Point and Nonpoint Source Technical Memorandum

Point and Nonpoint Sources of Temperature in the Coldwater Gwynns Falls Watershed

The U.S. Environmental Protection Agency (USEPA) requires that Total Maximum Daily Load (TMDL) allocations account for all sources of each impairing pollutant (CFR 2012). This technical memorandum identifies both the point sources and nonpoint sources of temperature in the Use Class III (coldwater) portions of the Maryland 8-Digit (MD 02130905) Gwynns Falls watershed. In general, point source wasteload allocations (WLA) are provided for National Pollutant Discharge Elimination System (NPDES) permitted wastewater and stormwater. There are no NPDES wastewater permits that impact temperature in the coldwater stream portions of the watershed. Therefore, this memorandum presents WLAs only for NPDES stormwater sources. Load allocations (LA) are also provided for nonpoint sources included within the Gwynns Falls watershed. Nonpoint source loads in the coldwater Gwynns Falls watershed include forest and agricultural loads, as well as loads from degraded riparian canopy. The State reserves the right to allocate the loads among different sources in any manner that is reasonably calculated to protect aquatic life from temperature related impacts.

All thermal loads in the coldwater Gwynns Falls Watershed TMDLs are estimated using a hydrological and pollutant transport model, the Soil and Water Assessment Tool (SWAT). SWAT is a river basin scale model developed to quantify the impact of land management practices in large, complex watersheds. The baseline model scenario represents 2013 conditions in the watershed, using land use from the Chesapeake Conservancy High Resolution Land Cover Classification. TMDLs were calculated separately for each of the sub-watersheds within the Gwynns Falls watershed, Red Run and Upper Gwynns Falls. The TMDL scenarios chosen were those which met the temperature water quality criteria (90^{th} percentile $\leq 20°C$). The Gwynns Falls Watershed temperature TMDLs are presented in terms of a long-term maximum daily thermal load [gigajoules/day (GJ/d)] established to ensure the support of aquatic life, and specifically coldwater species. For this TMDL, two management practices are simulated in SWAT that address the thermal impairments in the coldwater Gwynns Falls watershed—urban retrofit (filtration and infiltration practices) and increased riparian canopy.

Urban retrofit

Urban development dramatically alters a drainage system due to changes in surface cover (i.e. impervious surface) and the addition of stormwater handling systems. Increased and warmer runoff from impervious surfaces into streams can lead to a degradation of habitat for coldwater fish. In this TMDL report, the term retrofit refers to stormwater controls applied to existing, "untreated" impervious land with the goal of capturing and managing runoff from a 1-year, 24-hour design storm with practices defined in Chapters 3 and 5 of the Maryland Stormwater Design Manual. The retrofit goal is meant to simulate "woods in good condition". Within the context of this TMDL, retrofits include practices that filter or infiltrate urban runoff in order to

simulate pre-development runoff conditions.

Increased riparian canopy

Riparian vegetation positively affects stream temperature in three main ways. First, riparian vegetation absorbs incoming shortwave radiation (ultraviolet and visible light) from the sun. Since less thermal energy is reaching the stream, the water temperature is reduced. Second, as part of the earth's energy balance, some of the shortwave radiation absorbed by riparian vegetation is emitted back into the atmosphere as long-wave radiation (infrared light). Some of this energy also reaches the stream, and can increase the water temperature. Third, riparian vegetation may affect the stream micro-climate (e.g., air temperature, humidity, and wind speed), which in turn affects evaporation, conduction, ground temperature, and water temperature. (Rutherford, 1997) The amount of shading by the banks depends not only on their height but also on the elevation angle of the sun and the orientation of the sun relative to the stream channel. Riparian zone width and type of vegetation also influence impact of riparian canopy.

For the purposes of this TMDL, a stream is considered to be fully buffered when it has 50 meters of continuous canopy on either side, for a total of 100 meters. Riparian canopy percentage, within a stream buffer of 100 meters, was measured using the Chesapeake Conservancy High Resolution (1-meter) Land Cover dataset, which is derived from 2013 imagery (Chesapeake Conservancy 2018). The average riparian cover in the Gwynns Falls coldwater streams was estimated to be 69% effective cover in the Upper Gwynns Falls subwatershed and 79% effective cover in the Red Run subwatershed. The Upper Gwynns Falls subwatershed has approximately 29 miles of stream and the Red Run subwatershed has approximately 33 miles of stream. More detailed information regarding current riparian canopy can be provided by the MDE Watershed Protection, Restoration and Planning Program.

Point Source Thermal Loads

In this TMDL, the thermal loads attributed to NPDES stormwater discharges include loads from urban land use. As with other pollutants, urban land use has a greater thermal unit loading rate than woods in good condition.

Under the TMDL scenarios defined within Section 4 of the main TMDL report, both urban stormwater retrofits and increased riparian canopy are necessary in order to achieve the WLAs for the Red Run and Upper Gwynns Falls sub-watersheds. No stormwater retrofits are specified for forest or agricultural land use. Increased riparian canopy is addressed in the non-point source section of this technical memorandum.

Table 1 presents the baseline and stormwater WLA thermal loads in each sub-watershed. Tables 2 and 3 present the anticipated levels of urban retrofit and increases in riparian canopy required under the TMDL scenarios to achieve the temperature endpoints in each sub-watershed.

Table 1: NPDES Stormwater Baseline and WLA Thermal Loads

Sub-watershed	Baseline (GJ/d)	WLA (GJ/d)	Reduction (%)
Red Run	61	43	29
Upper Gwynns	118	61	48

Table 2: Estimated Additional Stormwater Retrofit Required for Achieving TMDL Temperature Endpoint

Sub-watershed	Additional TMDL Urban Retrofit (%)	Acres
Red Run	35	502
Upper Gwynns	55	1,471

NPDES stormwater sources in the Gwynns Falls watershed include Phase I Municipal Separate Storm Sewer Systems (MS4), Phase II MS4s, general construction permits, and general industrial stormwater permits. Each Phase I MS4 permit is assigned an individual WLA and the remaining permits are given an aggregate WLA. This aggregate WLA is referred to as the "Other NPDES regulated stormwater" WLA. Individual allocations for the Phase I MS4 permits and an aggregate allocation for the Other NPDES Regulated Stormwater sources were calculated based on the permitted acreages within the sub-watersheds.

Table 3 identifies all of the applicable NPDES stormwater permits in the Gwynns Falls watershed. Table 4 and Table 5 provide the distribution of the NPDES Regulated Stormwater WLA amongst the permits identified in Table 4, for Red Run and Upper Gwynns Falls, respectively.

Table 3: Gwynns Falls Watershed NPDES Stormwater Permits

Facility Name	NPDES#	Permit Type
Baltimore County Phase I MS4	MD0068314	Individual
State Highway Administration Phase I MS4	MD0068276	Individual
General Industrial Stormwater	MDR0000	Other NPDES Regulated Stormwater
Phase II MS4 General Permit for State and Federal Agencies	MDR055501	Other NPDES Regulated Stormwater
General Construction	MDRC	Other NPDES Regulated Stormwater

Table 4: Red Run Temperature TMDL WLAs for NPDES-Regulated Stormwater

Facility Name	NPDES #	Baseline Load (GJ/d)	WLA (GJ/d)	Reduction (%)
Baltimore County Phase I MS4	MD0068314	46	33	29
State Highway Administration Phase I MS4	MD0068276	3.7	2.6	29
Other NPDES Regulated Stormwater *(multiple permittees)*	N/A	10	7.4	29
TOTAL		**61**	**43**	**29**

Table 5: Upper Gwynns Falls Temperature TMDL WLAs for NPDES-Regulated Stormwater

Facility Name	NPDES #	Baseline Load (GJ/d)	WLA (GJ/d)	Reduction (%)
Baltimore County Phase I MS4	MD0068314	107	55	48
State Highway Administration Phase I MS4	MD0068276	0.8	0.4	48
Other NPDES Regulated Stormwater *(multiple permittees)*	N/A	10.9	5.6	48
TOTAL		**118**	**61**	**48**

Nonpoint Source

In order to achieve the LA in the main document, increased riparian canopy is required in the Red Run and Upper Gwynns Falls sub-watersheds. No stormwater retrofits are specified for forest or agricultural land use. However, riparian cover must be increased on forest, agricultural, and urban lands. Table 6 presents the percent riparian cover increase and equivalent stream miles required by the TMDL scenario in each sub-watershed. The nonpoint source baseline loads and LAs are presented in Table 7.

Table 6: Required Riparian Cover Increase in Agricultural Land Use Acres

Sub-watershed	Baseline riparian cover (%)	TMDL riparian cover (%)
Red Run	79	90
Upper Gwynns	69	90

Table 7: Baseline Nonpoint Source Loads and LAs

TMDL	Baseline Nonpoint Source Load (GJ/d)	TMDL LA (GJ/d)	Reduction (%)
Red Run Sub-Watershed	339	305	10
Upper Gwynns Falls Sub-Watershed	375	335	11

REFERENCES

CFR (Code of Federal Regulations). 2018. *40 CFR 130.7*. https://www.ecfr.gov/cgi-in/text-idx?SID=b321e937ec983523beaa18464e58a314&mc=true&node=se40.24.130_17&rgn=div8 (Accessed December 2018)

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