPs implemented at this site.

5. Stormwater Management BMP Design

The Friends of Peace Valley Nature Center, Inc. had been working to fund the design and implementation of an overflow parking area at Peace Valley Nature Center within Peace Valley Park to improve the use of the nature center and its surrounding trail network during field trips and other events. The location determined best suited for this use is a grassed field that is within 150 feet of the Lake Galena shoreline (photo in Appendix D). The proposed permeable paver option provides an alternative to a traditional asphalt parking lot, a particularly desirable option as this location is near Lake Galena.

As per the PADEP Stormwater BMP Manual, we estimate that permeable paving will reduce total suspended solids (TSS) and total phosphorus (TP) loading by up to 85%. In addition, the proposed lot will serve as a demonstration project to educate park stakeholders on a parking surface alternative that can reduce pollutant loading as well as the rate and volume of runoff. The remaining funding in our grant budget contributed toward the development of the designs for the new permeable paved lot. The Region 5 Urban BMP Model was used to estimate the anticipated loading reductions when the design is implemented: 2.17 tons sediment per year, 9 lbs. phosphorus per year, 62 lbs. nitrogen per year. The model output is provided in Appendix C and site plan is included in Appendix D.

Appendix A. Equestrian Facility Site Plans

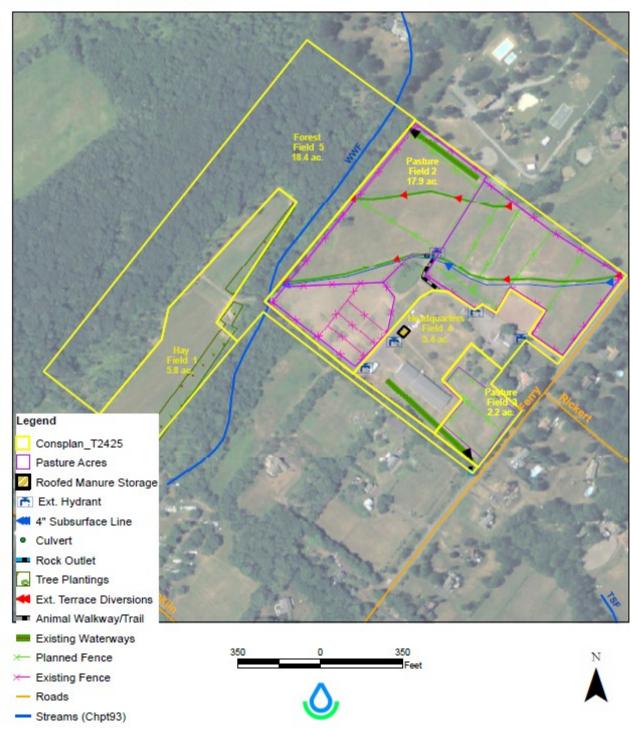


WIP Participant #44

Date: 4/2/2014

Field Office: PERKASIE SERVICE CENTER Agency: USDA-NRCS Assisted By: Kent Himelright State and County: PA, BUCKS

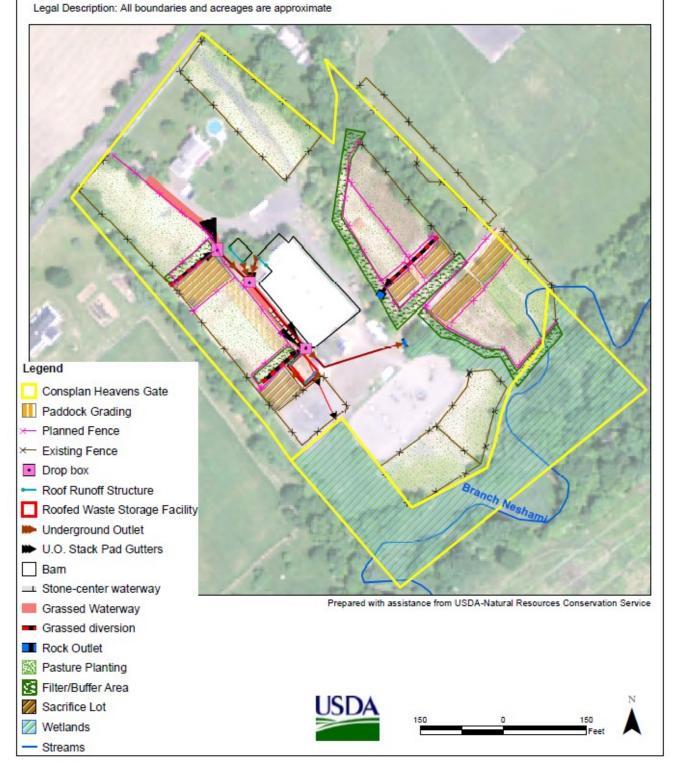




Plan View Participant #5

District: BUCKS COUNTY CONSERVATION DISTRICT Approximate Acres: 11.3 Field Office: PERKASIE SERVICE CENTER

Assisted By: RACHEL ONUSKA



Appendix B. Equestrian Facility BMP Project Photos



Photo 1. Before installation of subsurface drainage at (WIP Participant #44).



Photo 2. After subsurface drainage installation and diversion repair (WIP Participant #44)



Photo 3. Before roofed stack pad construction (WIP Participant #44).



Photo 4. Roofed stack pad shortly after construction (WIP Participant #44).



Photo 5. Erosion on Ferry Rd embankment before infiltration bed and level lip spreader install (WIP Participant #44).



Photo 6. Infiltration bed and level lip spreader shortly after construction (WIP Participant #44).



Photo 7. Before roofed stack pad construction (WIP Participant #5).



Photo 8. Roofed stack pad shortly after construction (WIP Participant #5).



Photo 9. Grassed diversion #3 and rock outlet stabilization (WIP Participant #5).

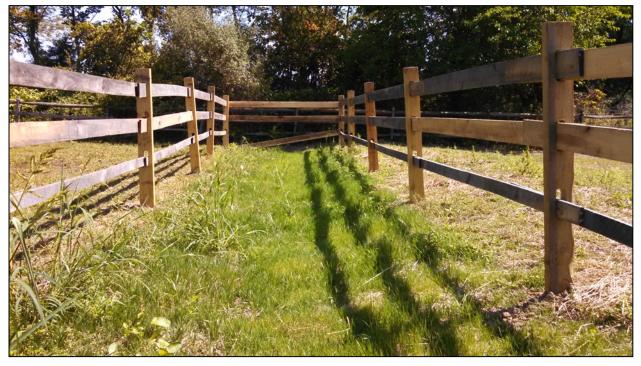


Photo 10. Fully stabilized grassed diversion #3 and exclusion fencing (WIP Participant #5).



Photo 11. Waterway #2 damage due to horse wash water (WIP Participant #5)



Photo 12. Waterway #2 after repair to rock-lined and looking up to Waterway #1 (WIP Participant #5).



Photo 13. Buffer planting approximately 10 months after planting (WIP Participant #5).

Appendix C. Region 5 Model Output

Noi An des The sys 2) i imp The Tra clin	Il in the gray areas below. tes: animal lot refers to an open lot or combin signed as a confinement area in which me e purpose of these calculations is to repre- stem is installed. This method has two as- installing the animal waste system will pre- pact to the hydrologic system being protect e fundamental methodology of this workst aining Manual" (Michigan DEQ, June 1995 natological data. In addition, biological ox EPL model, developed by Tetra Tech, Inc	nure accumulates or where the sent Biological Oxygen Dema sumptions: 1) the feedlot is ac- vent any further pollutants fro- ted should not be evaluated v neet is based on "Pollutants C). However, the Michigan DE ygen demand, phosphorus, a , in order to enhance consiste	the concentration of a and (BOD), phosphor djacent to a receiving with elot from reachivith this computation ontrolled Calculation Q methodology was and nitrogen constant ancy between method	nimals is such that vegetation can us (P), and nitrogen reductions aff g hydrological system without any ing the hydrologic system. Feedlo and Documentation for Section 3 modified to calculate annual load to used in this worksheet were derids.	not be maintained. ter an animal waste buffering areas; and ts that cannot show 19 Watersheds through inclusion of ved from U.S. EPA's
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		25-49%			
		50-74% 75-100%			
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	0	Dairy Cow	1,400	weight animals would be	expected to reach.
	0	Young Dairy Stock	500	_	
	0	Swine	200		
	0	Feeder Pig Sheep	50 100	_	
	0	Turkey	100	_	
	0	Chicken	4	_	
	0	Duck	4	—	
	37	Horse	1,000		
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			gen load (lbs/y		455
			0	,,,	

Gully Stabilization

These may include:

Grade Stabilization Structure Grassed Waterway Critical Area Planting in areas with gullies Water and Sediment Control Basins

C Sandy loam

C Fine sandy loam

- C Loams, sandy clay loams, sandy clay
- Silt loam

Please fill in the gray areas below:

Parameter			Gully	Example
Top Width (ft)			2	15
Bottom Width (ft)			2	4
Depth (ft)			2	5
Length (ft)			65	20
Number of Years			1	5
Soil Weight (tons/ft3)			0.0425	0.05
Soil P Conc (lb/lb soil)*	USER	-	0.0005	0.0005
Soil N Conc (lb/lb soil)*	USER	-	0.001	0.001

* If not using the default values, users must provide input (in red) for Total P and Total N soil concentrations

Estimated Load Reductions

	BMP		
	Efficiency*	Gully	Example
Sediment Load Reduction (ton/year)	1.0	11.1	10
Phosphorus Load Reduction (lb/year)		11.1	8
Nitrogen Load Reduction (lb/yr)		22.1	16

C C Silty clay loam, silty clay

- C Clay loam
- C Clay
- C C Organic

Agricultural Fields and Filter Strips

Please check which BMPs apply:

Please select a state and a county, and default USLE parameter values will be ente

Agricultural Field Practices

Users should use the local USLE parameter values if available! State County
Pennsylvania
Bucks

Please fill in the gray areas below:

T * Filter Strips

			Example	
	Before	After	Before	After
USLE or RUSLE	Treatment	Treatment	Treatment	Treatment
Rainfall-Runoff Erosivity Factor (R)	173.00	173.00	120	120
Soil Erodibility Factor (K)	0.35	0.35	0.35	0.35
Length-Slope Factor (LS)	0.49	0.49	0.44	0.44
Cover Management Factor (C<=1.0)*	0.04	0.00	0.7	0.5
Support Practice Factor (P<=1.0)*	1.00	1.00	0.775	0.11
Predicted Avg Annual Soil Loss (ton/acre/year)	1.27	0.07	10.03	1.02

17

* User must use the local C and/or P values (in red) to obtain the reduction due to the field practices.

Enter	contribut	ing area	(acres)	
LIILEI	CONTRIDUC		Iauresi	

Example
14

Please select a gross soil texture:

C Clay (clay, clay loam, and silt clay)

Silt (silt, silty clay loam, loam, and silt loam)

C Sand (sand, sandy clay, sandy clay loam, sandy loam, and loamy sand)

C Peat

Estimated Load Reductions for Agricultural Field Practices

	Treated	Example
Sediment Load Reduction (ton/year)	13	85
Phosphorus Load Reduction (lb/year)	21	100
Nitrogen Load Reduction (lb/yr)	42	200

Estimated Additional Load Reductions through Filter Strips

	Filter-Strip Efficiency	Filter-Strip Treated	Example
Sediment Load Reduction (ton/year)	0.65	0	0
Phosphorus Load Reduction (lb/year)	0.75	0	0
Nitrogen Load Reduction (lb/yr)	0.70	0	0

Total Estimated Load Reductions

	Total	Example
Sediment Load Reduction (ton/year)	13	85
Phosphorus Load Reduction (lb/year)	21	100
Nitrogen Load Reduction (lb/yr)	42	200

Pennsylvania State University. 1992. Nonpoint Source Database. In U.S. EPA, Guidance specifying management measures for sources of nonpoint pollution in coastal waters, page 2-15.

Note An a desi The syst 2) ir impa The Trai clim	Lin the gray areas below. es: animal lot refers to an open lot or combina igned as a confinement area in which mar purpose of these calculations is to repres tem is installed. This method has two ass stalling the animal waste system will prev act to the hydrologic system being protect fundamental methodology of this workshi ning Manual" (Michigan DEQ, June 1999) atological data. In addition, biological oxy EPL model, developed by Tetra Tech, Inc.	hure accumulates or where the sent Biological Oxygen Dema umptions: 1) the feedlot is a rent any further pollutants fro- ed should not be evaluated we et is based on "Pollutants C I. However, the Michigan DE gen demand, phosphorus, a	he concentration of an and (BOD), phosphoru djacent to a receiving m the lot from reachin with this computation.	himals is such that version of the such that version of the such that we hydrological system is the hydrologic system and Documentation for modified to calculate bused in this worksheet sused in the worksheet sused in this worksheet sused in this worksheet sused in this worksheet sused in the worksheet sused in this worksheet sused in this worksheet sused in this	egetation cannot be mainta eductions after an animal without any buffering area tem. Feedlots that canno for Section 319 Watershe annual load through inclu	ained. waste as; and t show ds sision of
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STEP						
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	0	Dairy Cow	1,400	weight animals	would be expected	to reach.
	0	Young Dairy Stock	500	_		
	0	Swine Feeder Pig	200 50	-		
	0	Sheep	100			
	0	Turkey	10			
	0	Chicken	4			
	0	Duck	4	_		
	35	Horse	1,000			
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	Diversion		Waste Storage	-		
	Filter Strip		Solids Separ	ation Basin		
	C Runoff Mgmt System		Solids Separ	ation Basin w/ Inf	filt Bed	
	C Terrace					
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	0	Sheep	100	-	
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4	Animal Numbers	Animal Type	Design Weight	*		
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	0	Dairy Cow	1,400	weight animals wo	ould be expect	ed to reach.
	0	Young Dairy Stock	500			
	0	Swine	200			
	0	Feeder Pig	50	_		
	0	Sheep Turkey	100 10	_		
	0	Chicken	4	_		
	0	Duck	4	_		
	4	Horse	1,000			
	-		.,			
STEP 5	Select a Best Management Pr	actice				
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			gen load (lbs/yr		NA	NA
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STEP 4	Animal Numbers	Animal Type Slaughter Steer Young Beef Dairy Cow Young Dairy Stock Swine Feeder Pig Sheep Turkey Chicken Duck Horse	Design Weight* 1,000 500 1,400 500 200 50 100 10 4 4 1,000	ht* *Design weight in pounds. Interpolation of values should be based on the maximum weight animals would be expected to reach.			
STEP 5	Select a Best Management Pr		◯ Waste Mgmt S	-			
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	C Runoff Mgmt System			ation Basin w/ Infilt	Bed		
	© Terrace		1				
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NA indicat	tes no BMP efficiency data availa	ble.					

leas <u>e fil</u>	II in the gray areas below.				
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The Tra clim	e fundamental methodology of this worksh ining Manual" (Michigan DEQ, June 1999	eet is based on "Pollutants C). However, the Michigan DE ygen demand, phosphorus, a	ontrolled Calculation a Q methodology was r nd nitrogen constants	and Documentation for Section 319 Watersh modified to calculate annual load through inc used in this worksheet were derived from U s.	clusion of
STEP					
1	0.16	Contributing Area (a to the discharge poi		contributing polluted water	
STEP 2	Percent Paved: Percent of th	e contributing area th 0-24% 25-49% 50-74% 75-100%	at is paved		
STEP 3	Please select your State.	Please select your C Bucks	County.	Nearest Weather Station PA ALLENTOWN A-B-E	
	Note: Precipitation data for Alaska and	Hawaii were unavailable for t	this version of the wor	rkbook.	
STEP 4	Animal Numbers	Animal Type Slaughter Steer	Design Weight	*]*Design weight in pounds. Interp	olation
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	0	Dairy Cow Young Dairy Stock	1,400 500	weight animals would be expected	d to reach.
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	0	Feeder Pig	50	_	
	0	Sheep Turkey	100 10	-	
	0	Chicken	4	-	
	0	Duck	4		
	4	Horse	1,000		
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			O Waste Mgmt	System	
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	© Terrace				
END	Estimated Load and Load Re			Load before Load Load	d after
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STEP 0.2 Contributing Area (acres): the area contributing polluted water 1 0.2 Contributing Area (acres): the area contributing polluted water STEP Percent Paved: Percent of the contributing area that is paved	Note An a desig The syste 2) in impa The Trair clima	animal lot refers to an open lot or combina gned as a confinement area in which man purpose of these calculations is to represe em is installed. This method has two ass stalling the animal waste system will prev act to the hydrologic system being protect fundamental methodology of this worksh ning Manual" (Michigan DEQ, June 1999) atological data. In addition, biological oxy	hure accumulates or where the sent Biological Oxygen Demai umptions: 1) the feedlot is ac rent any further pollutants fror ted should not be evaluated w eet is based on "Pollutants Co). However, the Michigan DEr gen demand, phosphorus, ar	e concentration of an nd (BOD), phosphoru djacent to a receiving in the lot from reachin rith this computation.	nimals is such that veget is (P), and nitrogen redu- hydrological system wit ig the hydrologic system and Documentation for s modified to calculate ani used in this worksheet	ation cannot be maint ictions after an anima hout any buffering are b. Feedlots that canno Section 319 Watershe ual load through inclu	ained. waste as; and t show ds ision of
To the discharge point(s): STEP 2 Percent Paved: Percent of the contributing area that is paved 0 0.24% 25-49% 50-74% 50-74% 75-100% 3 Please select your State. Please select your County. Nearest Weather Station Pennsylvania Bucks PALLENTOWN A-B-E Pennsylvania Note: Preceptation data for Alaska and Hawaii wee unvaliable for this version of the workbook. Steer 1 0 Staughter Steer 1.000 0 Voing Beef 100 Or young Dairy Stock 100 0 Oung Dairy Stock 100 Or young Dairy Stock 100 0 Oung Dairy Stock 100 Or young Dairy Stock 100 0 Oung Dairy Stock 100 Or young Dairy Stock 100 0 Chicken 4 0 Ouck 4 0 Duck 4 0 Unck 4 0 Duck 4 0 Unck 4 0 Duck 4 0	STEP						
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Phosphorus load (lbs/yr) 21 17 4			Pollutants				
		Bioc) 351	NA N	A
NA indicates no BMP efficiency data available.	NA indicat	es no BMP efficiency data availa	ble.				

Green Roof: The green roof in such a way that a generated would quality of runoff g the land use of th roof is on, i.e. cor institutional, resic the entire loading eliminated.

URBAN RUNOFF BMP POLLUTANT LOAD REDUCTION WORKSHEET (BASED ON LAND USE RUNOFF LOADING RATE)

Please fill in the gray areas below.

Notes: The methodology and efficiency values used in this worksheet were developed by the Illinois Environmental Protection Agency.

Please Select a Best Management Practice:

Vegetated Filter Strips Grass Swales Infiltration Device Extended Wet Detention Wetland Detention Dry Detention Settling Basin	C Sand Filters WQ Inlets Weekly Street Sweeping Infiltration Basin Infiltration Trench Porous Pavement Concrete Grid Pavement		Sand Filter/Infiltration Basin WQ Inlet w/ Sand Filter Oil/Grit Separator Wet Pond Green Roof
--	---	--	---

Please enter landuse of contributing/drainage area in acres:

	Sewered	Unsewered
Commercial	0	0
Industrial	0	0
Institutional	0	0
Transportation	0	0.8
Multi-Family	0	0
Residential	10	0
Agriculture	0	0
Vacant	0	0
Open Space	0	33

Note: Sewered and Unsewered refer to storm sewers.

Please enter landuse specific pollutant loading rate (lbs/ac/yr)

Default

DEFAULT AVERAGE POLLUTANT LOADS BY LAND USE (Lbs/Ac./Yr.) 1

C User Defined

	Commercial	Industrial	Institutional	Transportation	Multi-Family	Residential	Agriculture	Vacant	Open Space
BOD (Sewered)	85	50	52	50	52	22		2	1
BOD (Unsewered)	75	40	31	30	42	11	3	0.9	0.4
COD (Sewered)	589	260	320	881	320	140		64	46
COD (Unsewered)	520	230	190	518	260	71	28	26	15
TSS (Sewered)	1180	1240	1320	2260	1320	309		100	61
TSS (Unsewered)	1040	1080	790	1330	1050	154	153	40	20
LEAD (Sewered)	1.03	1.58	0.37	2.67	0.37	0.23		0.03	0.02
LEAD (Unsewered)	0.90	1.39	0.22	1.57	0.29	0.12	0.00	0.01	0.01
COPPER (Sewered)	0.2	0.21	0.1	0.56	0.1	0.048		0.01	0.01
COPPER (Unsewered)	0.18	0.18	0.061	0.33	0.081	0.024	0.0044	0.004	0.002
ZINC (Sewered)	1.6	1.3	0.57	3.2	0.57	0.9		0.1	0.08
ZINC (Unsewered)	1.4	1.2	0.34	1.9	0.46	0.45	0.069	0.06	0.03
TDS (Sewered)	2830	1290	623	6060	623	436		1210	724
TDS (Unsewered)	2500	1130	374	3565	498	218	89.2	483	241
TN (Sewered)	21	14	11	13	11	6		1	1
TN (Unsewered)	18	12	6.5	7.7	8.6	3.1	2.4	0.5	0.2
TKN (Sewered)	6.9	4	6.4	18	6.4	3.2		2.2	1.3
TKN (unsewered)	6.1	4	3.8	11	5.1	1.6	0.91	0.88	0.44
DP (Sewered)	0.69	0.86	0.61	0.2	0.61	0.26		0.1	0.08
DP (Unsewered)	0.61	0.75	0.36	0.1	0.48	0.13	0.08	0.05	0.03
TP (Sewered)	1.3	1.5	1.4	1.8	1.4	0.81		0.22	0.39
TP (Unsewered)	1.2	1.3	0.8	1.1	1.1	0.4	0.18	0.088	0.13
CADMIUM (sewered)	0.008	0.025	0.0037	0.021	0.0037	0.002		0.0003	0.0002
CADMIUM (Unsewered)	0.0071	0.022	0.0022	0.012	0.003	0.001	0.0002	0.0001	0.0001

1. Unit Area Pollutant Load Estimates for Lake County, Illinois Lake Michigan Watersheds." NIPC. August 1993.

Estimated Load and Load Reductions

	Load before BMP (Ibs/yr)	Load after BMP (Ibs/yr)	Load Reduction (Ibs/yr)
BOD	257	U	U
COD	2,309	462	1,848
TSS	4,814	481	4,333
LEAD	4	0	4
COPPER	1	U	U
ZINC	12	0	12
TDS	15,165	U	U
TN	73	11	62
TKN	55	U	U
DP	4	U	U
TP	13	5	9
CADMIUM	0	U	U

U = Removal Efficiency for the particular BMP and constituent unavailable.

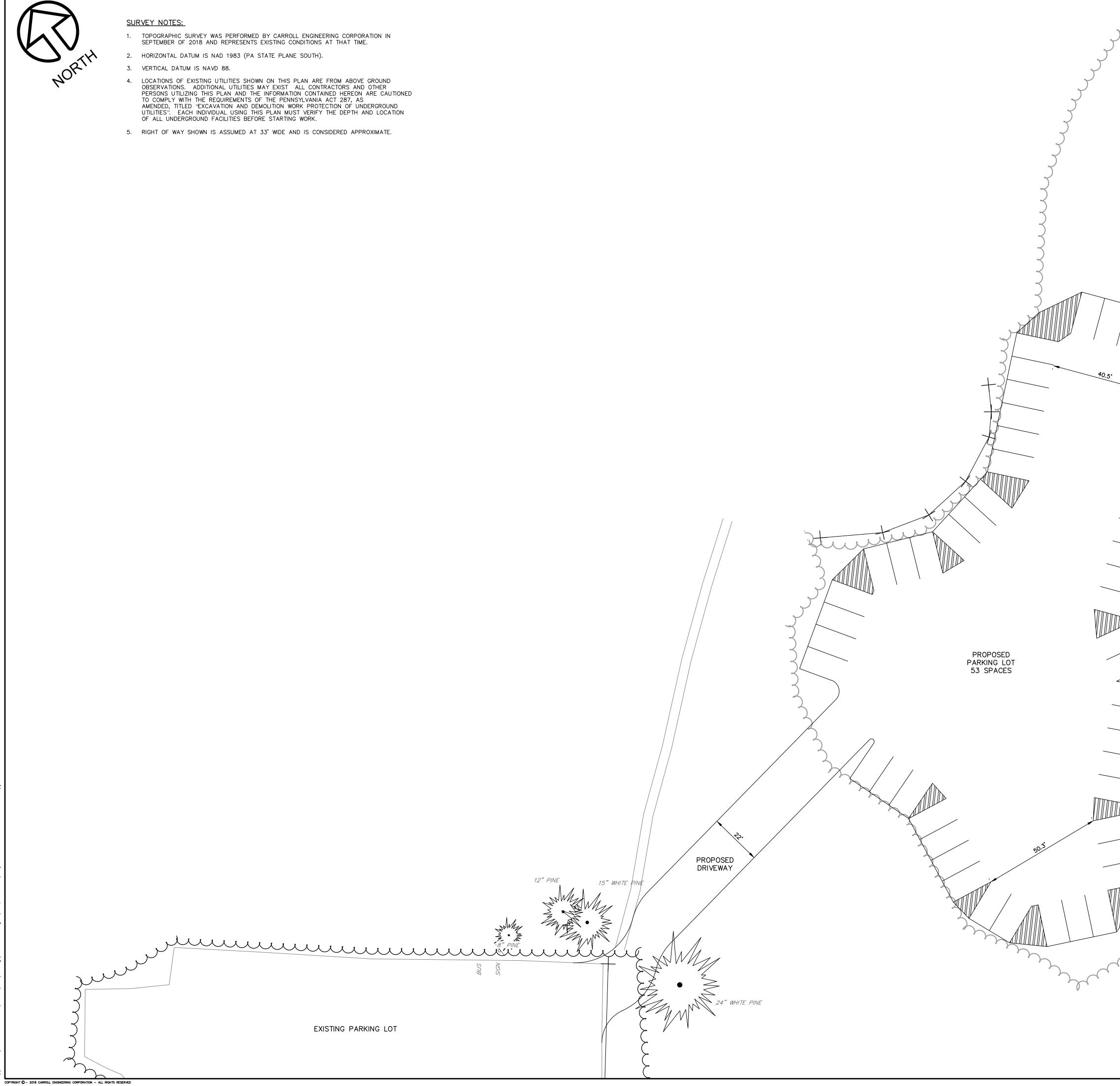
Appendix D. Peace Valley Nature Center Project Area Photos and Plan



Photo 1. Location of Peace Valley Nature Center permeable paving parking area.



- OF ALL UNDERGROUND FACILITIES BEFORE STARTING WORK.



PROPOSED 39' PAVILION	Carroll Engineering Corporation C O R P O R A T E O F F I C E 9 A 9 . E A S T O N . R O A D W A R R I N G T O N . P A . 18976 PHONE: 2 1 5 . 3 A 3 . 0 8 7 5 630 Freedom Business Ctr., 3rd Fl. 105 Raider Boulevard, Suite 206 Hillsborough, NJ 0884 Phone 610 - Start 200 FAX: 2 1 5 . 3 A 3 . 0 8 7 5 630 Freedom Business Ctr., 3rd Fl. 105 Raider Boulevard, Suite 206 Hillsborough, NJ 0884 Phone 610 - Start 200 FAX: 2 1 5 . 3 A 3 . 0 8 7 5 630 Freedom Business Ctr., 3rd Fl. 105 Raider Boulevard, Suite 206 Hillsborough, NJ 0884 Phone 610 - Start 200 FAX: 2 1 5 . 3 A 3 . 0 8 7 5 Fibres 484-873-3075 Malvern, PA 19355 Phone: 484-873-3075 Malvern, PA 19355 Malvern, PA 193555 Malvern, PA 1935555 Malvern, PA 1935555555
	SITE IMPROVEMENT PLAN BITE IMPROVEMENT PLAN FRACE VALLEY NATURE CENTER CAZEBO AND PARKING LOT ADDITION SITUATED IN NEW BRITAIN TOWNSHIP, BUCKS COUNTY PA PREPARED FOR PREPARED FOR TO NORTH CHAPMAN ROAD DOVLESTOWN, PA 18902
GRAPHIC SCALE 2 (IN FEET) 1 inch = 20 ft.	DATE <u>9/27/2018</u> CADD FILE <u>1814180002</u> JOB NO <u>18-1418</u> DSG BY <u>JLK</u> CKD BY <u>JLK</u> CKD BY <u>JLK</u> CKD BY <u>JLK</u> CKD BY <u>JLK</u> CKD BY <u>SCALE</u> <u>1" = 20'</u> DRAWER NUMBER <u>-</u> SHEET <u>1</u> OF <u>SHEETS</u> DRAWING NUMBER <u>C-101</u>