TMDL Plan
for
Christina River:
White Clay Creek Watershed

This Plan is required by PADEP and US EPA as part of a permit issued to allow discharge of stormwater to streams and other surface waters when it originates in any part from a Municipal Separate Storm Sewer System (MS4) and TMDLs have been established for that surface water.

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Prepared For:

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OVERVIEW

Franklin Township is currently covered under a Pennsylvania Department of Environmental Protection (PADEP), National Pollutant Discharge Elimination System (NPDES) Permit. This type of permit is required by both PADEP and the US Environmental Protection Agency (EPA) in order to comply with the Federal Clean Water Act and Pennsylvania's Clean Streams Law. Application for a new 2018 permit was previously submitted to PADEP in September 2017. Along with the application, a TMDL Plan for sediment (siltation) and nutrients (nitrogen and phosphorus) must be submitted along with the permit application. The TMDL Plan is for the land categorized as: 1) urbanized area based on the 2010 Census prepared by the US Census Bureau and 2) draining to non-attaining waters as determined by PADEP. Within Franklin Township, that is the Christina River TMDL Plan. Please note that when describing surface waters, non-attaining, impaired and polluted have the same meaning and are interchangeable. See Exhibit 1 –Stream Assessment Map for urbanized area and non-attaining streams and Exhibit 2 - MS4 Requirements Table for the PADEP requirement.

EPA prepared a "Hydrodynamic and Water Quality Model of Christina River Basin" with a Final Report date of December 5, 2000 and Errata dated April 30, 2007. That report contains TMDLs for nutrients and sediment for the White Clay Creek Watershed that drains nearly all of Franklin Township's urbanized area into the Christina River. The White Clay Creek Watershed is further divided into the East Branch (W09 & W08), Middle Branch (W03) and West Branch (W01). Within Franklin Township, these are identified by EPA as TMDL subbasins W09, W08, W03 and W01 respectively (see Exhibit 3). TMDL Baseline Loads, MS4 Waste Load Allocations, and MS4 required load reductions (% annual volume) were set by EPA as shown in Exhibit 4.

There are a total of 106 MS4 Outfalls and 10 MS4 Observation Points in Franklin Township within the White Clay Creek Watershed (see Exhibit 5- Stormwater Conveyance Overall Key Map). The 106 MS4 Outfalls and 10 MS 4 Observation Points consist of the following: 3 MS4 Observation Points within the East Branch (W09), 17 MS4 Outfalls and 5 MS4 Observation Points within the East Branch (W08), 35 MS4 Outfalls and 2 MS4 Observation Points within the Middle Branch (W03) and 54 MS4 Outfalls within the West Branch (W01). Together, all of these areas have been addressed in this TMDL Plan (see Exhibit 6 – Stormwater Conveyance and Storm Sewersheds - Sheets A thru C TMDL and see Exhibit 7 – Storm Sewersheds and Mapshed Land Use (Existing Cover) - 1995 TMDL & 2012 TMDL).

The calculation methodology for this TMDL Plan uses the Modified Christina Basin MapShed Model (Modified CMS). The Christina Basin Land Use Loading Rates Calculation Tool developed by the Chester County Water Resources Authority in consultation with Barry Evans, PhD, Penn State University and Bill Brown, PADEP were utilized to calculate the MapShed land use categories within each storm sewershed area. For the East Branch (W09), the East Branch (W08), the Middle Branch (W03) and the West Branch (W01), the Modified CMS watershed specific land use loading rates were applied to the 1995 MapShed land use categories within each storm sewershed area to calculate the Revised (1995) TMDL Baseline Load. For the East Branch (W09), the East Branch (W08), the Middle Branch (W03) and the West Branch (W01), the Modified CMS watershed specific land use loading rates were applied to the 2012 MapShed land use categories within each storm sewershed area to calculate the 2012 Load (without state compiled BMPs) (see Exhibit 8 – 1995 Land Use Loading Calculations & Exhibit 9 – 2012 Land Use Loading Calculations) .

For Franklin Township, the required long term reduction for the White Clay Creek Watershed is 45.36% for sediment, 50.00% for nitrogen and 63.49% for phosphorous as shown in Exhibit 4.

Calculations were previously provided to demonstrate that due to the conversion of land uses from 1995 to 2012 (without analyzing the existing BMP reductions), the 2012 loads were less than the 1995 loads. As per PADEP's technical deficiency letter, dated July 10, 2018, the previous reduction achieved from the change of land uses is not sufficient in meeting the short term and long term requirements per the TMDL plan instructions.

Since the reduction in land uses is not sufficient, existing BMPs loads have been deducted from the 2012 Load to determine the Existing 2017 Load (see Exhibit 12 - Existing BMP calculations). For the East Branch (W09), the East Branch (W08), the Middle Branch (W03) and the West Branch (W01), the Existing BMP calculations have been separated into the existing BMPs installed prior to 1995 and the existing BMPs installed between 1995 and 2012. The Christina Basin Urban BMP Load Reduction Calculation Tool has been utilized to calculate the existing BMP load reductions for the existing BMPs installed prior to 1995 and the existing BMPs installed between 1995 and 2012 (see Exhibit 10 – Existing BMP Locations and Existing BMP Drainage Areas, Exhibit 11 – BMP Drainage Areas and Mapshed Land Use (Existing Cover) – 1995 TMDL & 2012 TMDL and see Exhibit 12 – Existing BMP calculations).

As per bullet point #3 of Section 7.a of the "Key Outcomes of CCWRA/PADEP Communications Regarding Christina Basin TMDL & PRP Calculation Process", where the remaining required TMDL load reduction is not viable in this 5 year permit period and the applicant chooses to instead meet the 10% of Existing Load option, all BMPs (with required documentation) pre and post 1995 can be used to calculate the Existing 2017 Load. Since Franklin Township has elected to meet a 10% sediment load reduction for the Existing 2017 Load, all BMPs pre and post 1995 have been deducted from the 2012 Load to determine the Existing 2017 Load.

After the Existing 2017 Load was determined by deducting the existing BMPs, the required short term reductions (10% sediment, 5% nitrogen and 5% phosphorus) in the next 5 year permit cycle were calculated for the East Branch (W09), the East Branch (W08), the Middle Branch (W03), the West Branch (W01) and the Total White Clay Creek Watershed area (see Exhibit 13 – Required Loading Reduction Calculations).

A Riparian Opportunities Map, prepared by the Brandywine Conservancy, has been included in this narrative to delineate potential locations of proposed Forest/Riparian Buffer BMPs within the TMDL area (see Exhibit 14 – Riparian Opportunities Map).

The Christina Basin Urban BMP Load Reduction Calculation Tool has been utilized to calculate the proposed BMP load reductions for the proposed BMPs (see Exhibit 15 – Proposed BMP Locations and Exhibit 16 – Proposed BMP Calculations).

For Exhibits 12 and 16, the Christina Basin Urban BMP Load Reduction Calculation Tool requires a treatment depth to be entered for each BMP. In Exhibits 12 and 16, a spreadsheet has been provided to calculate a treatment depth for each existing or proposed land use utilizing the SCS Method with 3.2" of runoff from a 2 year/24 hour storm and Hydrologic Soil Group B soils. Hydrologic Soil Group B soils were selected for the treatment depth calculations to simulate, as close as possible, the treatment depths utilized in the sample calculations provided within the Christina Basin Urban BMP Load Reduction Calculation Tool. In the Christina Basin Urban BMP Load Reduction Calculation Tool, an average treatment depth was utilized for each BMP. For example, the drainage area to a BMP contains both Forest and Cropland land uses. The calculated treatment depth for Forest is 0.25 inches and the calculated treatment depth for Cropland is 1.09 inches. The average treatment depth utilized for each land use tributary to the BMP would be 0.67 inches ((0.25+1.09)/2).

After determining the required short term reductions for the East Branch (W09), the East Branch (W08), the Middle Branch (W03), the West Branch (W01) and the Total White Clay Creek Watershed area, proposed BMPs were selected to achieve the required short term reductions. Since all of the proposed BMPs are located within the same watershed, the load reductions achieved by the proposed BMPs have only been compared to the short term reduction requirements for the Total White Clay Creek Watershed Area to determine compliance. TMDL Plans may use a presumptive approach in which it is assumed that a 10% sediment reduction will also accomplish a 5% nitrogen reduction and a 5% phosphorous reduction (see Exhibit 17 – Load Reductions Achieved for 5 Year Permit Cycle).

SUPPORTIVE BACKGROUND AND HISTORY

The original TMDL narrative was submitted to PADEP on September 15, 2017. Franklin Township received a review letter from PADEP, dated July 10, 2018. On August 15, 2018, Elizabeth Mahoney of PADEP granted the first time extension from September 10, 2018 until December 7, 2018 by email. Representatives of Franklin Township and LTL Consultants, Ltd. attended a meeting at PADEP's southeast regional office on August 29, 2018 to discuss the comments in the July 10, 2018 review letter. After the meeting was completed, LTL Consultants, Ltd prepared meeting minutes and e-mailed them to PADEP on August 30, 2018.

The following is a list of items discussed and/or reviewed with PADEP since the meeting on August 29, 2018:

- On September 11, 2018, Juan Vicenty-Gonzalez sent an e-mail stating that the use of the Chester County surface water GIS map is acceptable to delineate the streams on Franklin Township's MS4 maps.
- On October 11, 2018, LTL Consultants, Ltd, e-mailed copies of Franklin Township's revised MS4 maps to PADEP for review. Review comments for Franklin Township's revised MS4 maps were received by e-mail from Juan Vicenty-Gonzalez of PADEP on October 25, 2018. Franklin Township's MS4 maps have been revised per the e-mail comments received on October 25, 2018.
- On October 23, 2018, LTL Consultants, Ltd, e-mailed five questions to PADEP. Krista Brown of PADEP responded to the five questions by e-mail on November 6, 2018. The following is a brief summary of the determinations provided by PADEP:
    - Refer to Section 6.6.3 of the PA BMP Manual for the design requirements for a Dry Extended Detention Basin.
    - If an existing BMP is retrofitted, the existing BMP must be counted as both an existing BMP and the retrofitted BMP must be counted as a proposed BMP. The retrofitted BMP may not be counted as only a proposed BMP. A list of the required information necessary to document an existing BMP was provided.
    - For a retrofit to a Dry Extended Detention Basin, amended soils are proposed to be added to the bottom. The designer shall determine how much amended soil is required to be added to the bottom of the existing BMP to achieve the desired result.
    - Drainage areas tributary to the existing BMPs and the proposed BMPs are not required to be provided on Franklin Township's MS4 maps.
    - Cost estimates for proposed BMPs are not required to be provided with the TMDL Narrative. Cost estimates for proposed BMPs should be included with the annual reports during the 5 year permit cycle.

- On November 29, 2018, LTL Consultants, Ltd, e-mailed two questions to PADEP. Krista Brown of PADEP responded to the two questions by e-mail on November 30, 2018. The following is a brief summary of the determination provided by PADEP:
    - Stream restoration projects utilizing mapshed to calculate the loads may utilize 115 lbs/ft. for the load reduction calculations.
    - Stream restoration projects may be located downstream of the urbanized area. Stream restoration projects located downstream of an urbanized area may only receive a partial credit based upon the percentage of the upstream drainage area that originates from the urbanized area. Stream restoration projects must be on a surface water delineated on the Chester County surface water GIS map or the designer must show that the stream is fed by groundwater.
- On November 29, 2018, LTL Consultants, Ltd, e-mailed one question to PADEP. Krista Brown of PADEP responded to the question by e-mail on November 30, 2018. The following is a brief summary of the determination provided by PADEP:
    - Offset BMPs. At this time the only proposed BMP that PADEP can approve outside of the urbanized area is a stream restoration.
- On December 11, 2018, Elizabeth Mahoney of PADEP granted the second time extension from December 7, 2018 until April 26, 2019 by email.
- On January 14, 2019, LTL Consultants, Ltd, e-mailed one question to PADEP regarding the use of the Christina Basin Urban BMP Load Reduction Calculation Tool. Bill Brown of PADEP's central office responded to the question by e-mail on January 17, 2019. The following is a brief summary of the determination provided by PADEP:
    - Clarification was provided on the proper method to calculate a basin retrofit from an existing Dry Detention Basin to a proposed Dry Extended Detention Basin utilizing the Christina Basin Urban BMP Load Reduction Calculation Tool.
- On March 15, 2019, Elizabeth Mahoney of PADEP granted the third time extension from April 26, 2019 until June 15, 2019 by email.
- TMDL Plan and PRP Plan were resubmitted to PADEP on June 21, 2019 for a second review.
- On February 26, 2020, Harmonie Hawley of PADEP, e-mailed a review comment explaining that our proposed exclusion of the agricultural land does not meet PADEP guidance and shall be removed from both the TMDL Plan and the PRP Plan. As per the e-mail, the deadline to resubmit is 30 days from the date of the e-mail or April 27, 2020.
- On March 13, 2020, Harmonie Hawley of PADEP granted a fourth time extension from April 27, 2020 until July 31, 2020 by email.
- On July 27, 2020, Harmonie Hawley of PADEP granted a fifth time extension from July 31, 2020 until September 30, 2020 by email. The current deadline to resubmit is September 30, 2020.

BIFURCATED APPROACH TO ADDRESSING POLLUTANT LOADS FROM AGRICULTURAL LAND IN THE URBANIZED AREA

Per PADEP's Frequently Asked Questions document on the MS4 webpage, it states that best management practices can be implemented on private property, that no landowner agreement is required with private landowners, and that farms meeting existing regulations will be considered to have met "baseline" conditions. Regarding this last topic, the guidance reads:

> For example, agricultural lands must comply with regulations relating to erosion and sediment control under 25 Pa. Code § 102.4(a) and regulations relating to manure management under 25 Pa. Code § 91.36(b) and have achieved the LA in an approved TMDL (or equivalent) to be considered as meeting their baseline requirement. These FAQs are consistent with all Pennsylvania laws, regulations and policies. (MS4 NPDES Permits – Frequently Asked Questions, revised October 21, 2019 at 17).

Based on this reasoning, a farm that has implemented BMPs to meet any applicable erosion, nutrient and TMDL requirements would have achieved baseline and the land area of that farm would not be contributing to the MS4 pollutant loads.

In constructing financing strategies to meet their MS4 obligations, municipalities are advised to first consider existing funding streams. The cost-share programs administered through county conservation districts and the Natural Resources Conservation Service are important existing funding streams for municipalities with agricultural lands in their urbanized areas. With this in mind, municipalities are advised that they can segment their MS4 compliance strategy to address loads coming from agricultural lands separately from loads on non-agricultural lands since those lands will not be beneficiaries of cost-share program funding and would need a separate funding strategy. To be clear, this does not mean that the municipality would be parsing out agricultural land from its mapping but that its strategy for meeting pollutant loads from agricultural land would be through implementation of agricultural cost-share program BMPs; the municipality's funding strategy for meeting pollutant load reductions from other lands in the urbanized area would target other funding streams and best management practices.

Based on our understanding of the guidance and verbal agreement from department staff, the following language has been drafted to explain this bifurcated approach to addressing the pollutant loads from agricultural land in the urbanized area in their TMDL plan:

For the TMDL Plan, there are 552.86 acres of agricultural land uses within the urbanized area for Franklin Township. The sediment load from these lands is 67.8% of the required sediment reduction for Franklin Township. Franklin Township will track the sediment loads from agricultural land uses separately from the sediment loads from the rest of the urbanized area so as to leverage the funding available through cost-share programs available to farmers to assist with the implementation of agricultural BMPs that can significantly reduce the pollution loads coming from agricultural lands. Franklin Township will work with the Chester County Conservation District to evaluate the extent of agricultural BMP implementation in its urbanized area and Franklin Township will partner with the conservation district to encourage farmers to participate in these programs. Franklin Township anticipates that 10% of its agricultural sediment load reduction will be addressed with this strategy during this permit cycle. Franklin Township will continue to dialogue with PADEP about additional appropriate measures to address agricultural pollution loads within Franklin Township's legal authority and consistent with the statutory purposes of the MS4 program.

PROPOSED BMPs

As part of this application, the Township has performed limited preliminary investigations, including site visits and calculations of several BMP candidates that include riparian buffer plantings, stream bank restoration, and detention basin retrofits in order to determine the extent of work that may be required to meet the reduction goal. It should be noted that PADEP's BMP Effectiveness Values table offers up to 16 BMP types that could be selected to meet sediment reduction loads. Any combination of BMPs could ultimately be evaluated and determined to meet the load reduction needs. Franklin Township will ultimately select from the list provided on PADEP's BMP Effectiveness Values table. The location for the BMP would typically be located within the urbanized area, with the exception of the stream restoration that is permitted to be located outside of the urbanized area.

The following is intended to generally demonstrate how the listed/selected BMP could meet the sediment reduction goal.

- **Riparian buffer plantings**
  (Option A - BMP 301)

  The Township has obtained information from the Brandywine Conservancy [see Exhibit 14] related to the inventory within the Township as to properties on protected and unprotected lands that would benefit from riparian buffer plantings.

  Looking at two specific properties (Option A – Properties 1+2+3) listed as being protected, we have calculated that there 10,280 ft. of available buffer that could be installed. The buffer depth would be 35' minimum.

  Property 1 = UPI #72-3-24.34.3 – White Clay Knoll HOA
  3 stream legs. Total stream length = 2,625 ft.
  Buffer Length (both sides of stream) = 5,250 ft.

  Property 2 = UPI #72-2-61 – Keen Property
  3 stream legs. Total stream length = 1,625 ft.
  2 ponds. Total pond perimeter = 830 ft.
  Buffer Length (2 sides of stream & 1 side of ponds) = 4,080 ft.

  Property 3 = UPI #72-2-50.4 – Pierson Property
  1 stream leg. Total stream length = 475 ft.
  Buffer Length (both sides of stream) = 950 ft.

For these locations, the calculations indicate a sediment reduction of 86,302.09 lbs/yr. Thus, riparian buffer plantings on this property would meet the reduction goal.

It should be noted that there are additional properties (including property 4) that the Conservancy has identified for buffer plantings in both protected and unprotected lands, so there are ample opportunities for which to evaluate and provide riparian buffer planting BMPs. Property 4 has not been included with Option A at this time, but are available if need at a future time.

- **Basin retrofit**
  (Option B - BMPs 002, 004, 005, 006, 011, 015, 017, 031, 032, 033, 034, 035, 036, 048, 049, 050, 057, 059, 062, 063, 064, 065, 075, 083 & 084)

  There are 25 existing basins that encompass a total drainage area of approximately 228.7 acres.

  Using this acreage, the calculations provide for a reduction of 80,812.01 lbs/yr.

  Thus, all 25 of the existing basins would need to a retrofit to meet the reduction goal.

  The existing detention basins have been constructed over the years related to various subdivision type projects, and are located on privately owned lands.

- **Stream restoration**
  (Option C – BMP 302)

  As noted in the History section, a reduction of 115 lbs/ft. is allowed for stream restoration project. Thus, to meet the reduction goal, 925 feet of stream restoration would be required.

  Using this stream restoration length, the calculations provide for a reduction of 40,020.00 lbs/yr.

  Franklin Preserve offers a minimum of 925 feet of stream that is eroded and is not currently heavily wooded. Thus, stream restoration on this property would meet the reduction goal.

  Franklin Preserve was considered as this property is owned by Franklin Township, and called BMP 302, located on UPI #72-5-17. It should be noted that there are many other first and second order streams within the Township that can be evaluated and would likely qualify as restoration candidates.

- **Combination of the above**

  Depending upon the final decisions and factor on the overall project, any combination of the above BMPs could me combined to meet the reduction goal.

- **Other BMPs per the DEP listing**

  Though not investigated at this time, the listing offers many BMPs that can be considered and evaluated.

BMPs will ultimately be selected for completion during the 5 year permit cycle. Once the permit is issued, Franklin Township will determine the most favorable option by analyzing the property owner cooperation potential, the engineering requirements, the permitting requirements and the cost projection to complete each option. Franklin Township reserves the right to only implement the minimum amount of proposed BMPs as necessary to obtain the required short term reductions. At a future time within the 5 year permit cycle, Franklin Township reserves the right to select an alternate BMP option not listed above to satisfy the short term reduction requirements. Any future BMP selections would be selected from the list of BMPs provided in the BMP Effectiveness Values Table.

REQUIRED ELEMENTS

In their TMDL Plan instructions document, PADEP identifies nine elements, A through I, that are required to be included in the TMDL Plan. These are addressed as follows:

A. Public Participation – This TMDL Plan has been advertised as available for public comment for a period of 30 days including at a public meeting of the Board of Supervisors. The advertisement occurred 45 days prior to the deadline for submission to PADEP. See a copy of the public notice in Exhibit 18. If any comments are received, they will be considered, and a response provided and included in Exhibit 18.

B. Map – A map identifying land uses and the storm sewershed boundary to each MS4 outfall that discharges to impaired waters is required. As noted above, there are 106 MS4 Outfalls and 10 MS4 Observation Points draining to the Christina River via the White Clay Creek. All required elements are shown in Exhibits 5, 6 & 7.

C. Pollutants of Concern – The pollutants of concern, per PADEP, for Christina River TMDL Plan are sediment and nutrients as shown in Exhibit 2.

D. Existing Load for Pollutants of Concern – As noted above, the calculation methodology for this TMDL Plan uses the Modified Christina Basin MapShed Model (Modified CMS) as shown in Exhibits 8 & 9.

E. Wasteload Allocations (WLAs) – Specific WLAs established for the municipality are to be reported. As noted above, the required long term reduction for the White Clay Creek Watershed is 45.36% for sediment, 50.00% for nitrogen and 63.49% for phosphorus as shown in Exhibit 4.

F. Analysis of TMDL Objectives – This item requires the long-term and short-term load reductions to be presented. The long-term reductions are those contained in the EPA's TMDL as shown in Exhibit 4 and the short-term reductions are minimums set by PADEP for the permit cycle (per PADEP TMDL Plan Instructions).

long-term reductions: sediment = 45.36%
nitrogen = 50.00%
phosphorus = 63.49%

short-term reductions: sediment = 10%
nitrogen = 5%
phosphorus = 5%

G. Select BMPs to Achieve the Minimum Required Reduction in Pollutant Load – If the WLAs cannot be achieved in the upcoming permit cycle, this item must be divided into two parts: short-term reduction for the permit cycle and long-term reductions to meet the WLAs. Specific BMPs must be chosen that when implemented will result in meeting the minimum required reduction in pollutants in the short-term and in long-term.

Short-Term Reductions – The calculations demonstrate that the proposed BMPs are sufficient to achieve the required short-term reductions for sediment, nitrogen and phosphorus of 10%, 5% and 5% as shown in Exhibit 16 and Exhibit 17. TMDL Plans may use a presumptive approach in which it is assumed that a 10% sediment reduction will also accomplish a 5% nitrogen reduction and a 5% phosphorous reduction.

Option A – forest/riparian buffers reductions achieved by proposed BMPs:	sediment = 10.89% nitrogen = 5.43% phosphorus = 3.07%
Option B – basin retrofits reductions achieved by proposed BMPs:	sediment = 10.19% nitrogen = 10.12% phosphorus = 4.91%
Option C – stream restoration reductions achieved by proposed BMPs:	sediment = 10.01% nitrogen = 4.63% phosphorus = 20.35%

Long-Term Reductions – In order to achieve the total long term load reductions to satisfy the Wasteload Allocations (WLAs), additional proposed BMPs will be provided on both Township lands and private lands during future permit cycles (2023-2028). The future proposed BMPs are anticipated to be installed within all three branches of the White Clay Creek watershed.

H. Identify Funding Mechanism(s) – This item requires expected sources of funding (preferred and alternative) including identification of possible sponsors and partners. Franklin Township is and has been an active member in the Christina Watersheds Municipal Partnership (CWMP) (formerly Christina TMDL Implementation Partnership). Franklin Township participated in the Suburban Pilot Project sponsored by the CWMP beginning in July of 2016. Although it was determined by the members of the Suburban Pilot Project that collaboration would not be pursued at this time, it was agreed that it likely would be in the future, and Franklin Township intends to participate should that evolve. Franklin Township is and has been an active member of the White Clay Creek Watershed Association. The White Clay Creek Watershed Association is in the process of developing a grant opportunity from the Delaware River Conservation Fund through the National Fish and Wildlife Foundation. Funding of the proposed BMPs for this 5 year permit cycle is expected to be obtained from a combination of the grant opportunity from the Delaware River Conservation Fund and the Township's general fund budget.

I. Identify Responsible Parties for Operation & Maintenance (O&M) of BMPs – O&M is required to assure that existing BMPs and proposed BMPs continue to function properly and provide the expected reduction in sediment and nutrient loads. For existing BMPs and proposed BMPs located on private property, it is the responsibility of the individual property owner or Homeowners Association to ensure that the existing and proposed BMPs are operated and maintained properly. Franklin Township has always taken an active role in assuring that all stormwater infrastructure within the entire Township is operated and maintained as designed. It is the Township's intention to continue inspecting all existing BMPs and proposed BMPs constructed in the Township and to continue monitoring and facilitating needed repairs whether they be the financial responsibility of an individual, a Homeowners Association or the Township itself.

Perpetual O & M procedures will be completed per the Pennsylvania Stormwater Best Management Practices Manual, BMP 6.7.1 (riparian buffer restoration), as follows:

BMP 6.7.1 (riparian buffer restoration)
The most critical period during buffer establishment is maintenance of the newly planted trees during canopy closure, typically the first 3 to 5 years. Ongoing maintenance practices are necessary for both small seedlings and larger plant materials. Maintenance and monitoring plans should be prepared for the specific site and caretakers need to be advised of required duties during the regular maintenance period. During the first four years, the new buffer should be monitored four times annually (February, May, August and November are recommended) and inspected after any severe storm. Repairs should be made as soon as possible.

Maintenance measures that should be performed regularly:

Watering
- Plantings need deep regular watering during the first growing season, either natural watering via rainfall, or planned watering, via caretaker.
- Planting in the fall increases the likelihood of sufficient rain during planting establishment.

Mulching
- Mulching will assist in water retention in the root zone of plantings, moderate soil temperature, provide some weed suppression, and retard evaporation.
- Use coarse, organic mulch that is slow to decompose in order to minimize repeat application.
- Apply 2-4 inch layer, leaving air space around tree trunk to prevent fungus growth.
- Use combination of wood chips, leaves and twigs that are stockpiled for six months to a year.

Weed Control

- Weed competition limits buffer growth and survival, therefore weeds should be controlled be either herbicides, mowing or weed mats.

  Herbicides

  - This is a short term maintenance technique (2-3 years) that is generally considered less expensive and more flexible than mowing, and will result in a quicker establishment of the buffer. Herbicide use is regulated by the PA Department of Agriculture. Proper care should be taken to ensure that proximity to water features is considered.

  Mowing

  - Mowing controls the height of the existing grasses, yet increases nutrient uptake, therefore competition for nutrients will exist until the canopy closure shades out lower layers. A planting layout similar to a grid format will facilitate ease of mowing yet yield an unnaturally spaced community. Mowing may result in strikes on the trunk unless protective measures are utilized. Mowing should occur twice each growing season. Mower height should be set between 8-12 inches.

  Weed Mats

  - Weed mats are geo-textile fabrics that are used to suppress weed growth around newly planted vegetation by providing shade and preventing seed deposition. Weed mats are installed after planting, and should be removed once the trees have developed a canopy that will naturally shade out weeds.

Deer Damage

- Deer will browse all vegetation within reach, generally between 5-6 feet above the ground.
- Approaches to minimize damage include: selecting plants that deer do not prefer (paper birch, beech, ash, common elderberry), homemade deer repellants and tree shelters.

Tree Shelters

- Repair broken stakes.
- Tighten stake lines.
- Straighten leaning tubes.
- Clean debris from tubes.
- Remove netting as tree grows.
- Remove when tree is approximately 2 inches wide.

Invasive Plants

- Monitor restoration sight regularly for any signs of invasive plants.
- Appendix B of the PA BMP Manual contains common invasive plants found in Pennsylvania.
- Choice of control method is based on a variety of considerations, but falls into three general categories: Mechanical, Mechanical with application of Herbicide and Herbicide.

Perpetual O & M procedures will be completed per the Pennsylvania Stormwater Best Management Practices Manual, BMP 6.6.3 (dry extended detention basin), as follows:

BMP 6.6.3 (dry extended detention basin)
Maintenance is necessary to ensure proper functionality of the dry extended detention basin and should take place on a quarterly basis. A basin maintenance plan should be developed which includes the following measures:

- All basin structures expected to receive and/or trap debris and sediment should be inspected for clogging and excessive debris and sediment accumulation at least four times per year, as well as after every storm greater than 1 inch. Structures include basin bottoms, trash racks, outlet structures, riprap or gabion structures and inlets.
- Sediment removal should be conducted when the basin is completely dry. Sediment should be disposed of properly and once sediment is removed, disturbed areas need to be immediately stabilized and revegetated.
- Mowing and/or trimming of vegetation should be performed as necessary to sustain the system, but all detrius should be removed from the basin.
- Vegetated areas should be inspected annually for erosion.
- Vegetated areas should be inspected annually for unwanted growth of exotic/invasive species.
- Vegetative cover should be maintained at a minimum of 95 percent. If vegetative cover has been reduced by 10%, vegetation should be reestablished.

Perpetual O & M procedures will be completed per the Pennsylvania Stormwater Best Management Practices Manual, BMP (stream restoration), as follows:

BMP (stream restoration)

Maintenance is necessary to ensure proper functionality of the stream restoration and should take place on a quarterly basis. A basin maintenance plan should be developed which includes the following measures:

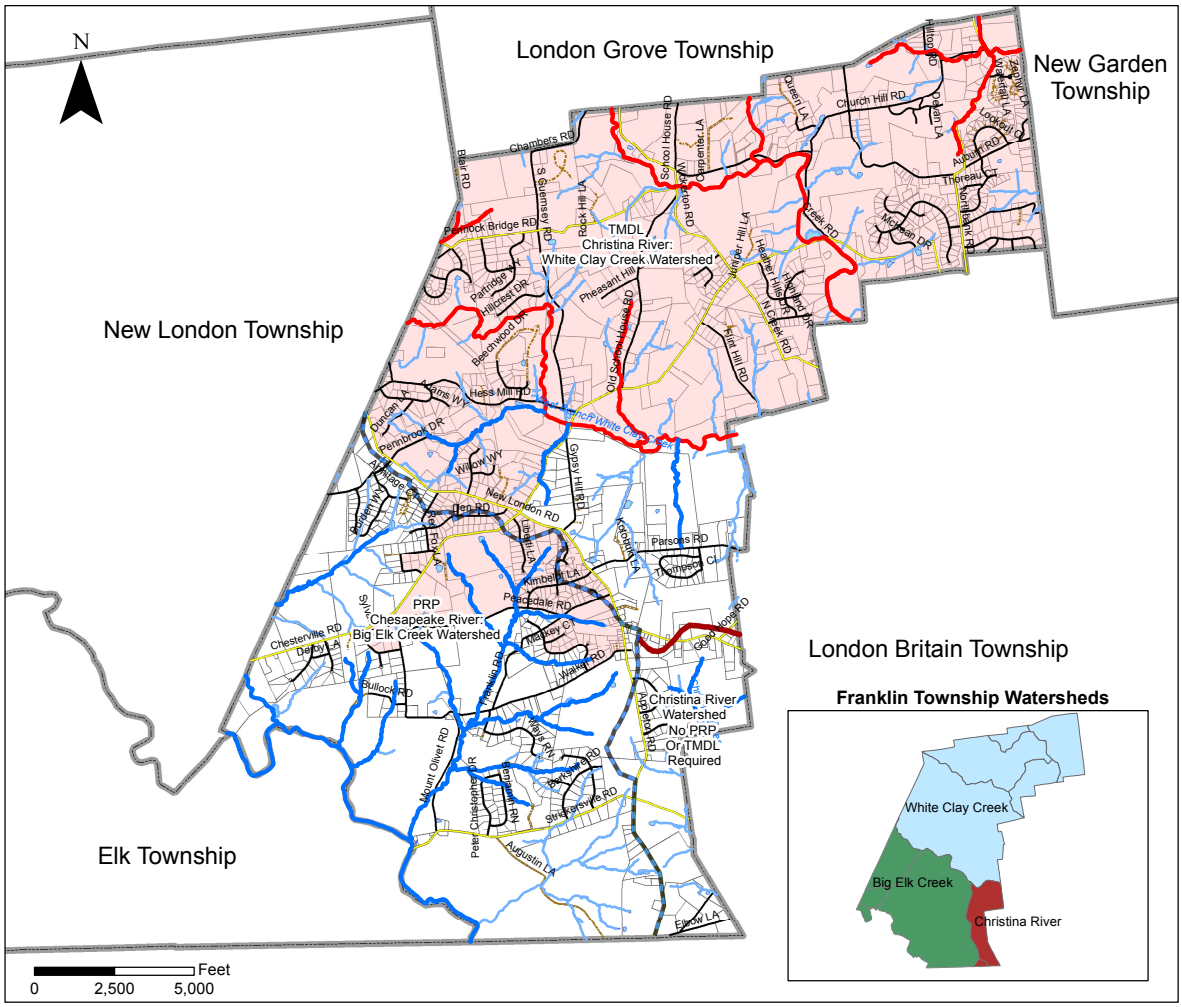
- Repair of any in channel structures (grade controls, rock cross vane, J hook, rock deflectors, mudsills, root wads, etc.)
- Repair or reformation of bank grading.
- Stabilization of eroding or unstable banks.
- Mowing and/or trimming of vegetation should be performed, if necessary.
- Vegetated areas should be inspected for erosion and re-stabilized, as necessary.
- Vegetated areas should be inspected for unwanted growth of exotic/invasive species. Exotic/invasive species shall be removed, as necessary.
- Vegetative cover should be maintained at a minimum of 70 percent. If vegetative cover has been reduced by 30%, vegetation should be re-established.

CONCLUSION

The short-term required pollutant reduction of 10% sediment 5% nitrogen and 5% phosphorus can be achieved by Franklin Township for White Clay Creek/Christina River watershed due to the addition of proposed BMPs.

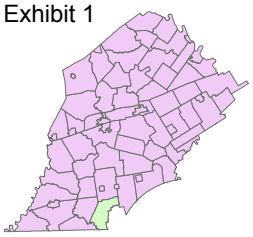
Exhibit 1

Stream Assessment Map



Franklin Township
Chester County
Stream
Assessment

Exhibit 1



Legend

- Attaining Streams
- Non Attaining Streams
- Streams
- Chesapeake Bay Watershed
- Watershed Boundary
- State Road
- Township Road
- Private Road
- Ponds/Lakes
- Municipal Boundary
- Urban Areas 2010
- Parcels

Franklin Township Watersheds

Notes:
-Parcel boundaries, Municipal Boundaries, and Roads Data provided by Chester County GIS.
-Streams data provided by Chester Couty GIS via Chester County Streams (line Features) -- via 1993 photo interpretation
-2010 Urbanized Areas, Attaining, and Non-Attaining streams data provided by EMapGIS, 2016.

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Document Path: E:\Franklin\0205-1508 MS4 Program\2018 MS4\Stream Assesment 013119.mxd

Exhibit 2

MS4 Requirements Table

MS4 Name	NPDES ID	Individual Permit Required?	Reason	Impaired Downstream Waters or Applicable TMDL Name	Requirement(s)	Other Cause(s) of Impairment
Chester County						
EASTTOWN TWP	PAI130509	Yes	SP, IP	Crum Creek	Appendix E-Siltation (5)	Cause Unknown (5), Water/Flow Variability (4c)
				Darby Creek	Appendix C-PCB (5), Appendix E-Siltation (5)	Cause Unknown (5), Other Habitat Alterations, Water/Flow Variability (4c)
				Julip Run	Appendix C-PCB (5)	Cause Unknown (5), Water/Flow Variability (4c)
				Little Darby Creek	Appendix C-PCB (5)	Cause Unknown (5), Water/Flow Variability (4c)
ELK TWP		Yes	SP	Chesapeake Bay Nutrients/Sediment	Appendix D-Nutrients, Siltation (4a)	
FRANKLIN TWP	PAG130058	Yes	TMDL Plan, SP	White Clay Creek	Appendix B-Pathogens (5)	
				Chesapeake Bay Nutrients/Sediment	Appendix D-Nutrients, Siltation (4a)	
				Christina River Basin Sediment	TMDL Plan-Siltation, Suspended Solids (4a)	
				East Branch White Clay Creek	Appendix B-Pathogens (5)	
				Indian Run	Appendix B-Pathogens (5)	
				Middle Branch White Clay Creek	Appendix B-Pathogens (5)	
				Christina River Basin Nutrients	TMDL Plan-Nutrients, Organic Enrichment/Low D.O. (4a)	
				West Branch White Clay Creek	Appendix B-Pathogens (5)	
HONEY BROOK BORO		Yes	TMDL Plan, SP	Christina River Basin Sediment	TMDL Plan-Siltation, Suspended Solids (4a)	
				Christina River Basin Nutrients	TMDL Plan-Nutrients, Organic Enrichment/Low D.O. (4a)	
HONEY BROOK TWP	PAI130535	Yes	TMDL Plan, SP, IP	Chesapeake Bay Nutrients/Sediment	Appendix D-Nutrients, Siltation (4a)	
				Christina River Basin Nutrients	TMDL Plan-Nutrients, Organic Enrichment/Low D.O. (4a)	
				Christina River Basin Sediment	TMDL Plan-Siltation, Suspended Solids (4a)	
				Pequea Creek	Appendix E-Nutrients, Organic Enrichment/Low D.O., Siltation (4a)	
				West Branch Brandywine Creek	Appendix C-PCB (4a)	Water/Flow Variability (4c)
KENNETT SQUARE BORO	PAG130037	Yes	TMDL Plan	West Branch Red Clay Creek	Appendix C-PCB (4a)	
				Christina River Basin Sediment	TMDL Plan-Siltation, Suspended Solids (4a)	
				Red Clay Creek	Appendix C-PCB (4a)	
				Christina River Basin Nutrients	TMDL Plan-Nutrients, Organic Enrichment/Low D.O. (4a)	
KENNETT TWP	PAG130146	Yes	TMDL Plan	Unnamed Tributaries to East Branch Red Clay Creek		Cause Unknown (4a)
				Christina River Basin Sediment	TMDL Plan-Siltation, Suspended Solids (4a)	
				West Branch Red Clay Creek	Appendix C-PCB (4a)	
				Christina River Basin Nutrients	TMDL Plan-Nutrients, Organic Enrichment/Low D.O. (4a)	
				Burrows Run	Appendix C-PCB (4a)	
				Burroughs Brook	Appendix C-PCB (4a)	
				Bucktoe Creek	Appendix C-PCB (4a)	
				Red Clay Creek	Appendix C-PCB (4a)	

Exhibit 2

Exhibit 3

Christina River Subbasins with Load Reduction Requirements

Christina Basin High-Flow TMDL

Map CB-4-2015

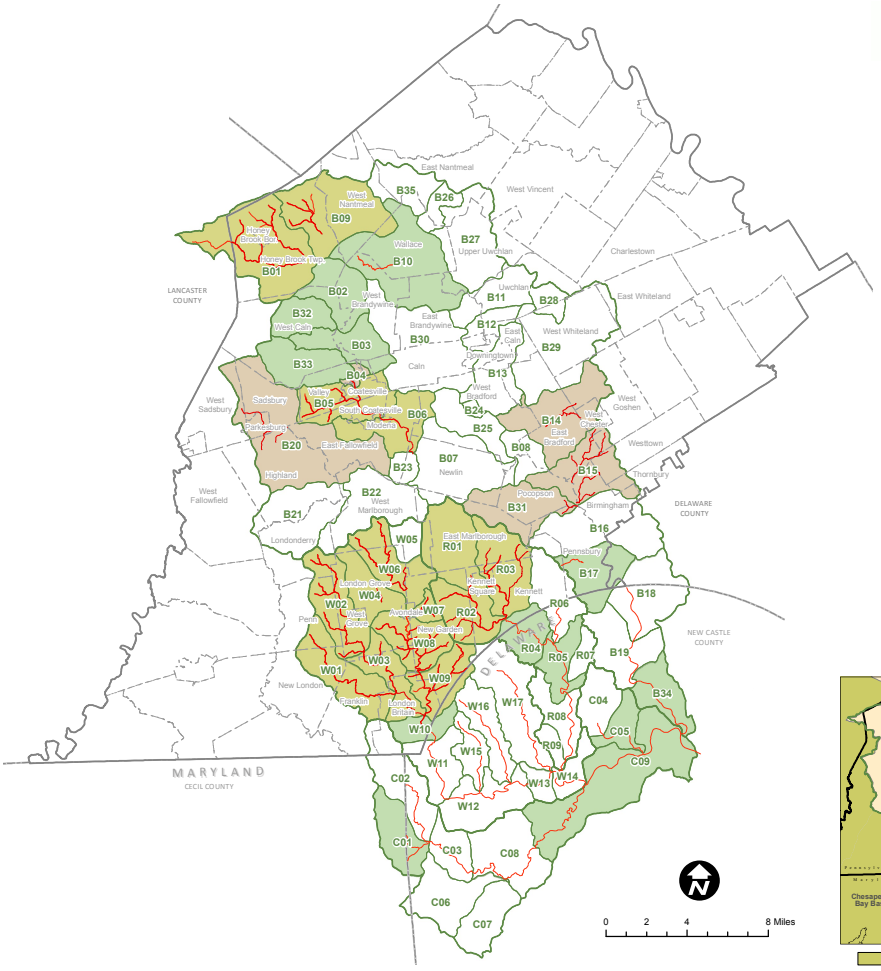
Nutrient Allocations from
2006 TMDL Report

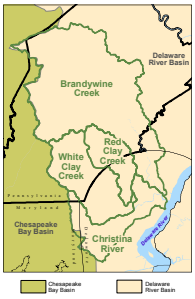
Exhibit 3

Christina River Basin Subbasins with Load Reduction Requirements

Traditional point sources (such as public and private wastewater and industrial facility discharges) and non-point sources (such as runoff from rooftops, lawns, agricultural fields, and roads) contribute nutrient, bacteria and sediment pollutant loads that impair the Christina River Basin's streams. A series of Total Maximum Daily Load (TMDLs) have been developed and are intended to provide limits on pollution in order to restore our waterways over time.

Thirty-three (33) subbasins within the Christina River Basin have been identified for reductions in nutrient or sediment loads from their stormwater discharges to meet quantitative targets established by the USEPA and PADEP within the TMDL reports.





Christina Basin HSPF model subbasins

- Stream segments impaired by nutrients or sediment 1996 or 1998 Section 303(d) lists
- Subbasins with nutrient load reductions per 2006 TMDL
- Subbasins with sediment load reductions per 2006 TMDL
- Subbasins with nutrient and sediment load reductions
- Subbasins without load reductions required
- Christina Basin watersheds
- Municipal Boundaries
- County Boundary

DATA SOURCES:
Subbasins with load allocations: EPA web site, 2009. "Revisions to Total Maximum Daily Loads for Nutrient and Low Dissolved Oxygen Under High-Flow Conditions Christina River Basin, Pennsylvania, Delaware, and Maryland, Section 4. TMDL Methodology and Calculation", September 2006. and "Total Maximum Daily Loads for Bacteria and Sediment in the Christina River Basin, Pennsylvania, Delaware, and Maryland, Section 4. TMDL Methodology and Calculation", September 2006.
Data Source for Stream Assessments: 1996 & 1998: Figures 0-1 & 0-2, and Figures 4-3 & 4-4 of TMDL (see full source above).
Subbasin Delineation: GIS files provided by USGS-Exton Office, 6/9/09.

Chester County Water Resources Authority
www.chesco.org/water
July 15, 2015

Chester County Water Resources Authority
CHESTER COUNTY – PENNSYLVANIA

Exhibit 4

Brandywine-Christina Watershed EPA TMDL MS4 Baseline Pollutant Loadings, MS4 Allocations and Reductions

Exhibit 4

Brandywine-Christina Watershed (HUC # 02040205)
EPA TMDL MS4 Baseline Pollutant Loadings, MS4 Allocations, and Reductions

MUNICIPALITIES LISTED IN TMDL REPORTS	Sediment (tons/year)				Total Nitrogen (kg/day)				Total Phosphorus (kg/day)			
Brandywine Creek Watershed	Baseline MS4 Load[1b.]	MS4 Load Allocation[1b.]	MS4 Load Reduction [1e.]	% Reduction[1b.]	Baseline MS4 Load[2g.]	MS4 Allocation[2a.]	MS4 Load Reduction[2m.]	% Reduction [2m.]	Baseline MS4 Load [2j.]	MS4 Allocation [2d.]	MS4 Load Reduction[2m.]	% Reduction [2m.]
BIRMINGHAM TWP	310.81	130.35	180.46	58.06%								
COATESVILLE CITY	231.29	86.06	145.23	65.52%	16.08	10.86	5.22	32.46%	3.015	2.031	0.984	32.64%
EAST BRADFORD TWP	1185.00	467.17	717.83	60.58%								
EAST BRANDYWINE TWP					54.19	44.44	9.75	17.99%	0.826	0.677	0.149	18.04%
EAST FALLOWFIELD TWP	803.23	426.42	376.81	46.91%	110.54	75.74	34.80	31.48%	22.365	15.348	7.017	31.37%
EAST MARLBOROUGH TWP	366.70	139.44	227.26	61.98%								
HIGHLAND TWP	384.80	238.86	145.94	37.93%								
HONEY BROOK BORO	20.58	13.23	7.35	35.70%	9.61	5.76	3.85	40.06%	0.184	0.11	0.074	40.22%
HONEY BROOK TWP	813.84	558.76	255.08	31.34%	421.64	279.02	142.62	33.83%	7.599	4.956	2.643	34.78%
KENNETT TWP					2.38	2.22	0.16	6.72%	0.213	0.198	0.015	7.04%
MODENA BORO	27.96	12.46	15.50	55.43%	4.80	3.25	1.55	32.29%	0.966	0.656	0.31	32.09%
NEWLIN TWP	144.18	59.59	84.59	58.67%	6.53	4.57	1.96	30.02%	1.337	0.936	0.401	29.99%
PARKESBURG BORO	52.11	32.35	19.76	37.93%								
PENNSBURY TWP	113.98	43.48	70.50	61.85%	47.00	43.71	3.29	7.00%	4.206	3.911	0.295	7.01%
POCOPSON TWP	821.21	320.79	500.42	60.94%								
SADSBURY TWP	289.73	172.13	117.60	40.59%	3.05	2.26	0.79	25.90%	0.329	0.205	0.124	37.69%
THORNBURY TWP	82.17	34.46	47.71	58.06%								
UPPER UWCHLAN TWP					10.92	8.96	1.96	17.95%	0.166	0.137	0.029	17.47%
VALLEY TWP	485.14	164.64	320.50	66.06%	57.57	43.75	13.82	24.01%	6.941	4.726	2.215	31.91%
WALLACE TWP	21.74	17.41	4.33	19.92%	126.53	103.76	22.77	18.00%	1.929	1.582	0.347	17.99%
WEST BRADFORD TWP	283.22	121.6	161.62	57.07%	17.25	12.08	5.17	29.97%	3.532	2.473	1.059	29.98%
WEST BRANDYWINE TWP					136.01	104.78	31.23	22.96%	9.63	8.344	1.286	13.35%
WEST CALN TWP	68.28	43.07	25.21	36.92%	183.72	149.26	34.46	18.76%	9.95	8.649	1.301	13.08%
WEST GOSHEN TWP	461.32	180.51	280.81	60.87%								

	Sediment (tons/year)				Total Nitrogen (kg/day)				Total Phosphorus (kg/day)			
Red Clay Creek Watershed	Baseline MS4 Load[1c.]	MS4 Load Allocation[1c.]	MS4 Load Reduction [1e.]	% Reduction[1c.]	Baseline MS4 Load [2h.]	MS4 Allocation[2b.]	MS4 Load Reduction[2m.]	% Reduction [2m.]	Baseline MS4 Load [2k.]	MS4 Allocation[2e.]	MS4 Load Reduction[2m.]	% Reduction [2m.]
EAST MARLBOROUGH TWP	8791.41	4,193.24	4598.17	52.30%	137.13	68.56	68.57	50.00%	2.742	1.372	1.37	49.96%
KENNETT SQUARE BORO	840.10	405.41	434.69	51.74%	13.26	6.63	6.63	50.00%	0.452	0.151	0.301	66.59%
KENNETT TWP	6751.63	3,312.06	3439.57	50.94%	157.97	97.83	60.14	38.07%	21.517	3.731	17.786	82.66%
NEW GARDEN TWP	4709.65	2,118.72	2590.93	55.01%	77.03	38.52	38.51	49.99%	27.708	2.87	24.838	89.64%
PENNSBURY TWP					4.32	4.32	0.00	0.00%	0.082	0.082	0.00	0.00%

	Sediment (tons/year)				Total Nitrogen (kg/day)				Total Phosphorus (kg/day)			
White Clay Creek Watershed	Baseline MS4 Load[1d.]	MS4 Load Allocation[1d.]	MS4 Load Reduction [1e.]	% Reduction[1d.]	Baseline MS4 Load [2i.]	MS4 Allocation[2c.]	MS4 Load Reduction[2m.]	% Reduction [2m.]	Baseline MS4 Load [2l.]	MS4 Allocation[2f.]	MS4 Load Reduction[2m.]	% Reduction [2m.]
AVONDALE BORO	463.65	140.02	323.63	69.80%	9.16	4.58	4.58	50.00%	0.322	0.135	0.187	58.07%
FRANKLIN TWP	4220.43	2,305.87	1914.56	45.36%	122.01	61.01	61	50.00%	15.219	5.557	9.662	63.49%
KENNETT TWP					2.17	2.17	0.00	0.00%	0.055	0.055	0	0.00%
LONDON BRITAIN TWP	2634.66	1,620.44	1014.22	38.50%	96.47	49.9	46.57	48.27%	15.732	7.333	8.399	53.39%
LONDON GROVE TWP	13616.33	4,842.81	8773.52	64.43%	262.76	128.47	134.29	51.11%	25.875	7.965	17.91	69.22%
NEW GARDEN TWP	6746.50	2,986.66	3759.84	55.73%	167.06	83.83	83.23	49.82%	41.916	13.374	28.542	68.09%
NEW LONDON TWP	1913.97	1,008.60	905.37	47.30%	53.56	26.61	26.95	50.32%	0.65	0.292	0.358	55.08%
PENN TWP	3584.76	1,410.29	2174.47	60.66%	71.23	33.36	37.87	53.17%	0.798	0.359	0.439	55.01%
WEST GROVE BORO	562.29	192.63	369.66	65.74%	9.24	4.36	4.88	52.81%	0.112	0.05	0.062	55.36%

(1) U.S. EPA Region III. 8 April 2005. Total Maximum Daily Loads for Bacteria and Sediment in the Christina River Basin Watershed Pennsylvania, Delaware, and Maryland. Philadelphia, PA.

(2) U.S. EPA Region III. 26 September 2006. Revisions to Total Maximum Daily Loads for Nutrient and Low Dissolved Oxygen under High-flow Conditions: Christina River Basin Watershed, Pennsylvania, Delaware, and Maryland. Philadelphia, PA

a. Table 4.2 Fecal coliform TMDL allocations for MS4 municipalities. p 4-5

b. Table 4.8 Sediment allocations for towns in Brandywine Creek Watershed. p 4-16

c. Table 4.9 Sediment allocations for towns in Red Clay Creek Watershed. p 4-16

d. Table 4.10 Preliminary sediment allocations for towns in White Clay Creek Watershed. p 4-16

e. Calculated by CCWRA using Tables listed in 1a.-1d. listed above.
MS4 Reduction = (Baseline MS4 Load) - (MS4 Load Allocation)

a. Appendix C -Table C-5b. Total nitrogen MS4 allocations for Brandywine Creek watershed (kg/day) p. C-6

b. Appendix C. Table C-7b. Total nitrogen MS4 allocations for Red Clay Creek watershed (kg/day) p. C-9

c. Appendix C. Table C-9b. Total nitrogen MS4 allocations for White Clay Creek watershed (kg/day) p. C-11

d. Appendix C. Table C-6b. Total phosphorus MS4 allocations for Brandywine Creek watershed (kg/day) p.C-8

e. Appendix C. Table C-8b. Total phosphorus MS4 allocations for Red Clay Creek watershed (kg/day) p. C-10

f. Appendix C. Table C-10b. Total phosphorus MS4 allocations for White Clay Creek watershed (kg/day) p. C-13

g. Appendix C -Table C-5a. Total nitrogen MS4 baseline loads for Brandywine Creek watershed (kg/day) p. C-5

h. Appendix C. Table C-7a. Total nitrogen MS4 baseline loads for Red Clay Creek watershed (kg/day) p. C-8

i. Appendix C. Table C-9a. Total nitrogen MS4 baseline loads for White Clay Creek watershed (kg/day) p. C-10

j. Appendix C. Table C-6a. Total phosphorus MS4 baseline loads for Brandywine Creek watershed (kg/day) p.C-7

k. Appendix C. Table C-8a. Total phosphorus MS4 baseline loads for Red Clay Creek watershed (kg/day) p. C-9

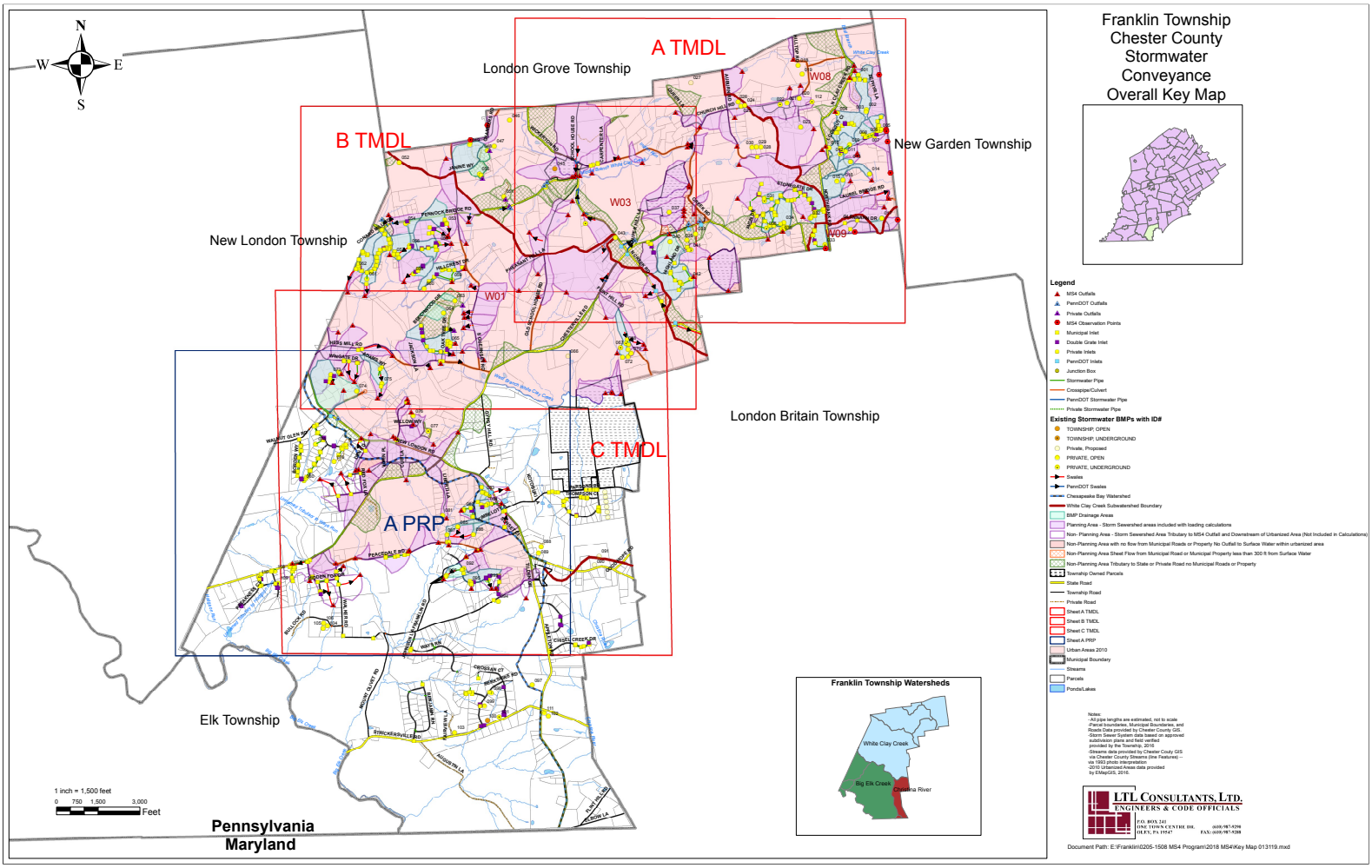
l. Appendix C. Table C-10a. Total phosphorus MS4 baseline loads for White Clay Creek watershed (kg/day) p. C-12

m. Calculated by CCWRA using Tables listed in 2a.-2l. listed above. MS4 Reduction = (MS4 Baseline Load) - (MS4 Allocation);
%Reduction = (MS4 Load Reduction) / (MS4 Baseline Load)

Exhibit 5

Stormwater Conveyance Overall Key Map

Exhibit 5


Franklin Township
Chester County
Stormwater
Conveyance
Overall Key Map
A TMDL
B TMDL
C TMDL
A PRP
London Grove Township
New Garden Township
New London Township
London Britain Township
Elk Township
Pennsylvania
Maryland
W01
W03
W08
W09
Legend
Franklin Township Watersheds
White Clay Creek
Big Elk Creek
Christina River
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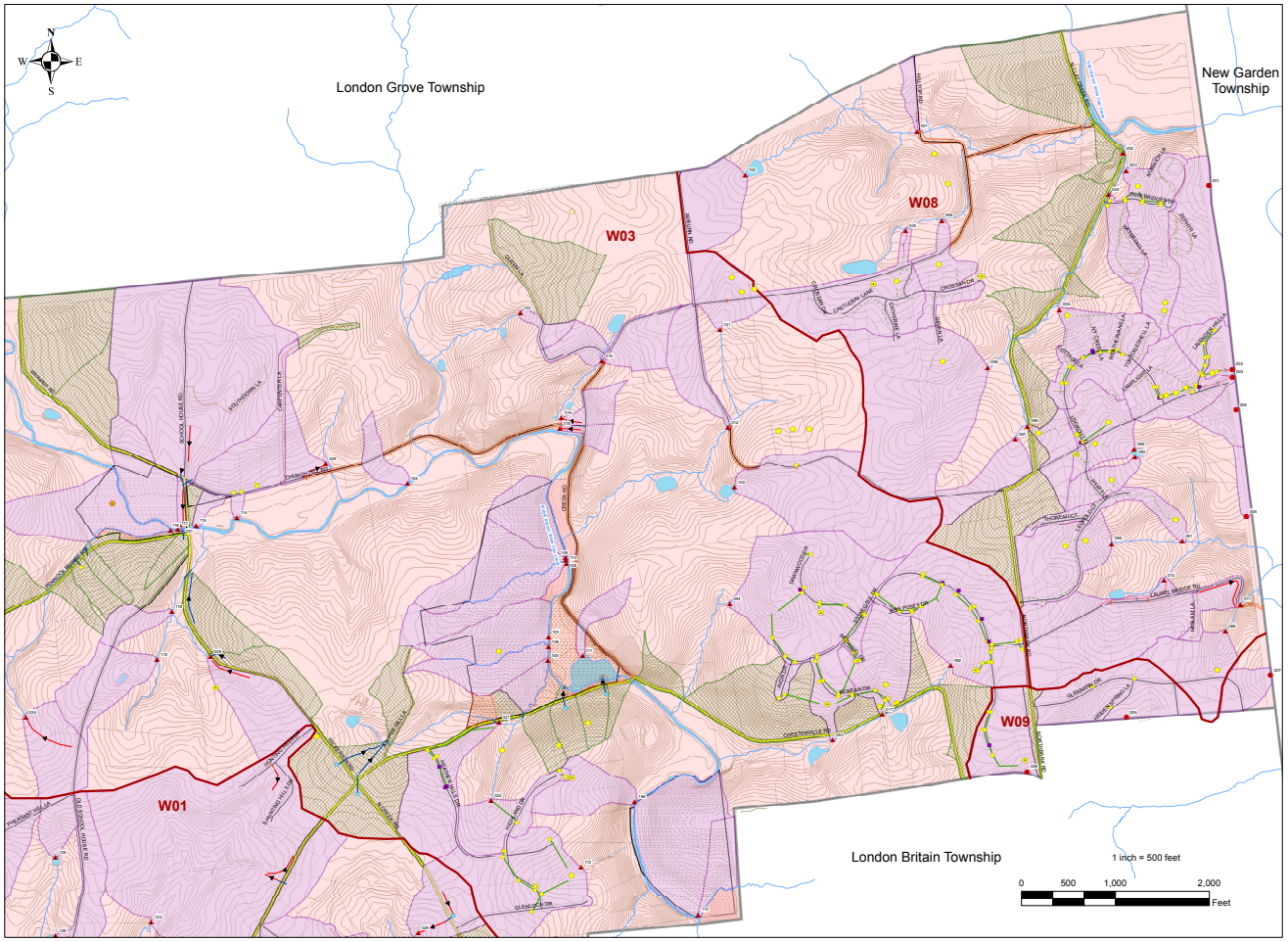
Document Path: E:\Franklin\0205-1508 MS4 Program\2018 MS4\Key Map 013119.mxd

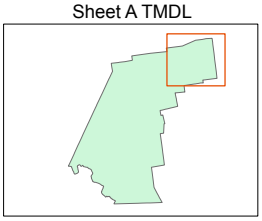
Exhibit 6

Stormwater Conveyance and Storm Sewersheds – Sheets A thru C TMDL

Exhibit 6

Franklin Township Stormwater Conveyance and Storm Sewersheds Sheet A TMDL





Legend

Existing Stormwater BMPs with ID#

Notes:
- All pipe lengths are estimated, not to scale
- Parcel boundaries, Municipal Boundaries, and Road Centerlines via Chester County GIS.
- Storm Sewer System data based on approved subdivision plans and field verified provided by the Township, 2016
- Streams data provided by Chester Couty GIS via Chester County Streams (line Features) -- via 1993 photo interpretation.
- 2010 Urbanized Areas data provided by ESRIaprGIS, 2016.

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Exhibit 6

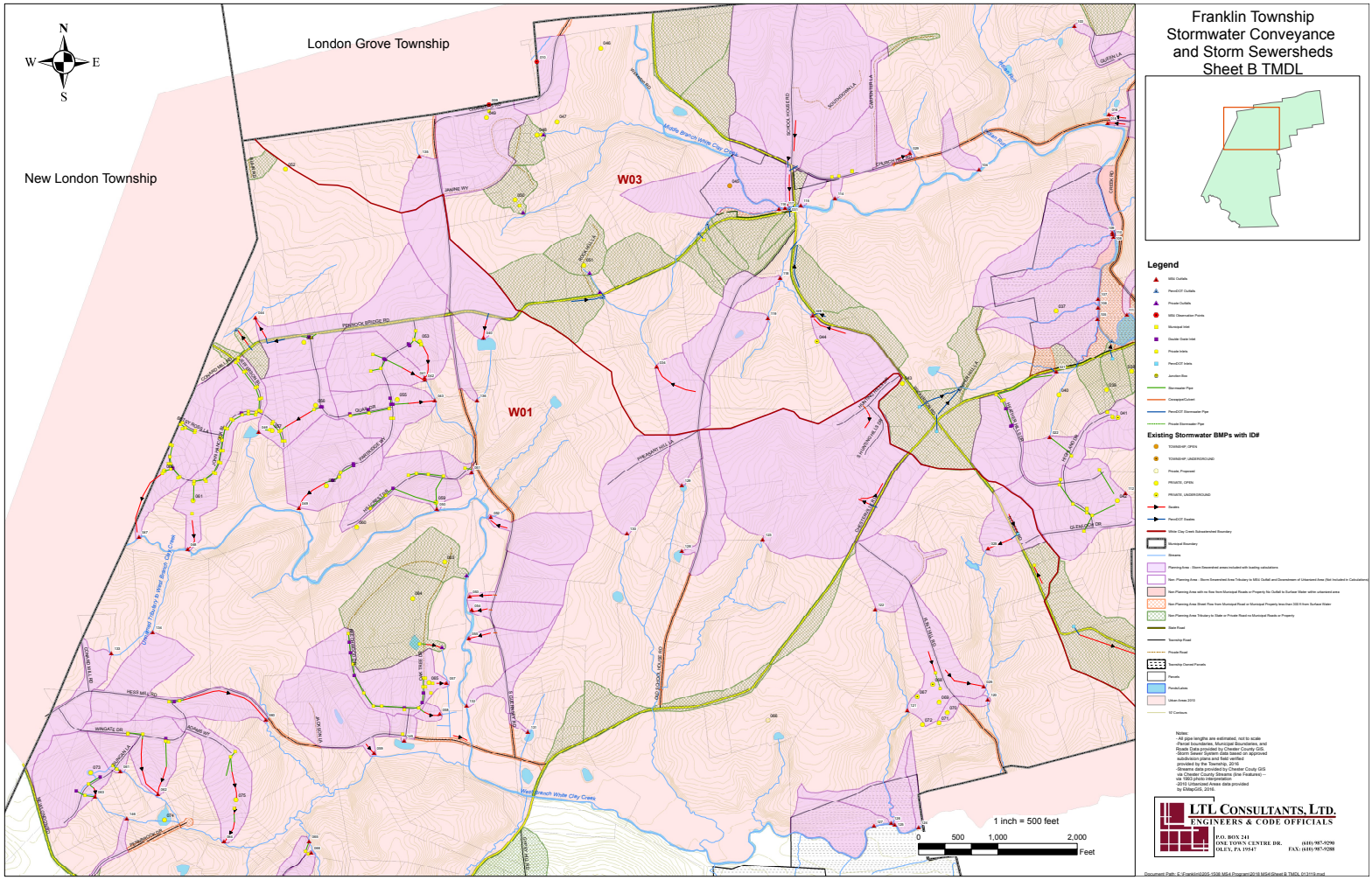
N
W
E
S
London Grove Township
New London Township
W03
W01
Middle Branch White Clay Creek
West Branch White Clay Creek
1 inch = 500 feet
0
500
1,000
2,000
Feet
Franklin Township
Stormwater Conveyance
and Storm Sewersheds
Sheet B TMDL
Legend
Existing Stormwater BMPs with ID#
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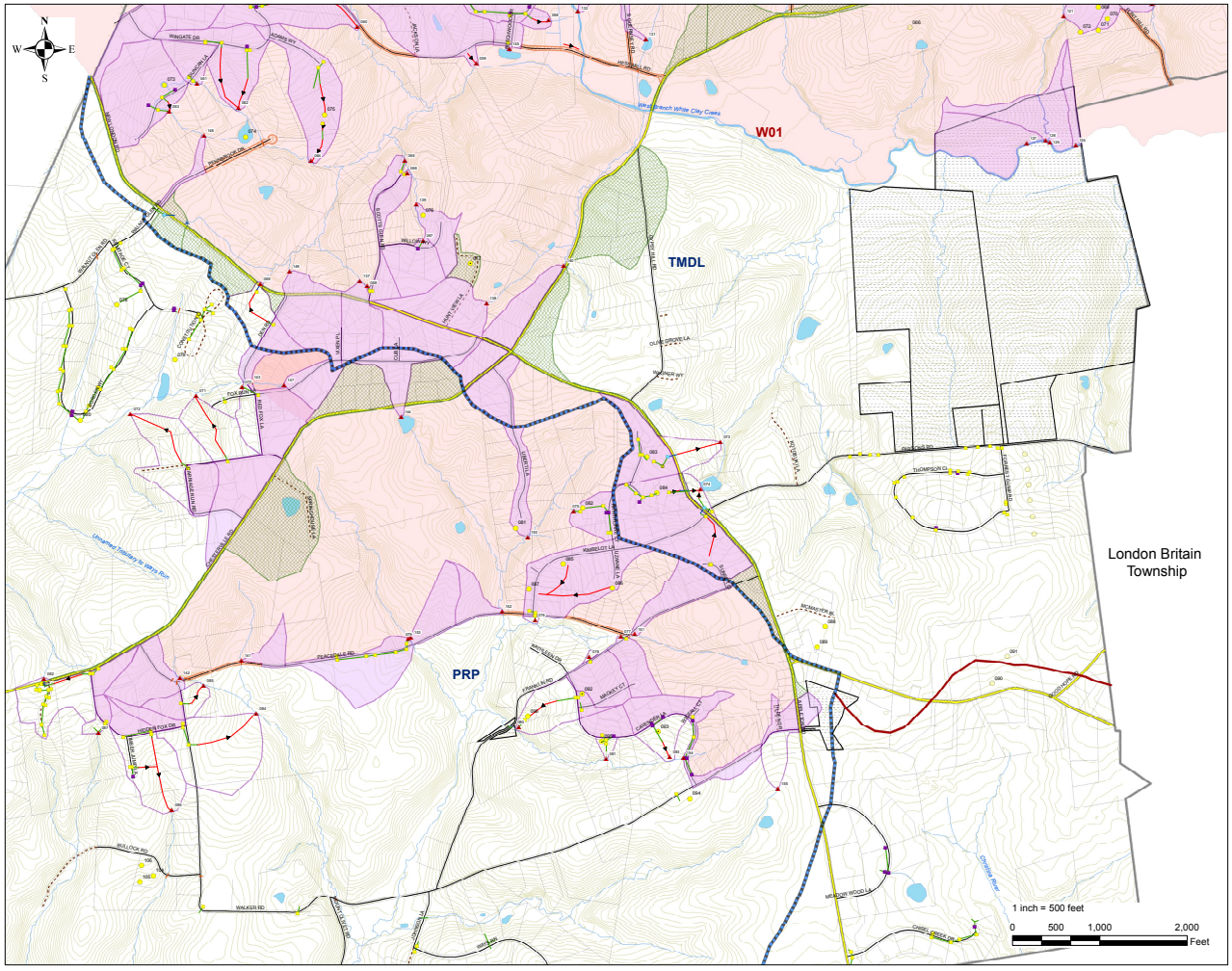
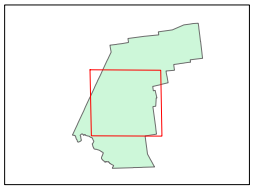
Exhibit 6

Franklin Township Stormwater Conveyance and Storm Sewersheds Sheet C TMDL





Legend

MS4 Outfalls
PennDOT Outfalls
Private Outfalls
MS4 Observation Points
Municipal Inlet
Double Grate Inlet
Private Inlets
PennDOT Inlets
Junction Box
Stormwater Pipe
Crosspipe
PennDOT Stormwater Pipe
Private Stormwater Pipe

Existing Stormwater BMPs with ID#

TOWNSHIP OPEN
TOWNSHIP UNDERGROUND
Private, Proposed
PRIVATE, OPEN
PRIVATE, UNDERGROUND
Swales
PennDOT Swales
Chesapeake Bay Watershed
White Clay Creek Subwatershed Boundary
Streams
Planning Area - Storm Sewersheds areas included in loading calculations
Non- Planning Area - Storm Sewersheds Area Tributary to MS4 Outfall and Downstream of Urbanized Area (Not Included in Calculations)
Non Planning Area with no flow from Municipal Roads or Property No Outfall to Surface Water within urbanized area
Non Planning Area Sheet Flow from Municipal Road or Municipal Property less than 300 ft from Surface Water
Non Planning Area Tributary to State or Private Road no Municipal Roads or Property
State Road
Township Road
Private
Township Owned Parcels
Parcels
Municipal Boundary
Ponds/Lakes
Urban Areas 2010
10' Contours

Notes:
- All pipe lengths are estimated, not to scale
-Parcel boundaries, Municipal Boundaries, and Roads Data provided by Chester County GIS.
-Storm Sewer System data based on approved Franklin Township MS4 Mapping provided by the Township, 2016
-Streams data provided by Chester Coudy GIS via Chester County Streams (line Features) – via 1993 photo interpretation
-Impervious Cover data provided by EMapGIS, 2016.

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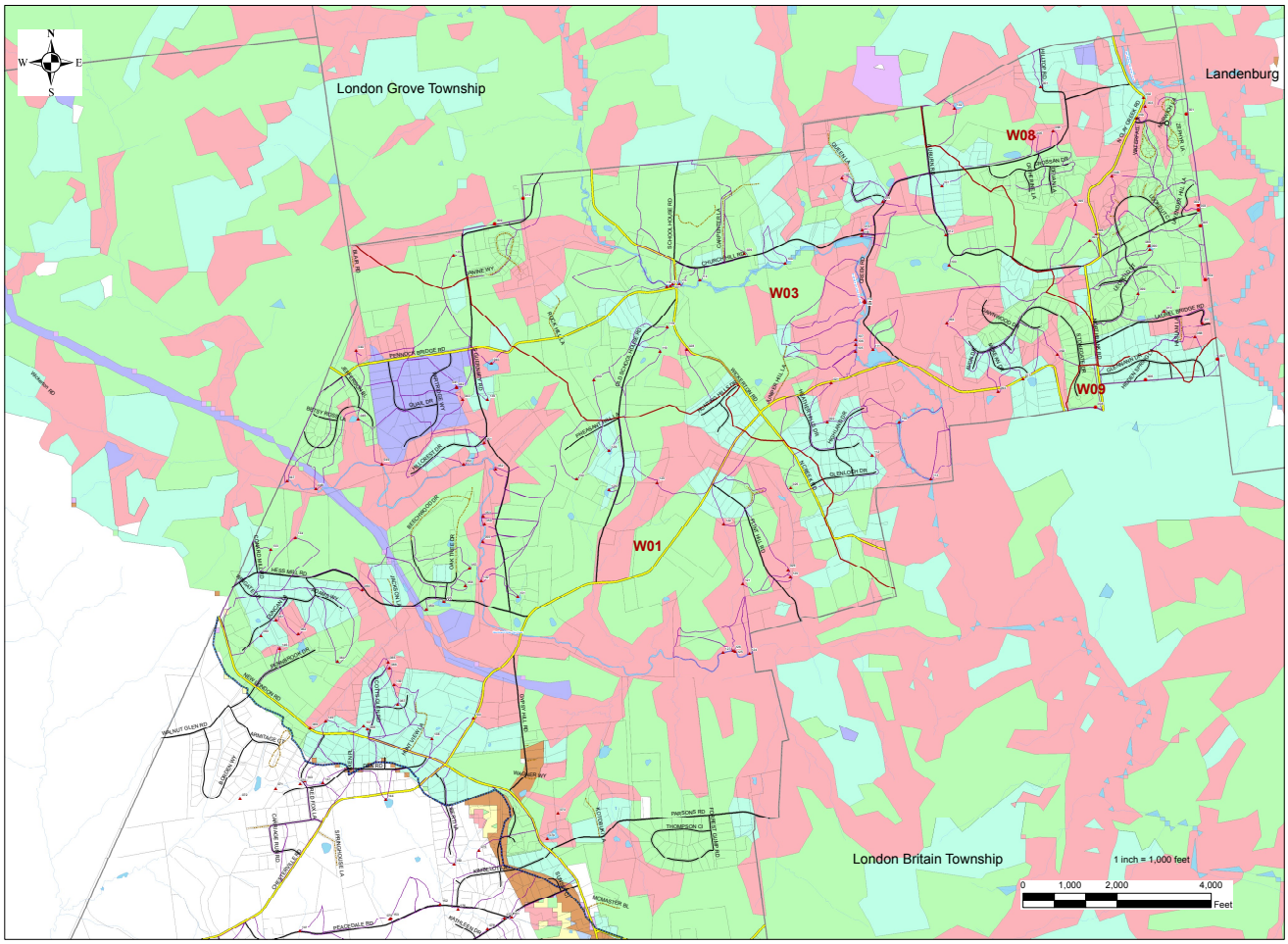
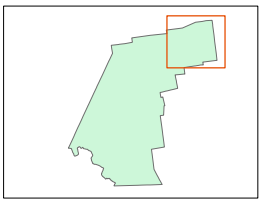
Exhibit 7

Storm Sewersheds and Mapshed Land Use (Existing Cover) – 1995 TMDL & 2012 TMDL

Exhibit 7

Storm Sewersheds and Mapshed Landuse 1995 TMDL





Legend

- MS4 Outfalls
- MS4 Observation Points
- Chesapeake Bay Watershed
- White Clay Creek Subwatershed Boundary
- Streams
- Planning Area - Storm Sewershed areas included with loading calculations
- State Road
- Township Road
- Private Road
- Parcels
- Municipal Boundary
- Ponds/Lakes
- Cropland
- Disturbed
- Forest
- Hay/Pasture
- High-Density Mixed Urban
- Low-Density Residential
- Medium-Density Residential
- Open Land
- Water
- Wetland

Notes:
- All pipe lengths are estimated, not to scale
-Parcel boundaries, Municipal Boundaries, and Roads Data provided by Chester County GIS.
-Storm Sewer System data based on approved subdivision plans and field verified provided by the Township, 2016
-Streams data provided by Chester Couty GIS via Chester County Streams (line Features) -- via 1993 photo interpretation
-2010 Urbanized Areas data provided by EMapGIS, 2016.

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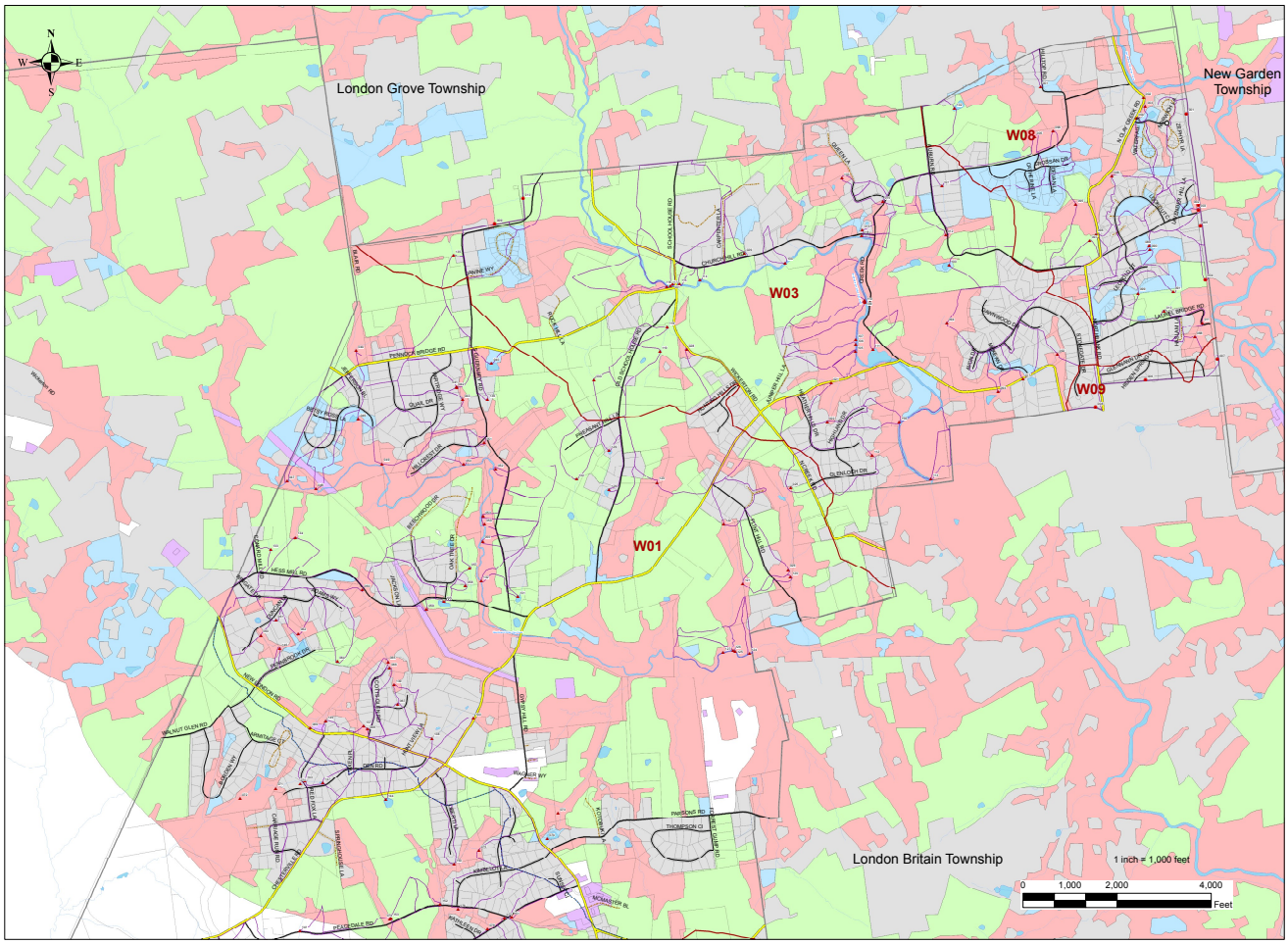
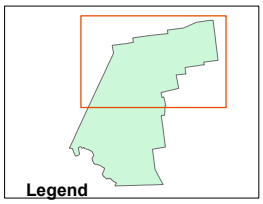
Document Path: E:\Franklin\0205-1908 MS4 Program\2018 MS4\Mapshed Landuse 1995 TMDL 021119 storm sewersheds.mxd

Exhibit 7

Storm Sewersheds and Mapshed Landuse 2012 TMDL





Legend

- MS4 Outfalls
- MS4 Observation Points
- Chesapeake Bay Watershed
- White Clay Creek Subwatershed Boundary
- Streams
- Planning Area - Storm Sewershed areas included with loading calculations
- State Road
- Township Road
- Private Road
- Parcels
- Municipal Boundary
- Ponds/Lakes
- Cropland
- Disturbed
- Forest
- High-Density Mixed Urban
- Low-Density Residential
- Water
- Wetland

Notes:
- All pipe lengths are estimated, not to scale
-Parcel boundaries, Municipal Boundaries, and Roads Data provided by Chester County GIS.
-Storm Sewer System data based on approved subdivision plans and field verified provided by the Township, 2016
-Streams data provided by Chester Couty GIS via Chester County Streams (line Features) -- via 1993 photo interpretation
-2010 Urbanized Areas data provided by EMapGIS, 2016.

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Exhibit 8

1995 Land Use Loading Calculations

Watershed: White Clay Creek East Branch (W09)
Land Use Loading Calculations
Year: 1995 Land Use

Includes Storm Sewershed areas from:
MS4 Outfalls: None
MS4 Observation Points: 6 thru 8

Mapshed Land Use Categories

Hay/Pasture	Cropland	Forest	Wetland/ Water	Open Land	HD_ Mixed	LD_ Residential	MD_ Residential	Total
(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)
0.00	10.72	0.13	0.00	0.00	0.00	23.11	0.00	33.96

Apply 1995 land use loading rates

Land Use	Area	1995 Sediment Loading Rate	1995 Sediment Loading	1995 Nitrogen Loading Rate	1995 Nitrogen Loading	1995 Phosphorus Loading Rate	1995 Phosphorus Loading
	(acres)	(lbs/acre/yr)	(lbs/yr)	(lbs/acre/yr)	(lbs/yr)	(lbs/acre/yr)	(lbs/yr)
Hay/Pasture	0.00	181.72	0.00	0.94	0.00	0.26	0.00
Cropland	10.72	1499.30	16077.14	5.96	63.91	1.57	16.84
Forest	0.13	111.43	14.20	0.15	0.02	0.04	0.01
Wetland/Water	0.00	97.86	0.00	0.48	0.00	0.04	0.00
Open Land	0.00	230.82	0.00	1.13	0.00	0.12	0.00
HD_Mixed	0.00	2055.61	0.00	6.83	0.00	0.95	0.00
LD_Residential	23.11	616.19	14239.53	1.64	37.90	0.25	5.78
MD_Residential	0.00	1464.34	0.00	6.83	0.00	0.89	0.00
Total	33.96		30330.87		101.83		22.62

Watershed: White Clay Creek East Branch (W08)
Land Use Loading Calculations
Year: 1995 Land Use

Includes Storm Sewershed areas from:
MS4 Outfalls: 1 thru 6, 10, 11, 88, 89, 91, 95 thru 99, 102
MS4 Observation Points: 1 thru 5

Mapshed Land Use Categories

Hay/Pasture	Cropland	Forest	Wetland/ Water	Open Land	HD_ Mixed	LD_ Residential	MD_ Residential	Total
(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)
0.00	173.45	48.42	0.00	0.00	0.00	37.02	0.00	258.88

Apply 1995 land use loading rates

Land Use	Area	1995 Sediment Loading Rate	1995 Sediment Loading	1995 Nitrogen Loading Rate	1995 Nitrogen Loading	1995 Phosphorus Loading Rate	1995 Phosphorus Loading
	(acres)	(lbs/acre/yr)	(lbs/yr)	(lbs/acre/yr)	(lbs/yr)	(lbs/acre/yr)	(lbs/yr)
Hay/Pasture	0.00	181.72	0.00	0.94	0.00	0.26	0.00
Cropland	173.45	1499.30	260053.59	5.96	1033.76	1.57	272.32
Forest	48.42	111.43	5395.30	0.15	7.26	0.04	1.94
Wetland/Water	0.00	97.86	0.00	0.48	0.00	0.04	0.00
Open Land	0.00	230.82	0.00	1.13	0.00	0.12	0.00
HD_Mixed	0.00	2055.61	0.00	6.83	0.00	0.95	0.00
LD_Residential	37.02	616.19	22808.89	1.64	60.71	0.25	9.25
MD_Residential	0.00	1464.34	0.00	6.83	0.00	0.89	0.00
Total	258.88		288257.77		1101.73		283.51

Watershed: White Clay Creek Middle Branch (W03)
Land Use Loading Calculations
Year: 1995 Land Use

Includes Storm Sewershed areas from:
MS4 Outfalls: 12, 15 thru 18, 21, 22, 28 thru 31, 34, 92 thru 94, 100, 101, 103 thru 119, 135, 156
MS4 Observation Points: 9, 10

Mapshed Land Use Categories

Hay/Pasture	Cropland	Forest	Wetland/ Water	Open Land	HD_ Mixed	LD_ Residential	MD_ Residential	Total
(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)
0.00	252.84	138.63	2.02	0.00	0.00	122.53	0.00	516.02

Apply 1995 land use loading rates

Land Use	Area	1995 Sediment Loading Rate	1995 Sediment Loading	1995 Nitrogen Loading Rate	1995 Nitrogen Loading	1995 Phosphorus Loading Rate	1995 Phosphorus Loading
	(acres)	(lbs/acre/yr)	(lbs/yr)	(lbs/acre/yr)	(lbs/yr)	(lbs/acre/yr)	(lbs/yr)
Hay/Pasture	0.00	181.72	0.00	0.94	0.00	0.26	0.00
Cropland	252.84	1499.30	379077.61	5.96	1506.90	1.57	396.95
Forest	138.63	111.43	15448.04	0.15	20.80	0.04	5.55
Wetland/Water	2.02	97.86	197.26	0.48	0.97	0.04	0.08
Open Land	0.00	230.82	0.00	1.13	0.00	0.12	0.00
HD_Mixed	0.00	2055.61	0.00	6.83	0.00	0.95	0.00
LD_Residential	122.53	616.19	75504.29	1.64	200.96	0.25	30.63
MD_Residential	0.00	1464.34	0.00	6.83	0.00	0.89	0.00
Total	516.02		470227.20		1729.62		433.21

Watershed: White Clay Creek West Branch (W01)
Land Use Loading Calculations
Year: 1995 Land Use

Includes Storm Sewershed areas from:
MS4 Outfalls: 26, 40 thru 44, 46 thru 55, 57 thru 69, 73, 74, 120 thru 134, 136 thru 140, 145, 146, 149
MS4 Observation Points: None

Mapshed Land Use Categories

Hay/Pasture	Cropland	Forest	Wetland/ Water	Open Land	HD_ Mixed	LD_ Residential	MD_ Residential	Total
(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)
0.22	258.31	102.23	0.49	83.42	0.25	217.44	6.82	669.18

Apply 1995 land use loading rates

Land Use	Area	1995 Sediment Loading Rate	1995 Sediment Loading	1995 Nitrogen Loading Rate	1995 Nitrogen Loading	1995 Phosphorus Loading Rate	1995 Phosphorus Loading
	(acres)	(lbs/acre/yr)	(lbs/yr)	(lbs/acre/yr)	(lbs/yr)	(lbs/acre/yr)	(lbs/yr)
Hay/Pasture	0.22	181.72	39.85	0.94	0.21	0.26	0.06
Cropland	258.31	1499.30	387279.84	5.96	1539.51	1.57	405.54
Forest	102.23	111.43	11392.01	0.15	15.34	0.04	4.09
Wetland/Water	0.49	97.86	48.38	0.48	0.24	0.04	0.02
Open Land	83.42	230.82	19253.97	1.13	94.26	0.12	10.01
HD_Mixed	0.25	2055.61	516.57	6.83	1.72	0.95	0.24
LD_Residential	217.44	616.19	133982.51	1.64	356.60	0.25	54.36
MD_Residential	6.82	1464.34	9985.92	6.83	46.58	0.89	6.07
Total	669.18		562499.05		2054.44		480.39

Christina Basin Land Use Loading Rates Calculation Tool

Watershed: White Clay Creek **Year: 1995**

prepared by:
Chester County Water Resources Authority (CCWRA)

in consultation with:
Barry Evans, Ph.D., Pennsylvania State University
and
Bill Brown, PA Department of Environmental Protection (PADEP)

Original Publication Date: May 5, 2017
CORRECTED Publication Date: May 12, 2017

PURPOSE AND LIMITATIONS: This Excel workbook tool was developed for use by municipalities that have MS4 discharges and load reduction responsibilities within the PA portion of the Christina Basin. This tool calculates land use pollutant loading rates for TSS, TN and TP using calculations, methodology, assumptions, and data based on and consistent with the desktop Christina Basin MapShed model, and consistent with PADEP's 2017 TMDL and PRP instructions for MS4s. This tool is not recommended for use in other geographic areas or with other load calculation methodologies, or other land use load data. The desktop Christina Basin MapShed model was developed by CCWRA (2012, revised 2017) in conjunction with Dr. Barry Evans (Pennsylvania State University) and in consultation with Mr. Bill Brown (PADEP).

_____

On behalf of the Christina Watersheds Municipal Partnership, the Chester County Water Resources Authority gratefully acknowledges the assistance provided to this effort by Dr. Barry Evans (Pennsylvania State University) and Mr. Bill Brown, PA Department of Environmental Protection.

Partial Funding for the Christina Watersheds Municipal Partnership and the Brandywine/Christina Water Quality Restoration Collaboration Effort was made available through:
Brandywine Red Clay Alliance by
National Fish and Wildlife Foundation

Funding to provide technical assistance for this Calculation Tool was made available to:
Pennsylvania State University by
PA Department of Environmental Protection
and
Chester County Water Resources Authority by
Chester County Board of Commissioners

Look-Up Table: Christina Basin MapShed Land Use Loading Rates

Christina Basin MapShed Output File Results Converted to Land Use Loading Rates

Watershed: White Clay Creek

Year: 1995

Section 1: Instructions & Overview

INSTRUCTIONS:

Municipalities are to use the Look-Up Table provided herein and copy the loading rates for the applicable watershed, applicable year, and applicable pollutants and use those values in their further calculations. The intention is that the municipality prints out each workbook for the years 1995 and 2012 for each watershed located in their Planning Area(s). It is suggested that these workbooks be placed in an appendix in their PA DEP MS4 submittal as documentation of the source of the loading rates they used in their plans and calculations.

OVERVIEW:

Seperate Look-up Tables have been created for 3 Christina Basin watersheds (Brandywine, White Clay or Red Clay) for the years 1995 and 2012. This workbook is one of six workbook files that have been provided; each file contains loading rates for pollutants Sediment, Nitrogen and Phosphorus.

The Christina Basin MapShed model and the methodology used herein to calcute Chrsitina MapShed Land Use Loading Rates were developed by Chester County Water Resources Authority in conjunction with and direction from Dr. Barry Evans (Penn State) and Bill Brown (PADEP).

Municipalties Do NOT need to enter values into this workbook. This workbook serves as a Look-up Table.

THIS WORKBOOK CONTAINS:

Section 2 (Land Use Loading Rates Look-Up Table) contains the Look-Up Table with final Christina MapShed land use loading rates that incorporate Land Use (upland source), Stream Bank (erosion) and Farm Animal Loads. **The bolded Total (pollutant) Loading Rate values in this Table are to be used by municipalities to calculate their Baseline and Existing loads and urban BMP load reductions. The "From Land Use" values in this Table are to be used to calculate street sweeping load reductions.**

***** In the MapShed model, Stream Bank and Farm Animal loads are modeled as separate sources/outputs, and therefore must be apportioned into the land use loads. This calculation has been completed herein and the results are summarized on the Look-up Table. Stream Bank loads are mostly attributable to developed lands. Farm Animal loads are attributed to Cropland and Hay/Pasture land uses.

***** The Look-Up Table also shows loads calculated by the Christina MapShed model from septic, groundwater and point sources, however, per PA DEP guidance, these loads are NOT included in the land use loading rates presented in the Table. These loads are not loads that enter the MS4 and therefore these loads are not a pollutant load that is required to be addressed in the MS4 program. Please note, when comparing the nitrogen and phosphorus loading rates to other literature values for a watershed, the rates in this workbook may appear lower by land use for nutrients because of these adjustments. Groundwater loading of nitrogen and phosphorus are generally attributed to long-term agricultural practices.

Section 3 (Christina Basin MapShed Output) contains the actual Christina MapShed output file data that are used for calculations throughout this workbook. DO NOT USE THESE DATA. This section is for CCWRA Use only.

Section 4 (Map) Contains a Map of Chester County's portion of the Christina Basin watershed.

Sections 5 through 8 Contain supporting documentation that show how the calculations were performed to arrive at the values for the watershed that were presented in the Look-up Table in Section 2.

Section 9 Contains a table that presents EPA Christina TMDL Baseline Pollutant Loadings, MS4 Wasteload Allocations, and required volume and Percent Reductions for each municipality by watershed. These data were taken from the tables in the EPA TMDL reports by Chester County Water Resources Authority in 2012.

Look-Up Table: Christina Basin MapShed Loading Rates

Watershed: White Clay Creek

Year: 1995

Source File: 1995WCnewrun_noatten-Summary_sum.csv

Section 2: Land Use Loading Rates Look-Up Table

TOTAL WATERSHED ANNUAL LOADS from Christina MapShed

ANNUAL LAND USE LOADING RATES (lbs/acre) based on land use, stream bank and farm animal sources

	Source	Area	Sediment	Total Nitrogen	Total Phosphorus	SEDIMENT: From Land Use	SEDIMENT: From Stream Banks ①	SEDIMENT: TOTAL SEDIMENT LOADING RATE	NITROGEN: From Land Use	NITROGEN: From Stream Banks ①	NITROGEN: From Farm Animals ②	NITROGEN: TOTAL NITROGEN LOADING RATE	PHOSPHORUS: From Land Use	PHOSPHORUS: From Stream Banks ①	PHOSPHORUS: From Farm Animals ②	PHOSPHORUS: TOTAL PHOSPHORUS LOADING RATE	
	Units	*Acres*	*Tons*	*Pounds*	*Pounds*	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	lbs/acre	
						Tons * 2000 lbs/ton / acres of a land use		Sum of previous two sources	Tons * 2000 lbs/ton / acres of a land use			Sum of previous three sources	Tons * 2000 lbs/ton / acres of a land use			Sum of previous three sources	
MapShed Land Use Categories	Hay/Past	1,490.00	64.97	782.75	246.19	87.21	94.51	**181.72**	0.53	0.05	0.36	**0.94**	0.17	0.02	0.07	**0.26**	Hay/Past
	Cropland	20,630.80	14,490.98	114,472.98	30,594.17	1,404.79	94.51	**1,499.30**	5.55	0.05	0.36	**5.96**	1.48	0.02	0.07	**1.57**	Cropland
	Forest	16,299.00	137.92	1,691.01	253.51	16.92	94.51	**111.43**	0.10	0.05	n/a	**0.15**	0.02	0.02	n/a	**0.04**	Forest
	Wetland	560.90	0.94	239.33	13.49	3.35	94.51	**97.86**	0.43	0.05	n/a	**0.48**	0.02	0.02	n/a	**0.04**	Wetland
	Disturbed	56.80	1.31	7.80	3.48	46.13	94.51	**140.64**	0.14	0.05	n/a	**0.19**	0.06	0.02	n/a	**0.08**	Disturbed
	Turfgrass	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**	Turfgrass
	Open_Land	5,305.30	361.59	5,755.65	525.14	136.31	94.51	**230.82**	1.08	0.05	n/a	**1.13**	0.10	0.02	n/a	**0.12**	Open_Land
	Bare_Rock	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**	Bare_Rock
	Sandy_Areas	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**	Sandy_Areas
	Unpaved_Road	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	n/a	**0.00**	0.00	0.00	n/a	**0.00**	Unpaved_Road
	Ld_Mixed	3,237.10	71.51	3,842.92	425.23	44.18	556.72	**600.90**	1.19	0.28	n/a	**1.47**	0.13	0.10	n/a	**0.23**	Ld_Mixed
	Md_Mixed	1,722.30	223.25	9,724.98	1,013.82	259.25	1,191.69	**1,450.93**	5.65	0.60	n/a	**6.25**	0.59	0.22	n/a	**0.81**	Md_Mixed
	Hd_Mixed	773.40	101.81	4,583.40	482.55	263.28	1,792.33	**2,055.61**	5.93	0.90	n/a	**6.83**	0.62	0.33	n/a	**0.95**	Hd_Mixed
	Ld_Residential	6,251.80	185.92	8,522.07	921.38	59.48	556.72	**616.19**	1.36	0.28	n/a	**1.64**	0.15	0.10	n/a	**0.25**	Ld_Residential
	Md_Residential	101.30	13.81	631.60	67.84	272.66	1,191.69	**1,464.34**	6.23	0.60	n/a	**6.83**	0.67	0.22	n/a	**0.89**	Md_Residential
	Hd_Residential	192.70	26.55	1,270.48	137.08	275.56	1,792.33	**2,067.89**	6.59	0.90	n/a	**7.49**	0.71	0.33	n/a	**1.04**	Hd_Residential

	Source	Sediment	Total Nitrogen	Total Phosphorus
	Units	*Tons*	*Pounds*	*Pounds*
Addt'l Sources	Farm Animals		7,887.31	1,484.08
	Tile Drainage	0.00	0.00	0.00
	Stream Bank	6,689.09	6,688.82	2,469.17

Notes:

- Separate worksheets are used to calculate and apportion the loading rates from the **Stream Bank** source loads (for sediment, total nitrogen, and total phosphorus) from the Christina MapShed Output file into each land use category, using methodology provided from Dr. Barry Evans (Pennsylvania State University), the author of MapShed, and with concurrence from Mr. Bill Brown (PADEP).

- A separate worksheet is used to calculate and apportion the "Total Nitrogen" and "Total Phosphorus" loading rates from the **Farm Animals** source load from the Christina Basin MapShed Output file into the two agricultural land uses, Hay/Pasture and Cropland, based on area weighting. The methodology was provided by Dr. Barry Evans (Pennsylvania State University), the author of MapShed, and with concurrence from Mr. Bill Brown (PADEP). Additionally, since the **Farm Animals** source loads do not apply to other land use catergories, the values in those cells are "n/a".

Look-Up Table: Christina Basin MapShed Land Use Loading Rates

Watershed: White Clay Creek

Year: 1995

Section 3: Christina Basin MapShed Output

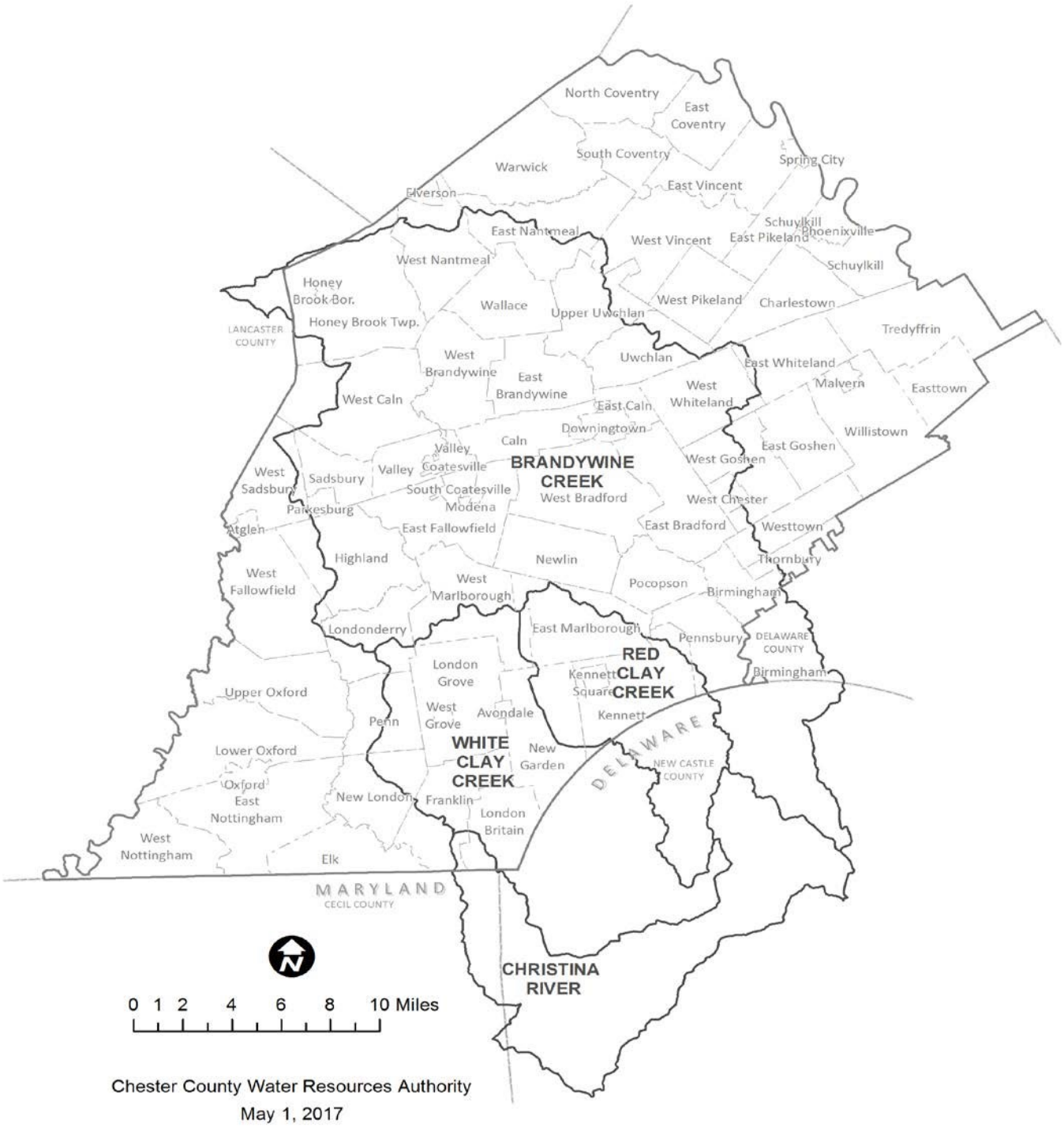
This page is where the output data from Christina Basin MapShed model is entered into this workbook and is the source data for calculations throughout the workbook. DO NOT USE OR CHANGE THE VALUES BELOW.
For use by CCWRA only.
Instructions followed by Chester County Water Resources Authority staff: Enter the data below from the MapShed output file without any modifications. Only enter data in the cells shaded blue.
1. Source File Name - filename for the output file from Christina Basin Version of MapShed.
2. Watershed Name - Name of Watershed for which land use loading rates were calculated (Brandywine Creek, White Clay Creek and Red Clay Creek).
3. Source file - The annual pollutant data, in English Units, is copied directly from the Christina Basin MapShed output file to the table below.
4. Year - the year modeled.

Data Entered By: Chester County Water Resources Authority
Date Data Entered: 5/12/2017
Source File Name: 1995WCnewrun_noatten-Summary_sum.csv
Watershed: White Clay Creek
Year: 1995

CHRISTINA BASIN MapShed OUTPUT DATA

Source	Area	Runoff	Erosion	Sediment	Dis N	Tot N	Dis P	Tot P
Units	*acres*	*inches/year*	*tons/year*	*tons/year*	*lbs/year*	*lbs/year*	*lbs/year*	*lbs/year*
Hay/Past	1,490.00	2.06	466.68	64.97	522.87	782.75	169.69	246.19
Cropland	20,630.80	4.17	108,030.90	14,490.98	56,509.04	114,472.98	6,184.11	30,594.17
Forest	16,299.00	1.62	1,014.41	137.92	1,139.39	1,691.01	59.99	253.51
Wetland	560.90	9.75	6.65	0.94	235.56	239.33	12.39	13.49
Disturbed	56.80	9.97	10.81	1.31	2.56	7.80	1.30	3.48
Turfgrass	-	-	-	-	-	-	-	-
Open_Land	5,305.30	7.17	2,448.59	361.59	4,309.28	5,755.65	86.20	525.14
Bare_Rock	-	-	-	-	-	-	-	-
Sandy_Areas	-	-	-	-	-	-	-	-
Unpaved_Road	-	-	-	-	-	-	-	-
Ld_Mixed	3,237.10	4.28	-	71.51	1,239.50	3,842.92	168.26	425.23
Md_Mixed	1,722.30	11.24	-	223.25	3,178.18	9,724.98	403.29	1,013.82
Hd_Mixed	773.40	16.46	-	101.81	1,485.52	4,583.40	191.07	482.55
Ld_Residential	6,251.80	4.83	-	185.92	2,414.85	8,522.07	342.80	921.38
Md_Residential	101.30	7.89	-	13.81	201.02	631.60	26.61	67.84
Hd_Residential	192.70	11.15	-	26.55	402.87	1,270.48	53.66	137.08
Farm Animals						7,887.31		1,484.08
Tile Drainage				-		-		-
Stream Bank				6,689.09		6,688.82		2,469.17
Groundwater					793,466.26	793,466.26	52,667.09	52,667.09
Point Source					32,897.34	32,897.34	2,924.65	2,924.65
Septic Systems					66,561.35	66,561.35	1,759.29	1,759.29

Section 4: Map of Chester County's portion of the Christina Basin Watersheds



Look-Up Table: Christina Basin MapShed Loading Rates

Watershed: White Clay Creek

Year: 1995

Section 5: Farm Animals TN and TP Loading Rates Worksheet

This worksheet calculates and apportions the "Total Nitrogen" and "Total Phosphorus" loading rates from the "Farm Animals" source load from the Christina Basin MapShed Output file into the two applicable agricultural land uses, Hay/Pasture and Cropland, based on area weighting. The methodology was provided by Dr. Barry Evans (Stroud Water Research Center, Pennsylvania State University), the author of MapShed, and with concurrence from Mr. Bill Brown (PADEP).

The MapShed output file provides the Farm Animals "Total Nitrogen" and "Total Phosphorus" loads in pounds.

Step 1. The Farm Animal "Total Nitrogen" and "Total Phosphorus" load, in pounds, and land areas for each land use category, in acres, from the Christina MapShed Output file are presented below.

Christina MapShed Total Watershed Load

	Total Nitrogen	Total Phosphorus	
Nutrient Load from Farm Animals	7,887.31	1,484.08	pounds
	①		

Note: The loads are taken from cells G33 and I33 from the Christina Basin MapShed Output worksheet

Land Use Categories from MapShed

Source	Area (acres)
Hay/Pasture	1,490.00
Cropland	20,630.80

- Since only the 'Hay/Pasture' and 'Cropland' land uses are apportioned Farm Loading Rates, the remaining land use categories are not applicable to this worksheet.

Step 2. Total Acres in "Hay/Pasture" and "Cropland" land uses are summed.

Area of Hay/Pasture & Cropland, acres	22,120.80 acres	=	[1490 acres + 20630.8 acres]

Step 3. Calculate the unit area Farm Animals loading rate (lbs/ac) to Total Nitrogen and Total Phosphorus for each land use by dividing the Farm Animal Load by the land use acres.

	Total Nitrogen	Total Phosphorus	
Nutrient Load from Farm Animals	7,887.31	1,484.08	pounds, from Step 1
Area of Hay/Pasture & Cropland	22,120.80	22,120.80	acres, from Step 2
Loading Rate for Hay/Pasture & Cropland	**0.36**	**0.07**	**pounds per acre**

Step 4. Add these Farm Animals loading rates to the Land Use (upland) and Stream Bank loading rates for Hay/Pasture and Cropland to calculate the Toal Nitrogen and Total Phosphorus loading rates as shown on the Land Use Loading Rates Look-Up Table.

Look-Up Table: Christina Basin MapShed Loading Rates

Watershed: White Clay Creek

Year: 1995

Section 6: Stream Bank Sediment Loading Rates Worksheet

This worksheet calculates and apportions the loading rates from the Stream Bank source load for sediment from the Christina MapShed Output file into each land use category, using methodology provided from Dr. Barry Evans (Pennsylvania State University), the author of MapShed, and with concurrence from Mr. Bill Brown (PADEP).

The MapShed output file provides the sediment load in tons, which are converted to pounds to be consistent with the loading rates for Total Nitrogen and Total Phosphorus.

Step 1. The Stream Bank Sediment Load, in tons, and land areas for each land use category, in acres, are presented below.

	Sediment		
Stream Bank	6,689.09	tons	Note: The sediment load is taken from Cell E35 in the Christina Basin MapShed Output worksheet

	Source	Area (acres)
Land Use Categories from MapShed	Hay/Pasture	1,490.00
	Cropland	20,630.80
	Forest	16,299.00
	Wetland	560.90
	Disturbed	56.80
	Turfgrass	0.00
	Open_Land	5,305.30
	Bare_Rock	0.00
	Sandy_Areas	0.00
	Unpaved_Road	0.00
	Ld_Mixed	3,237.10
	Md_Mixed	1,722.30
	Hd_Mixed	773.40
	Ld_Residential	6,251.80
	Md_Residential	101.30
	Hd_Residential	192.70
	Total Acres, Watershed	**56,621.40**

Step 2. Convert the Stream Bank Sediment Load to pounds by multiplying tons by 2,000 pounds per ton.

	Sediment Load, pounds		
Stream Bank	13,378,180.00	pounds	= [6689.09 tons x 2,000 pounds per ton]

Step 3. Sum the total acres in the White Clay Creek watershed.

Total Acres in watershed	56,621.40	acres

Watershed: White Clay Creek

Year: 1995

Step 4. Calculate the total acres in the watershed that are considered "Developed," which includes Low Density Mixed (Ld_Mixed), Medium Density Mixed (Md_Mixed), High Density Mixed (Hd_Mixed); and Low Density Residential (Ld_Residential), Medium Density Residential (Md_Residential), and High Density Residential (Hd_Residential).

Area of Developed Lands	*acres*	*percent*	
Low Density Developed	9,488.90	77%	[Ld_Mixed + Ld_Residential]
Medium Density Developed	1,823.60	15%	[Md_Mixed + Md_Residential]
High Density Developed	966.10	8%	[Hd_Mixed + Hd_Residential]
Total	12,278.60	100%	[All "Developed" land use categories]

Step 5. Calculate the portion of the Stream Bank Sediment Load resulting from "Developed" Lands
This is A) 40% of the Stream Bank Sediment Load times the percent of developed lands in the watershed plus B) 60% of the Stream Bank Sediment Load:

Stream Bank Sediment Load	13,378,180.00	pounds		from Step 2
Total Developed Acres	12,278.6	acres		from Step 4
Total Acres in watershed	56,621.4	acres		from Step 3
Percent of Developed lands in watershed	22%		=	[12278.6 acres / 56621.4 acres]
A) 40% x Stream Bank Sediment Load x Percent of Developed Lands	1,160,446.90	pounds	=	[40% x 13378180 pounds x 22%]
B) 60% x Stream Bank Sediment Load	8,026,908.00	pounds	=	[60% x 13378180 pounds]
Load Assigned to Developed Lands	9,187,354.90	pounds		

Step 6. Calculate the portion of the Stream Bank Sediment Load from "Developed" Lands that is assigned to each of the land use categories by calculating relative components from "Impervious" surfaces and from the land use as a whole:

Estimated Percent of Impervious Area for corresponding land use categories (MapShed Values)	
Low Density Developed	15%
Medium Density Developed	52%
High Density Developed	87%

Step 7. Calculate how many acres within the watershed are "Impervious" by multiplying the acres in Step 4 by the percent in Step 6:

Estimated Impervious Surfaces for Developed Lands				
Low Density Developed	1,423.34	acres	=	[9488.9 acres x 15 percent]
Medium Density Developed	948.27	acres	=	[1823.6 acres x 52 percent]
High Density Developed	840.51	acres	=	[966.1 acres x 87 percent]
Total Developed Impervious Surface Area	3,212.11	acres		

Watershed: White Clay Creek

Year: 1995

Step 8. Calculate the percent of total developed Impervious Surface for each land use:

Percent of Total Impervious Surfaces			
Low Density Developed	44%	=	[1423.34 acres / 3212.11 acres]
Medium Density Developed	30%	=	[948.27 acres / 3212.11 acres]
High Density Developed	26%	=	[840.51 acres / 3212.11 acres]
Total	100%		

Step 9. Assign 60% of the "Total Load Assigned to Developed Lands", from Step 5, as a result of "Impervious" surfaces, and assign 40% based on the percent of land area in the land use category:

Load Assigned to Developed Lands	9,187,354.90	pounds	=	[result of Step 5]
60% of Load assigned to Impervious	5,512,412.94	pounds	=	[9187354.9 pounds x 60%]
40% of Load assigned for total land area	3,674,941.96	pounds	=	[9187354.9 pounds x 40%]

Step 10. Apportion Load Assigned to "Impervious" surfaces to each "Developed" land use category by multiplying the 'Percent of Total Impervious Surfaces' (Step 8) by 5512412.94 pounds (calculated in Step 9):

Stream Bank Sediment Load Assigned to Impervious Surface, pounds		
Low Density Developed	2,442,631.33	= [44 % x 5512412.94 pounds]
Medium Density Developed	1,627,360.31	= [30 % x 5512412.94 pounds]
High Density Developed	1,442,421.30	= [26 % x 5512412.94 pounds]

Step 11. Apportion Load Assigned to Total Land Area to each "Developed" land use category by multiplying the 'Percent of Area of Developed Lands' (from Step 4) by 3674941.96 pounds (calculated in Step 9):

Stream Bank Sediment Load Assigned to Total Developed Land Area, pounds		
Low Density Developed	2,839,994.53	= [77 % x 3674941.96 pounds]
Medium Density Developed	545,797.09	= [15 % x 3674941.96 pounds]
High Density Developed	289,150.35	= [8 % x 3674941.96 pounds]

Step 12. Combine the loads apportioned to "Impervious" surfaces, from Step 10, and the loads apportioned to Total Developed Land Area, from Step 11:

Total Stream Bank Sediment Load per Land Use, pounds		
Low Density Developed	5,282,625.85	= [2442631.33 pounds + 2839994.53 pounds]
Medium Density Developed	2,173,157.40	= [1627360.31 pounds + 545797.09 pounds]
High Density Developed	1,731,571.65	= [1442421.3 pounds + 289150.35 pounds]

Watershed: White Clay Creek

Year: 1995

Step 13. Calculate the Stream Bank Loading Rate for each "Developed" Land Use, in pounds per acre, by dividing the load from Step 12 by the acres in Step 4:

Stream Bank Sediment Land Use Loading Rate	pounds	Land Use area, acres	**Stream Bank Sediment Loading Rate, pounds/acre**
Low Density Developed	5,282,625.85	9,488.90	**556.72** = [5282625.85 lbs / 9488.9 acres]
Medium Density Developed	2,173,157.40	1,823.60	**1,191.69** = [2173157.4 lbs / 1823.6 acres]
High Density Developed	1,731,571.65	966.10	**1,792.33** = [1731571.65 lbs / 966.1 acres]

Step 14. Calculate the Stream Bank Loading Rate for "Undeveloped Land" (all other land use categories):

Total Stream Bank Load	13,378,180.00	pounds =	[from Step 3]
Load assigned to Developed La	9,187,354.90	pounds =	[from Step 5]
Remaining Load assigned to Undeveloped Lands	4,190,825.10	pounds =	[13378180 pounds - 9187354.9 pounds]
Acres of Undeveloped Lands	44,342.80	acres =	[sum of "Undeveloped Land" from Step 1]
Stream Bank Sediment Loading rate for Undeveloped Lands	**94.51**	**pounds per acre**	= [4190825.1 pounds / 44342.8 acres]

Step 15. Add these Stream Bank Sediment Land Use Loading Rates to the Land Use (upland source) Loading Rates for each of the corresponding land uses in the Land Use Loading Rates Look-Up Table to calculate the Total Sediment Loading Rate.

Look-Up Table: Christina Basin MapShed Loading Rates

Watershed: White Clay Creek

Year: 1995

Section 7: Stream Bank Nitrogen Loading Rates Worksheet

This worksheet calculates and apportions the loading rates from the Stream Bank source load for Total Nitrogen from the Christina MapShed Output file into each land use category, using methodology provided from Dr. Barry Evans (Pennsylvania State University), the author of MapShed, and with concurrence from Mr. Bill Brown (PADEP).

The MapShed output file provides the nitrogen load in pounds.

Step 1. The land areas for each land use category, in acres, are presented below.

	Source	Area (acres)
Land Use Categories from MapShed	Hay/Pasture	1,490.00
	Cropland	20,630.80
	Forest	16,299.00
	Wetland	560.90
	Disturbed	56.80
	Turfgrass	0.00
	Open_Land	5,305.30
	Bare_Rock	0.00
	Sandy_Areas	0.00
	Unpaved_Road	0.00
	Ld_Mixed	3,237.10
	Md_Mixed	1,722.30
	Hd_Mixed	773.40
	Ld_Residential	6,251.80
	Md_Residential	101.30
	Hd_Residential	192.70
	Total Acres, Watershed	**56,621.40**

Step 2. The Stream Bank Total Nitrogen Load, in pounds, is presented below:

	Total Nitrogen Load, pounds	
Stream Bank	6,688.82	pounds

Step 3. Sum the total acres in the White Clay Creek watershed.

Total Acres in watershed	56,621.40	acres

Watershed: White Clay Creek

Year: 1995

Step 4. Calculate the total acres in the watershed that are considered "Developed," which includes Low Density Mixed (Ld_Mixed), Medium Density Mixed (Md_Mixed), High Density Mixed (Hd_Mixed); and Low Density Residential (Ld_Residential), Medium Density Residential (Md_Residential), and High Density Residential (Hd_Residential):

Area of Developed Lands	*acres*	*percent*	
Low Density Developed	9,488.90	77%	[Ld_Mixed + Ld_Residential]
Medium Density Developed	1,823.60	15%	[Md_Mixed + Md_Residential]
High Density Developed	966.10	8%	[Hd_Mixed + Hd_Residential]
Total	12,278.60	100%	[All "Developed" land use categories]

Step 5. Calculate the portion of the Stream Bank Total Nitrogen (TN) Load resulting from "Developed" Lands
This is A) 40% of the Stream Bank Total Nitrogen Load times the percent of developed lands in the watershed plus B) 60% of the Stream Bank Total Nitrogen Load:

Stream Bank TN Load	6,688.82	pounds		from Step 2
Total Developed Acres	12,278.6	acres		from Step 4
Total Acres in watershed	56,621.4	acres		from Step 3
Percent of Developed lands in watershed	22%		=	[12278.6 acres / 56621.4 acres]
A) 40% x Stream Bank TN Load x Percent of Developed Lands	580.20	pounds	=	[40% x 6688.82 pounds x 22%]
B) 60% x Stream Bank TN Load	4,013.29	pounds	=	[60% x 6688.82 pounds]
Load Assigned to Developed Lands	4,593.49	pounds		

Step 6. Calculate the portion of the Stream Bank Total Nitrogen Load from "Developed" Lands that is assigned to each of the land use categories by calculating relative components from "Impervious" surfaces and from the land use as a whole:

Estimated Percent of Impervious Area for corresponding land use categories (MapShed Values)	
Low Density Developed	15%
Medium Density Developed	52%
High Density Developed	87%

Step 7. Calculate how many acres within the watershed are "Impervious" by multiplying the acres in Step 4 by the percent in Step 6:

Estimated Impervious Surfaces for Developed Lands				
Low Density Developed	1,423.34	acres	=	[9488.9 acres x 15 percent]
Medium Density Developed	948.27	acres	=	[1823.6 acres x 52 percent]
High Density Developed	840.51	acres	=	[966.1 acres x 87 percent]
Total Developed Impervious Surface Area	3,212.11	acres		

Watershed: White Clay Creek

Year: 1995

Step 8. Calculate the percent of total developed Impervious Surface for each land use:

Percent of Total Impervious Surfaces			
Low Density Developed	44%	=	[1423.34 acres / 3212.11 acres]
Medium Density Developed	30%	=	[948.27 acres / 3212.11 acres]
High Density Developed	26%	=	[840.51 acres / 3212.11 acres]
Total	100%		

Step 9. Assign 60% of the "Total Load Assigned to Developed Lands", from Step 5, as a result of "Impervious" surfaces, and assign 40% based on the percent of land area in the land use category.

Load Assigned to Developed Lands	4,593.49	pounds	=	[result of Step 5]
60% of Load assigned to Impervious	2,756.10	pounds	=	[4593.49 pounds x 60%]
40% of Load assigned for total land area	1,837.40	pounds	=	[4593.49 pounds x 40%]

Step 10. Apportion Load Assigned to "Impervious" surfaces to each "Developed" land use category by multiplying the 'Percent of Total Impervious Surfaces' (Step 8) by 2756.1 pounds (calculated in Step 9):

Stream Bank Total Nitrogen Load Assigned to Impervious Surface, pounds		
Low Density Developed	1,221.27	= [44 % x 2756.1 pounds]
Medium Density Developed	813.65	= [30 % x 2756.1 pounds]
High Density Developed	721.18	= [26 % x 2756.1 pounds]

Step 11. Apportion Load Assigned to Total Land Area to each "Developed" land use category by multiplying the 'Percent of Area of Developed Lands' (from Step 4) by 1837.4 pounds (calculated in Step 9):

Stream Bank Total Nitrogen Load Assigned to Total Developed Land Area, pounds		
Low Density Developed	1,419.94	= [77 % x 1837.4 pounds]
Medium Density Developed	272.89	= [15 % x 1837.4 pounds]
High Density Developed	144.57	= [8 % x 1837.4 pounds]

Step 12. Combine the loads apportioned to "Impervious" surfaces, from Step 10, and the loads apportioned to Total Developed Land Area, from Step 11:

Total Stream Bank Total Nitrogen Load per Land Use, pounds		
Low Density Developed	2,641.21	= [1221.27 pounds + 1419.94 pounds]
Medium Density Developed	1,086.53	= [813.65 pounds + 272.89 pounds]
High Density Developed	865.75	= [721.18 pounds + 144.57 pounds]

Watershed: White Clay Creek

Year: 1995

Step 13. Calculate the Stream Bank Loading Rate for each "Developed" Land Use, in pounds per acre, by dividing the load from Step 12 by the acres in Step 4:

Stream Bank Total Nitrogen Land Use Loading Rate	pounds	Land Use area, acres	**Stream Bank Total Nitrogen Loading Rate, pounds/acre**
Low Density Developed	2,641.21	9,488.90	**0.28** = [2641.21 lbs / 9488.9 acres]
Medium Density Developed	1,086.53	1,823.60	**0.60** = [1086.53 lbs / 1823.6 acres]
High Density Developed	865.75	966.10	**0.90** = [865.75 lbs / 966.1 acres]

Step 14. Calculate the Stream Bank Loading Rate for "Undeveloped Land" (all other land use categories):

Total Stream Bank Load	6,688.82	pounds =	[from Step 3]
Load assigned to Developed Lands	4,593.49	pounds =	[from Step 5]
Remaining Load assigned to Undeveloped Lands	2,095.33	pounds =	[6688.82 pounds - 4593.49 pounds]
Acres of Undeveloped Lands	44,342.80	acres =	[sum of "Undeveloped Land" from Step 1]
Stream Bank Total Nitrogen Loading rate for Undeveloped Lands	**0.05**	**pounds per acre**	= [2095.33 pounds / 44342.8 acres]

Step 15. Add these Stream Bank Total Nitrogen Land Use Loading Rates to the Land Use (upland source) and Farm Animals Loading Rates for each of the corresponding land uses in the Land Use Loading Rates Look-Up Table to calculate the final Total Nitrogen Loading Rate.

Look-Up Table: Christina Basin MapShed Loading Rates

Watershed: White Clay Creek

Year: 1995

Section 8: Stream Bank Phosphorus Loading Rates Worksheet

This worksheet calculates and apportions the loading rates from the Stream Bank source load for Total Phosphorus from the Christina MapShed Output file into each land use category, using methodology provided from Dr. Barry Evans (Pennsylvania State University), the author of MapShed, and with concurrence from Mr. Bill Brown (PADEP).

The MapShed output file provides the Phosphorus load in pounds.

Step 1. The land areas for each land use category, in acres, are presented below.

	Source	Area (acres)
Land Use Categories from MapShed	Hay/Pasture	1,490.00
	Cropland	20,630.80
	Forest	16,299.00
	Wetland	560.90
	Disturbed	56.80
	Turfgrass	0.00
	Open_Land	5,305.30
	Bare_Rock	0.00
	Sandy_Areas	0.00
	Unpaved_Road	0.00
	Ld_Mixed	3,237.10
	Md_Mixed	1,722.30
	Hd_Mixed	773.40
	Ld_Residential	6,251.80
	Md_Residential	101.30
	Hd_Residential	192.70
	Total Acres, Watershed	**56,621.40**

Step 2. The Stream Bank Total Phosphorus Load, in pounds, is presented below:

	Total Phosphorus Load, pounds	
Stream Bank	2,469.17	pounds

Step 3. Sum the total acres in the White Clay Creek watershed.

Total Acres in watershed	56,621.40	acres

Page 2 of Stream Bank ***Total Phosphorus Loading Rates*** worksheet

Watershed: White Clay Creek

Year: 1995

Step 4. Calculate the total acres in the watershed that are considered "Developed," which includes Low Density Mixed (Ld_Mixed), Medium Density Mixed (Md_Mixed), High Density Mixed (Hd_Mixed); and Low Density Residential (Ld_Residential), Medium Density Residential (Md_Residential), and High Density Residential (Hd_Residential):

Area of Developed Lands	*acres*	*percent*	
Low Density Developed	9,488.90	77%	[Ld_Mixed + Ld_Residential]
Medium Density Developed	1,823.60	15%	[Md_Mixed + Md_Residential]
High Density Developed	966.10	8%	[Hd_Mixed + Hd_Residential]
Total	12,278.60	100%	[All "Developed" land use categories]

Step 5. Calculate the portion of the Stream Bank Total Phosphorus (TP) Load resulting from "Developed" Lands
This is A) 40% of the Stream Bank Total Phosphorus Load times the percent of developed lands in the watershed plus B) 60% of the Stream Bank Total Phosphorus Load:

Stream Bank TP Load	2,469.17	pounds		from Step 2
Total Developed Acres	12,278.6	acres		from Step 4
Total Acres in watershed	56,621.4	acres		from Step 3
Percent of Developed lands in watershed	22%		=	[12278.6 acres / 56621.4 acres]
A) 40% x Stream Bank TP Load x Percent of Developed Lands	214.18	pounds	=	[40% x 2469.17 pounds x 22%]
B) 60% x Stream Bank TP Load	1,481.50	pounds	=	[60% x 2469.17 pounds]
Load Assigned to Developed Lands	1,695.68	pounds		

Step 6. Calculate the portion of the Stream Bank Total Phosphorus Load from "Developed" Lands that is assigned to each of the land use categories by calculating relative components from "Impervious" surfaces and from the land use as a whole:

Estimated Percent of Impervious Area for corresponding land use categories (MapShed Values)	
Low Density Developed	15%
Medium Density Developed	52%
High Density Developed	87%

Step 7. Calculate how many acres within the watershed are "Impervious" by multiplying the acres in Step 4 by the percent in Step 6:

Estimated Impervious Surfaces for Developed Lands				
Low Density Developed	1,423.34	acres	=	[9488.9 acres x 15 percent]
Medium Density Developed	948.27	acres	=	[1823.6 acres x 52 percent]
High Density Developed	840.51	acres	=	[966.1 acres x 87 percent]
Total Developed Impervious Surface Area	3,212.11	acres		

Watershed: White Clay Creek

Year: 1995

Step 8. Calculate the percent of total developed Impervious Surface for each land use:

Percent of Total Impervious Surfaces			
Low Density Developed	44%	=	[1423.34 acres / 3212.11 acres]
Medium Density Developed	30%	=	[948.27 acres / 3212.11 acres]
High Density Developed	26%	=	[840.51 acres / 3212.11 acres]
Total	100%		

Step 9. Assign 60% of the "Total Load Assigned to Developed Lands", (from Step 5), as a result of "Impervious" surfaces, and assign 40% based on the percent of land area in the land use category.

Load Assigned to Developed Lands	1,695.68	pounds	=	[result of Step 5]
60% of Load assigned to Impervious	1,017.41	pounds	=	[1695.68 pounds x 60%]
40% of Load assigned for total land area	678.27	pounds	=	[1695.68 pounds x 40%]

Step 10. Apportion Load Assigned to "Impervious" surfaces to each "Developed" land use category by multiplying the 'Percent of Total Impervious Surfaces' (Step 8) by 1017.41 pounds (calculated in Step 9):

Stream Bank Total Phosphorus Load Assigned to Impervious Surface, pounds		
Low Density Developed	450.83	= [44 % x 1017.41 pounds]
Medium Density Developed	300.36	= [30 % x 1017.41 pounds]
High Density Developed	266.22	= [26 % x 1017.41 pounds]

Step 11. Apportion Load Assigned to Total Land Area to each "Developed" land use category by multiplying the 'Percent of Area of Developed Lands' (from Step 4) by 678.27 pounds (calculated in Step 9):

Stream Bank Total Phosphorus Load Assigned to Total Developed Land Area, pounds		
Low Density Developed	524.17	= [77 % x 678.27 pounds]
Medium Density Developed	100.74	= [15 % x 678.27 pounds]
High Density Developed	53.37	= [8 % x 678.27 pounds]

Step 12. Combine the loads apportioned to "Impervious" surfaces, from Step 10, and the loads apportioned to Total Developed Land Area, from Step 11:

Total Stream Bank Total Phosphorus Load per Land Use, pounds		
Low Density Developed	975.00	= [450.83 pounds + 524.17 pounds]
Medium Density Developed	401.09	= [300.36 pounds + 100.74 pounds]
High Density Developed	319.59	= [266.22 pounds + 53.37 pounds]

Watershed: White Clay Creek

Year: 1995

Step 13. Calculate the Stream Bank Loading Rate for each "Developed" Land Use, in pounds per acre, by dividing the load from Step 12 by the acres in Step 4:

Stream Bank Total Phosphorus Land Use Loading Rate	pounds	Land Use area, acres	**Stream Bank Total Phosphorus Loading Rate, pounds/acre**
Low Density Developed	975.00	9,488.90	**0.10** = [975 lbs / 9488.9 acres]
Medium Density Developed	401.09	1,823.60	**0.22** = [401.09 lbs / 1823.6 acres]
High Density Developed	319.59	966.10	**0.33** = [319.59 lbs / 966.1 acres]

Step 14. Calculate the Stream Bank Loading Rate for "Undeveloped Land" (all other land use categories):

Total Stream Bank Load	2,469.17	pounds =	[from Step 3]
Load assigned to Developed Lands	1,695.68	pounds =	[from Step 5]
Remaining Load assigned to Undeveloped Lands	773.49	pounds =	[2469.17 pounds - 1695.68 pounds]
Acres of Undeveloped Lands	44,342.80	acres =	[sum of "Undeveloped Land" from Step 1]
Stream Bank Total Phosphorus Loading rate for Undeveloped Lands	**0.02**	**pounds per acre**	= [773.49 pounds / 44342.8 acres]

Step 15. Add these Stream Bank Total Phosphorus Land Use Loading Rates to the Land Use (upland source) and Farm Animals Loading Rates for each of the corresponding land uses in the Land Use Loading Rates Look-Up Table to calculate the final Total Phosphorus Loading Rate.

Brandywine-Christina Watershed (HUC # 02040205)
EPA TMDL MS4 Baseline Pollutant Loadings, MS4 Allocations, and Reductions

MUNICIPALITIES LISTED IN TMDL REPORTS	Sediment (tons/year)				Total Nitrogen (kg/day)				Total Phosphorus (kg/day)			
Brandywine Creek Watershed	**Baseline MS4 Load[1b.]**	**MS4 Load Allocation[1b.]**	**MS4 Load Reduction[1e.]**	**% Reduction[1b.]**	**Baseline MS4 Load[2b.]**	**MS4 Allocation[2a.]**	**MS4 Load Reduction[2m.]**	**% Reduction[2m.]**	**Baseline MS4 Load[2j.]**	**MS4 Allocation[2d.]**	**MS4 Load Reduction[2m.]**	**% Reduction[2m.]**
BIRMINGHAM TWP	310.81	130.35	180.46	58.06%								
COATESVILLE CITY	231.29	86.06	145.23	65.52%	16.08	10.86	5.22	32.46%	3.015	2.031	0.984	32.64%
EAST BRADFORD TWP	1185.00	467.17	717.83	60.58%								
EAST BRANDYWINE TWP					54.19	44.44	9.75	17.99%	0.826	0.677	0.149	18.04%
EAST FALLOWFIELD TWP	803.23	426.42	376.81	46.91%	110.54	75.74	34.80	31.48%	22.365	15.348	7.017	31.37%
EAST MARLBOROUGH TWP	366.70	139.44	227.26	61.98%								
HIGHLAND TWP	384.80	238.86	145.94	37.93%								
HONEY BROOK BORO	20.58	13.23	7.35	35.70%	9.61	5.76	3.85	40.06%	0.184	0.11	0.074	40.22%
HONEY BROOK TWP	813.84	558.76	255.08	31.34%	421.64	279.02	142.62	33.83%	7.599	4.956	2.643	34.78%
KENNETT TWP					2.38	2.22	0.16	6.72%	0.213	0.198	0.015	7.04%
MODENA BORO	27.96	12.46	15.50	55.43%	4.80	3.25	1.55	32.29%	0.966	0.656	0.31	32.09%
NEWLIN TWP	144.18	59.59	84.59	58.67%	6.53	4.57	1.96	30.02%	1.337	0.936	0.401	29.99%
PARKESBURG BORO	52.11	32.35	19.76	37.93%								
PENNSBURY TWP	113.98	43.48	70.50	61.85%	47.00	43.71	3.29	7.00%	4.206	3.911	0.295	7.01%
POCOPSON TWP	821.21	320.79	500.42	60.94%								
SADSBURY TWP	289.73	172.13	117.60	40.59%	3.05	2.26	0.79	25.90%	0.329	0.205	0.124	37.69%
THORNBURY TWP	82.17	34.46	47.71	58.06%								
UPPER UWCHLAN TWP					10.92	8.96	1.96	17.95%	0.166	0.137	0.029	17.47%
VALLEY TWP	485.14	164.64	320.50	66.06%	57.57	43.75	13.82	24.01%	6.941	4.726	2.215	31.91%
WALLACE TWP	21.74	17.41	4.33	19.92%	126.53	103.76	22.77	18.00%	1.929	1.582	0.347	17.99%
WEST BRADFORD TWP	283.22	121.6	161.62	57.07%	17.25	12.08	5.17	29.97%	3.532	2.473	1.059	29.98%
WEST BRANDYWINE TWP					136.01	104.78	31.23	22.96%	9.63	8.344	1.286	13.35%
WEST CALN TWP	68.28	43.07	25.21	36.92%	183.72	149.26	34.46	18.76%	9.95	8.649	1.301	13.08%
WEST GOSHEN TWP	461.32	180.51	280.81	60.87%								

	Sediment (tons/year)				Total Nitrogen (kg/day)				Total Phosphorus (kg/day)			
Red Clay Creek Watershed	**Baseline MS4 Load[1c.]**	**MS4 Load Allocation[1c.]**	**MS4 Load Reduction[1e.]**	**% Reduction[1c.]**	**Baseline MS4 Load[2h.]**	**MS4 Allocation[2b.]**	**MS4 Load Reduction[2m.]**	**% Reduction[2m.]**	**Baseline MS4 Load[2k.]**	**MS4 Allocation[2e.]**	**MS4 Load Reduction[2m.]**	**% Reduction[2m.]**
EAST MARLBOROUGH TWP	8791.41	4,193.24	4598.17	52.30%	137.13	68.56	68.57	50.00%	2.742	1.372	1.37	49.96%
KENNETT SQUARE BORO	840.10	405.41	434.69	51.74%	13.26	6.63	6.63	50.00%	0.452	0.151	0.301	66.59%
KENNETT TWP	6751.63	3,312.06	3439.57	50.94%	157.97	97.83	60.14	38.07%	21.517	3.731	17.786	82.66%
NEW GARDEN TWP	4709.65	2,118.72	2590.93	55.01%	77.03	38.52	38.51	49.99%	27.708	2.87	24.838	89.64%
PENNSBURY TWP					4.32	4.32	0.00	0.00%	0.082	0.082	0.00	0.00%

	Sediment (tons/year)				Total Nitrogen (kg/day)				Total Phosphorus (kg/day)			
White Clay Creek Watershed	**Baseline MS4 Load[1d.]**	**MS4 Load Allocation[1d.]**	**MS4 Load Reduction[1e.]**	**% Reduction[1d.]**	**Baseline MS4 Load[2i.]**	**MS4 Allocation[2c.]**	**MS4 Load Reduction[2m.]**	**% Reduction[2m.]**	**Baseline MS4 Load[2l.]**	**MS4 Allocation[2f.]**	**MS4 Load Reduction[2m.]**	**% Reduction[2m.]**
AVONDALE BORO	463.65	140.02	323.63	69.80%	9.16	4.58	4.58	50.00%	0.322	0.135	0.187	58.07%
FRANKLIN TWP	4220.43	2,305.87	1914.56	45.36%	122.01	61.01	61	50.00%	15.219	5.557	9.662	63.49%
KENNETT TWP					2.17	2.17	0.00	0.00%	0.055	0.055	0	0.00%
LONDON BRITAIN TWP	2634.66	1,620.44	1014.22	38.50%	96.47	49.9	46.57	48.27%	15.732	7.333	8.399	53.39%
LONDON GROVE TWP	13616.33	4,842.81	8773.52	64.43%	262.76	128.47	134.29	51.11%	25.875	7.965	17.91	69.22%
NEW GARDEN TWP	6746.50	2,986.66	3759.84	55.73%	167.06	83.83	83.23	49.82%	41.916	13.374	28.542	68.09%
NEW LONDON TWP	1913.97	1,008.60	905.37	47.30%	53.56	26.61	26.95	50.32%	0.65	0.292	0.358	55.08%
PENN TWP	3584.76	1,410.29	2174.47	60.66%	71.23	33.36	37.87	53.17%	0.798	0.359	0.439	55.01%
WEST GROVE BORO	562.29	192.63	369.66	65.74%	9.24	4.36	4.88	52.81%	0.112	0.05	0.062	55.36%

(1) U.S. EPA Region III. 8 April 2005. Total Maximum Daily Loads for Bacteria and Sediment in the Christina River Basin Watershed Pennsylvania, Delaware, and Maryland. Philadelphia, PA.

(2) U.S. EPA Region III. 26 September 2006. Revisions to Total Maximum Daily Loads for Nutrient and Low Dissolved Oxygen under High-flow Conditions: Christina River Basin Watershed, Pennsylvania, Delaware, and Maryland. Philadelphia, PA.

a. Table 4.2 Fecal coliform TMDL allocations for MS4 municipalities. p 4-5

b. Table 4.8 Sediment allocations for towns in Brandywine Creek Watershed. p 4-16

c. Table 4.9 Sediment allocations for towns in Red Clay Creek Watershed. p 4-16

d. Table 4.10 Preliminary sediment allocations for towns in White Clay Creek Watershed. p 4-16

e. Calculated by CCWRA using Tables listed in 1a.-1d. listed above.
MS4 Reduction = (Baseline MS4 Load) - (MS4 Load Allocation)

a. Appendix C -Table C-5b. Total nitrogen MS4 allocations for Brandywine Creek watershed (kg/day) p. C-6

b. Appendix C. Table C-7b. Total nitrogen MS4 allocations for Red Clay Creek watershed (kg/day) p. C-9

c. Appendix C. Table C-9b. Total nitrogen MS4 allocations for White Clay Creek watershed (kg/day) p. C-11

d. Appendix C. Table C-6b. Total phosphorus MS4 allocations for Brandywine Creek watershed (kg/day) p.C-8

e. Appendix C. Table C-8b. Total phosphorus MS4 allocations for Red Clay Creek watershed (kg/day) p. C-10

f. Appendix C. Table C-10b. Total phosphorus MS4 allocations for White Clay Creek watershed (kg/day) p. C-13

g. Appendix C -Table C-5a. Total nitrogen MS4 baseline loads for Brandywine Creek watershed (kg/day) p. C-5

h. Appendix C. Table C-7a. Total nitrogen MS4 baseline loads for Red Clay Creek watershed (kg/day) p. C-8

i. Appendix C. Table C-9a. Total nitrogen MS4 baseline loads for White Clay Creek watershed (kg/day) p. C-10

j. Appendix C. Table C-6a. Total phosphorus MS4 baseline loads for Brandywine Creek watershed (kg/day) p.C-7

k. Appendix C. Table C-8a. Total phosphorus MS4 baseline loads for Red Clay Creek watershed (kg/day) p. C-9

l. Appendix C. Table C-10a. Total phosphorus MS4 baseline loads for White Clay Creek watershed (kg/day) p. C-12

m. Calculated by CCWRA using Tables listed in 2a.-2l. listed above. MS4 Reduction = (MS4 Baseline Load) - (MS4 Allocation);
%Reduction = (MS4 Load Reduction) / (MS4 Baseline Load)