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Memorandum

To: Pat Brennan, PGB Engineering, LLC
Edward Pesce, Pesce Engineering & Associates, Inc.

From: Eduard Eichner, TMDL Solutions, Principal Water Scientist

RE: WRPD Nitrogen Loading Review: Bridle Crossing 40B, Marshfield (Parcels G12-29-02 and H12-01-09B)

Date: January 6, 2024

As requested, I reviewed the available submittals for the proposed Bridle Crossing 40B development off Ferry Street for potential issues related to compliance with the Town Marshfield Water Resources Protection District (WRPD) nitrogen loading regulations. Review of these materials shows that the nitrogen loading proposed for the currently planned uses can achieve the Town's WRPD 5 mg/L nitrogen loading limit provided appropriate wastewater treatment technology is utilized. It is recommended that the Town establish provisions for monitoring and contingencies if the selected technology does not perform as anticipated.

The submitted Bridle Crossing plans show that all of the proposed development will be located on parcel G12-29-02, but parcel H12-01-09B, which is located adjacent and north of parcel G12-29-02, is also included in the development proposal. Both lots are located with the contributing areas to the Town public water supplies, in the overlapping area between the Furnace Brook and Church Street wellfields (**Figure 1**). The proposed development will have 57 units with a total of 88 bedrooms plus a small office. Total Title 5 wastewater flow for the project is 9,680 gallon per day (gpd) and the wastewater will be treated with an alternative nitrogen reducing septic system.¹

The Town of Marshfield WRPD nitrogen loading calculations include nitrogen loads from wastewater, road and roof runoff, and turf fertilizers. These calculations also make a distinction between different soil types with greater infiltration rates for various hydrologic soil groups (*i.e.*, higher rates for sandy areas, lower rates for areas near wetlands). Hydrologic Soil Groups (HSGs) are determined by the United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS) and parcel-specific report may be obtained from the USDA Web Soil Survey website.² The report for the two Bridle Crossing properties shows that the parcel G12-29-02 is mostly split between soils with HSG A and B classifications, while parcel H12-01-09B has mostly HSG A soils (**Figure 2**). Because the development area for parcel G12-29-02 is split between A and B HSG soils, the areas of roads, buildings, and turf were divided based on their locations relative to the soil dividing line on this parcel.

¹ Personal communication, E. Pesce, 12/20/23.

² <https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm> (accessed 1/4/24).

Massachusetts Department of Environmental Protection (MassDEP) reviews and categorizes alternative nitrogen-reducing septic systems.³ If a system is approved by MassDEP, it is assigned a permit for one of three categories:

- 1) piloting use: field testing to establish performance,
- 2) provisional use: alternative systems that appear to perform at least as well as a standard Title 5 system, but need further evaluation, or
- 3) general use: provide a level of environmental protection at least equivalent to that of a conventional on-site system designed in accordance with Title 5.

Systems approved for provisional or piloting use generally have a number of conditions, including quarterly effluent monitoring requirements, system operator qualifications and responsibilities, and limits on the number of systems that can be installed in the state (≤ 15 systems for piloting, ≤ 50 systems for provisional). Installation of these systems can increase the 440 gpd per acre limit of wastewater flow in WRPDs to 550 gpd/ac or 660 gpd/ac provided the alternative system has Title 5 wastewater flows less than 2,000 gpd. Most of the approved alternative systems have a standard total nitrogen (TN) limit of 19 mg/L required in the system effluent, but some have lower permitted TN concentrations (*e.g.*, NitROE® system has a 11 mg/L TN effluent limit⁴).

Review of the proposed details of the Bridle Crossing project show that it will require an alternative nitrogen reducing septic system that attains 14.5 mg/L TN or less in order to meet the Town's WRPD 5 mg/L nitrogen loading limit (**Table 1**). If a system with the standard TN limit of 19 mg/L that is conventionally assigned to nitrogen reducing septic system is used, the estimated nitrogen loading concentration for the Bridle Crossing 40B is 6.3 mg/L (**Table 2**). Use of a NitROE® system or equivalent with a 11 mg/L TN effluent would attain nitrogen loading concentration of 4.0 mg/L (**Table 3**).

Given this review, there are MassDEP-approved nitrogen reducing systems that could be utilized for the Bridle Crossing project that can meet the Town's WRPD 5 mg/L nitrogen loading limit. Each alternative septic system technology has a system-specific list of requirements included in the MassDEP approval permits (*e.g.*, each NitROE® system has 36 special conditions), but the key for the Town in this regard is regular reporting on monitoring performance and establishment of contingencies related to failure to meet performance goals.

Based on the NitROE® system as an example, the MassDEP provisional us permit initially requires quarterly sampling of pH, BOD5, TSS, and TN for three years followed by permanent quarterly TN monitoring and water use flow metering if the project used the improved treatment to increase the flow intensity greater than the 440 gpd/ac WRPD limit (which is the case for the Bridle Crossing project). It is recommended that the Town also receive the collected monitoring data at the same time as MassDEP and work with the applicant to establish long-term monitoring provisions to ensure performance beyond the initial three years.

In addition to the monitoring, it is recommended that the Town establish contingencies with the applicant as part of any project approval to establish what actions will occur if monitoring results have concentrations that are greater than the permitted targets. The current project exceeds the Title 5 440 gpd/ac Wellhead Protection Area limit only as a result of the use of a nitrogen reducing

³ <https://www.mass.gov/guides/approved-title-5-innovativealternative-technologies> (accessed 1/6/24).

⁴ <https://www.mass.gov/doc/nitroe-waste-water-treatment-system-provisional-use-approval/download> (accessed 1/6/24).

system. If the system fails, the project will need to select another system that has nitrogen removal performance that achieves the nitrogen limit; a standard Title 5 system will not meet the Town and MassDEP water quality goals. Nitrogen reducing permits typically include as a condition that, in part, requires the System Owner to “repair, replace, modify or take any other action as required by the Department or the local approving authority to meet the total nitrogen concentration limits in the effluent”⁵ if a system fails. Establishing the details of what constitutes system failure from the Town’s perspective and what actions will be acceptable to the Town to address system failure should be developed with the applicant as part of project approval.

Please let me know if you have any questions or comments regarding this review.

⁵ *e.g.*, from special condition #28 in the NitRoe May 2020 Provisional Permit

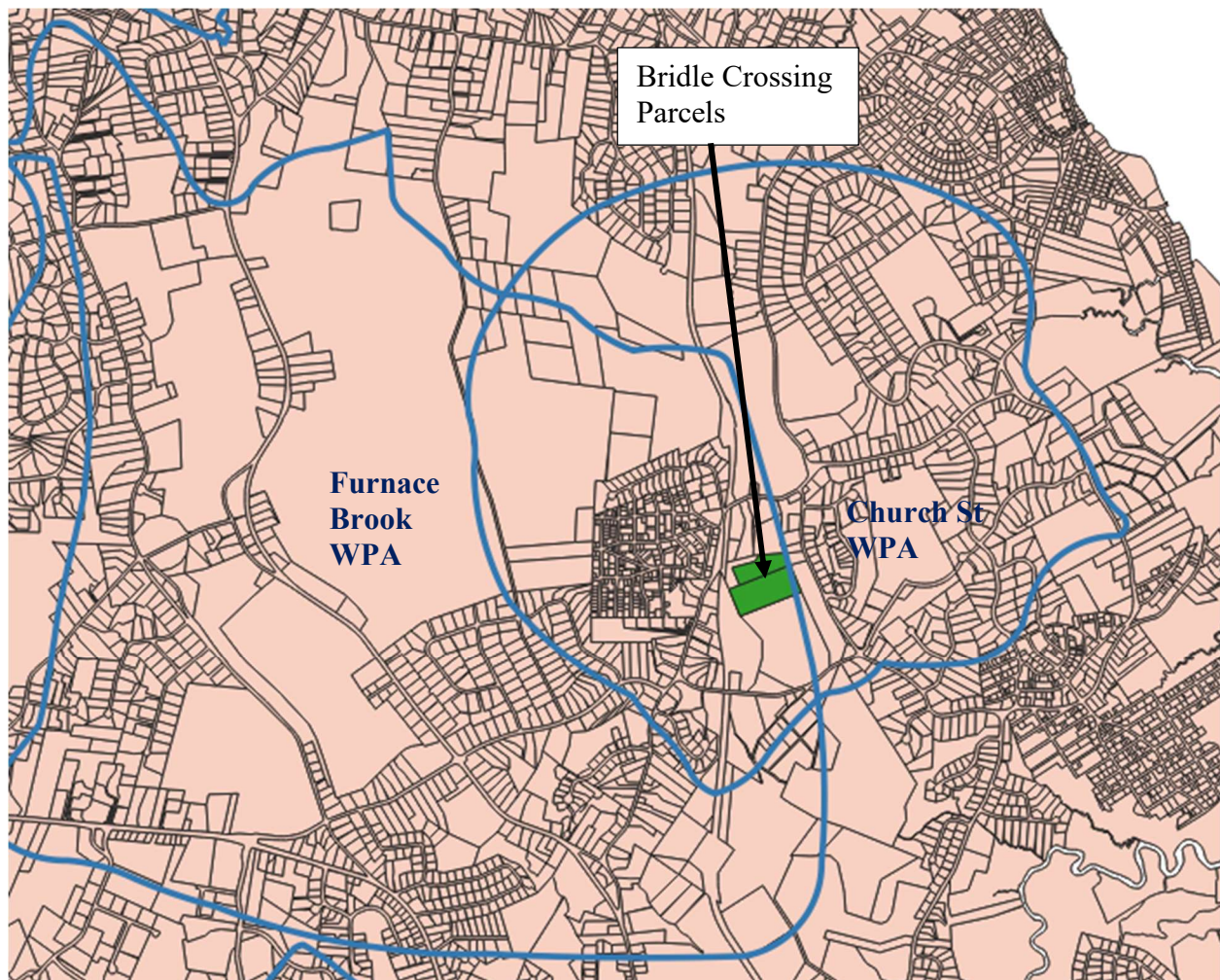


Figure 1. Bridle Crossing Parcels and Town of Marshfield Wellhead Protection Areas. Bridle Crossing parcels are located in an area shared by the contributing areas to the Church Street and Furnace Brook wellfields.



Figure 2. USDA NRCS Soil Survey Classifications for Bridle Crossing parcels. The NRCS soils classification for the two Bridle Crossing properties shows that the parcel G12-29-02 is mostly split between soils with HSG A and B classifications, while parcel H12-01-09B has mostly HSG A soils.

Table 1. Nitrogen Loading Calculations: Bridle Crossing 40B Maximum TN concentration. Wastewater concentration of 14.5 mg/L Total Nitrogen is the upper limit for the Bridle Crossing project to attain the Town Water Resources Protection District 5 mg/L nitrogen loading limit.

PROJECT LOCATION	Bridle Crossing 40B (LOTS G12-29-02 and H12-01-09B)
DATE	1/4/24 (by E Eichner)
APPLICANT	
NAME OF DEVELOPMENT ON SITE PLAN	

LOADING ASSUMPTIONS		Whole Parcel	Area within Zone II
A1	Wastewater Effluent from a Standard On-Site System	35	mg/L
	Wastewater Effluent from a DEP Approved Denitrification System	14.5	mg/L
	Wastewater Effluent from a Centralized Wastewater Treatment Facility	10	mg/L
A2	Runoff from Rooftops	0.75	mg/L
A3	Runoff from Roadways and Driveways	1.5	mg/L
A4	Turf Application	3	lbs/year/1,000 sq feet
A5	Nitrogen leaching rate from turf	25%	
A6	Rainfall (Runoff on natural surfaces)	0.05	mg/L

RECHARGE ASSUMPTIONS		
	NRCS Soils Group	Recharge Rates
B1	A Soils	24 inches per year
	B Soils	18 inches per year
	C Soils	10 inches per year
	D Soils	3 inches per year
	Wetlands and Surface Waters	0 inches per year

NITROGEN SOURCES

Wastewater Flows

C1	Total Residential Wastewater Flow (Actual Title 5)	9,680	gpd
	Total Residential Wastewater Flow (Modified Title 5)	-	gpd
	Total Non-Residential Wastewater Flow (Title 5) gpd	18	gpd
	Total Non-Residential Wastewater Flow (Measured)		gpd
	TOTAL	9,698	gpd

Area of Roof

C2	A Soils	18,375	square feet
	B Soils	30,250	square feet
	C Soils		square feet
	D Soils		square feet
	TOTAL	48,625	square feet

Area of Roads and Driveways

C3	A Soils	28,700	square feet
	B Soils	24,020	square feet
	C Soils		square feet
	D Soils		square feet
	TOTAL	52,720	square feet

Area of Turf

C4	A Soils	61,252	square feet
	B Soils	56,311	square feet
	C Soils		square feet
	D Soils		square feet
	TOTAL	117,563	square feet

Natural Area

C5	A Soils	421,424	square feet
	B Soils		square feet
	C Soils		square feet
	D Soils		square feet
	TOTAL	421,424	square feet

Total Site Area

C6		640,332	square feet
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RECHARGE VOLUMES FROM IMPERVIOUS SURFACES

D1	Roofs gallons per year Rooftop Area x Recharge Rates for Underlying Soil Types	614,338	gallons per year
D2	Roadways and Driveways gallons per year Roadways and Driveways Area for Underlying Soil Types	698,905	gallons per year
D3	Alternative Calculation in Redevelopment Scenario gallons per year		gallons per year
D4	TOTAL	1,313,243	gallons per year

RECHARGE VOLUMES FROM PERVIOUS SURFACES

E1	Turf square feet Turf Area x Recharge Rates for Underlying Soil Types	1,548,248	gallons per year
E2	Natural Areas square feet Natural Area x Recharge Rates for Underlying Soil Types	6,304,941	gallons per year
E3	TOTAL	7,853,189	gallons per year

LOADING CALCULATION

F1	Load from Wastewater lbs N per year Wastewater Flow x N Concentration in Wastewater (C1 x A1)	426.87	lbs/yr
F2	Load from Rooftops lbs N per year Volume of Recharge from Roof Runoff x N Concentration in Roof Runoff (D1 x A2)	3.85	lbs/yr
F3	Load from Roadways and Driveways lbs N per year Volume of Recharge from Roadways and Driveways x N and Driveways (D2 x A3)Concentration in and Driveways (D2 x A3)	8.75	lbs/yr
F4	Load from Turf lbs N per year Turf Application Rate x Area of Turf/1,000 x Leaching Rate (A4 x C4/1,000 x A5)	88.17	lbs/yr
F5	Load from Natural Area lbs N per year Volume of Recharge from Natural Areas x N Concentration in Rainfall (C5 x A6)	2.63	lbs/yr
F6	TOTAL	530.27	lbs/yr

Total N load		240,526,660	mg/yr
Total Recharge (+wastewater)		48,098,459	liters/yr
N LOADING CONCENTRATION		5.00	mg/l

Table 2. Nitrogen Loading Calculations: Bridle Crossing 40B 19 mg/L TN Conventional Nitrogen Reducing Septic System TN concentration. MassDEP typically assigns a 19 mg/L TN limit to nitrogen reducing septic system permitted for state review. A wastewater concentration of 19 mg/L Total Nitrogen for the Bridle Crossing project will not attain the Town Water Resources Protection District 5 mg/L nitrogen loading limit.

PROJECT LOCATION	Bridle Crossing 40B (LOTS G12-29-02 and H12-01-09B)
DATE	1/4/24 (by E Eichner)
APPLICANT	
NAME OF DEVELOPMENT ON SITE PLAN	

LOADING ASSUMPTIONS		Whole Parcel Area within Zone II
A1	Wastewater Effluent from a Standard On-Site System	35 mg/L
	Wastewater Effluent from a DEP Approved Denitrification System	19 mg/L
	Wastewater Effluent from a Centralized Wastewater Treatment Facility	10 mg/L
A2	Runoff from Rooflops	0.75 mg/L
A3	Runoff from Roadways and Driveways	1.5 mg/L
A4	Turf Application	3 lbs/year/1,000 sq feet
A5	Nitrogen leaching rate from turf	25%
A6	Rainfall (Runoff on natural surfaces)	0.05 mg/L

RECHARGE ASSUMPTIONS		Recharge Rates
B1	NRCS Soils Group	
	A Soils	24 inches per year
	B Soils	18 inches per year
	C Soils	10 inches per year
	D Soils	3 inches per year
	Wetlands and Surface Waters	0 inches per year

NITROGEN SOURCES

Wastewater Flows

C1	Total Residential Wastewater Flow (Actual Title 5)	9,680 gpd
	Total Residential Wastewater Flow (Modified Title 5)	- gpd
	Total Non-Residential Wastewater Flow (Title 5) gpd	18 gpd
	Total Non-Residential Wastewater Flow (Measured)	gpd
TOTAL		9,698 gpd

Area of Roof

C2	A Soils	18,375 square feet
	B Soils	30,250 square feet
	C Soils	square feet
	D Soils	square feet
TOTAL		48,625 square feet

Area of Roads and Driveways

C3	A Soils	28,700 square feet
	B Soils	24,020 square feet
	C Soils	square feet
	D Soils	square feet
TOTAL		52,720 square feet

Area of Turf

C4	A Soils	61,252 square feet
	B Soils	56,311 square feet
	C Soils	square feet
	D Soils	square feet
TOTAL		117,563 square feet

Natural Area

C5	A Soils	421,424 square feet
	B Soils	square feet
	C Soils	square feet
	D Soils	square feet
TOTAL		421,424 square feet

Total Site Area

C6		640,332 square feet
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RECHARGE VOLUMES FROM IMPERVIOUS SURFACES

D1	Roofs gallons per year Rooftop Area x Recharge Rates for Underlying Soil Types	614,338	gallons per year
D2	Roadways and Driveways gallons per year Roadways and Driveways Area for Underlying Soil Types	698,905	gallons per year
D3	Alternative Calculation in Redevelopment Scenario gallons per year		gallons per year
D4	TOTAL	1,313,243	gallons per year

RECHARGE VOLUMES FROM PERVIOUS SURFACES

E1	Turf square feet Turf Area x Recharge Rates for Underlying Soil Types	1,548,248	gallons per year
E2	Natural Areas square feet Natural Area x Recharge Rates for Underlying Soil Types	6,304,941	gallons per year
E3	TOTAL	7,853,189	gallons per year

LOADING CALCULATION

F1	Load from Wastewater lbs N per year Wastewater Flow x N Concentration in Wastewater (C1 x A1)	561.29	lbs/yr
F2	Load from Rooftops lbs N per year Volume of Recharge from Roof Runoff x N Concentration in Roof Runoff (D1 x A2)	3.85	lbs/yr
F3	Load from Roadways and Driveways lbs N per year Volume of Recharge from Roadways and Driveways x N and Driveways (D2 x A3) Concentration in and Driveways (D2 x A3)	8.75	lbs/yr
F4	Load from Turf lbs N per year Turf Application Rate x Area of Turf/1,000 x Leaching Rate (A4 x C4/1,000 x A5)	88.17	lbs/yr
F5	Load from Natural Area lbs N per year Volume of Recharge from Natural Areas x N Concentration in Rainfall (C5 x A6)	2.63	lbs/yr
F6	TOTAL	664.68	lbs/yr

Total N load		301,495,554	mg/yr
Total Recharge (+wastewater)		48,098,459	liters/yr
	N LOADING CONCENTRATION	6.27	mg/l

Table 3. Nitrogen Loading Calculations: Bridle Crossing 40B 11 mg/L Nitrogen Reducing Septic System TN concentration. MassDEP has assigned an 11 mg/L TN limit to the NitROE® nitrogen reducing septic system. A wastewater concentration of 11 mg/L TN from this system or equivalent for the Bridle Crossing project will attain the Town Water Resources Protection District 5 mg/L nitrogen loading limit.

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LOADING ASSUMPTIONS		Whole Parcel Area within Zone II
A1	Wastewater Effluent from a Standard On-Site System	35 mg/L
	Wastewater Effluent from a DEP Approved Denitrification System	11.0 mg/L
	Wastewater Effluent from a Centralized Wastewater Treatment Facility	10 mg/L
A2	Runoff from Rooflops	0.75 mg/L
A3	Runoff from Roadways and Driveways	1.5 mg/L
A4	Turf Application	3 lbs/year/1,000 sq feet
A5	Nitrogen leaching rate from turf	25%
A6	Rainfall (Runoff on natural surfaces)	0.05 mg/L

RECHARGE ASSUMPTIONS		Recharge Rates
B1	NRCS Soils Group	
	A Soils	24 inches per year
	B Soils	18 inches per year
	C Soils	10 inches per year
	D Soils	3 inches per year
	Wetlands and Surface Waters	0 inches per year

NITROGEN SOURCES

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	Total Residential Wastewater Flow (Modified Title 5)	- gpd
	Total Non-Residential Wastewater Flow (Title 5) gpd	18 gpd
	Total Non-Residential Wastewater Flow (Measured)	gpd
TOTAL		9,698 gpd

Area of Roof

C2	A Soils	18,375 square feet
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	C Soils	square feet
	D Soils	square feet
TOTAL		48,625 square feet

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TOTAL		52,720 square feet

Area of Turf

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TOTAL		117,563 square feet

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RECHARGE VOLUMES FROM PERVIOUS SURFACES

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E2	Natural Areas square feet Natural Area x Recharge Rates for Underlying Soil Types	6,304,941	gallons per year
E3	TOTAL	7,853,189	gallons per year

LOADING CALCULATION

F1	Load from Wastewater lbs N per year Wastewater Flow x N Concentration in Wastewater (C1 x A1)	324.96	lbs/yr
F2	Load from Rooftops lbs N per year Volume of Recharge from Roof Runoff x N Concentration in Roof Runoff (D1 x A2)	3.85	lbs/yr
F3	Load from Roadways and Driveways lbs N per year Volume of Recharge from Roadways and Driveways x N and Driveways (D2 x A3) Concentration in and Driveways (D2 x A3)	8.75	lbs/yr
F4	Load from Turf lbs N per year Turf Application Rate x Area of Turf/1,000 x Leaching Rate (A4 x C4/1,000 x A5)	88.17	lbs/yr
F5	Load from Natural Area lbs N per year Volume of Recharge from Natural Areas x N Concentration in Rainfall (C5 x A6)	2.63	lbs/yr
F6	TOTAL	428.35	lbs/yr

Total N load		194,297,498	mg/yr
Total Recharge (+wastewater)		48,098,459	liters/yr
	N LOADING CONCENTRATION	4.04	mg/l