

Appendix C
Watershed Treatment Model

As a part of the Small Watershed Action Plan for the Declaration Run and Riverside Watersheds, the URS team developed a baseline water quality model for the two watersheds based on Harford County (County) geographic information system (GIS) data and additional information on County operations. The team used the data as input into the Watershed Treatment Model (WTM), a spreadsheet-based model developed by the Center for Watershed Protection (CWP 2013).

The WTM calculates annual pollutant loading rates based on various primary and secondary sources of pollution. The model accounts for different sources of pollutants and factors in Best Management Practices (BMPs) to estimate pollutant load reductions. It can be used to estimate the following pollutants:

- Total nitrogen
- Total phosphorus
- Total suspended solids
- Fecal coliform (bacteria)

The WTM was used to estimate current pollutant loads in the two watersheds and projected pollutant load reductions from future Best Management Practices.

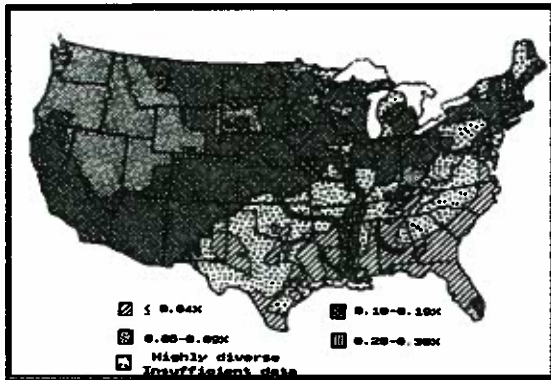
C.1 EXISTING CONDITIONS ANALYSIS

An existing conditions model was developed to estimate the pollutant loads from primary sources such as existing land use and secondary sources such as illicit discharges, onsite sanitary disposal systems, and sanitary sewer overflows and the current pollutant reductions from existing BMPs.

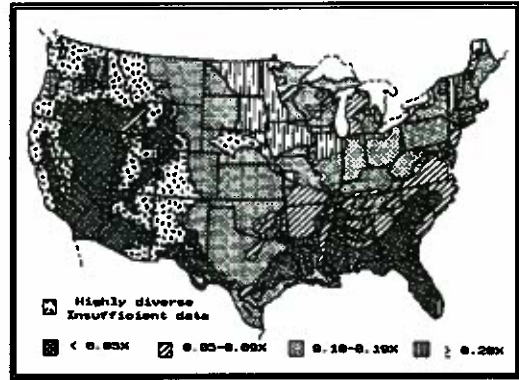
The data that were used in the model to estimate the current pollutant loads were based on the following:

- **Primary sources:** The primary sources are existing land use and impervious cover. GIS data for existing land use were obtained by modifying County land cover data by verifying the data against aerial imagery. The impervious cover was obtained from County GIS data. The default impervious cover percentage per land use type was adjusted in the model to reflect existing watershed conditions by intersecting the land use and impervious cover GIS data. Table C-1 provides the primary source data that were used as input.
- **Secondary sources:** The input information for secondary sources was obtained from County GIS data, operations information, and research. The secondary sources are as follows:
 - **Nutrient concentration in stream channel:** Because the County does not have any sampling/monitoring data on the current nutrient concentration in the stream channels, the phosphorus and nitrogen concentrations for Maryland provided in Figures 4.1 and 4.2 of Watershed Treatment Model (CWP 2013) documentation were used. Based on

the figures, phosphorus concentration of 0.020 percent and nitrogen concentration of 0.05 percent were assumed in the stream channel.



Distribution of phosphorus (P2O5) in the top 12 inch of soil (Source: Figure 4.1, CWP 2013)



Distribution of nitrogen in the top 12 inch of soil (Source: Figure 4.2, CWP 2013)

Table C-1: Primary Source Data for Declaration Run and Riverside Watersheds

Land Use Category	Declaration Run		Riverside	
	Area (acres)	Impervious Cover (%)	Area (acres)	Impervious Cover (%)
Low-density residential	1.9	12%	—	—
Medium-density residential	51.6	21%	45.6	29%
High-density residential	82.6	33%	51.0	36%
Open space	8.9	44%	48.7	5%
Commercial	22.8	12%	7.1	52%
Office	0.6	72%	22.1	70%
Institutional	15.4	72%	5.6	45%
Unimproved land	—	—	8.4	2%
Other mixed land uses	—	80%	7.2	21%
Roadway	60.0	80%	49.6	56%
Industrial	—	—	24.6	77%
Forest	129.1	—	32.6	—
Wetland	52.7	—	—	—
Open water	1.3	—	0.25	—

- **Onsite sewage disposal system (OSDS):** Based on County information, the Riverside watershed does not include any OSDSs. Two OSDSs in the Declaration Run watershed were included in the model and were assumed to be conventional OSDSs.
- **Sanitary sewer overflows:** Based on County GIS data, the Declaration Run watershed has approximately 8.5 miles of sanitary sewer lines, and the Riverside watershed has approximately 6.8 miles of sanitary sewer lines.

- **Combined sewer overflows:** Neither watershed has any combined sewer outfalls.
- **Illicit connections:** The WTM default assumptions were used to estimate the pollutant loads from illicit connections (1 in 1,000 homes and 10 percent of businesses are assumed to be illicitly connected).
- **Urban channel erosion:** Estimates of urban channel erosion in both the watersheds were based on typical estimates of channel erosion rates. Moderate sediment loads were used for both the watersheds based on indications of degradation and areas of severe channel erosion that were observed in both watersheds during the field reconnaissance.
- **Livestock and marinas:** Neither watershed has livestock or marinas.
- **Road sanding:** Based on County information, road sanding is not performed in either watershed.
- **Non-stormwater point sources:** Neither watershed has facilities with individual National Pollutant Discharge Elimination System (NPDES) permits for wastewater discharges.
- **Existing management practices:** Input data for existing management practices were developed based on field observations, County GIS data, and other management practices data related to County operations.
- **Turf condition and management practices:** Input data for existing turf condition and management practices were based on field observations. During field investigation, it was observed that approximately 5 percent of the lawns in the watersheds appeared to be bare or compacted and 10 percent appeared to be highly managed as a result of excess fertilization.
- **Erosion and sediment control:** Based on County information, the County's existing erosion and sediment control program was assumed to be 70 percent efficient. All building permits were assumed to be regulated with frequent site inspections.
- **Street sweeping:** According to the County, all County roads are swept using mechanical sweepers. The Declaration Run watershed has approximately 2.1 acres of County roads, and the Riverside watershed has approximately 10.5 acres of County roads.
- **Structural stormwater management (SWM) practices:** Information on existing structural SWM practices was obtained from County stormwater management GIS data. Drainage areas for most of the SWM facilities in the watersheds were available. Drainage areas for SWM facilities implemented in the last few years were not available and were delineated based on the County's SWM plans for the facilities. See Table C-2.

Table C-2: Existing Stormwater Management Practices in the Declaration Run and Riverside Watersheds and Drainage and Impervious Areas

SWM Practice	Declaration Run		Riverside	
	Drainage Area (acres)	Impervious Area (acres)	Drainage Area (acres)	Impervious Area (acres)
Wet pond	4.8	1.2	—	—
Filters – sand filter	0.6	0.5	6.6	3.9
Dry swale (bio swale, water quality swale)	8.8	5.0	23.45	15.9
Infiltration practice	8.19	4.4	—	—
ESD practice	—	—	0.9	0.6

The default pollutant removal efficiencies in the model were modified to match the *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* (MDE 2011). Table C-3 provides the efficiencies of stormwater management practices used in the model.

Table C-3: Pollutant Removal Efficiencies of Stormwater Management Practices

SWM Practice	Pollutant Removal Efficiency (Percent)		
	Total Suspended Solids	Total Phosphorus	Total Nitrogen
Constructed between 1985-2002	40	30	17
Construction between 2002 and 2010	80	40	30
Environmental Site Design Practices	90	60	50

- **Riparian Buffers:** The input data for riparian buffers was calculated based on County GIS data and aerials. The default pollutant removal efficiencies in the model were modified to match the MDE approved pollutant removal efficiencies.
- **Catch basin cleanouts:** Based on County information, catch basins in the County are cleaned every 3 years.
- **Baseline pollutant loads:** The pollutant loads from primary and secondary sources and subsequent load reductions from existing management practices are provided in Table C-4 and C-5.

Table C-4: Existing Pollutant Loads in Declaration Run and Riverside Watersheds

Watershed Source	Receiving Waterbody	Total Nitrogen (lbs/yr)	Total Phosphorus (lbs/yr)	Total Suspended Solids (lbs/yr)	Fecal Coliform Bacteria (billion/yr)
Declaration Run	Surface water	3,005	501	180,126	157,734
	Groundwater	16,129	817	N/A	31
Riverside	Surface water	3,456	628	148,405	176,594

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Watershed Source	Receiving Waterbody	Total Nitrogen (lbs/yr)	Total Phosphorus (lbs/yr)	Total Suspended Solids (lbs/yr)	Fecal Coliform Bacteria (billion/yr)
	Groundwater	30,204	1,451	N/A	37

Table C-5: Pollutant Load Reductions from Existing Management Practices

Stormwater Management Practice	Total Nitrogen (lbs/yr)		Total Phosphorus (lbs/yr)		Total Suspended Solids (lbs/yr)		Fecal Coliform Bacteria (billion/yr)	
	DR	R	DR	R	DR	R	DR	R
Structural stormwater management practices	88	362	16	69	2,663	10,519	3,645	8,644
Riparian Buffers	559	57	93	10	16,296	1,272	19,768	1,669
Street Sweeping	0.4	2	0.05	0.2	24	108	—	—
Catch basin cleanouts	104	25	11	3	9,819	2,409	—	—

DR = Declaration Run
R = Riverside

C.2 FUTURE CONDITIONS ANALYSIS

The proposed watershed improvements described in Section 3 of the Small Watershed Action Plan for the Declaration Run and Riverside Watersheds are stormwater structural projects, stormwater nonstructural projects, stream restoration projects, and improvements from education and outreach.

- Structural SWM practices:** Structural SWM projects include green infrastructure, urban retrofits, environmental site design, low impact development, and stream restoration. Pollutant removal efficiencies for proposed projects were obtained from the MDE's *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* (MDE 2011) document. Table C-6 lists the pollutant removal efficiencies used for the proposed projects.

Table C-6: Pollutant Removal Efficiencies of Proposed Structural Stormwater Management Practices

SWM Practice	Pollutant Removal Efficiency (Percent)		
	Total Suspended Solids	Total Phosphorus	Total Nitrogen
Urban BMP Retrofit	65	35	25
Environmental Site Design Practices	90	60	50

SWM Practice	Pollutant Removal Efficiency (lb/ft)		
	Total Suspended Solids	Total Phosphorus	Total Nitrogen
Stream Restoration	2.5	0.0035	0.02

- **Residential lawn care education and pet waste education:** An outreach program developed by the County to educate homeowners on lawn care and pet waste is proposed. It is assumed that the County will use brochures to educate homeowners.
- **Impervious cover disconnection program:** An outreach program to educate homeowners on the benefits of disconnecting impervious areas such as rooftops and driveways is proposed for implementation by the County. It is assumed that the County will use brochures to educate homeowners.
- **Septic system upgrade:** The two onsite OSDS located in Declaration were assumed to be upgraded to improve their efficiency
- **Other practices:** It was assumed that the County would continue the existing BMPs.

Table C-7 shows the pollutant load reductions that will be achieved by implementing the proposed watershed improvements.

Table C-7: Estimated Pollutant Load Reductions from Proposed Stormwater Management Practices in the Declaration Run and Riverside Watersheds

Stormwater Management Practice	Total Nitrogen (lbs/yr)		Total Phosphorus (lbs/yr)		Total Suspended Solids (lbs/yr)		Fecal Coliform Bacteria (billion/yr)	
	DR	R	DR	R	DR	R	DR	R
Structural improvements	259	891	43	191	8,151	29,893	9,256	32,970
Lawn care	27	47	6	11	—	—	—	—
Pet waste education	14	18	2	2	—	—	121	159
Septic system – surface	7	—	1	—	50	—	731	—
Stream restoration	55	—	10	—	6,962	—	—	—

DR = Declaration Run
R = Riverside