

ESTABLISHMENT OF A NUTRIENT HOTSPOT IDENTIFICATION PROJECT (NHIP OR PROJECT)

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August 28, 2020

Revised June 2, 2022

Introduction

As part of the Countywide Biological Monitoring Program (CBMP), a water quality grab sample is now collected at each aquatic biological assessment station. A variety of parameters are measured, including major nitrogen and phosphorus species like nitrate/nitrite, orthophosphate, and total ammonia, along with total phosphorus and total nitrogen. While most stations show moderate to low concentrations of these parameters, there are occasional occurrences of higher values that warrant investigation to identify potential sources and options for remedy.

BWPR works to ensure that TMDLs for total nitrogen (TN), total phosphorus (TP) and total suspended sediment (TSS) can be achieved. Establishment of the NHIP could potentially lead to management activities that result in direct, measurable reductions in these pollutants with a relatively low expenditure of resources, when accounting for the considerable implementation costs of BMP and stream restoration projects often undertaken to reduce these pollutants. Of note, while TSS is a pollutant of concern the CBMP does not collect baseflow water quality data for this parameter. This is because TSS is more likely to be mobilized during elevated flow events as opposed to baseflow, and the CBMP is designed to collect data during baseflow conditions. Thus, the NHIP focuses only on TN and TP.

Criteria Development

Before an initiative like this can be implemented, actionable criteria (henceforth referred to as action levels or thresholds) must be established for parameters that are relevant to the pertinent regulatory requirements. Additionally, parameters used for the Project must allow for discrimination amongst sites during baseflow conditions.

Because certain TMDLs issued to the County focus on TN and TP, it is proposed that they be used as thresholds for the Project. It is probable if TN or TP are controlled, then many of the particular species that comprise them will also be somewhat controlled. For example, total nitrogen and NO₃-nitrogen concentrations track well with each other (see Figure 1), with nitrate-nitrite comprising approximately 60% of nitrogen observed in the 2017-2019 baseflow dataset. Other nitrogen compounds (NH₃, TKN) are not well correlated, largely due to the large number of values below detection limits, a frequent occurrence when sampling during baseflow conditions (Victoria et al. 2020). For phosphorus, a weak correlation between total phosphorus and orthophosphate exists once values below the detection limit and one PO₄ outlier are removed (see Figure 2).

To establish action levels for TN and TP, two main approaches were considered. Sites could be selected subjectively based upon the statistical properties of the dataset itself. Alternatively, thresholds could be set at values that have been empirically related to desirable ecological outcomes, such as the attainment of a particular IBI correlated with a particular nutrient concentration. There are strengths and weaknesses associated with both approaches.

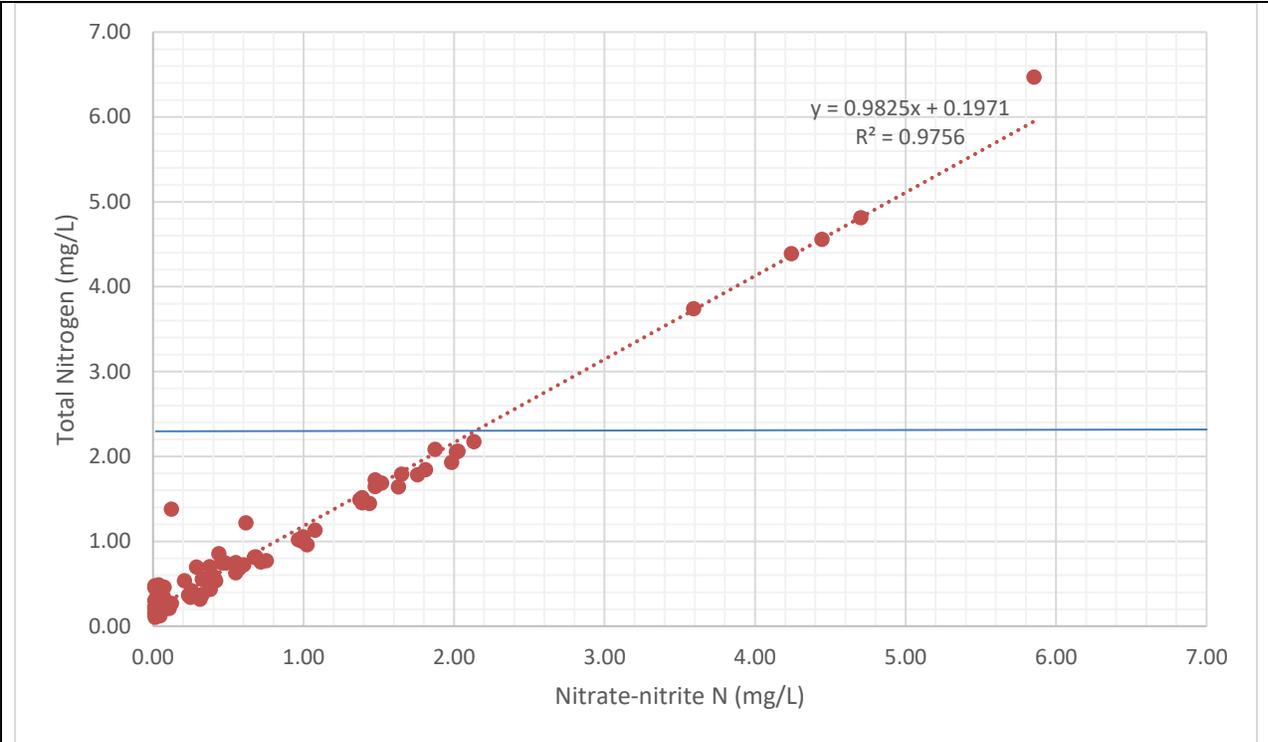


Figure 1. Plot of Total Nitrogen against Nitrate/Nitrite-N. The blue line represents the proposed TN action level value (2017-2019 values).

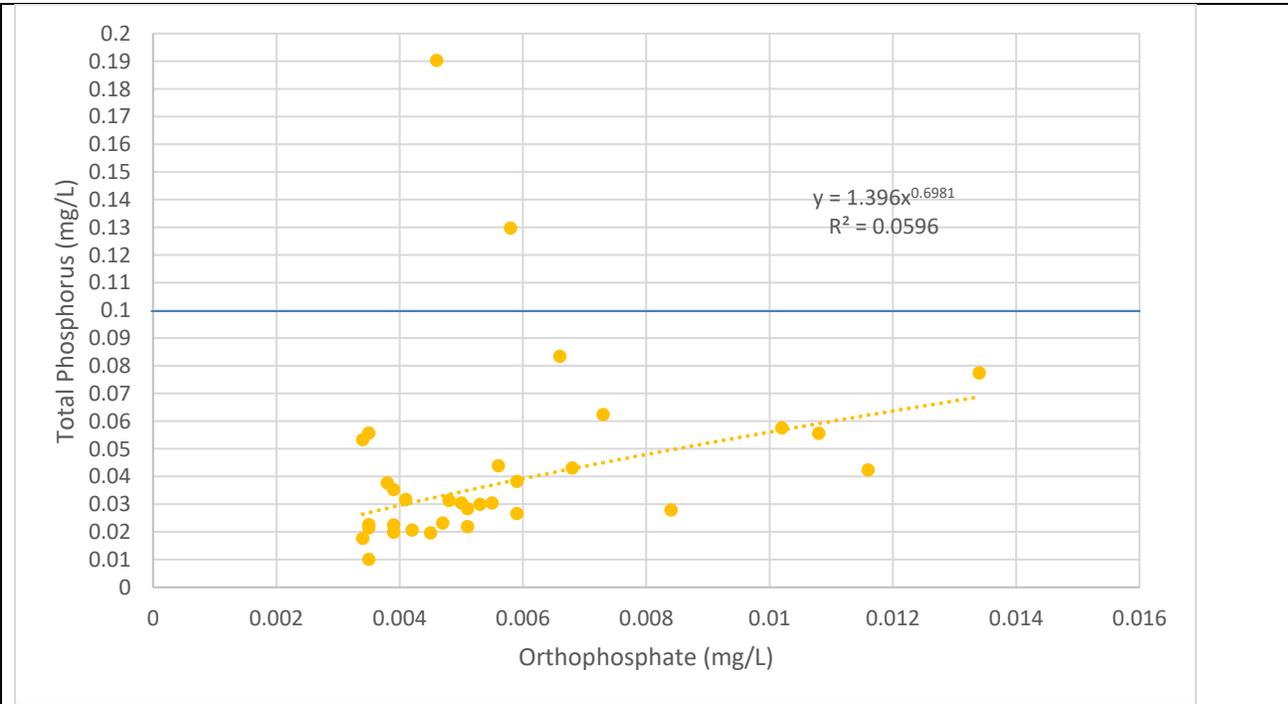


Figure 2. Plot of Total Phosphorus against orthophosphate. The blue line represents the proposed TP action level value (2017-2019 values).

Objective thresholds are developed using relevant supporting literature or other data sources. In this exercise, nutrient concentrations associated with specific IBI outcomes are derived from work detailed in Morgan et al. (2007) and Morgan et al. (2012). Total nitrogen concentrations associated with benthic macroinvertebrate communities of moderate quality (BIBI = 3.00, or Fair) or greater range from 1.3 to 2.5 mg/L, as illustrated in Table 1. Total phosphorus concentrations for the same BIBI conditions range from 0.043 mg/L to 0.065 mg/L.

The subjective thresholds developed from CBMP samples collected during Round 3 (2017 to 2021) are also presented in Table 1. To develop these values, descriptive statistics were calculated on the entire water quality data set collected during the Round 3 spring sampling work. A cutoff value of two standard deviations above the mean value for each parameter was used as it is well established that approximately 95% of all values in a distribution fall within two standard deviations, regardless of shape of the distribution associated with the data set (Altman and Bland 2005). Consequently, values equal to or greater than this cutoff should represent genuinely large values compared to those observed in other sample reaches.

Source	Threshold Type ¹	TN (mg/L)	TP (mg/L)	Notes
Morgan et al. (2007)	O	1.30	0.043	Cutoffs for BIBIs observed in the Fair range. From MBSS data.
Morgan et al. (2012)	O	2.50	0.065	Represent 75 th percentile values in CP MBSS data for reference streams in Good range.
CBMP 2017-21	S	6.58	0.255	Values are 2 SD above the 2017-21 average.
Final Thresholds	Mix	3.45	0.121	Proposed final thresholds are averages of the others.

¹ O = Objective Threshold; S = Subjective Threshold

In setting final action levels for the Project, as presented in Table 1, a judgement call was made to focus on locations that may disproportionately contribute nutrients to County watersheds while still capturing reaches where nutrient concentrations could result in impaired biological communities. Using an average of the objective and subjective thresholds to set action levels represents a balance between efficacy and efficiency in addressing nutrient issues observed in County streams. As summarized in Table 2, employing an averaging approach does leave sites that exceed the Morgan criteria unaddressed, but it results in more sites than if just the CBMP subjective threshold is used. Basically, using the threshold averages captures approximately the top 8 to 20% of reaches with the highest concentrations from the available population, which seems to strike the balance described above.

Threshold	TP sites (% total)	TN sites (% total)
Morgan 2007	187 (49%)	157 (41%)
Morgan 2012	144 (38%)	66 (17%)
CBMP	19 (5%)	12 (3%)
Threshold Averages (Proposed Thresholds)	77 (20%)	31 (8%)

1) N = 384

NHIP Procedures

To begin the Project, all CBMP station water quality data currently available (2017-2021) have been screened against the action levels presented in Table 1 for possible candidates. The results are presented in Table 3.

Stations in Table 3 are prioritized for action in the following way:

- those that exceed both action levels will be first priority,
- followed by stations that exceed the TN action level (second priority),
- then stations that exceed the TP action levels (third priority),

Within each priority group, all stations will be ranked high to low in simple numerical order of concentration value. The focus on nitrogen in the ranking process is in line with the increased emphasis on nitrogen in the State’s WIP Phase III Implementation plan (MDE 2019) due to the apparent difficulties that localities are having in achieving nitrogen reductions. Conversely, most jurisdictions appear to be on track in achieving necessary reductions to meet watershed caps associated with phosphorus. Additionally, stations in Table 3 where landowners requested the County share monitoring results with them are highlighted, as such landowners might be more willing to allow additional assessment work to occur on their properties and may also be willing to work with the County and other entities to assist on nutrient mitigation or reduction measures.

Table 3. Stations from 2017-2019 CBMP that exceed one or both action levels.	
Priority Group: Condition (Total Stations) CBMP Round Year: No. Stations	CBMP Stations
First Priority: Exceeds Both Action Levels (11) 2017: 0 2018: 2 2019: 0 2020: 8 2021: 1	01-R3M-04-18 05-R3S-08-18 02-R3S-13-20 07-R3S-08-20 07-R3S-12-20 14-R3M-17-20 14-R3S-02-20 14-R3S-12-20 20-R3S-02-20 20-R3S-03-20 24-R3S-13-21
Second Priority: Exceeds TN Action Level (31) 2017: 2 2018: 1 2019: 5 2020: 20 2021: 3	06-R3S-11-17 02-R3S-06-20 10-R3S-09-17 07-L1M-03-20 03-L1M-03-18 07-L2M-03-20 04-R3S-18-19 07-R3M-04-20 17-R3S-04-19 07-R3M-07-20 18-R3S-04-19 07-R3S-05-20 18-R3S-05-19 07-R3S-07-20 18-R3S-10-19 07-R3S-11-20 02-L1M-01-20 20-L2M-01-20 02-L2M-01-20 20-R3M-03-20

Table 3. Stations from 2017-2019 CBMP that exceed one or both action levels.

	02-L2M-04-20	20-R3M-06-20
	02-R3M-02-20	20-R3S-04-20
	02-R3M-03-20	22-L2M-01-21
	02-R3M-05-20	22-R3M-09-21
	02-R3S-02-20	22-R3S-04-21
	02-R3S-03-20	
<p>Third Priority: Exceeds TP Action Level (77) 2017: 15 2018: 7 2019: 2 2020: 21 2021: 32</p>	10-R3S-15-17	14-R3S-38-20
	11-R3S-05-17	14-R3S-48-20
	11-R3S-07-17	20-L1M-04-20
	13-L2M-04-17	20-L1M-08-20
	13-R3M-01-17	20-L2M-03-20
	13-R3M-05-17	20-R3M-09-20
	13-R3M-33-17	20-R3S-07-20
	13-R3S-01-17	20-R3S-08-20
	13-R3S-02-17	20-R3S-10-20
	13-R3S-04-17	15-R3M-01-21
	13-R3S-06-17	15-R3M-03-21
	13-R3S-09-17	15-R3M-04-21
	13-R3S-14-17	15-R3S-04-21
	13-R3S-24-17	15-R3S-07-21
	03-R3S-06-18	15-R3S-10-21
	03-R3S-19-18	15-R3S-11-21
	08-R3M-05-18	15-R3S-13-21
	19-L2M-07-18	15-R3S-14-21
	19-R3S-07-18	21-L2M-02-21
	12-R3S-03-19	21-R3S-01-21
	17-R3M-06-19	21-R3S-03-21
	02-R3S-11-20	21-R3S-27-21
	14-L1M-01-20	22-L2M-02-21
	14-L1M-02-20	22-R3S-06-21
	14-L2M-02-20	22-R3S-11-21
	14-L2M-03-20	22-R3S-12-21
	14-R3M-05-20	23-L2M-03-21
	14-R3M-07-20	23-R3S-04-21
	14-R3M-10-20	23-R3S-05-21
	14-R3S-03-20	23-R3S-11-21
	14-R3S-04-20	23-R3S-14-21
	14-R3S-05-20	24-L1M-03-21
14-R3S-33-20	24-R3M-02-21	
	24-R3S-01-21	
	24-R3S-08-21	
	24-R3S-10-21	

Once a station has been identified as a candidate site, a brief data summary report about each site will be developed to better understand general basin conditions. This report will include and address the following.

- All upstream land uses and impervious area coverage of the contributing drainage area to the station with emphasis on:
 - if the drainage area is served by sanitary sewer
 - the type of agricultural land use if applicable (e.g. – row crop, animal husbandry)
 - the land use conditions within 300 feet of each side of the stream
 - the number and age of septic systems and % of systems with BAT treatment
- Proximity of any major stormdrain outfalls in the upstream reach
- Current BMP implementation in the upstream drainage area
- Sanitary sewer infrastructure in the station’s floodplain
- Biological conditions at and in reaches upstream of the station, if known
- the Watershed study stream walk results, if any
- available site photography
- a parcel map and list of property owners that border or own floodplain property

Most of this information is collected as part of the work associated with various CBMP assessment activities, so this data summary will largely be an assembly of existing information rather than collection or generation of new information about a particular station.

Next, the stations identified as possible Project sites will be resampled to confirm the original observation. Resampling will take place between March 1 and April 30 to better match conditions under which the original sample was collected. During resampling, a discharge measurement will be simultaneously obtained to estimate the flux for each parameter. If resample values are within 10% of the original values or still above the action level for the parameter(s) in question, then sample collection will commence up the drainage network until a potential adjacent land or tributary source is identified or the zero order headwaters are reached (dry channels). If permission has been obtained or if the contributing stream is largely within a County floodplain, a re-inspection of areas of concern identified during a County watershed study, if applicable, will also occur.

If a source or sources cannot be definitively identified during the office evaluation and subsequent field sampling, then no further corrective action is possible. Should a possible source or sources be identified, then corrective actions will be identified and pursued as appropriate. Any management actions specified will vary depending upon the potential sources. For example, in agricultural watersheds coordination with the SCD will be pursued to determine if appropriate BMPs and other approaches are in place. If in a suburban or urban watershed, stormwater outfalls will be screened for illicit discharges and coordination with the CIP program will occur to identify possible new BMP installation or retrofit opportunities. If the developed areas are not served by County sewer, then screening for potential failing septic systems will be pursued.

Reporting

Each year, an annual summary report will be produced detailing the activities that occurred for each site included in the Project work effort for that year, including details on all sampling that occurred in the track down effort and the results of any outreach or other corrective activities that occurred. Outcomes

for any previous year's sites will also be discussed and will include an estimate of total nutrient load reduced. It is possible that a combination of modeling and empirical work will be used to quantify any loading reductions associated with Project activities. The final format and content of this reporting document will be determined once the Project is underway.

References

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