

DATE: November 19, 2018

TO: Bryan Hartsook – Milwaukee

FROM: Nick Lent – Milwaukee

SUBJECT: Water Quality-Based Effluent Limitations for Paddock Lake Wastewater Treatment Facility
WPDES Permit No. WI-0025062-10-0 (FID 230003070)

This is in response to your request for an evaluation of the need for water quality-based effluent limitations (WQBELs) using Chapters NR 102, 104, 105, 106, 207, 210, 212, and 217 of the Wisconsin Administrative Code (where applicable), for the discharge from the Paddock Lake Wastewater Treatment Facility in Kenosha County. This municipal wastewater treatment facility (WWTF) discharges to Brighton Creek, located in the Des Plaines River Watershed (FX01) in the Fox (IL) River Basin. The evaluation of the permit recommendations is discussed in more detail in the attached report.

No changes are recommended in the permit limitations for BOD₅, Total Suspended Solids (TSS), and pH. Based on our review, the following recommendations are made on a chemical-specific basis:

Outfall 001

Parameter	Daily Maximum	Daily Minimum	Weekly Average	Monthly Average	Six-Month Average	Footnotes
BOD ₅ May – October November – April			5 mg/L 10 mg/L	5 mg/L 10 mg/L		1
TSS			10 mg/L	10 mg/L		1
Fecal Coliforms May – September			656#/100 mL geometric mean	400#/100 mL geometric mean		2
pH	9.0 s.u.	6.0 s.u.				1
Ammonia Nitrogen April - May June – September October November – March	pH-Variable pH-Variable pH-Variable pH-Variable		5.2 mg/L 3.5 mg/L 8.7 mg/L 9.9 mg/L	2.1 mg/L 1.4 mg/L 3.5 mg/L 4.0 mg/L		3
Chloride			400 mg/L 2,600 lbs/day	400 mg/L		2,4
Dissolved Oxygen		7.0 mg/L				5
Phosphorus MDV Interim Final				0.7 mg/L 0.225 mg/L	0.075 mg/L 0.5 lbs/day	6
Temperature, maximum						7

Footnotes:

1. No changes from the current permit
2. Additional limits to comply with the expression of limits requirements in ss. NR 106.07 and NR 205.065(7), Wis. Adm. Code are included in bold.
3. Daily maximum ammonia nitrogen effluent limitations based upon the range of potential effluent pH (6.0 – 9.0 s.u.) are recommended instead of a single daily maximum effluent limit based upon

the maximum expected effluent pH. The pH-variable effluent ammonia nitrogen limits are summarized in the following table:

Effluent pH (s.u.)	NH ₃ -N Limit (mg/L)	Effluent pH (s.u.)	NH ₃ -N Limit (mg/L)	Effluent pH (s.u.)	NH ₃ -N Limit (mg/L)
6.0 < pH ≤ 6.1	54	7.0 < pH ≤ 7.1	33	8.0 < pH ≤ 8.1	6.9
6.1 < pH ≤ 6.2	53	7.1 < pH ≤ 7.2	30	8.1 < pH ≤ 8.2	5.7
6.2 < pH ≤ 6.3	52	7.2 < pH ≤ 7.3	26	8.2 < pH ≤ 8.3	4.7
6.3 < pH ≤ 6.4	51	7.3 < pH ≤ 7.4	23	8.3 < pH ≤ 8.4	3.9
6.4 < pH ≤ 6.5	49	7.4 < pH ≤ 7.5	20	8.4 < pH ≤ 8.5	3.2
6.5 < pH ≤ 6.6	47	7.5 < pH ≤ 7.6	17	8.5 < pH ≤ 8.6	2.7
6.6 < pH ≤ 6.7	45	7.6 < pH ≤ 7.7	14	8.6 < pH ≤ 8.7	2.2
6.7 < pH ≤ 6.8	42	7.7 < pH ≤ 7.8	12	8.7 < pH ≤ 8.8	1.8
6.8 < pH ≤ 6.9	39	7.8 < pH ≤ 7.9	10	8.8 < pH ≤ 8.9	1.6
6.9 < pH ≤ 7.0	36	7.9 < pH ≤ 8.0	8.4	8.9 < pH ≤ 9.0	1.3

4. This is the water quality-based effluent limitation for chloride. **An alternative effluent limitation of 510 mg/L (105% of the highest reported 4-day average effluent chloride concentration from May 2014 through September 2018) as a weekly average may be included in the permit in place of this limit if the chloride variance application that was submitted is approved by EPA.** The mass limit of 2,600 lbs/day would only be needed if the variance is not approved. An alternative wet weather limit would also be needed in the permit if the variance is not approved.
5. For zero dilution conditions, a daily minimum dissolved oxygen limit of 7.0 mg/L is needed to arrive at the 5 mg/L summer (May – Oct) and 10 mg/L winter (Nov – Apr) BOD₅ limits using the 26-lb method.
6. This is the recommended MDV interim limit. See Part 4 of the attached memo for more information.
7. Monitoring in the fourth year of the permit term

Along with the chemical-specific recommendations mentioned above, the need for acute and chronic whole effluent toxicity (WET) testing is also evaluated for the discharge from Paddock Lake. No WET testing is required based on Chapter 1.11 of the WET Guidance (WET Testing of Minor Municipal Discharges). This is a minor municipal (< 1.0 MGD) discharge comprised solely of domestic wastewater, with no WET failures ever on record, and no toxic compounds detected at levels of concern. Because there is a very low risk of toxicity, **no WET testing is recommended.**

Please consult the attached report for details regarding the above recommendations. If there are any questions or comments, please contact Nick Lent at (414) 263-8623 or Nicholas.Lent@wisconsin.gov.

Attachments:

1. WQBEL memo – Paddock Lake Wastewater Treatment Facility
2. Effluent Temperature Limit Calculation Table
3. Site Map

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E-cc: Diane Figiel, Water Resources Engineer – WY/3

Attachment # 1
**Water Quality-Based Effluent Limitations for
Paddock Lake Wastewater Treatment Facility**

**WPDES Permit No. WI-0025062-10-0
(FID 230003070)**

Prepared by: Nick Lent

PART 1 – BACKGROUND INFORMATION

Facility Description:

The Paddock Lake Wastewater Treatment Facility (WWTF) includes fine screening, a two-ring oxidation ditch, clarification, post-aeration and UV disinfection. Sludge is digested aerobically, stored on drying beds for dewatering, and then landfilled by an independent contractor. The facility was expanded in 2011-2012 to provide treatment for an annual average design flow of 0.8 million gallons per day (MGD). Effluent is pumped to Brighton Creek via force main, approximately 1.2 miles east of the WWTF.

Existing Permit Limitations:

The current permit, expiring on March 31, 2019, includes the following effluent limitations:

Parameter	Daily Maximum	Daily Minimum	Weekly Average	Monthly Average	Six-Month Average	Footnotes
BOD ₅ May – October November – April			5.0 mg/L 10 mg/L	5.0 mg/L 10 mg/L		1
TSS			10 mg/L	10 mg/L		1
Fecal Coliforms May – September				400#/100 mL geometric mean		
pH	9.0 s.u.	6.0 s.u.				1
Ammonia Nitrogen April – May June – September October November – March	17 mg/L 17 mg/L 17 mg/L 17 mg/L		5.2 mg/L 3.5 mg/L 8.7 mg/L 9.9 mg/L	2.1 mg/L 1.4 mg/L 3.5 mg/L 4.0 mg/L		
Chloride May – November December – April			612 mg/L 685 mg/L			2
Dissolved Oxygen		6.0 mg/L				3
Phosphorus Interim Final				0.225 mg/L	0.8 mg/L 0.075 mg/L	4
Temperature, maximum						5
Chronic WET						6

Footnotes:

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1. These limitations are not being evaluated as part of this review. Because the water quality criteria (WQC), reference effluent flow rates, and receiving water characteristics have not changed, limitations for these water quality characteristics do not need to be re-evaluated at this time.
2. These are US EPA approved interim chloride limits. The weekly average WQBEL is 400 mg/L.
3. When considering the current BOD₅ limits, the daily minimum DO limit of 6.0 mg/L is not consistent with the calculations of the 26-lb method used to protect in stream dissolved oxygen standard of 5.0 mg/L. For zero dilution design conditions, a daily minimum DO limit of 7.0 mg/L is needed to arrive at the existing 5 mg/L summer and 10 mg/L winter BOD₅ limits.
4. The final water quality-based effluent limit is 0.075 mg/L as six-month average and 0.225 mg/L as a monthly average. A compliance schedule is in the current permit to meet the final WQBEL by March 1, 2023.
5. Monitoring in 2018 for daily maximum temperature.
6. Three chronic WET tests required. The instream waste concentration (IWC) used to assess chronic WET results is 100 %.

Receiving Water Information:

- Name: Brighton Creek
- Classification: Warm water sport fish community, non-public water supply.
- Low-Flow: The following 7-Q₁₀ and 7-Q₂ values are from USGS for Brighton Creek at HWY K, USGS Station 05527622 (letter dated 07/26/2018). The Harmonic Mean has been estimated as recommended in *State of Wisconsin Water Quality Rules Implementation Plan* (Publ. WT-511-98)
 - 7-Q₁₀ = 0 cfs (cubic feet per second)
 - 7-Q₂ = 0.01 cfs
 - 90-Q₁₀ = 85% of 7-Q₂ = 0.0085 cfs
 - Harmonic Mean Flow = 0 cfs

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
7-Q₁₀ (cfs)	0.03	0.03	0.12	0.29	0.09	0.02	0.00	0.00	0.00	0.00	0.02	0.03
7-Q₂ (cfs)	0.17	0.22	0.94	1.0	0.44	0.16	0.05	0.02	0.02	0.05	0.13	0.20

- Hardness = 392 mg/L as CaCO₃. This value represents the geometric mean of data from the last four WET tests and from the 2018 permit application. Effluent hardness is used in place of receiving water because the receiving water is effluent dominated at design conditions near the discharge.
- % of low-flow used to calculate limits: 25%
- Source of background concentration data: Background concentrations are not included because they don't impact the calculated WQBEL when the receiving water low-flows are equal to zero.
- Multiple dischargers: there are no other discharges in the area
- Impaired water status: Brighton Creek is not listed as impaired, but 4.5 miles downstream, the Des Plaines River is impaired for total phosphorus.

Effluent Information:

- Design Flow Rate(s):
 - Annual average = 0.8 MGD (Million Gallons per Day)
 - Peak daily = 3.0 MGD
 - Peak weekly = not available, use Ch. 6 of the GLI Implementation Guidance worksheet if needed.
 - Peak monthly = 1.6 MGD
- For reference, the actual average flow from May 2014 through September 2018 was 0.43 MGD.
- Hardness = 392 mg/L as CaCO₃. This value represents the geometric mean of data from the last four WET tests and from the 2018 permit application.

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- Acute dilution factor used: Not applicable – this facility does not have an approved Zone of Initial Dilution (ZID).
- Water Source: Split between privately owned wells and Paddock Lake Municipal Water Supply
- Additives: Alum is used for total phosphorus removal
- Effluent characterization: This facility is categorized as a minor municipality, so the permit application required effluent sample analyses for a limited number of common pollutants, primarily metal substances plus nitrogen and hardness. The permit-required monitoring for chloride from May 2014 through September 2018 is used in this evaluation.

Sample Date	Copper µg/L	Sample Date	Copper µg/L	Sample Date	Copper µg/L
05/17/2018	2.0	05/29/2018	< 1.6	06/10/2018	3.1
05/20/2018	< 1.6	06/01/2018	< 1.6	06/13/2018	3.4
05/23/2018	1.7	06/04/2018	1.8	08/20/2018	5.3
05/26/2018	< 1.6	06/07/2018	1.7		
Average = 1.7 µg/L					

“<” means that the pollutant was not detected at the indicated level of detection. The mean concentration was calculated using zero in place of the non-detected results.

	Chloride mg/L
1-day P ₉₉	581
4-day P ₉₉	485
30-day P ₉₉	485
Mean	402
Standard deviation	67
Sample size	212
Range	180 - 580

Effluent data for substances for which a single sample was analyzed is shown in the tables in Part 2 below, in the column titled “MEAN EFFL. CONC.”.

The following table presents the average concentrations and loadings at Outfall 001 from May 2014 – September 2018 for all parameters with limits in the current permit to meet the requirements of s. NR 201.03(6), Wis. Adm. Code:

	Average Measurement	Average Mass Discharged
BOD ₅	2.62 mg/L*	
TSS	3.62 mg/L*	
pH field	7.85 s.u.	
Phosphorus	0.46 mg/L	1.65 lbs/day
Ammonia Nitrogen	0.49 mg/L*	
Chloride	402 mg/L	

*Results below the level of detection (LOD) were included as zeroes in calculation of average.

**PART 2 – WATER QUALITY-BASED EFFLUENT LIMITATIONS
FOR TOXIC SUBSTANCES – EXCEPT AMMONIA NITROGEN**

In general, permit limits for toxic substances are recommended whenever any of the following occur:

1. The maximum effluent concentration exceeds the calculated limit (s. NR 106.05(3), Wis. Adm. Code)
2. If 11 or more detected results are available in the effluent, the upper 99th percentile (or P₉₉) value exceeds the comparable calculated limit (s. NR 106.05(4), Wis. Adm. Code)
3. If fewer than 11 detected results are available, the mean effluent concentration exceeds 1/5 of the calculated limit (s. NR 106.05(6), Wis. Adm. Code)

Acute Limits based on 1-Q₁₀

Daily maximum effluent limitations for toxic substances are based on the acute toxicity criteria (ATC), listed in ch. NR 105, Wis. Adm. Code. Previously daily maximum limits for toxic substances were calculated as two times the ATC. However, changes to ch. NR 106, Wis. Adm. Code (September 1, 2016) require the Department to calculate acute limitations using the same mass balance equation as used for other limits along with the 1-Q₁₀ receiving water low-flow to determine if more restrictive effluent limitations are needed to protect the receiving stream from discharges which may cause or contribute to an exceedance of the acute water quality standards.

$$\text{Limitation} = \frac{(\text{WQC}) (Q_s + (1-f) Q_e) - (Q_s - f Q_e) (C_s)}{Q_e}$$

Where: WQC = Acute toxicity criterion or secondary acute value according to ch. NR 105

Q_s = average minimum 1-day flow which occurs once in 10 years (1-day Q₁₀)

if the 1-day Q₁₀ flow data is not available = 80% of the average minimum 7-day flow which occurs once in 10 years (7-day Q₁₀).

Q_e = Effluent flow (in units of volume per unit time) as specified in s. NR 106.06(4)(d)

f = Fraction of the effluent flow that is withdrawn from the receiving water, and

C_s = Background concentration of the substance (in units of mass per unit volume) as specified in s. NR 106.06(4)(e).

Because the receiving water is effluent dominated under low stream flow conditions, the 1-Q₁₀ method of limit calculation produces the most stringent daily maximum limitations and should be used while making reasonable potential determinations. The following tables list the WQBELs for this discharge along with the results of effluent sampling for all the detected substances. All concentrations are expressed in term of micrograms per Liter (µg/L), except for hardness and chloride (mg/L).

Daily Maximum Limits based on Acute Toxicity Criteria (ATC)

RECEIVING WATER FLOW = 0 cfs, (1-Q₁₀ (estimated as 80% of 7-Q₁₀)).

SUBSTANCE	REF. HARD.* mg/L	ATC	MEAN BACK-GRD.	MAX. EFFL. LIMIT**	1/5 OF EFFL. LIMIT	MEAN EFFL. CONC.	1-day P ₉₉	1-day MAX. CONC.
Arsenic		340		339.8	68.0	< 1.0		
Cadmium	392	49.4		49.4	9.9	< 0.19		
Chromium	301	4446		4445.8	889	< 0.83		
Copper	392	56.3		56.3	11.3	1.70		
Lead	356	365		364.7	72.9	< 4.3		
Nickel	268	1080		1080.3	216	< 1.1		

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SUBSTANCE	REF. HARD.* mg/L	ATC	MEAN BACK-GRD.	MAX. EFFL. LIMIT**	1/5 OF EFFL. LIMIT	MEAN EFFL. CONC.	1-day P ₉₉	1-day MAX. CONC.
Zinc	333	345		344.7	68.9	21		
Chloride (mg/L)		757		757			581	580

* The indicated hardness may differ from the effluent hardness because the effluent hardness exceeded the maximum range in ch. NR 105 over which the acute criteria are applicable. In that case, the maximum of the range is used to calculate the criterion.

** Per the changes to s. NR 106.07(3), Wis. Adm. Code, effective 09/01/2016 consideration of ambient concentrations and 1-Q₁₀ flow rates yields a more restrictive limit than the 2 × ATC method of limit calculation.

Weekly Average Limits based on Chronic Toxicity Criteria (CTC)

RECEIVING WATER FLOW = 0 cfs (¼ of the 7-Q₁₀)

SUBSTANCE	REF. HARD.* mg/L	CTC	MEAN BACK-GRD.	WEEKLY AVE. LIMIT	1/5 OF EFFL. LIMIT	MEAN EFFL. CONC.	4-day P ₉₉
Arsenic		152.2		152	30.4	< 1.0	
Cadmium	175	3.82		3.82	0.8	< 0.19	
Chromium	301	325.75		326	65.2	< 0.83	
Copper	392	33.32		33.3	6.66	1.7	
Lead	356	95.51		95.5	19.1	< 4.3	
Nickel	268	120.18		120	24.0	< 1.1	
Zinc	333	344.68		345	68.9	21	
Chloride (mg/L)		395		395			485

* The indicated hardness may differ from the receiving water hardness because the receiving water hardness exceeded the maximum range in ch. NR 105, Wis. Adm. Code, over which the chronic criteria are applicable. In that case, the maximum of the range is used to calculate the criterion.

Monthly Average Limits based on Wildlife Criteria (WC) The effluent characterization did not include any effluent sampling results for substances for which Wildlife Criteria exist.

Monthly Average Limits based on Human Threshold Criteria (HTC)

RECEIVING WATER FLOW = 0 cfs (¼ of the Harmonic Mean)

SUBSTANCE	HTC	MEAN BACK-GRD.	MO'LY AVE. LIMIT	1/5 OF EFFL. LIMIT	MEAN EFFL. CONC.
Cadmium	370		370	74.0	< 0.19
Chromium (+3)	3818000		3818000	763600	< 0.83
Lead	140		140	28.0	< 4.3
Nickel	43000		43000	8600	< 1.1

Monthly Average Limits based on Human Cancer Criteria (HCC)

RECEIVING WATER FLOW = 0 cfs (¼ of the Harmonic Mean)

SUBSTANCE	HCC	MEAN BACK-GRD.	MO'LY AVE. LIMIT	1/5 OF EFFL. LIMIT	MEAN EFFL. CONC.
Arsenic	13.3		13.3	2.66	< 1.0

In addition to evaluating the need for limits for each individual substance for which HCC exist, s. NR 106.06(8) requires the evaluation of the cumulative cancer risk. Because effluent data is available for only one substance for which Human Cancer Criteria exists, and it was not detected in the effluent, determination of the cumulative cancer risk is not needed per s. NR 106.06(8), Wis. Adm. Code.

Conclusions and Recommendations:

Chloride – Considering available effluent data from the current permit term May 2014 through September 2018, the 1-day P₉₉ chloride concentration is 581 mg/L, and the 4-day P₉₉ of effluent data is 485 mg/L.

Because the 4-day P₉₉ exceeds the calculated weekly average WQBEL, an effluent limit is needed in accordance with s. NR 106.05(4)(b) Wis. Adm. Code.

However, Subchapter VII of ch. NR 106 provides for a variance from water quality standards for this substance, and Paddock Lake has requested such a variance. That variance may be granted subject to the following conditions:

- 1) The permit shall include an “Interim” limitation intended to prevent an increase in the discharge of Chloride;
- 2) The permit shall specify “Source Reduction Measures” to be implemented during the permit term, with periodic progress reports; and
- 3) The permit shall include a “Target Limit” to gage the effectiveness of the Source Reduction Measures, and progress toward the water quality-based effluent limitations.

Interim Limit for Chloride: Section NR 106.82(9) defines a “Weekly average interim limitation” as either the 4-day P₉₉ concentration or 105% of the highest weekly average concentration of the representative data. The current permit includes seasonal interim weekly average limits of 612 mg/L for May through September and 685 mg/L for December through April. All reported data was well below these interim limits from May 2014 through September 2018 (current permit term). The following table shows a statistical breakdown of effluent chloride data from the current permit term.

Paddock Lake WWTF Effluent Chloride, mg/L			
May 2014 – Sept 2018			
	All chloride data	May through November	December through April
1-day P ₉₉	581	594	548
4-day P ₉₉	485	486	479
Max 4-day average	485	482.5	485
Mean	402	393	417
Standard deviation	67	73	50
Sample size	212	132	80
Range	180 - 580	180 - 580	220 - 510

In review of effluent chloride data from the current permit term, the difference between the chloride levels observed between the two seasons has apparently decreased. The average and peaks have also decreased. As a result, **a year-round weekly average interim limitation of 510 mg/L is recommended**

for permit reissuance. This value is equal to 105% of the maximum 4-day average concentration (March 2018) of representative effluent data. This approach is taken instead of using the 4-day P₉₉ because there have been two instances when the 4-day average concentration exceeded 479 mg/L from May 2014 through September 2018.

A target limit and permit language for Source Reduction Measures are not recommended as part of this evaluation. These should follow contact with Paddock Lake. Though if the Department and the Paddock Lake are unable to reach agreement on all the terms of a Chloride Variance, the calculated limits described earlier should be included in the permit, in accordance with s. NR 106.83(3), Wis. Adm. Code.

Chloride monitoring recommendations: Four samples per month (on consecutive days) are recommended. This allows for averaging of the results to compare with the interim limit and allows the use of the average in determining future interim limits, and degree of success with chloride reduction measures.

In the absence of a variance, Paddock Lake would be subject to the water quality-based effluent limit of 400 mg/L as a weekly average; the weekly average mass limit of 2,600 lbs/day (395 mg/L × 0.8 MGD × 8.34); and an alternative wet weather mass limit.

Mercury – The permit application did not require monitoring for mercury because the Paddock Lake is categorized as a minor facility as defined in s. NR 200.02(8), Wis. Adm. Code. In accordance with s. NR 106.145(3)(a)3., a minor municipal discharger shall report results of influent and effluent mercury monitoring once every three months if, “there are two or more exceedances in the last five years of the high-quality sludge mercury concentration of 17 mg/kg specified in s. NR 204.07(5).” A review of the past five years of sludge characteristics data reveals that all the sample results are within expected analytical ranges and well below the 17 mg/kg level. The average concentration in the sludge from May 2014 through September 2018 was 1.1 mg/kg, with a maximum reported concentration of 1.8 mg/kg. **Therefore, no mercury monitoring is recommended at Outfall 001.**

PART 3 – WATER QUALITY-BASED EFFLUENT LIMITATIONS FOR AMMONIA NITROGEN

The State of Wisconsin promulgated revised water quality standards for ammonia nitrogen effective March 1, 2004 which includes criteria based on both acute and chronic toxicity to aquatic life. The current permit has daily maximum, weekly average and monthly average limits for Outfall 001 (calculated in 2005). These limits are re-evaluated at this time due to the following changes:

- Updates to subchapter IV of ch. NR 106, Wis. Adm. Code allow limits based on available dilution at low-flow instead of limits set to twice the acute criteria.
- The maximum expected effluent pH has increased

Potential changes to daily maximum Ammonia Nitrogen effluent limitations:

Updates to subchapter IV of ch. NR 106, Wis. Adm. Code (effective September 1, 2016) outline the option for the Department to implement use of the 1-Q₁₀ receiving water low-flow to calculate daily maximum ammonia nitrogen limits if it is determined that the previous method of acute ammonia limit calculation (2×ATC) is not sufficiently protective of the fish and aquatic life. The more restrictive calculated limits would apply. Because there is practically no 1-Q₁₀ flow rate in Brighton Creek outside of the spring months, the daily maximum limit should be set equal to the calculated acute toxicity criteria.

Daily Maximum Limits based on Acute Toxicity Criteria (ATC):

Daily maximum limitations are based on acute toxicity criteria, which are a function of the effluent pH and the receiving water classification. The acute toxicity criterion (ATC) for ammonia is calculated using the following equation.

$$\text{ATC in mg/L} = [A \div (1 + 10^{(7.204 - \text{pH})})] + [B \div (1 + 10^{(\text{pH} - 7.204)})]$$

Where:

A = 0.411 and B = 58.4 for a Warm Water Sport fishery, and
 pH (s.u.) = maximum reasonably expected pH of the effluent

The current permit includes a daily maximum limit of 17 mg/L, which was based upon effluent pH data from July 2003 through August 2005, and the previous 2×ATC method. The effluent pH data for the past five years was examined as part of this evaluation. A total of 1152 sample results were reported from May 2014 through September 2018. The maximum reported value was 8.4 s.u. (Standard pH Units). The effluent pH was 8.2 s.u. or less 99 % of the time. The 1-day P₉₉, calculated in accordance with s. NR 106.05(5), Wis. Adm. Code, is 8.26 s.u. And the mean plus the standard deviation multiplied by a factor of 2.33, an estimate of the upper ninety ninth percentile for a normally distributed dataset, is 8.25 s.u. A value of 8.2 s.u. is believed to represent the maximum reasonably expected pH, and therefore most appropriate for determining daily maximum limitations for ammonia nitrogen. Substituting a value of 8.2 s.u. into the equation above yields an ATC = 5.7 mg/L and a computed daily maximum limit of 5.7 mg/L (1-Q₁₀ flow is zero cfs). This change represents more than a 50 % reduction from the previous limit.

The daily maximum limit can also be determined on a day to day basis using the actual effluent pH for the day. Daily maximum limits corresponding to various effluent pH values are shown in the following table. The permittee has requested that the pH-variable daily maximum limit approach be used for the reissued permit. Therefore, **the following pH-variable daily maximum ammonia nitrogen limits are recommended for permit reissuance.**

pH-variable daily maximum ammonia nitrogen effluent limitations – WWSF

Effluent pH s.u.	NH ₃ -N Limit mg/L	Effluent pH s.u.	NH ₃ -N Limit mg/L	Effluent pH s.u.	NH ₃ -N Limit mg/L
6.0 < pH ≤ 6.1	54	7.0 < pH ≤ 7.1	33	8.0 < pH ≤ 8.1	6.9
6.1 < pH ≤ 6.2	53	7.1 < pH ≤ 7.2	30	8.1 < pH ≤ 8.2	5.7
6.2 < pH ≤ 6.3	52	7.2 < pH ≤ 7.3	26	8.2 < pH ≤ 8.3	4.7
6.3 < pH ≤ 6.4	51	7.3 < pH ≤ 7.4	23	8.3 < pH ≤ 8.4	3.9
6.4 < pH ≤ 6.5	49	7.4 < pH ≤ 7.5	20	8.4 < pH ≤ 8.5	3.2
6.5 < pH ≤ 6.6	47	7.5 < pH ≤ 7.6	17	8.5 < pH ≤ 8.6	2.7
6.6 < pH ≤ 6.7	45	7.6 < pH ≤ 7.7	14	8.6 < pH ≤ 8.7	2.2
6.7 < pH ≤ 6.8	42	7.7 < pH ≤ 7.8	12	8.7 < pH ≤ 8.8	1.8
6.8 < pH ≤ 6.9	39	7.8 < pH ≤ 7.9	10	8.8 < pH ≤ 8.9	1.6
6.9 < pH ≤ 7.0	36	7.9 < pH ≤ 8.0	8.4	8.9 < pH ≤ 9.0	1.3

Weekly Average & Monthly Average Limits based on Chronic Toxicity Criteria (CTC)

No changes are recommended to the current weekly and monthly average ammonia limits because there have been no significant changes in the effluent and receiving water flow rates since the limits were last calculated in 2005. The updated stream flow data from USGS shows that there is not much additional dilution to consider during the summer, fall and winter months. The calculated effluent limits would be increased slightly in the spring however the Department would be unable to raise the permit limits without a demonstration of need per ch. NR 207, Wis. Adm. Code (Antidegradation/Antibacksliding).

Final adjustments of the effluent limitations may be necessary to meet limit expression requirements in s. NR 106.07, Wis. Adm. Code. See Part 7 of this attachment; Limit Expression

PART 4 –PHOSPHORUS**Technology Based Effluent Limit (TBL)**

Wisconsin Administrative Code, ch. NR 217, requires municipal wastewater treatment facilities that discharge greater than 150 pounds of Total Phosphorus per month to comply with a monthly average limit of 1.0 mg/L, or an approved alternative concentration limit.

Because Paddock Lake currently has an existing technology-based limit of 1.0 mg/L, this limit should be included in the reissued permit. This limit remains applicable unless a more stringent water quality-based concentration limit is given.

Water Quality-Based Effluent Limits (WQBEL)

Revisions to administrative rules regulating phosphorus took effect on December 1, 2010. These rule revisions include additions to ch. NR 102 (s. NR 102.06), which establish phosphorus standards for surface waters. Revisions to ch. NR 217 (s. NR 217, Subchapter III) establish procedures for determining WQBELs for phosphorus, based on the applicable standards in ch. NR 102.

Section NR 102.06(3)(a) specifically names sections of rivers for which a phosphorus criterion of 0.1 mg/l applies. For other stream segments that are not specified in s. NR 102.06(3)(a), s. NR 102.06(3)(b), Wis. Adm. Code, specifies a phosphorus criterion of 0.075 mg/L. The phosphorus criterion of 0.075 mg/L applies for Brighton Creek.

The conservation of mass equation is described in s. NR 217.13 (2)(a), Wis. Adm. Code, for phosphorus WQBELs and includes variables of water quality criterion (WQC), receiving water flow rate (Qs), effluent flow rate (Qe), and upstream phosphorus concentrations (Cs):

$$\text{Limitation} = [(WQC)(Q_s + (1-f) Q_e) - (Q_s - f Q_e) (C_s)] / Q_e$$

Where:

WQC = 0.075 mg/L for Brighton Creek.

Qs = 100% of the 7-Q₂ of 0.01 cfs

Cs = background concentration of phosphorus in the receiving water pursuant to s. NR 217.13(2)(d), Wis. Adm. Code

Qe = effluent flow rate = 0.8 MGD = 1.24 cfs

f = the fraction of effluent withdrawn from the receiving water = 0

Attachment # 1

Section NR 217.13(2)(d), Wis. Adm. Code, specifies that the background phosphorus concentration used in the limit calculation formula shall equal the median of at least four samples collected during the months of May through October, and that all samples collected during a 28-day period shall be considered as a single sample and the average of these concentrations used to determine a median. Averaging begins at date of the first sample in the range of May through October.

A previous evaluation resulted in a WQBEL of 0.075 mg/L using a background concentration of 0.104 mg/L. Section NR 217.13(2)(d), Wis. Adm. Code, states that the determination of upstream concentrations shall be evaluated at each permit reissuance.

An updated review shows that eleven total phosphorus samples are available from the growing season in the Department’s surface water integrated monitoring systems (SWIMS) database for Brighton Creek upstream of the discharge (Station Name; “Brighton Creek – 45th St.”). The s. NR 217 Wis. Adm. Code, median concentration at this location, SWIMS Station ID 10008154, is still 0.104 mg/L.

Substituting a median value of 0.104 mg/L into the limit calculation equation above would result in a calculated limit that is less than the applicable criterion of 0.075 mg/L. However, s. NR 217.13(7), Wis. Adm. Code, specifies that “if the water quality-based effluent limitation calculated pursuant to the procedures in this section is less than the phosphorus criterion specified in s. NR 102.06, Wis. Adm. Code, for the water body, the effluent limit shall be set equal to the criterion.”

Even if the median background concentration was well below the 0.075 mg/L criteria, the 7-Q₂ stream flow is negligible compared to the 0.8 MGD discharge resulting in a calculated limit is equal to the criteria after rounding. Since the receiving water flow is practically equal to zero, the calculated effluent limit is set equal to criteria.

Effluent Data

The following table summarizes effluent total phosphorus monitoring data from May 2014 through September 2018.

	Phosphorus mg/L
1-day P ₉₉	1.05
4-day P ₉₉	0.71
30-day P ₉₉	0.54
Mean	0.46
Standard deviation	0.19
Sample size	685
Range	0.03 – 1.08

Reasonable Potential Determination

The calculated WQBEL of 0.075 mg/L is less than the current technology-based limit of 1.0 mg/L, so the WQBEL should be included in the permit per s. NR 217.15(2), Wis. Adm. Code.

Limit Expression

Because the calculated QBEL is less than or equal to 0.3 mg/L, the effluent limit of 0.075 mg/L may be expressed as a six-month average. If a concentration limitation expressed as a six-month average is included in the permit, a monthly average concentration limitation of 0.225 mg/L, equal to three times the QBEL calculated under s. NR 217.13 shall also be included in the permit. The six-month average should be averaged during the months of May – October and November – April.

Mass Limits

Because the discharge is upstream of an impaired water (Des Plaines River), a mass limit is also required, pursuant to s. NR 217.14(1)(a), Wis. Adm. Code. **This final mass limit shall be 0.075 mg/L × 8.34 × 0.8 MGD = 0.50 lbs/day expressed as a six-month average**

Multi-Discharge Variance Interim Limit

With the permit application, Paddock Lake has applied for the phosphorus multi-discharger variance (MDV). Conditions of the phosphorus MDV require the facility to comply with an interim phosphorus limit in lieu of meeting the final QBEL. Section 283.16 (6) 1, Wis. Stats. requires an interim limit of 0.8 mg/L as a monthly average for the first permit term under the MDV. However, if 0.8 mg/L does not represent the highest attainable condition, a more stringent limit should be met by no later than the end of the permit term pursuant s. 283.16 (7), Wis. Stats. Since the WWTF has shown the ability to consistently treat below monthly averages of 0.8 mg/L, a more stringent limit is required. The recommended interim limit is 0.70 mg/L as a monthly average. This value represents the 4-day P₉₉ of effluent total phosphorus data from the recent permit term. Based on a discussion with the permittee during the most recent compliance inspection, **no compliance schedule is necessary, and the 0.7 mg/L monthly average interim limit can become effective immediately at permit reissuance.**

PART 5 –THERMAL

New surface water quality standards for temperature took effect on October 1, 2010. These new regulations are detailed in chs. NR 102 (Subchapter II – Water Quality Standards for Temperature) and NR 106 (Subchapter V – Effluent Limitations for Temperature) of the Wisconsin Administrative Code. Daily maximum and weekly average temperature criteria are available for the 12 different months of the year depending on the receiving water classification.

In accordance with s. NR 106.53(2), Wis. Adm. Code, the highest daily maximum flow rate for a calendar month is used to determine the acute (daily maximum) effluent limitation, and the highest 7-day rolling average flow rate for a calendar month is used to determine the sub-lethal (weekly average) effluent limitation. These values were based off actual flow reported from May 2014 through September 2018.

The discharge is pumped through approximately 6,800' of force main before reaching Brighton Creek. Studies have shown that a small amount of temperature loss can occur before discharge from force mains of this size, however the effect is negligible during some parts of the year due to ground temperatures. Therefore, no cooling is factored into the temperature limit calculations.

The table below summarizes the maximum temperatures reported during monitoring from May 2014 through September 2018, and the calculated effluent limits using ¼ of the monthly 7-Q₁₀ flows.

Attachment # 1

Month	Representative Highest Monthly Effluent Temperature		Calculated Effluent Limit	
	Weekly Maximum	Daily Maximum	Weekly Average Effluent Limitation	Daily Maximum Effluent Limitation
	(°F)	(°F)	(°F)	(°F)
JAN	55	56	49	76
FEB	55	58	50	76
MAR	54	56	52	77
APR	59	61	55	80
MAY	62	65	65	82
JUN	69	74	76	84
JUL	71	72	81	85
AUG	72	73	81	84
SEP	71	73	73	82
OCT	67	68	61	80
NOV	61	64	49	77
DEC	55	57	49	76

Reasonable Potential

Permit limits for temperature are recommended based on the procedures in s. NR 106.56.

- An acute limit for temperature is recommended for each month in which the representative daily maximum effluent temperature for that month exceeds the acute WQBEL. The representative daily maximum effluent temperature is the greater of the following:
 - (a) The highest recorded representative daily maximum effluent temperature
 - (b) The projected 99th percentile of all representative daily maximum effluent temperatures
- A sub-lethal limitation for temperature is recommended for each month in which the representative weekly average effluent temperature for that month exceeds the weekly average WQBEL. The representative weekly average effluent temperature is the greater of the following:
 - (a) The highest weekly average effluent temperature for the month.
 - (b) The projected 99th percentile of all representative weekly average effluent temperatures for the month

Comparing the representative highest effluent temperature to the calculated effluent limits determines the reasonable potential of exceeding the effluent limits. Based on this analysis, weekly average temperature maximum limits are triggered for the months of October through April.

However, s. NR 106.59(4), Wis. Adm. Code, allows POTW’s to make Dissipative Cooling (DC) demonstrations. Dissipative cooling is the cooling effect associated with heat loss to the ambient water, the atmosphere, and the surrounding environment. The general idea of the demonstration is to show that the sub-lethal criterion is not exceeded for an unreasonable amount of area beyond the outfall. If successful, DC can justify the exclusion of sub-lethal weekly average temperature limits in WPDES permits.

Attachment # 1

Paddock Lake submitted a dissipative cooling demonstration on September 28, 2015. The study was conducted in November 2014 and included instream temperature data from four locations approximately 90 feet downstream of the Paddock Lake discharge to Brighton Creek. The study shows that:

- Although effluent is discharged into Brighton Creek at a temperature higher than the applicable sub-lethal water quality criterion, that criterion is attained within a reasonable distance of the outfall (which in this case is no more than 3 stream-widths).
- The discharge from Paddock Lake to Brighton Creek does not significantly impact in-stream temperature. There was limited temperature variation from one bank of the stream to the other at the single cross section located downstream of the outfall during discharge, and there was no significant fluctuation of the temperature between discharge and non-discharge periods.

The demonstration was supportive of rapid heat dissipation; therefore, DC was approved on October 15, 2015, and the permit was modified effective August 1, 2017 to remove the sub-lethal weekly average temperature limits.

Future WPDES Permit Reissuance

Dissipative cooling requests must be re-evaluated every permit reissuance. The permittee is responsible to submit an updated DC request prior to permit reissuance. Such a request must either include:

- a) A statement by the permittee that there have been no substantial changes in operation of, or thermal loadings to, the treatment facility and the receiving water; or
- b) New information demonstrating DC to supplement the information used in the previous DC determination. If significant changes in operation or thermal loads have occurred, additional DC data must be submitted to the Department.

PART 6 – WHOLE EFFLUENT TOXICITY (WET)

WET testing is used to measure, predict, and control the discharge of toxic materials that may be harmful to aquatic life. In WET tests, organisms are exposed to a series of effluent concentrations for a given time and effects are recorded. The following evaluation is based on procedures in the Department's WET Program Guidance Document (revision #11, dated November 1, 2016).

The WET Checklist was not used to evaluate this discharge. Instead, guidance in Chapter 1.11 of the WET Guidance (WET Testing of Minor Municipal Discharges) was consulted. This is a minor municipal (< 1.0 MGD) discharge comprised solely of domestic wastewater, with no WET failures and no toxic compounds detected at levels of concern (ammonia < 20 mg/L, chloride < 750 mg/L, copper < 20 µg/L, zinc < 100 µg/L). Chloride levels have been reduced considerably compared to previous permit terms. Because there is a very low risk of toxicity, **no WET testing is recommended for permit reissuance.**

PART 7 – EXPRESSION OF LIMITS

Revisions to chs. NR 106 and 205, Wis. Adm. Code align Wisconsin's water quality-based effluent limitations with 40 CFR 122.45(d), which requires WPDES permits contain the following concentration limits, whenever practicable and necessary to protect water quality:

- Weekly average and monthly average limitations for continuous discharges subject to ch. NR 210.
- Daily maximum and monthly average limitations for all other discharges.

Paddock Lake is a municipal treatment facility and is therefore subject to weekly average and monthly average limitations whenever limitations are determined to be necessary.

This evaluation provides additional limitations necessary to comply with the expression of limits in ss. NR 106.07 and NR 205.065(7), Wis. Adm. Code. Pollutants already compliant with these rules or that have an approved impracticability demonstration, are excluded from this evaluation including water-quality based effluent limitations for phosphorus, temperature, and pH, among other parameters. Mass limitations are not subject to the limit expression requirements if concentrations limits are given.

Method for calculation:

The methods for calculating limitations for continuous discharges subject to ch. NR 210, Wis. Adm. Code, to conform to 40 CFR 122.45(d) are specified in s. NR 106.07(3), and are as follows:

1. Whenever a daily maximum limitation is determined necessary to protect water quality, a weekly and monthly average limitation shall also be included in the permit and set equal to the daily maximum limit unless a more restrictive limit is already determined necessary to protect water quality.
2. Whenever a weekly average limitation is determined necessary to protect water quality, a monthly average limitation shall also be included in the permit and set equal to the weekly average limit unless a more restrictive limit is already determined necessary to protect water quality.
3. Whenever a monthly average limitation is determined necessary to protect water quality, a weekly average limit shall be calculated using the following procedure and included in the permit unless a more restrictive limit is already determined necessary to protect water quality:

$$\text{Weekly Average Limitation} = (\text{Monthly Average Limitation} \times \text{MF})$$

Where:

MF= Multiplication factor as defined in Table 1

CV= coefficient of variation (CV) as calculated in s. NR 106.07(5m)

[CV = standard deviation/arithmetic mean, or 0.6 for fecal coliform]

n= the number of samples per month required in the permit

s. NR 106.07 (3) (e) 4. Table 1 — Multiplication Factor (for CV = 0.6)

CV	n=1	n=2	n=3	n=4	n=8	n=12	n=16	n=20	n=24	n=30
0.6	1.00	1.31	1.51	1.64	1.95	2.12	2.23	2.30	2.36	2.43

Note: This methodology is based on the *Technical Support Document for Water Quality-based Toxics Control* (March 1991). PB91-127415.

Fecal Coliform: The once per week monitoring frequency leads to a multiplication factor of 1.64. Therefore, a weekly geometric mean limit of 656# /100mL is needed for permit reissuance

Chloride: If the variance application is not approved, a monthly average limit is needed for permit reissuance, and should be set at the same value as the weekly average concentration limit.

Summary of Additional Limitations:

In conclusion, the following additional limitations are required to comply with ss. NR 106.07 and NR 205.065(7) Expression of Limits.

Attachment # 1

Parameter	Daily Maximum	Weekly Average	Monthly Average	Weekly Geometric Mean	Monthly Geometric Mean	Multiplication Factor (CV)	Assumed Monitoring Frequency (n)
Fecal Coliform				656# /100mL	400# /100 mL	1.64 (0.6)	Weekly = 4 / month
Chloride		400 mg/L	400 mg/L			Not applicable	

Temperature limits for receiving waters with unidirectional flow

(calculation using default ambient temperature data)

Facility:	Paddock Lake	Data Range	7-Q ₁₀ :	0 cfs		
Outfall(s):	001	Start:	Dilution:	25%		
Date Prepared:	10/15/18	End:	f:	0		
Design Flow (Qe):	0.8 MGD	Stream type:		Small warm water sport or forage fish commun ▼		
Region:	SER	Qs:Qe ratio:		0.0 :1		
				Calculation Needed?	YES	

Month	Water Quality Criteria			Receiving Water Flow Rate (Qs) (cfs)	Representative Highest Effluent Flow Rate (Qe)		Representative Highest Monthly Effluent Temperature		99th Percentile of Representative Data		Calculated Effluent Limits	
	Ta (default) (°F)	Sub-Lethal WQC (°F)	Acute WQC (°F)		7-day Rolling Ave (Qesl) (MGD)	Daily Max Flow Rate (Qea) (MGD)	Weekly Ave (°F)	Daily Max (°F)	Weekly Ave (°F)	Daily Max* (°F)	Weekly Ave Limit (°F)	Daily Max Limit (°F)
JAN	33	49	76	0.03	0.674	0.909	55	56	51	NA	49	76
FEB	34	50	76	0.03	0.848	1.554	55	58	51	NA	50	76
MAR	38	52	77	0.12	0.870	1.611	54	56	52	NA	52	77
APR	48	55	79	0.29	1.040	1.572	59	61	55	NA	55	80
MAY	58	65	82	0.09	0.997	1.656	62	65	60	NA	65	82
JUN	66	76	84	0.02	0.897	1.622	69	74	66	NA	76	84
JUL	69	81	85	0.00	1.288	2.615	71	72	69	NA	81	85
AUG	67	81	84	0.00	0.523	0.808	72	73	71	NA	81	84
SEP	60	73	82	0.00	0.802	1.476	71	73	70	NA	73	82
OCT	50	61	80	0.00	0.494	1.040	67	68	65	68	61	80
NOV	40	49	77	0.02	0.917	1.558	61	64	60	65	49	77
DEC	35	49	76	0.03	0.832	1.243	55	57	54	57	49	76

*NA - Indicates that there are greater than 100 daily maximum values, therefore 99th percentile would be a value less than the recorded daily maximum.

No weekly average temperature limits recommended for permit reissuance based upon results of a dissipative cooling demonstration which was approved on October 15th, 2015.

