

Appendix to Nutrient Source Identification Report

Methods

Methods described here are based on guidance within the EPA MS4 Permit for MA, but refined and elaborated by staff from Neponset River Watershed Association and Pioneer Valley Planning Commission in consultation with MassDEP, and EPA.

Prepared by Neponset River Watershed Association and
updated for Pioneer Valley region communities by PVPC

June 30, 2021

Page left blank intentionally.

Introduction

This is an appendix to the Town's/City's Nutrient Source Identification Report. This document explains the methods followed to produce the information in the report. All actions described were performed using ArcMap 10.6.1.

The analysis requires three existing shapefiles. Information on each of these required shapefiles is provided in Table 1 below.

Table 1. Shapefiles Used in Analysis

Existing Data Set	Origin	Date Published/Updated	Link
2016 Land Cover/Land Use	MassGIS	May 2019	https://docs.digital.mass.gov/dataset/massgis-data-2016-land-coverland-use
Soil Survey Geographic (SSURGO) Database for Norfolk and Suffolk Counties, Massachusetts	USDA	June 2020	Downloaded through Web Soil Survey (https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm). Hydrologic soil groups extracted using Soil Data Viewer Version 6.1 (https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053619)
Town/City Catchments	Town/City GIS Files	Current as of 6/10/21	N/A

Creation of Base Shapefile

First a 2016 land cover/land use crosswalk was developed to determine phosphorus loading rates, by expanding on the 2005 land use crosswalk in the MS4. This crosswalk method compares general land use to land cover and assigns a P load crosswalk value based on the predominant condition. General land use determined the crosswalk value where the predefined crosswalk category expressed an accurate depiction of land use activity, e.g. Agriculture to "Ag" or Commercial to "Com_Ind". Land cover was used to

determine the P load crosswalk value when the general land use predefined crosswalk category did not accurately depict land use activity, e.g. Tax Exempt, ROW, Open Land, Recreation, Unknown –are all better represented by using the land cover value to determine crosswalk values as opposed to the predefined land use crosswalk value of "Com_Ind".

Table 2a. MassGIS 2016 Land Use Phosphorus Load Crosswalk

COVERNAME	USEGENNAME	PLCRSS
Pervious	Agriculture	Ag
Impervious	Agriculture	Ag
Water	Agriculture	Water
Pervious	Commercial	Com_Ind
Impervious	Commercial	Com_Ind
Water	Commercial	Water
Pervious	Forest	For
Impervious	Forest	For
Water	Forest	Water
Pervious	Industrial	Com_Ind
Impervious	Industrial	Com_Ind
Water	Industrial	Water
Bare Land	Mixed use, other	Open
Cultivated	Mixed use, other	Ag
Deciduous Forest	Mixed use, other	For
Developed Open Space	Mixed use, other	Open
Evergreen Forest	Mixed use, other	For
Grassland	Mixed use, other	Open
Impervious	Mixed use, other	Open
Palustrine Aquatic Bed	Mixed use, other	For
Palustrine Emergent Wetland	Mixed use, other	For
Palustrine Forested Wetland	Mixed use, other	For
Palustrine Scrub/Shrub	Mixed use, other	For
Pasture/Hay	Mixed use, other	Ag
Scrub/Shrub	Mixed use, other	For
Water	Mixed use, other	Water
Pervious	Mixed use, primarily commercial	Com_Ind
Impervious	Mixed use, primarily commercial	Com_Ind
Water	Mixed use, primarily commercial	Water
Pervious	Mixed use, primarily residential	LDR

COVERNAME	USEGENNAME	PLCRSS
Impervious	Mixed use, primarily residential	LDR
Water	Mixed use, primarily residential	Water
Bare Land	Open land	Open
Cultivated	Open land	Ag
Deciduous Forest	Open land	For
Developed Open Space	Open land	Open
Evergreen Forest	Open land	For
Grassland	Open land	Open
Impervious	Open land	Open
Palustrine Aquatic Bed	Open land	For
Palustrine Emergent Wetland	Open land	For
Palustrine Forested Wetland	Open land	For
Palustrine Scrub/Shrub	Open land	For
Pasture/Hay	Open land	Ag
Scrub/Shrub	Open land	For
Water	Open land	Water
Bare Land	Recreation	Open
Cultivated	Recreation	Ag
Deciduous Forest	Recreation	For
Developed Open Space	Recreation	Open
Evergreen Forest	Recreation	For
Grassland	Recreation	Open
Impervious	Recreation	Open
Palustrine Aquatic Bed	Recreation	For
Palustrine Emergent Wetland	Recreation	For
Palustrine Forested Wetland	Recreation	For
Palustrine Scrub/Shrub	Recreation	For
Pasture/Hay	Recreation	Ag
Scrub/Shrub	Recreation	For
Water	Recreation	Water
Pervious	Residential - multi-family	MFR_HDR
Impervious	Residential - multi-family	MFR_HDR
Water	Residential - multi-family	Water
Pervious	Residential - other	MDR

COVERNAME	USEGENNAME	PLCRSS
Impervious	Residential - other	MDR
Water	Residential - other	Water
Pervious	Residential - single family	LDR
Impervious	Residential - single family	LDR
Water	Residential - single family	Water
Bare Land	Right-of-way	Open
Cultivated	Right-of-way	Ag
Deciduous Forest	Right-of-way	For
Developed Open Space	Right-of-way	Open
Evergreen Forest	Right-of-way	For
Grassland	Right-of-way	Open
Impervious	Right-of-way	HWY
Palustrine Aquatic Bed	Right-of-way	For
Palustrine Emergent Wetland	Right-of-way	For
Palustrine Forested Wetland	Right-of-way	For
Palustrine Scrub/Shrub	Right-of-way	For
Pasture/Hay	Right-of-way	Ag
Scrub/Shrub	Right-of-way	For
Water	Right-of-way	Water
Bare Land	Tax exempt	Open
Cultivated	Tax exempt	Ag
Deciduous Forest	Tax exempt	For
Developed Open Space	Tax exempt	Open
Evergreen Forest	Tax exempt	For
Grassland	Tax exempt	Open
Impervious	Tax exempt	HWY
Palustrine Aquatic Bed	Tax exempt	For
Palustrine Emergent Wetland	Tax exempt	For
Palustrine Forested Wetland	Tax exempt	For
Palustrine Scrub/Shrub	Tax exempt	For
Pasture/Hay	Tax exempt	Ag
Scrub/Shrub	Tax exempt	For
Water	Tax exempt	Water
Bare Land	Unknown	Open

COVERNAME	USEGENNAME	PLCRSS
Cultivated	Unknown	Ag
Deciduous Forest	Unknown	For
Developed Open Space	Unknown	For
Evergreen Forest	Unknown	For
Grassland	Unknown	Open
Impervious	Unknown	HWY
Palustrine Aquatic Bed	Unknown	For
Palustrine Emergent Wetland	Unknown	For
Palustrine Forested Wetland	Unknown	For
Palustrine Scrub/Shrub	Unknown	For
Pasture/Hay	Unknown	Ag
Scrub/Shrub	Unknown	For
Water	Unknown	Water
Bare Land	Water	Open
Cultivated	Water	Ag
Deciduous Forest	Water	For
Developed Open Space	Water	For
Evergreen Forest	Water	For
Grassland	Water	Open
Impervious	Water	Open
Palustrine Aquatic Bed	Water	For
Palustrine Emergent Wetland	Water	For
Palustrine Forested Wetland	Water	For
Palustrine Scrub/Shrub	Water	For
Pasture/Hay	Water	Ag
Scrub/Shrub	Water	Open
Water	Water	Water
COVERNAME	USEGENNAME	PLCRSS

To support the analysis, a base shapefile containing pertinent information for land cover, land use, and soil types in the area of interest was created. This was completed by performing a “intersect” operation with two input shapefiles shown in Table 1 above: the 2016 Land Cover/Land Use shapefile and a shapefile containing the SSURGO soil hydrologic groups. Each record in the shapefile represents areas with specific land cover, land use, and soil types.

Several fields were then added to the resulting “Land Use Loading Rate” (MS4_NSI_NPL_210614) shapefile to support later steps of this analysis. Table 2b below lists the added field and provides a brief description of the data that was added.

Table 2b. Summary of Fields Added to “MS4_NSI_NPL_210614” Shapefile

Added Field	Description
P Load Crosswalk	The phosphorus loading category to which a record was assigned. See Table 1-2 in Attachment 1 of Appendix F of the 2016 Massachusetts Small MS4 General Permit for a full listing of loading categories and rates.
N Load Crosswalk	The nitrogen loading category to which a record was assigned. See Table 1 in Attachment 1 of Appendix H of the 2016 Massachusetts Small MS4 General Permit for a full listing of loading categories and rates
PLER	The numerical phosphorus loading rate assigned to a record. The value originates from Table 1-2 in Attachment 1 of Appendix F of the 2016 Massachusetts Small MS4 General Permit
NLER	The numerical nitrogen loading rate assigned to a record. The value originates from Table 1 in Attachment 1 of Appendix H of the 2016 Massachusetts Small MS4 General Permit
DCIA_M	The multiplier from the applicable Sutherland equation to estimate directly connected impervious area for a record. Note that entry is <Null> for all non-impervious records. For more detailed information about how these values were assigned, see the “DCIA Calculation” section below.
DCIA_E	The exponent from the applicable Sutherland equation to estimate directly connected impervious area for a record. Note that entry is <Null> for all non-impervious records. For more detailed information about how these values were assigned, see the “DCIA Calculation” section below.

Preparation of Catchment Shapefile and Intersect with Base Shapefile

To prepare the catchment shapefile for later analysis, a field entitled either “CatchAreaAcre” was added to the attribute table. The “calculate geometry” function was used to populate this field for each record, measuring the total area of each catchment in acres.

Once the additional field was added, the “Intersect” tool was run with two input datasets: “Land use Loading Rate” (described in the last section) and the Town’s/City’s Catchment shapefile. The resulting shapefile was entitled “[Municipality]Catchment Segments” and is available in the files the Town/City received upon completion of this project.

This resulting shapefile limits the information contained in the broader “Land use Loading Rate” to just what specifically occurs in each of the Town’s/City’s catchments, allowing further catchment-level analysis of several criteria.

For the purposes of this analysis, in some cases only the portions of catchments within the Town/City boundaries were considered. For instance, if a catchment along the border of the Town/City actually extended into a neighboring jurisdiction, that portion outside of the boundary was removed during this step and any land area outside of the Town/City boundaries was not considered in the subsequent analysis. This decision was made because, even though the catchment may be mapped outside of the boundaries, the Town/City generally does not have the ability to impact properties in other jurisdictions. If the Town/City wishes to include those areas outside of Town/City in this analysis, the above steps could be repeated using the same shapefiles and steps, but without limiting the base shapefile creation by Town/City boundaries.

Summarized Analysis

New fields were added to the recently created shapefile. Table 3 below lists the new fields, the description of the data they contain, and shows the operations involved in calculating the applicable data. Further details about each calculation can be found in the individual sections below.

Table 3. New Fields Added to "[Town/CityName]Intersect" Shapefile

New Field	Description	Units	Function Used to Calculate	Calculation Method
SEG_ACRE	The area of a record.	Acres	Calculate Geometry	Calculate the area in acres.
IMPA_ACRE	The area of impervious surfaces occupied by a record.	Acres	Calculate Geometry	Query only records with “Impervious” entry for CoverName, then calculate the area in acres. After removing the query, all non-impervious records will have a “0” listed for this field.

New Field	Description	Units	Function Used to Calculate	Calculation Method
IMPA_PRCT	The amount of impervious area in a record.	Percentage of the total catchment area	Field Calculator	$([IMPA_ACRE]/[Catch_Total_Acres])*100$
CATCH_PRCT	The percentage of the catchment represented by a record.	Percentage of the total catchment area	Field Calculator	$([SEG_ACRE]/[Catch_Total_Acres])*100$
DCIA_PRCT	An estimate of directly connected impervious area represented by a record	Percentage of the total catchment area.	Field Calculator	$([IMPA_PRCT]^{[DCIA_E]})*[DCIA_M]$
DCIA_ACRE	An estimate the amount of directly connected impervious area associated with a record.	Acres	Field Calculator	$([DCIA_PRCT]/100)*[Catch_Total_Acres]$
P_LOAD_1_2	The estimated phosphorus load from a record	Lbs/Year	Field Calculator	$[SEG_ACRE]*[PLER]$
N_LOAD	The estimated nitrogen load from a record	Lbs/Year	Field Calculator	$[SEG_ACRE]*[NLER]$

*PercentOfCatch was only used as a “check” field and is not described further in this document.

Impervious Calculation

The “[Municipality]Catchment Segments” shapefile contains polygons of areas within each catchment with like land cover, land use, and soil type. To begin, the “[Municipality]Catchment Segments” was queried so that only polygons with an entry of “Impervious” for the “CoverName” field were shown. Then, the Calculate Geometry tool was used on those queried records to display the area of each impervious polygon in acres. These results were eventually summed for overall catchment totals of impervious area as described in the “Final Preparation of Deliverable Shapefile” section below.

To further illustrate impervious cover statistics and for use in DCIA calculation, the impervious cover in each polygon was also calculated as a percentage of each catchment. For this measurement, the Field Calculator tool was used on the “ImpPercent” field to divide the impervious area of each polygon (“ImpAreaAcre”) by the total catchment size (“CatchAreaAcre”, created when preparing the catchment shapefile). This figure was then multiplied by 100 to obtain a percent.

DCIA Calculation

DCIA estimates were based on the Sutherland equations within the EPA guidance document entitled “Estimating Change in Impervious Area (IA) and Directly Connected Impervious Areas (DCIA) for Massachusetts Small MS4 Permit” (Revised April 2014). Table 4 below shows the relation between various land uses in the watershed, the chosen “connectedness” category, and the associated Sutherland equation used in the DCIA estimate. Note that these estimates only occurred on polygons that contained an “Impervious” entry in the CoverName field, as DCIA only exists where impervious area exists.

Table 4. "Connectedness" Category and Sutherland DCIA Equation Assignments for All Land Uses. NOTE: DCIA and IA are both percentages.

USEGENNAME	"Connectedness" Category	Sutherland Equation
Agriculture	Mostly Disconnected	$DCIA=0.01(IA)^2$
Commercial	Average	$DCIA=0.1(IA)^{1.5}$
Forest	Mostly Disconnected	$DCIA=0.01(IA)^2$
Industrial	Average	$DCIA=0.1(IA)^{1.5}$
Mixed use, other	Average	$DCIA=0.1(IA)^{1.5}$
Mixed use, primarily commercial	Average	$DCIA=0.1(IA)^{1.5}$
Mixed use, primarily residential	Average	$DCIA=0.1(IA)^{1.5}$
Open land	Average	$DCIA=0.1(IA)^{1.5}$
Recreation	Average	$DCIA=0.1(IA)^{1.5}$

USEGENNAME	"Connectedness" Category	Sutherland Equation
Residential - multi-family	Highly Connected	$DCIA=0.4(IA)^{1.2}$
Residential - other	Average	$DCIA=0.1(IA)^{1.5}$
Residential - single family	Average	$DCIA=0.1(IA)^{1.5}$
Right-of-way	Average	$DCIA=0.1(IA)^{1.5}$
Tax exempt	Average	$DCIA=0.1(IA)^{1.5}$
Unknown	Average	$DCIA=0.1(IA)^{1.5}$
Water	Average	$DCIA=0.1(IA)^{1.5}$

In these equations, the percentage of impervious cover for a given area is used to determine the percentage of DCIA in the same area. Thus, DCIA percent was calculated in the “DCIAPercent” field using Field Calculator. In this calculation, the impervious percentage represented by the polygon (“ImpPercent”) was raised to the power shown in the appropriate equation (already entered in the “DCIA_E” field when preparing the base shapefile) and multiplied by the factor shown (already entered in the “DCIA_M” field when preparing the base shapefile). Essentially, the Field Calculator equation was “DCIAPercent” = (“ImpPercent” ^ “DCIA_E”) * “DCIA_M”. These results were eventually summed for overall catchment totals of impervious area as described in the “Final Preparation of Deliverable Shapefile” section below.

Finally, the estimated acreage of DCIA for each polygon was calculated in the “DCIAAcre” field using Field Calculator. In this calculation, “DCIAPercent” was divided by 100 and multiplied by the overall catchment size (“CatchAreaAcr” or “CatchAreaA”).

Phosphorus Load Calculation

Phosphorus loads were calculated for each record in the [Municipality]Catchment Segments shapefile by multiplying the area of each polygon (“AreaAcre”) by the phosphorus loading rate assigned to the record’s specific land cover/land use/soil type combination (the “PLER” field, which was entered during the creation of the base shapefile). The Field Calculator tool was used to complete this calculation in the “P_Load” field. As the name suggests, the units for the loading rates are pounds/acre/year. These results are eventually summed for overall catchment totals of impervious area as described in the “Final Preparation of Deliverable Shapefile” section below.

For reference, the phosphorus loading category into which each record is assigned is recorded in the “PLCRSS” field, which stands for Phosphorus Load Crosswalk. The entries in this field correspond to the

land uses and phosphorus load export rates shown in Table 1-2 of Attachment 1 to Appendix F of the 2016 Massachusetts Small MS4 General Permit. An abbreviated crosswalk is shown in Table 5 below.

Table 5. Crosswalk Linking Land Use and Land Cover to the Phosphorus Source Categories Shown in Table 1-2 of Attachment 1 to Appendix F of the 2016 Massachusetts Small MS4 General Permit

USEGENNAME	Phosphorus Source Category
Agriculture	Agriculture (Ag)
Commercial	Commercial/Industrial (Com-Ind)
Forest	Forest (For)
Industrial	Commercial/Industrial (Com-Ind)
Mixed use, other	Varied based on land cover
Mixed use, primarily commercial	Commercial/Industrial (Com-Ind)
Mixed use, primarily residential	Medium-Density Residential (MDR)
Open land	Open Land (Open)
Recreation	Open Land (Open)
Residential - multi-family	Multi-Family and High-Density Residential (MFR-HDR)
Residential - other	Medium-Density Residential (MDR)
Residential - single family	Medium-Density Residential (MDR)
Right-of-way	Varied based on land cover
Tax exempt	Varied based on land cover
Unknown	Varied based on land cover
Water	Varied based on land cover

N Load Calculation

Nitrogen loads were calculated for each record in the [Municipality]Catchment Segments shapefile by multiplying the area of each polygon (“AreaAcre”) by the nitrogen loading rate assigned to the record’s specific land cover/land use/soil type combination (the “NLER” field, which was entered during the creation of the base shapefile). The Field Calculator tool was used to complete this calculation in the “N_Load” field. As the name suggests, the units for the loading rates are pounds/acre/year. These results are eventually summed for overall catchment totals of impervious area as described in the “Final Preparation of Deliverable Shapefile” section below.

For reference, the nitrogen loading category into which each record is assigned is recorded in the “NLCRSS” field, which stands for Nitrogen Load Crosswalk. The entries in this field correspond to the Nitrogen Source Categories and nitrogen load export rates shown in Table 1 of Attachment 1 to Appendix H of the 2016 Massachusetts Small MS4 General Permit. An abbreviated crosswalk is shown in Table 6 below. Note that this crosswalk only considers the land cover of the record (the “CoverName” field) and, where necessary, the soil type of the record (the “HSG_N” field).

Table 6. Crosswalk Linking Land Cover and Soil Type to the Nitrogen Loading Categories Shown in Table 1 of Attachment 1 to Appendix H of the 2016 Massachusetts Small MS4 General Permit

Land Cover	Soil Type	Nitrogen Source Category
Impervious	All	All Impervious Cover
Water	All	None, rate was set to 0 for records that represented surface water.
Non-Impervious, Non-Water	A	Developed Land Pervious (DevPERV)-HSG A
Non-Impervious, Non-Water	B	Developed Land Pervious (DevPERV)-HSG B
Non-Impervious, Non-Water	C	Developed Land Pervious (DevPERV)-HSG C
Non-Impervious, Non-Water	D	Developed Land Pervious (DevPERV)-HSG D
Non-Impervious, Non-Water	A/D	Developed Land Pervious (DevPERV)-HSG A
Non-Impervious, Non-Water	B/D	Developed Land Pervious (DevPERV)-HSG B
Non-Impervious, Non-Water	C/D	Developed Land Pervious (DevPERV)-HSG C/D

Final Preparation of Deliverable Shapefile

Once all calculations were made as described above, the “[Town/CityName]Intersect” shapefile was condensed using the Dissolve tool. The “Dissolve_Field” was defined as the field containing catchment identifiers and the following fields were defined as “Statistics Fields” with a “Statistic Type” of “Sum”: “AreaAcre,” “ImpAreaAcre,” “ImpPercent,” “DCIAAcre,” “DCIAPercent,” “P_Load,” and “N_Load.”

The resulting layer was named “[Municipality]_Outfall_Catchments” and was provided with all other deliverables from this project. This shapefile displays the Town’s/City’s catchment and contains totals of each catchment’s area, impervious area, estimated DCIA, impervious percentage, estimated DCIA percentage, estimated phosphorus load, and estimated nitrogen load.

Selection of SCM/BMP Sites

Building on method described within the *Pioneer Valley 2014 Regional Green Infrastructure Plan* and through subsequent pilot projects in Springfield and Agawam, PVPC has developed a screening process approach to identify public properties that might be most appropriate for green infrastructure stormwater retrofit locations.

As part of this work, PVPC developed an on-line map/data screening tool to identify potential retrofit opportunities using ESRI’s application builder (referred to as *on-line ArcGIS data viewer*). The use of this interface with these layers can help immensely in facilitating decision making. The on-line ArcGIS data viewer displays municipal, state, federal, and private properties by total score of suitability for green infrastructure retrofitting and allows the end user to further explore the values associated with the suitability score for each parcel. Input values can be viewed by either clicking on a parcel to display a “pop-up box” or by viewing the master data table at the bottom of the screen.

Screening considerations, with each their own associated score include all the elements noted in Table 7 below. Note that the outfall catchment area phosphorus or nitrogen loading rate below mean value and the outfall catchment area phosphorus or nitrogen loading rate above mean value are the latest updates to the screening tool based on the work of this project on nutrient source identification reports. These shape files were developed in ArcMap for Desktop and displayed in the on-line viewer.

For local decision making, considerations in this screening process can be further supplemented and fine-tuned based on local priorities. For some communities, localized flooding has been an important additional consideration and has been included in scoring below. PVPC has also been recommending that where possible communities add tree canopy analysis in the ranking so that investments for improved stormwater pollution control through vegetated systems might also possibly serve to cool summer temperatures in neighborhoods where there are few trees.

Table 7. GI Retrofit Screening Tool Layers and Associated Points Scoring

GIS Layers and Point System for Initial Ranking and Screening of Properties			
<i>Italics = Use will depend on whether applies to municipality.</i>	Points based on whether present or not present	Total Possible Points	Total Possible Score
General evaluation criteria - all of municipality			
A or B hydrologic soil group A/D or B/D hydrologic soil group This value is determined by average value of all soil types present in a tax parcel.	5.0 or 0 2.5 or 0	5.0	
MassGIS Drainage Areas sub-basins of waters designated as TMDL completed (Category 4a) or Impaired/Requiring a TMDL (Category 5) on the Massachusetts List of Integrated	5.0 or 0	5.0	
Environmental Justice Areas, 2010	5.0 or 0	5.0	
Impervious area larger than 1 acre Impervious area 0.5 to 1 acre Impervious area less than 1 acre	5.0 2.5 1.0	5.0	
<i>*Localized flooding areas MassGIS Drainage Areas sub-basins (see discussion in next section below)</i>	5.0 or 0	5.0	
Located within MS4 regulated area	5.0 or 0	5.0	
			30.0
Loading criteria - within MS4 regulated outfall catchment area			
Outfall Catchment area Phosphorus or Nitrogen loading rate <u>below</u> mean value	35.0 or 0	35.0	65.0
OR			
Outfall Catchment area Phosphorus or Nitrogen loading rate <u>above</u> mean value	70.0 or 0	70.0	100

Some notes on GIS layers

Hydrologic Soil Groups

Though there are thousands of soil types, soils have been grouped *according to their runoff potential* under similar storm and cover conditions.

Group A type soils, for example, “...have low runoff potential and high infiltration rates even when thoroughly wetted. They consist of deep, well to excessively drained sand or gravel and have a high rate of water transmission (greater than 0.30 in/hr).” On the other end of the spectrum are the Group D soils, which “...have high runoff potential and very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0 to 0.05 in/hr).”¹

The mapping layer for hydrologic soils groups provides some understanding of what the conditions may be at a site, but it is important to note that mapping is done at a scale that does not provide a fine level of detail or ensure accuracy. In developed areas the use of fill brought in from other locations may have altered the existing conditions. In heavily urbanized areas in particular, so much fill has been used that mapping provides no soils information for such areas other than to indicate “urban fill.”

For the hydrologic soils group layer, see Natural Resources Conservation Service SSURGO Certified Soils data from MassGIS, November 2012, last updated December 2017.

Drainage Areas of Impaired/TMDL Status

Taken together, Total Maximum Daily Load (TMDL) status and watershed delineation is one important way of understanding where waters are impacted by human activity and which drainage areas contribute to these waters. The question here is: *Where are the biggest known water quality problems* and hence where might there be the best opportunities to improve water quality through stormwater management retrofits? A TMDL establishes the amount of a particular pollutant that a water body can receive while still meeting water quality standards.² The TMDL status map layer identifies those waters that do not meet applicable state water quality standards. These waters are deemed to be “impaired” by MassDEP pursuant to section 303(d) of the Clean Water Act. These include waters with approved TMDLs and those for which TMDL development has been identified as necessary, but for which a TMDL has not yet been approved. The TMDL status layers comes from MassGIS, which is derived from the *MassDEP Integrated List of Waters (305(b)/303(d)) – Last updated January 2018*.

¹ Part 630 Hydrology, National Engineering Handbook, Appendix A: Hydrologic Soil Groups. United States Department of Agriculture, Natural Resources Conservation Service. January 2009.

² <http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/index.cfm>

Environmental Justice Area

By explicitly mapping Environmental Justice Areas, decisions about stormwater management retrofits and the associated investments can be made with greater awareness and intention in *meaningful involvement of all people and neighborhoods* regardless of race, color, national origin, or income.

Base mapping information for Environmental Justice Areas relies on four criteria from Census block groups. These criteria are as follows:

- where population is 25 percent or more minority
- where median household income is less than 65 percent of the statewide median household income
- where 75 percent or less of households have proficiency with the English language, indicating linguistic isolation
- where 25 percent or more of the population is foreign-born

Localized Flooding Areas*

Climate records for the northeastern United States indicate that the frequency of larger downpours is increasing, and this trend is expected to continue. As such, it may serve municipalities to develop a GIS map layer that identifies known flooding locations through local knowledge or insurance claim records (if obtainable). Then impervious areas located upgradient of these known flooding locations could carry a higher ranking than large impervious properties in other locations within the municipality. Localized flooding areas layer is defined by MassGIS drainage area sub-basin containing municipality identified localized flooding locations.

Impervious Areas

There is a direct correlation between the amount of impervious area—surfaces such as roofs, driveways, roads, and parking lots—and flooding and water quality in rivers, streams, and lakes receiving discharges from these areas. Removal or "disconnection" of impervious cover through retrofitting with green infrastructure stormwater management plays an important role in resolving localized flooding and water quality issues.

Additional Screening Considerations from the MS4 Permit

The Massachusetts MS4 permit in Section 2.3.6.d identifies other considerations. In determining the potential for modifying or retrofitting particular properties, the permittee shall consider factors such as:

- access for maintenance purposes
- subsurface geology
- depth to water table
- proximity to aquifers and subsurface infrastructure including sanitary sewers and septic systems
- opportunities for public use and education

In determining its priority ranking, the permittee shall consider factors such as:

- schedules for planned capital improvements to storm and sanitary sewer infrastructure and paving projects
- public swimming beaches
- drinking water supply sources
- shellfish growing areas

- current storm sewer level of service
- control of discharges to water quality limited waters
- first or second order streams

Other Resources

There are other more complicated tools to conduct similar ranking analyses for stormwater retrofit locations that may be useful. In particular, Opti Tool described below was designed for EPA Region 1. The second and third tools described below are not currently supported. These are listed here with the idea that there may be elements within the tools that could be of interest to municipalities looking to customize their approaches to ranking municipal properties for improved stormwater management.

- Opti Tool (Stormwater Management Optimization Tool) is a spreadsheet-based optimization tool designed for EPA, Region 1. It uses SUSTAIN (see bullet below) in the background but is more user friendly. The tool helps planners determine the best mix of BMPs to provide the greatest benefit for achieving water resource goals while balancing costs. Opti Tool provides analysis at both a planning level and implementation level. Planning Level Analysis provides maximum possible load reduction for all feasible BMP opportunities or cost-effective single solution that meets the numeric load reduction target. Implementation Level Analysis provides optimal combination of different BMP types, sizes and spatial locations or cost-effective solutions for a range of load reduction targets.

For more information, see the following links:

http://neiwppc.org/nationalnpsold/documents/presentations/Voorhees_Session%205.pdf
<https://www.epa.gov/npdes-permits/stormwater-tools-new-england#pcsm>

- System for Urban Stormwater Treatment and Analysis Integration Model (SUSTAIN) is a somewhat complicated decision support tool developed and piloted by EPA with the Towns of Bellingham, Franklin, and Milford that involves a cost optimization approach. The tool aggregates benefits and helps to select “best buys” or projects with the greatest environmental value per dollar. SUSTAIN was piloted in these communities because of the requirements they face in meeting federal compliance targets to reduce phosphorous inputs so that the Upper Charles River can meet Massachusetts Surface Water Quality Standards. Cost optimization analysis has involved mapping information on land use categories, unit cost information for stormwater facilities, and pollutant loading export rates for each land use category.
 - For the Chesapeake Bay, the Maryland State Highway Administration, in tandem with EPA Region 3 and the U.S. Army Corps of Engineers, developed a related decision-making approach called the *Watershed Resources Registry*. The Registry is an interactive online GIS mapping tool that prioritizes areas for preservation and restoration of wetlands, riparian zones, terrestrial areas, and stormwater management control across an entire state. Driven by the Total Maximum Daily Load goals for the Chesapeake Bay, the Watershed Resources Registry identifies best opportunities to protect high quality resources, restoration of impaired resources, and improvement of stormwater management.³ Retrofits go beyond green infrastructure stormwater management to include, urban tree plantings, stream buffer plantings, wetland restoration, stream restoration, innovative methods, and improved operations (street sweeping, inlet cleaning). The Registry scores potential restoration and preservation areas on a scale of one to five stars based on their potential benefits. Watershed Resources Registries are now available in four mid-Atlantic states, including Delaware, Maryland, Pennsylvania, and West Virginia.
-

Final Deliverables

On-line map/data screening tool displaying:

- Municipal, state, federal, and private properties by total score of suitability for green infrastructure retrofitting and allows the end user to further explore the values associated with the suitability score for each parcel.
- Outfall catchment areas with nitrogen and phosphorus loading rates and impervious/directly connected impervious areas.
- Outfall catchment segment areas with nitrogen and phosphorus loading rate and land use/crosswalk values.

To access the screening tool, see: <https://tinyurl.com/MS4-NSI-PVPC>. Along with the final report, the Town/City was provided with copies ArcGIS shapefiles that were used in or products of the analysis. Table 8 below gives a brief description of each shapefile.

Table 8. Descriptions of Shapefiles Provided as Deliverables of this Project

Shapefile Name	Description
MS4_NSI_NPL_210614	A shapefile containing polygons with like land cover, land use, soil type, and pertinent loading rates, multipliers, etc. This file will be referred to throughout this document as the “base shapefile” as it contains all the information necessary to perform the analysis.
[Municipality]_Catchment Segments	The product of an intersect operation between the base shapefile above and the Town’s/City’s stormwater catchment shapefile. This shapefile specifically shows only the information from the base shapefile that is pertinent to the Town’s/City’s catchments. Calculations for impervious area, directly connected impervious area, and pollutant loads were made within this shapefile’s attribute table.
[Municipality]_Catchments	This shapefile is the final product of the analysis. It contains the following for each catchment within the Town/City: total area (acres), total impervious area (acres), percent of impervious area within the catchment, total estimated directly connected impervious area (acres), estimated percent of directly connected impervious area within the catchment, estimated phosphorus load from catchment (lbs./year), estimated nitrogen load from catchment (lbs./year)
[Municipality]_BMP_Municipal [Municipality]_BMP_State [Municipality]_BMP_Federal [Municipality]_BMP_Private	These shapefiles are the result of the PVPC “Green Retrofit Analysis” incorporating catchment loading data as an analysis variable.