Section 7

Deerfield River Watershed

SECTION 7 – DEERFIELD RIVER WATERSHED

7.1 INTRODUCTION

The Deerfield River originates in southern Vermont. The 73 mile long river runs through Massachusetts before discharging to the Connecticut River in Greenfield, Massachusetts, downstream of Turners Falls. This study includes one POTW that discharges directly to the Deerfield River, the Greenfield WWTF.

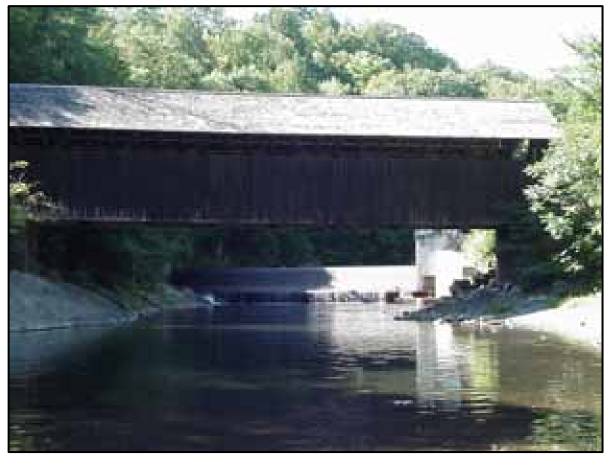

Image from www.mass.gov

Figure 7.1-1 shows the Deerfield River watershed and the facility mentioned above. The impact of nitrogen removal at this facility is presented in this section.

(continued)

N

POTW Permitted Flow Range (mgd)

0.1-1.0

1.1 - 5.0

5.1 - 10.0

10.1 - 50.0

50.1 - 100.0

Watershed

MA Town Boundaries

0 2.5 5 10 Miles

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One Cambridge Place, 50 Hampshire Street
Cambridge, MA 02139
Tel: (617) 452-6000

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ENGINEERING FEASIBILITY AND COST ANALYSES OF NITROGEN REDUCTION FROM SELECTED POTWS IN MASSACHUSETTS

Permitted Flows for POTWs in Deerfield Subwatershed
Figure 7-1-1

\\CDMD1VR72B1\Projects\MA_DEP_TN_Study\ JPD 03/2008

7.2 GREENFIELD

A. **Introduction.** The Greenfield wastewater treatment facility is located at 384 Deerfield Street in Greenfield, MA. It has a permitted annual average flow of 3.2 mgd and serves approximately 80% of the Town of Greenfield. There are three pump stations in the combined collection system and no CSOs since they were eliminated in the 1980s. There are no significant industrial dischargers, and only septage from the remaining unsewered portions of Greenfield is accepted at the facility.

The current facility was built in 1974. Prior to 1974, two primary clarifiers and sludge digesters existed on the site. The plant was upgraded in 2000 in which the trickling filters were upgraded with increased capacity and new drives. The design average daily flow for this upgrade is 4.65 mgd. The outfall also was relocated to discharge to the Deerfield River, a new chlorine contact tank and equipment were added, and the headworks was upgraded.

The facility is located in the floodplain and there is believed to be Native American burial grounds on the site.

B. **Existing Facilities.**

1. **Description of existing facilities.** All flow conveyed to the Greenfield Wastewater Treatment Facility (WWTF) enters the headworks structure. This structure contains mechanical bar screens and an aerated grit chamber. From there, flow passes through the Parshall flume and flows by gravity to the primary settling tanks.

Aerial photo from www.google.com

After primary clarification, the primary effluent flows by gravity to the trickling filters.

The facility has two trickling filters with stacked plastic media. Each tank is 100 ft in diameter and 10 ft deep. The trickling filters are followed by two 10 ft deep, 75 ft diameter final settling tanks.

Secondary effluent receives chlorination and dechlorination prior to discharge to the Deerfield River. A liquid process flow schematic is shown in Figure 7.2-1.

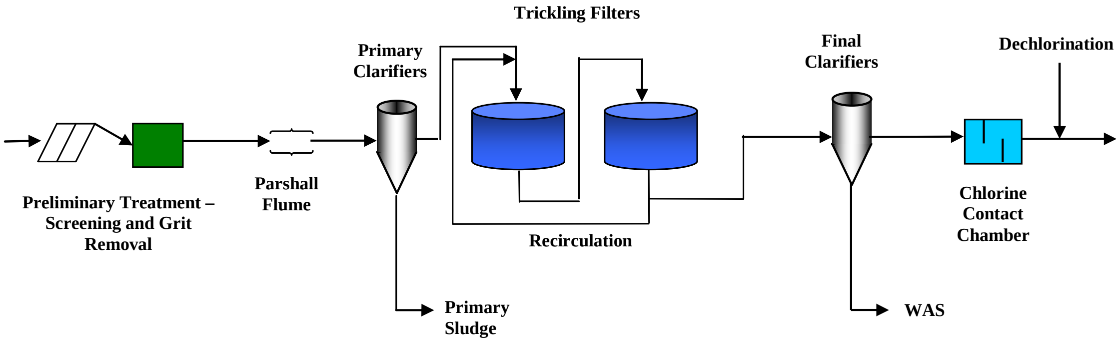


FIGURE 7.2-1: PROCESS FLOW SCHEMATIC – EXISTING FACILITY

Primary sludge and humus sludge are thickened in a gravity thickener. Thickened sludge is then transferred to a storage tanker from which it is trucked off site for incineration.

Plant sidestream flows are returned downstream of the Parshall flume and influent sampler. Grab samples are taken from the primary effluent channel and these include the side stream.

Both primary settling tanks, both trickling filters and one of the two final settling tanks are on line under normal operation. Only three primary clarifiers are operated during the summer. Nitrification is not required. However, the plant does not try to suppress nitrification at any time of the year. In fact, the facility is operated to achieve maximum treatment under low river flows in order to benefit the river. The trickling filters are operated in series rather than parallel more than 95 percent of the time to accomplish this. The trickling filters cannot be operated in series during a succession of very cold days. The water temperature drops from flowing through the second filter and icing can occur in the secondary clarifiers. The filters also are not operated in series during high flows (> 9mgd) since little benefit is gained over parallel operation.

The plant has funding for 5.5 total individuals: a superintendent, an operations supervisor, a lab technician and four operators. The staff is shared at with the water treatment facility which is why the total allocation is less than the number of people listed; their time is split between the two jobs.

As the aerial photo demonstrates, there is open space south of the headworks facility as well as east of the disinfection facility. The difficulty in siting tankage will be the potential Native American burial grounds on the site.

2. **Summary of Plant Data.** Data from January 2004 through December 2006 was provided by the Town for this study. A summary of the monthly data is shown in the following Table 7.2-1. Seasonal and annual average and maximum month data is summarized in the table.

(continued)

Table 7.2-1

GREENFIELD WWTF

Greenfield, Massachusetts

Monthly Averages 2004-2006

GENERAL		INFLUENT						PRIMARY EFFLUENT				FINAL EFFLUENT							
DATE		INF	pH	BOD	TSS	TEMP	DO	pH	BOD	TSS	DO	pH	BOD	TSS	DO	F. COLI	TKN	NO2	NO3
MONTH	YEAR	MGD		MG/L	MG/L	DEG F	MG/L		MG/L	MG/L	MG/L		MG/L	MG/L	MG/L	# / 100ML	MG/L	MG/L	MG/L
January	2004	3.6	7.0	105.4	85.6	49.8	4.9	7.0	68.4	30.3	7.1	7.0	10.4	4.6	11.2		2.1	0.3	10.2
February	2004	2.7	7.2	122.4	89.9	48.6	4.5	7.1	88.5	49.4	63.0	6.9	8.2	3.8	10.9				
March	2004	3.9	7.0	86.7	68.5	49.5	6.0	7.0	66.5	38.7	8.1	6.9	9.1	8.3	11.1	56.0	1.0	0.3	8.2
April	2004	5.8	6.8	54.7	48.9	51.6	6.8	6.8	52.7	37.0	8.2	6.8	10.6	15.2	11.3	12.0			
May	2004	3.9	6.9	114.4	118.9	57.7	3.5	6.9	77.7	59.1	5.1	6.9	18.6	17.1	9.9	8.0	2.0	0.1	10.8
June	2004	2.9	7.0	163.0	169.6	61.7	1.9	6.8	80.8	39.8	3.0	6.7	16.5	11.4	9.3	12.0			
July	2004	2.3	7.0	197.5	193.6	65.8	2.3	6.8	100.6	50.6	3.4	6.6	18.9	14.0	8.2	15.0	2.1	0.0	18.2
August	2004	3.4	7.0	146.3	124.8	67.8	2.8	6.8	62.4	38.1	4.5	6.8	17.1	9.7	8.3	15.0			
September	2004	3.8	6.9	129.9	118.9	66.0	3.1	6.8	58.5	34.2	4.4	6.8	18.5	9.4	8.7	16.0	1.4	0.0	14.1
October	2004	3.6	6.9	143.3	128.7	61.7	3.8	6.9	43.7	22.6	5.4	6.9	18.6	10.4	9.3	15.0			
November	2004	3.3	7.0	156.8	149.8	57.4	4.2	6.9	60.8	32.3	3.7	6.9	10.6	5.2	9.9		1.7	0.0	12.4
December	2004	4.6	6.9	100.1	95.0	52.2	6.5	6.9	42.3	25.2	6.7	6.9	9.7	5.4	10.4				
January	2005	4.3	7.2	129.5	102.4	48.2	7.7	7.2	48.3	43.4	7.9	7.3	8..5	4.3	11.3		2.9	0.1	15.0
February	2005	4.1	7.2	127.8	130.7	46.6	8.1	7.1	50.5	46.2	8.4	7.2	10.7	6.3	11.4				
March	2005	4.6	7.1	106.8	105.3	46.8	8.1	7.1	49.1	32.1	8.8	7.1	14.2	15.0	11.5	26.0			
April	2005	5.6	7.1	96.0	100.9	51.4	7.9	7.0	39.2	24.1	8.9	7.0	23.0	13.8	11.0	3.0			
May	2005	3.6	7.1	153.4	156.1	54.9	4.9	7.0	63.2	39.6	6.5	6.9	20.7	11.0	10.1	5.0	1.8	0.0	11.8
June	2005	2.7	7.1	211.2	209.4	61.9	2.8	7.0	103.2	40.5	5.8	6.7	27.0	15.0	8.9	4.0			
July	2005	3.4	7.0	175.1	188.7	65.8	3.1	6.9	69.5	31.2	6.0	6.9	22.8	11.6	8.3	6.0	1.4	0.0	0.7
August	2005	2.5	7.1	198.2	188.0	68.5	2.2	6.9	106.8	37.7	5.2	6.8	22.3	10.6	8.1	10.0			
September	2005	2.2	7.1	225.0	219.4	67.5	2.0	6.7	139.6	53.7	5.1	6.5	23.4	6.5	8.1	8.0	2.9	0.0	14.2
October	2005	6.3	6.9	120.7	125.8	61.9	5.2	6.9	71.6	31.1	6.8	6.9	29.5	11.4	9.1	16.0			
November	2005	4.9	6.9	86.3	109.6	56.7	5.6	6.9	37.1	25.7	6.4	7.1	13.3	9.7	9.9		1.6	0.2	9.7
December	2005	4.6	7.0	108.3	113.4	51.6	6.9	7.0	38.4	19.9	7.5	7.1	10.8	9.2	11.2				
January	2006	6.2	6.9	86.1	97.1	48.2	8.8	6.9	35.4	26.5	9.1	7.0	10.3	9.7	11.5		1.8	0.1	11.0
February	2006	5.0	6.9	117.1	134.0	46.4	8.3	6.9	38.7	22.8	8.9	7.0	13.4	13.8	11.7				
March	2006	3.0	7.1	160.1	159.6	48.2	7.0	7.0	64.7	29.7	7.1	6.7	16.8	14.4	11.5		2.1	0.1	12.5
April	2006	3.0	7.0	164.8	149.4	51.8	6.1	6.9	73.7	38.9	5.4	6.6	28.3	11.8	10.9				
May	2006	4.5	6.9	120.6	118.0	55.4	5.7	6.9	59.7	35.5	5.7	6.7	26.8	11.1	10.2		2.0	0.0	14.4
June	2006	3.6	6.9	144.5	142.2	60.8	3.8	6.9	61.0	39.0	5.3	6.7	19.8	6.5	9.1				
July	2006	3.2	6.9	176.9	146.0	66.2	2.5	6.9	73.2	35.8	5.6	6.8	25.7	9.6	8.6		2.9	0.0	12.8
August	2006	2.3	7.0	215.8	176.1	68.0	1.5	6.8	105.4	36.5	4.2	6.5	23.7	8.9	8.3				
September	2006	2.3	7.0	175.4	162.0	66.2	1.9	6.7	90.6	35.3	4.1	6.5	16.3	8.6	8.4		3.1	0.0	14.8
October	2006	3.8	7.0	139.9	119.7	60.8	3.8	6.8	64.5	35.2	4.6	6.9	12.5	6.4	9.1		2.5	0.0	12.4
November	2006	5.4	7.0	85.5	98.4	57.2	6.3	7.0	34.7	23.5	6.5	7.2	11.4	9.5	10.0		2.9	0.0	14.2
December	2006	3.4	7.0	133.3	135.5	53.6	5.8	6.9	49.0	27.6	5.1	7.1	8.3	6.5	10.4		2.7	0.1	15.2
Min. Month		2.2	6.8	54.7	48.9	46.4	1.5	6.7	34.7	19.9	3.0	6.5	8.2	3.8	8.1	3.0	1.0	0.0	0.7
Seasonal Average		**3.3**	**7.0**	**164.0**	**155.9**	**63.3**	**3.2**	**6.9**	**79.6**	**38.6**	**5.0**	**6.8**	**21.0**	**10.5**	**8.9**	**10.8**	**2.2**	**0.0**	**12.4**
Average Annual		**3.8**	**7.0**	**138.3**	**132.8**	**57.1**	**4.9**	**6.9**	**65.8**	**35.2**	**7.7**	**6.9**	**17.1**	**9.9**	**9.9**	**14.2**	**2.1**	**0.1**	**12.2**
Max. Month		6.3	7.2	225.0	219.4	68.5	8.8	7.2	139.6	59.1	63.0	7.3	29.5	17.1	11.7	56.0	3.1	0.3	18.2

With a current average daily flow of 3.8 mgd and a design capacity of 4.65 mgd, this facility is operating at approximately 82% of its design average day capacity and 118% of its permitted capacity. Based on the average BOD concentration of 138 mg/L and TSS concentration of 133 mg/L, this wastewater would be considered low strength. No influent nitrogen data is available for this plant.

3. **Permit Requirements and Current Performance.** The current permit for this facility has been in effect since October 30, 2002. Monthly permit limits that are relevant to this study are shown below in Table 7.2-2.

Table 7.2-2

SELECT MONTHLY PERMIT LIMITS

PARAMETER	LIMIT
BOD5	30 mg/L
TSS	30 mg/L
TKN	Report
Nitrite Nitrogen	Report
Nitrate Nitrogen	Report

The above BOD and TSS limits have been met in all months of the data collection period.

4. **Nitrogen Removal Performance.** This facility does not collect influent nitrogen data and only samples effluent nitrogen six times a year as required by permit. The data available suggests the plant is nitrifying year-round.

C. **Nitrogen Removal Alternatives.** The existing maximum month loads over the three-year data collection period were used to determine the design data. The primary effluent data which correspond to maximum-month loads are shown in Table 7.2-3 below for each permitting scenario. The minimum temperature for the permit condition is also shown. In addition, due to a lack of influent nitrogen data, the TN/BOD ratio was estimated to be 0.18

(continued)

Table 7.2-3

EXISTING PRIMARY EFFLUENT PARAMETERS

PERMIT CONDITION	PARAMETER	VALUE
Annual Average	Flow, mgd	2.2
	BOD, mg/L	140
	TSS, mg/L	75
	TN, mg/L	36
	Temperature, F	46
Seasonal	Flow, mgd	2.2
	BOD, mg/L	140
	TSS, mg/L	75
	TN, mg/L	36
	Temperature, F	55

The existing plant data was then projected to the permitted capacity of the facility to develop model input parameters for the average annual and seasonal model runs. The resultant data is shown in Table 7.2-4.

Table 7.2-4

PARAMETERS AT PERMITTED CAPACITY

PERMIT CONDITION	PARAMETER	VALUE
Annual Average	Flow, mgd	2.7
	BOD, mg/L	140
	TSS, mg/L	75
	TN, mg/L	36
	Temperature, F	46
Seasonal	Flow, mgd	2.7
	BOD, mg/L	140
	TSS, mg/L	75
	TN, mg/L	36
	Temperature, F	55

The model input data was used to size nitrogen reduction processes in order to determine planning level, order-of-magnitude costs for implementing different levels of nitrogen reduction at the facility. A discussion of operational changes or minor modifications that can be made to the facility to improve current nitrogen reduction performance as well as a presentation of the evaluation results are presented in the following sections.

1. **Minor Modifications/Retrofits.** Based on the trickling filter secondary system, there are no operational or minor modifications/retrofits that could be implemented at this facility to achieve any appreciable level of nitrogen removal.

2. **Modifications Required to Meet TN of 8.** Modifications to the facility that are required to meet an effluent TN of 8 mg/L on a seasonal and annual average basis are as follows.

a. **Seasonal.** The existing facility is not amenable to suspended growth nitrogen removal processes due to the existing trickling filter arrangement. BAF filters are recommended to achieve nitrification and denitrification filters are recommended to achieve denitrification as shown in the process schematic in Figure 7.2-2 below. The data suggests that nitrification is occurring when the trickling filters are operated in series, but with such limited data and results from a BioWin simulation suggesting otherwise, it is assumed biological aerated filters are required. This would have to be investigated further.

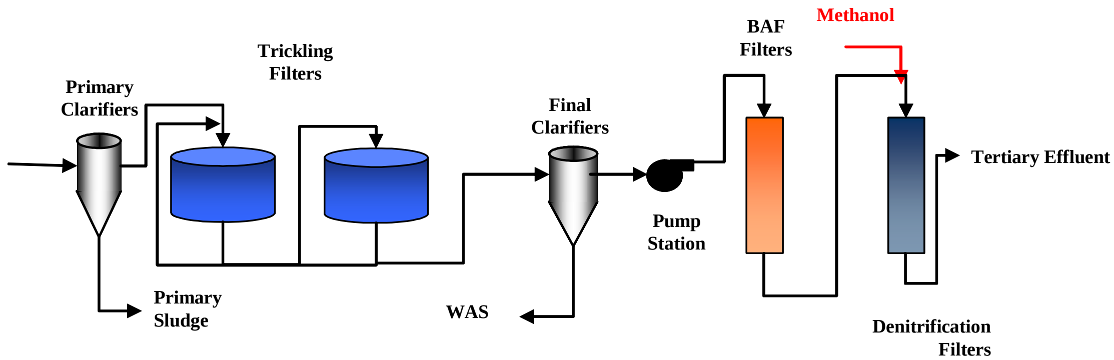


FIGURE 7.2-2: PROCESS SCHEMATIC FOR SEASONAL TN LIMIT

Based on the clarifier evaluation procedures established in Section 2, it would be determined that two additional secondary clarifiers would be required. However, the existing clarifiers are performing well at approximately 70-80% of the design average-day hydraulic capacity, and the nitrification and denitrification filters being recommended can remove solids. Therefore, no additional clarifiers were recommended for this facility. It should be noted that the existing clarifiers at this facility are 10 feet deep. According to TR-

16, clarifiers at nitrogen removal facilities should be a minimum of 13 feet deep. Because the clarifiers do not meet the minimum requirements set forth in Section 2 and since the downstream filters are being partially depended on for solids removal, it is recommended that they be further evaluated to determine if they will require replacement or derating because of the shallow depth.

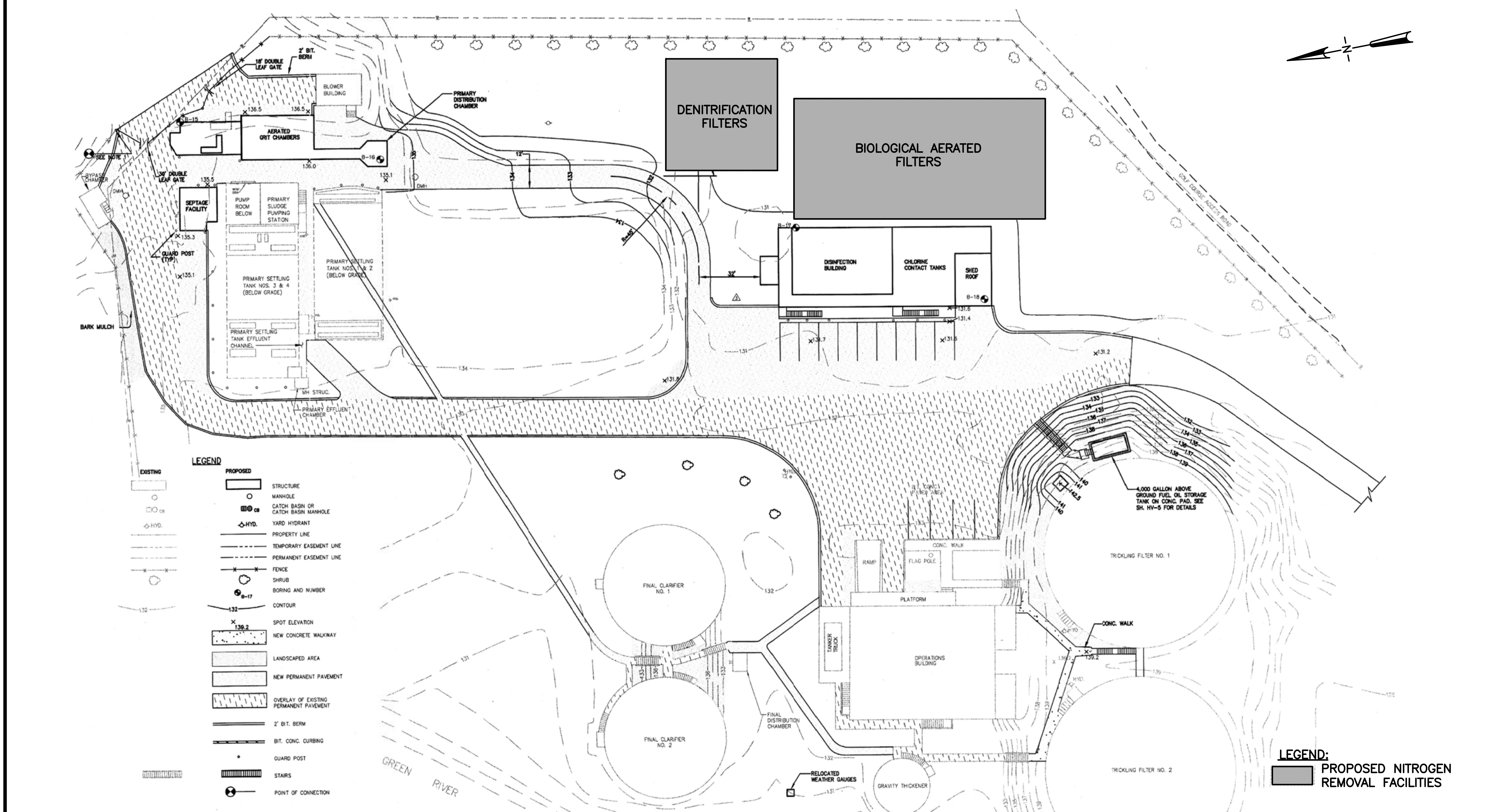
As shown in the site plan in Figure 7.2-3, the site appears to have enough space for the new filters. Specific information regarding the design results is shown in Table 7.2-5 below.

Table 7.2-5

PROCESS DESIGN FOR SEASONAL LIMIT OF 8 mg/L TN

PARAMETER	VALUE
Aerobic SRT	N/A
Total SRT	N/A
First Anoxic Fraction	N/A
Total Anoxic Fraction	N/A
Reaeration HRT	N/A
Total Volume	1.17 MG trickling filter (existing); 0.45 MG BAF filters (4 cells); 0.14 denitrification filters (4 cells)
RAS Rate	N/A
Nitrate Recycle Rate	N/A
Max MLSS at Loading Rate	N/A
Effluent TN	8 mg/L
Methanol Addition	Yes; 190 gpd
Fixed Film Required?	Yes (existing TF)
Clarifiers?	2 new clarifiers
Effluent Filtration Required?	Yes; 8,500 square feet (BAF total footprint); 3,300 square feet (denitrification total footprint)

Compensatory storage has to be provided to account for the land area within the flood plain consumed by the new facilities. A methanol feed facility and intermediate pump station to overcome the headloss added by the filters are also required. Other plant modifications may be needed including upgrades to sludge handling. However, all facilities outside of the activated sludge process are outside of the scope of this study.



NOTE:

1. Background is from Drawing C–2 from Contract Documents entitled "Upgrade and Improvements to the Water Pollution Control Plant" by Metcalf & Eddy and dated 2001.

2. Auxiliary facilities associated with nitrogen removal processes are not shown.

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Latest Revision: Tuesday, June 03, 2008

STEARNS & WHELER LLC
Environmental Engineers & Scientists
1545 Iyannough Road, Route 132
Hyannis, MA 02601
Tel: (508) 362–5680
Fax: (508) 362–5684
www.stearnswheler.com

CDM
Camp Dresser & McKee Inc.
One Cambridge Place, 50 Hampshire Street
Cambridge, MA 02139
Tel: (617) 452-6000
consulting • engineering • construction • operations

ENGINEERING FEASIBILITY AND COST ANALYSES OF NITROGEN REDUCTION FROM SELECTED POTWS IN MASSACHUSETTS

GREENFIELD, MASSACHUSETTS
FIGURE 7.2–3

b. **Annual Average.** As with the seasonal permit condition, BAF filters are recommended to achieve nitrification and denitrification filters are recommended to achieve denitrification as shown in the process schematic in the following Figure 7.2-4. The data suggests that nitrification is occurring when the trickling filters are operated in series, but the trickling filters cannot be operated in series during the winter months. Therefore, it is assumed the BAF is required.

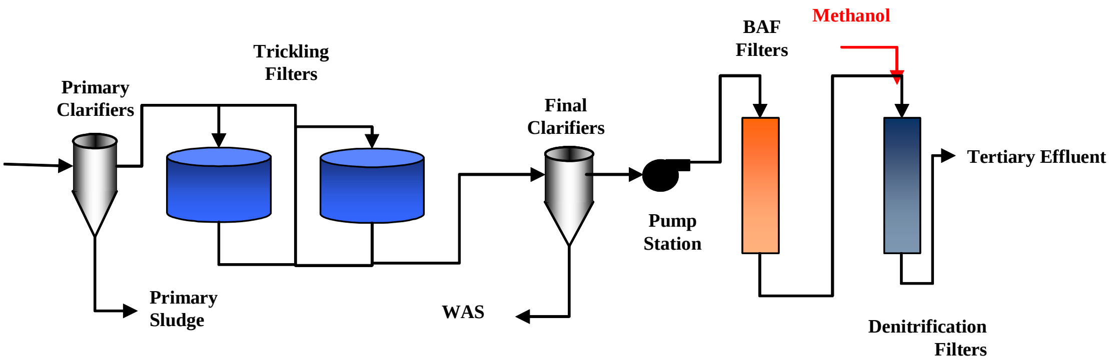

FIGURE 7.2-4: PROCESS SCHEMATIC FOR ANNUAL AVERAGE TN LIMIT

Based on the clarifier evaluation procedures established in Section 2, it would be determined that two additional secondary clarifiers would be required. However, the existing clarifiers are performing well at approximately 70-80% of the design average-day hydraulic capacity, and the nitrification and denitrification filters being recommended can remove solids. Therefore, no additional clarifiers were recommended for this facility. It should be noted that the existing clarifiers at this facility are 10 feet deep. According to TR-16, clarifiers at nitrogen removal facilities should be a minimum of 13 feet deep. Because the clarifiers do not meet the minimum requirements set forth in Section 2 and since the downstream filters are being partially depended on for solids removal, it is recommended that they be further evaluated to determine if they will require replacement or derating because of the shallow depth.

As shown in the site plan in Figure 7.2-3, the site appears to have enough space for the new filters. Specific information regarding the modeling results is shown in the following Table 7.2-6.

Table 7.2-6

PROCESS DESIGN FOR ANNUAL AVERAGE LIMIT of 8 mg/L TN

PARAMETER	VALUE
Aerobic SRT	N/A
Total SRT	N/A
First Anoxic Fraction	N/A
Total Anoxic Fraction	N/A
Reaeration HRT	N/A
Total Volume	1.17 MG trickling filter (existing); 0.45 MG BAF filters (4 cells); 0.14 denitrification filters (4 cells)
RAS Rate	N/A
Nitrate Recycle Rate	N/A
Max MLSS at Loading Rate	N/A
Effluent TN	8 mg/L
Methanol Addition	Yes; 190 gpd
Fixed Film Required?	Yes (existing TF)
Clarifiers?	2 new clarifiers
Effluent Filtration Required?	Yes; 8,500 square feet (BAF total footprint); 3,300 square feet (denitrification total footprint)

Compensatory storage has to be provided to account for the land area within the flood plain consumed by the new facilities. A methanol feed facility and intermediate pump station to overcome the headloss added by the filters also are required. Other plant modifications may be needed including upgrades to sludge handling. However, all facilities outside of the activated sludge process are outside of the scope of this study.

3. **Modifications Required to Meet a TN of 5.** Meeting a lower limit will require the same type of technology and facility modifications presented above.

D. **Plant and Cost Summary.**

Table 7.2-7 presents flow data for the Greenfield WWTP as well as the current nitrogen removal performance of the plant. As shown, the facility is not meeting the proposed effluent goals with their current process.

Table 7.2-7

PLANT FLOW AND EFFLUENT LIMIT SUMMARY

PARAMETER	VALUE
Permitted Flow (mgd)	3.2[1]
Existing Flow (2004-6)	3.8
% of permitted capacity	118.8
Current average seasonal effluent TN (mg/L)	14.6
Current average annual effluent TN (mg/L)	14.4
Permit Limits Seasonal Nitrification (mg/L) Year-round nitrification (mg/L) Seasonal TN Limit Annual TN Limit	 No No Report Report

1. Analyses were based on a treatment capacity of 4.65 mgd since the facility is currently operating at 118% of its permitted hydraulic capacity.

Table 7.2-8 presents the nitrogen removal processes required to meet the four different permit conditions considered. A biological aerated filter followed by a denitrification filter are recommended for each scenario. The filters for both conditions are the same since similar peak flows and loads occurred during both permit conditions.

Table 7.2-8

NITROGEN REMOVAL PROCESS SUMMARY FOR GREENFIELD WWTF

EXISTING PROCESS	PROCESS TO ACHIEVE SEASONAL TN OF 8 MG/L	PROCESS TO ACHIEVE ANNUAL AVERAGE TN OF 8 MG/L	PROCESS TO ACHIEVE SEASONAL TN OF 5 MG/L	PROCESS TO ACHIEVE ANNUAL AVERAGE TN OF 5 MG/L
Trickling filters	Biological aerated filter and denitrification filter	Biological aerated filter and denitrification filter	Biological aerated filter and denitrification filter	Biological aerated filter and denitrification filter

The modifications required at Greenfield to convert to a new nitrogen removal process are summarized in Table 7.2-9. As noted, no minor modifications can be made to the treatment facility to improve nitrogen removal due to the current trickling filter arrangement.

Table 7.2-9

REQUIRED MODIFICATIONS SUMMARY FOR GREENFIELD WWTF

MINOR MODIFICATIONS/ RETROFITS	MODIFICATIONS TO ACHIEVE SEASONAL TN OF 8 MG/L	MODIFICATIONS TO ACHIEVE ANNUAL AVERAGE TN OF 8 MG/L	MODIFICATIONS TO ACHIEVE SEASONAL TN OF 5 MG/L	MODIFICATIONS TO ACHIEVE ANNUAL AVERAGE TN OF 5 MG/L	SPECIAL CONDITIONS
None	BAFs and denitrification filters; methanol feed facility; intermediate pump station compensatory storage	BAFs and denitrification filters; methanol feed facility; intermediate pump station compensatory storage	BAFs and denitrification filters; methanol feed facility; intermediate pump station compensatory storage	BAFs and denitrification filters; methanol feed facility; intermediate pump station compensatory storage	Located in flood plain; potential Native American burial sites

The cost estimating procedures established in Section 2 were used to estimate capital, annual O&M, and 20-year present worth costs associated with the process changes and facility modifications summarized above. The cost estimates are included in Table 7.2-10. Since the same plant modifications are required for all scenarios, an additional row was included to demonstrate the costs if BAFs were not required to meet seasonal permits. It was assumed that two new clarifiers would be required however to avoid overloading the denitrification filter.

Table 7.2-10

COST SUMMARY FOR NITROGEN REMOVAL AT GREENFIELD WWTF[1]

LIMIT	CAPITAL COSTS (IN MILLIONS)	TOTAL ANNUAL COSTS[2] (IN THOUSANDS)	20-YR PRESENT WORTH (IN MILLIONS)
Minor Modifications/Retrofits	N/A	N/A	N/A
Seasonal Effluent TN of 8 mg/L	\$49	\$210	\$52
Seasonal Effluent TN of 8 mg/L (no BAFs)	\$26	\$140	\$28
Annual Average Effluent TN of 8 mg/L	\$49	\$260	\$53
Seasonal Effluent TN of 5 mg/L	\$49	\$220	\$52
Seasonal Effluent TN of 5 mg/L (no BAFs)	\$26	\$160	\$28
Annual Average Effluent TN of 5 mg/L	\$49	\$290	\$53

1. It should be noted that these costs represent one method by which this facility can achieve the stated TN goals. It is not intended to be the most cost effective method nor the recommended method, but it represents a planning tool for MassDEP to estimate the fiscal impacts of establishing total nitrogen limits.
2. Represents incremental increase over current conditions.