

9 Pollutant Loading

A pollutant loading analysis was performed for the North Branch Park River. A pollutant loading model was applied to the watershed using the land use/land cover data described in Section 7. The model was used to compare existing pollutant loads from the watershed to projected future pollutant loads under a watershed buildout scenario. The predicted change in pollutant loads in each of the subwatersheds is an indicator of their relative vulnerability to future development. The pollutant loading model is also used to identify and rank pollution sources, as well as assist in identifying, prioritizing, and evaluating subwatershed pollution control strategies. It is important to note that the results of this screening-level analysis are intended for the purpose of comparing existing and future conditions and not to predict future water quality. This section summarizes the methods and results of the analysis, which are presented in greater detail in *Appendix E*.

9.1 Model Description

The Watershed Treatment Model (WTM), Version 3.1, developed by the Center for Watershed Protection, was used for this analysis. This model calculates watershed pollutant loads primarily based on nonpoint source (NPS) runoff from various land uses. The model was also used to estimate pollutant loads from other sources, including:

- Combined Sewer Overflows
- Illicit Discharges
- Septic Systems
- Sanitary Sewer Overflows
- Managed Turf
- Road Sanding

Reductions in future pollutant loads in the watershed can be estimated using a range of treatment measures, such as structural and nonstructural best management practices, that are included in the WTM.

Other similar screening-level pollutant loading models were considered for use in development of a watershed management plan for the North Branch Park River, including the Spreadsheet Tool for the Estimation of Pollutant Load (STEPL), the Generalized Watershed Loading Function (GWLF) model, and other similar models. While STEPL was identified as a suitable choice for the North Branch Park River, it was determined that the WTM is better suited for modeling bacterial loads and provides a larger suite of best management practices for urban areas. The ArcView GIS version of the GWLF model was also considered for use in the evaluation, although the AVGWLF model has limited capability for modeling CSOs when using the urban runoff module RUNQUAL within the GWLF model. Again, the WTM model was determined to be better suited for modeling CSOs than the AVGWLF model.

The pollutants modeled in this analysis are the default pollutants contained in the WTM model: total phosphorus, total nitrogen, total suspended solids, and total fecal coliform bacteria. These pollutants are the major NPS pollutants of concern in environmental systems. Additional loadings from combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs) were simulated where such wet weather discharges are known to exist (i.e., North Branch Park River subwatershed).

9.2 Model Inputs

9.2.1 Nonpoint Source Runoff

The land use and land cover data described in Section 7 were adapted for use in the WTM to simulate pollutant loadings under existing and potential future (watershed buildout) conditions. The WTM uses the Simple Method to calculate nutrient, sediment, and bacteria loads from various land uses. The user specifies several model parameters for each land use in the watershed to estimate runoff quantity and pollutant levels. These parameters include Event Mean Concentrations (EMCs), which are literature values for the mean concentration of a pollutant in stormwater runoff for each land use, and an average impervious cover percentage for each land use.

A literature review was conducted to determine EMC values and impervious percentage values for use in the evaluation. EMC values were selected to reflect the relative difference in NPS pollutant characteristics between existing and future land uses. The default impervious cover coefficients in the WTM were adjusted to better reflect local conditions in the North Branch Park River watershed. Impervious cover estimates for each land use category were modified based on measured total impervious area (TIA) for representative parcels or areas within each land use.

9.2.2 Other Pollutant Sources

In addition to nonpoint source runoff pollutant loads, the WTM also provides the capability to model other pollutant sources including point sources and subsurface contributions. The following sections summarize the model inputs for other pollutant sources within the North Branch Park River watershed.

9.2.2.1 Combined Sewer Overflows

The WTM uses a modification of the Simple Method to calculate annual loads from CSOs. The primary assumption is that CSO discharges occur when the combined volume of stormwater and wastewater exceeds the total system capacity. The MDC system experiences approximately 50 CSO discharge events annually in the North Branch Park River (MDC, 2009). Statistical analysis of 15 years of precipitation data at a nearby weather station reveals that the approximate critical depth of rainfall to cause 50 CSO discharge events per year is 0.3 inches.

The volume of a typical CSO is based on the median storm event. In the WTM, any rainfall beyond the system capacity contributes to the CSO volume. Thus, this volume is calculated as the runoff caused by the difference between the median storm event depth and the rainfall depth that causes CSOs (assumed to be 0.3 inch). The runoff volume from this storm event is determined using the Simple Method. The resulting CSO pollutant load is the product of the CSO volume, the number of CSO events, and typical CSO pollutant concentrations.

9.2.2.2 Illicit Discharges

The WTM default assumptions for illicit discharges were used (i.e., a fraction of the total sewage flow contributes to illicit connections). The WTM makes separate assumptions for residential and business illicit connections. For residential connections, the WTM's default assumption is that one in every 1,000 sewered individuals is connected to the sewer system via an illicit connection. This value is then multiplied by the number of individuals connected to the system, and then by typical per capita flow and pollutant concentrations for raw sewage. For businesses, it is assumed that 10% of businesses have illicit connections, and approximately 10% of those have direct sewage discharges.

9.2.2.3 Septic Systems

Although the majority of the North Branch Park River watershed is served by sanitary sewers, portions of the western and northwestern sections of Bloomfield are on private septic systems (Thiesse, pers. comm., December 18, 2009). The number of unsewered dwelling units in each subwatershed was estimated using GIS data including the mapped sewer service area, impervious cover, and aerial photographs. The WTM default values were used for septic system failure rate (30%) and effluent concentrations from both working and failing septic systems.

9.2.2.4 Sanitary Sewer Overflows

There is currently one sanitary sewer overflow (SSO) discharge location in the North Branch Park River subwatershed. WTM default assumptions were used since detailed information on the volume and frequency of overflow was unavailable.

The WTM estimates the SSO load as a product of total flow from SSOs and pollutant concentrations of raw sewage. Unlike most urban pollutant sources, which can be classified as either storm loads or non-storm loads, SSOs can occur both during and between storms. Some are initiated by storm events, such as when the cause of the overflow is lack of capacity, or infiltration of rainfall into the sanitary system. SSOs can also be caused by pipe breakage or blockage, resulting in flow between storm events. The WTM default assumption is that 50% of the load from SSOs occurs as a storm load, with the remainder as a non-storm load.

Based on the MDC GIS data, there are 82 miles of sanitary sewer that convey wastewater to the SSO location in the North Branch Park River subwatershed. An estimated 12 overflows occur per year by assuming the default rate of 140 SSOs per 1,000 miles of sewer.

9.2.2.5 Managed Turf

In urban watersheds, subsurface flow constitutes a relatively small fraction of total annual flow, and most constituents have a relatively low concentration in groundwater. One possible exception is nitrogen, which can leach from urban lawns and other managed turf grass. The annual nitrogen load from managed turf areas is calculated as the product of its concentration and the annual infiltration volume. The area of managed turf in each subwatershed is based on the land cover data described in Section 7 and includes residential lawns, golf courses, parks, and other areas with grass or turf.

9.2.2.6 Road Sanding

Sediment loads from road sanding are calculated based on the quantity of sand applied to roads in a typical year. Data from the West Hartford Public Works Department was extrapolated to the rest of the watershed since more detailed data was unavailable. A sanding application rate for typical roads was calculated based on the average rate in West Hartford in pounds per mile per year. The local roads GIS layer was used to calculate the total length of roads in each subwatershed and the total amount of sand applied to the roads in an average year. Default delivery ratios were used for various road types since not all road sand that is applied will reach the receiving water body.

9.3 Existing Pollutant Loads

Table 9-1 presents the existing modeled pollutant loads for the North Branch Park River watershed. Nonpoint source runoff accounts for approximately 71% of the total nitrogen load, 89% of the total phosphorus load, 33% of the total suspended solids load, and 7% of the fecal coliform bacteria load for the entire watershed. Road sanding accounts for nearly the entire balance of the total suspended solids load, while CSOs and SSOs contribute more than 90% of the fecal coliform load for the watershed. Table 9-2 presents a breakdown of estimated annual loadings of total nitrogen, total phosphorus, TSS, and fecal coliform by subwatershed.

Table 9-1. Modeled Existing Pollutant Loads by Source Type

Source	N (lb/yr)	P (lb/yr)	TSS (lb/yr)	Fecal Coliform (billion/yr)
Nonpoint Source Runoff	97,441	15,234	3,686,296	883,935
Other Sources	38,949	1,874	7,487,076	11,170,230
Septic Systems	14,487	182	7,274	0
SSOs	516	86	3,441	390,550
CSOs	3,653	731	73,054	10,654,285
Illicit Discharges	1,004	586	9,416	125,395
Managed Turf	19,288	289	0	0
Road Sanding	0	0	7,393,891	0
Watershed Total	136,389	17,108	11,173,372	12,054,165

Table 9-2. Modeled Existing Pollutant Loads

Subwatershed	N (lb/yr)	P (lb/yr)	TSS (lb/yr)	Fecal Coliform (billion/yr)	N (lb/ac- yr)	P (lb/ac- yr)	TSS (lb/ac- yr)	Fecal Coliform (billion/ ac-yr)
Beaman Brook East (163 ac)	778	112	65,702	18,530	4.8	0.7	403	113.8
Beaman Brook West (1,185 ac)	8,917	1,096	892,088	63,816	7.5	0.9	753	53.9
Blue Hills Reservoir (1,035 ac)	6,740	1,115	500,837	27,292	6.5	1.1	484	26.4
Cold Spring Reservoir (1,155 ac)	8,825	822	499,416	95,667	7.6	0.7	432	82.8
Filley Brook (404 ac)	4,349	543	454,764	30,696	10.8	1.3	1,126	76.0
North Branch Park River (4,033 ac) (excluding CSOs and SSOs)	37,808	5,121	3,537,838	279,377	9.4	1.3	877	69.3
CSOs and SSOs	4,169	817	76,495	11,044,834	1.0	0.2	19.0	2,738.4
Tumbledown Brook (1,561 ac)	15,486	1,660	1,112,424	93,446	9.9	1.1	713	59.9
Tumbledown Brook South (1,622 ac)	10,149	937	895,817	84,370	6.3	0.6	552	52.0
Tunxis Reservoir (874 ac)	7,142	672	381,828	41,445	8.2	0.8	437	47.4
Wash Brook North (762 ac)	5,187	845	527,067	26,722	6.8	1.1	692	35.1
Wash Brook South (1,559 ac)	13,603	1,778	1,263,600	111,061	8.7	1.1	810	71.2
Wash Brook West (1,029 ac)	6,680	602	329,983	68,767	6.5	0.6	321	66.8
West Hartford Reservoir (2,048 ac)	1,839	332	246,421	33,749	0.9	0.2	120	16.5
Wintonbury Reservoir (894 ac)	4,719	657	389,091	34,393	5.3	0.7	435	38.5
Watershed Total (18,323 ac)	136,389	17,108	11,173,372	12,054,165	7.4	0.9	610	657.9

Because the study subwatersheds vary in size, pollutant loads were also evaluated in terms of loading rates (i.e., pollutant loads per acre of land area, as shown in *Table 9-2*). A higher loading rate indicates relatively greater pollutant sources per unit area, which suggests that implementation of best management practices (BMPs) in these areas may be more effective in reducing pollutant loads. The highest loading rates for nitrogen and phosphorus are associated with the North Branch Park River, Filley Brook, Wash Brook South, Tumbledown Brook, and Wash Brook North subwatersheds. Filley Brook has the loading rates of total suspended solids, while the North Branch Park River subwatershed has the largest fecal coliform loading rate due to contributions from CSOs and SSOs.

- North Branch Park River.* The North Branch Park River subwatershed is the largest subwatershed by area. It also has the largest amount of commercial/industrial, institutional, and transportation land uses. The nutrient loads in this subwatershed are approximately 3 times greater than the next highest subwatershed, primarily due to the comparatively large size and highly urban nature of the subwatershed. The estimated nitrogen loading rate (excluding CSO and SSO contributions) is the second highest of the subwatersheds at 9.4 lb/ac-year, while the phosphorus loading rate is the highest of the subwatersheds at 1.3 lb/ac-year. The estimated fecal coliform loading due to nonpoint source runoff is 279,377 billion per year, while the contribution of fecal coliform from sewer overflows is approximately 2 orders of magnitude larger than the nonpoint source runoff contribution.

- *Wash Brook South.* Wash Brook South ranks among the top four subwatersheds in annual pollutant loading and loading rates. The high loading is due to the proportionally high commercial/industrial, residential, and roadway land uses in this subwatershed.
- *Filley Brook.* The Filley Brook subwatershed has the highest TSS loading rate in the watershed and is among the 4 highest subwatersheds in terms of pollutant loading rates for nitrogen, phosphorus, and fecal coliform bacteria. However, the total loading of each pollutant is among the lowest in the watershed due to its small size. The high pollutant loading rates reflect the large percentage of medium density residential (50%) and commercial/industrial (20%) development in the subwatershed.

Table 9-3 summarizes the contribution of nonpoint source pollutant loads by land use for the entire watershed. The majority of the nitrogen and phosphorus loads are from roadway, commercial/industrial, and residential land uses. The majority of the TSS loads is due to roadway (41.8%) and commercial/industrial (31.1%) land use. Residential land use accounts for approximately 81% of the nonpoint source bacterial load. Other modeled pollutant sources contribute significantly to the watershed pollutant loads, particularly CSOs and SSOs, which are the predominant source of the fecal coliform loads in the watershed.

Table 9-3. Modeled Existing Pollutant Loads by Land Use

Land Use	N (lb/yr)	P (lb/yr)	TSS (lb/yr)	Fecal Coliform (billion/yr)	N	P	TSS	Fecal Coliform
Agriculture	274	37	3,506	416	0.3%	0.2%	0.1%	0.0%
Commercial/Industrial	25,239	4,589	1,147,223	73,199	25.9%	30.1%	31.1%	8.3%
Forest	389	195	136,280	4,436	0.4%	1.3%	3.7%	0.5%
Institutional	7,112	1,185	264,709	25,209	7.3%	7.8%	7.2%	2.9%
Medium Density Residential	18,778	2,209	336,905	437,981	19.2%	14.5%	9.1%	49.5%
Multi-family/High Density Residential	8,071	897	142,590	118,528	8.3%	5.9%	3.9%	13.4%
Open Space (Urban)	2,109	211	28,126	3,205	2.2%	1.4%	0.8%	0.4%
Roadway	30,887	5,148	1,544,327	65,691	31.7%	33.7%	41.8%	7.4%
Single-family/Low Density Residential	4,713	785	86,793	155,719	4.8%	5.1%	2.4%	17.6%
Watershed Total	97,572	15,256	3,690,458	884,382	100%	100%	100%	100%

9.4 Future Pollutant Loads

Anticipated future land use due to new development and redevelopment within the watershed was used in the WTM model to simulate potential future pollutant loads under a watershed buildout scenario. Future land use categories were derived from the watershed buildout scenario presented in Section 7. Future controls or best management practices were not considered in the calculation of future pollutant loads. Therefore, the predicted future pollutant loads reflect a potential worst-case scenario against which potential watershed management pollution control strategies may be evaluated. Additionally, future pollutant loads were modeled with and without CSO and SSO mitigation to evaluate the potential reductions in pollutant loads that could be achieved by the MDC's ongoing and planned sewer overflow mitigation projects.

Table 9-4 presents projected future pollutant loads in terms of loading rate increase and percent increase in total loads under a watershed buildout scenario. Significant increases in pollutant loads are predicted in many of the subwatersheds. The watershed as a whole is predicted to experience a 13% increase in nitrogen loads, a 16% increase in phosphorus loads, and a 20% increase in TSS loads under a future buildout scenario and assuming completion of the ongoing and planned CSO and SSO mitigation projects. Overall, fecal coliform loads for the entire watershed are predicted to decrease by 64%, primarily as a result of the MDC sewer overflow mitigation projects. However, these projects will only affect pollutant loads in the North Branch Park River subwatershed. Almost all of the other subwatersheds are predicted to experience significant increases in fecal coliform loads (generally 20% to 80% increases) under a watershed buildout scenario due to nonpoint source runoff. Several of the subwatersheds are predicted to experience significantly higher increases in pollutant loads and loading rates under a watershed buildout scenario. These subwatersheds, which include the Beamans Brook East, Wash Brook North, Wash Brook West, and Wintonbury Reservoir subwatersheds, correspond to areas with significant developable land.

Table 9-4. Modeled Future Pollutant Loading Rate Increases and Load Increases

Subwatershed	Projected Future Loading Rate*				Projected Load Increase* (%)			
	N (lb/ac-yr)	P (lb/ac-yr)	TSS (lb/ac-yr)	Fecal Coliform (billion/yr)	N	P	TSS	Fecal Coliform
Beamans Brook East (163 ac)	11.2	1.2	638	169	134%	75%	58%	49%
Beamans Brook West (1,185 ac)	8.4	1.0	845	65	11%	12%	12%	21%
Blue Hills Reservoir (1,035 ac)	7.8	1.3	581	36	20%	20%	20%	35%
Cold Spring Reservoir (1,155 ac)	8.3	0.8	499	105	9%	14%	15%	27%
Filley Brook (404 ac)	12.0	1.6	1315	82	11%	18%	17%	8%
North Branch Park River (4,033 ac) (excluding CSOs and SSOs)	10.4	1.4	990	83	11%	12%	13%	19%
CSOs and SSOs	0.4	0.1	5.4	757	-66%	-67%	-72%	-72%
Tumbledown Brook (1,561 ac)	11.0	1.2	804	73	11%	13%	13%	22%
Tumbledown Brook South (1,622 ac)	7.1	0.7	695	78	13%	19%	26%	50%
Tunxis Reservoir (874 ac)	8.8	0.9	503	65	8%	11%	15%	36%
Wash Brook North (762 ac)	10.5	1.8	1099	46	54%	61%	59%	32%
Wash Brook South (1,559 ac)	9.8	1.3	912	92	13%	11%	13%	29%
Wash Brook West (1,029 ac)	6.1	0.8	453	113	-7%	30%	41%	70%
West Hartford Reservoir (2,048 ac)	1.2	0.2	163	29	37%	32%	36%	77%
Wintonbury Reservoir (894 ac)	8.4	1.3	733	57	59%	71%	68%	48%
Watershed Total* (18,323 ac)	8.4	1.1	729	239	13%	16%	20%	-64%

*Reflects completion of ongoing and planned CSO and SSO mitigation projects.