ATTACHMENT 11

CDM

Town of Marion

Supplemental Comprehensive Wastewater Management Plan (CWMP)

April 30, 2002

Section 3
Implementation

3.1 Overview

The Town's decision to provide sewer service to the outlying three needs areas and treat the wastewater at the central wastewater treatment plant has impacts on the design of the plant upgrade, project funding and the overall wastewater facilities program implementation schedule. DEP, in its April 22, 2002 approval letter, identified several additional items that need to be addressed. These items are described in this section.

3.2 Wastewater Treatment Plant Design

Design flows and loads are presented below for the expanded system, accounting for the added three outlying areas. The flow and load data presented below are generally consistent with the May 2001 draft CWMP.

3.2.1 Flows and Loads

Flows

Flow projections are based on the 0.588 million gallon per day (mgd) average design flows as defined in the May 2001 draft CWMP. The average annual flow is based on the projected service population growth from infill and new connections and the resultant increase in domestic wastewater, plus projected increases in commercial, industrial and institutional flow, and infiltration/inflow.

The draft CWMP did not include a projected maximum-month flow. The projected maximum-month flow herein is based on the historic maximum month to average annual peaking factor from 1999 through 2000. During this time period, the average annual flow was 0.465 mgd, and the maximum month average flow was 0.75 mgd, resulting in a peaking factor of 0.75/0.465 = 1.61.

The maximum day flow is based on the historical data peaking factor data, and is 1.84 mgd, based on the same maximum day to average annual day peaking factor.

The peak hourly flow projections are the sum of peak sanitary flow, peak infiltration in the high-groundwater season, and peak inflow related to precipitation. For the sanitary component, the peak is based on application of standard peaking factors to the average flows. The peak infiltration and inflow components are based on historical data. This analysis results in a peak hour to average annual peaking factor 5.1 for the expanded system.

There are no plans to receive septage at the WWTF, and the design flows and loads do not account for any septage contribution.

The following table summarizes the design flows.

Table 3-1: Influent Design Flows	
Flow Condition	**Expanded System**
Annual Average (mgd)	0.588
Maximum Month (mgd)	0.947
Maximum Day (mgd)	1.84
Peak Hour (mgd)	3.00

Loads

Average annual loads for BOD and total N are based on the following per capita rates from *TR-16* for the domestic component of the influent wastewater: BOD - 0.19 lb/day and total N - 0.04 lb/day. For TSS, using the *TR-16* per capita value of 0.22 lb/day results in average annual loads that are significantly higher than those measured at the plant historically. The annual average TSS loading was therefore taken as the average between the calculation using the textbook value and the observed loading.

Loads from commercial, industrial, and institutional flows are estimated based on assumed concentrations of 200 mg/L for BOD, 200 mg/L for TSS, and 42 mg/L for total N (using the same N:BOD ratio as the domestic component).

The maximum-month loading conditions were not included in the draft Wastewater Facilities Plan. For the maximum-month condition, the peaking factors included in *TR-16* are used for BOD (1.14) and TSS (1.3) loading. For total N, a peaking factor of 1.14 is used, assuming that the ratio of total N to BOD does not change.

The maximum-day loading conditions in the draft Wastewater Facilities Plan were calculated assuming a peaking factor of 1.5 for BOD, TSS and total N. These peaking factors are not verifiable for use in design because of the lack of sufficient historical data. Therefore, for design the maximum-day peaking factors included in *TR-16* will be used for BOD (1.8) and TSS (2.1) loading. For total N, a peaking factor of 1.8 will be used, again assuming that the ratio of total N to BOD does not change.

Table 3-2 summarizes the design loads.

Table 3-2: Influent Design Loads	
Load Condition	**Expanded System**
BOD load	
■ Average annual (mg/L at average flow)	185
■ Average annual (ppd)	909
■ Maximum month (ppd)	1036
■ Maximum day (ppd)	1636
TSS load (ppd)	
■ Average annual (mg/L at average flow)	179
■ Average annual (ppd)	880
■ Maximum month (ppd)	1144
■ Maximum day (ppd)	1848
N load (ppd)	
■ Average annual (mg/L at average flow)	39
■ Average annual (ppd)	191
■ Maximum month (ppd)	218
■ Maximum day (ppd)	344

Table 3-3 presents the existing and projected flow data in the format requested in DEP's April 22, 2002 letter. This data is consistent with the data presented in the draft CWMP, except as noted in the above description.

Table 3-3: Existing and Projected Flows			
Flow Component	**Existing (mgd)**	**Initial (mgd)**	**Design (mgd)**
Average Daily Residential	0.180	0.180	0.280
Average Daily Industrial/Commercial	0.040	0.040	0.057
Average Daily Institutional/Special	0.020	0.020	0.024
Average Daily Intermunicipal	0	0	0
Septage	0	0	0
Average Daily Total	**0.240**	**0.240**	**0.361**
Peaking Factor	1.5	1.5	1.5
Maximum Wastewater Flow	**0.360**	**0.360**	**0.542**
Average Daily Infiltration	0.219	0.219	0.228
Peak Monthly Infiltration (approx)	0.400	0.400	0.400
Peak Inflow	2.24	2.24	2.46
Average Annual Flow	**0.459**	**0.459**	**0.588**
Peak Monthly Average Flow	**0.739**	**0.739**	**0.947**
Peak Daily Flow	**1.57**	**1.57**	**1.84**
Peak Hourly Flow	**2.60**	**2.60**	**3.00**

3.2.2 Conceptual Design

Design work on the plant upgrade has progressed since the submittal of the draft CWMP. Appendix C contains excerpts from a Conceptual Design Package for the plant upgrade. This material includes preliminary data for the plant upgrade, including a site plan, hydraulic profile, and design criteria.

3.2.3 Present-Worth Comparison

The draft CWMP includes an evaluation of alternative technologies to meet the Town's wastewater goals. The evaluation, which included both economic and non-economic considerations, resulted in the recommended process (Sequencing Batch Reactors, or SBRs) that is developed as shown in the Conceptual Design Package in Appendix C. However, the capital costs, annual operations and maintenance (O&M) costs, and therefore the 20-year present worth costs of the final three alternatives were all virtually identical. DEP's April 22, 2002 letter requested that the present-worth costs of the evaluated alternatives be presented; however, since this data were not the deciding factor in selecting SBRs, it is not presented.

CDM

Town of Marion

Wastewater Treatment Plant Upgrade

March 2002

Conceptual Design Package

Contents

1.2.8 Odor Control

The new Headworks Building will be provided with an odor-control system. The Inlet Tank and the interior of the headworks process area will be ventilated through a humidification tower and discharged through two biofilters located adjacent to the building.

1.2.9 Lagoon Storage and Aeration

The existing lagoons will serve two purposes as part of the upgraded plant: peak flow equalization and WAS and filter backwash stabilization. The new SBR system will be sized to handle twice the average daily flow rate. On those rare occasions when the influent flow to the plant site exceeds that value, the extra flow will be processed through the headworks and then will drain to the lagoon system. This volume of water will be stored until the influent flow rate decreases to within the SBR capacity, at which time the lagoon contents will be slowly pumped back to the SBR process. Two lagoon recycle pumps (one standby) will be used for this purpose.

The lagoons will be aerated to reduce the incidence of nuisance odor. Floating diffusers will be installed throughout the lagoon system, and will be designed to diffuse approximately 1,000 scfm into the lagoons. Figure 1-4 shows a preliminary layout of the lagoon diffuser system. Air will be provided by three PD blowers, located in the Blower Room of the Main Building.

1.2.10 Site Work

Much of the upgraded plant as described above will be constructed on the Town property currently occupied by the sand filter beds. These beds were recently taken out-of-service. The Contactor's work will include regrading and cleanup of this area in preparation for the new construction.

A new paved plant road system will be required to support the new facilities, and new security fencing will encircle the facilities. A new water service will be brought into the site from Benson Brook Road.

Figure 1-5 shows a proposed boring plan, showing the planned geotechnical investigation program that should be implemented at the beginning of the final design.

1.2.11 Instrumentation and Control

The new facility will be provided with an instrumentation and control system that will provide the ability to run much of the plant in automatic mode. Each process area (e.g., headworks) will be provided with a programmable logic controller (PLC) that will be hardwired to the local instrumentation. The PLCs will be networked to a central computer, and the system will allow for remote monitoring and control. The system will also be sized and configured to allow for the future addition of the collection system pumping stations. The Main Pump Station, which transfers all of the

CDM Camp Dresser & McKee

Town of Marion

Wastewater Facilities Plan

Draft

May 2001

Section 2
Environmental Monitoring

2.1 Introduction

A comprehensive sampling plan was developed in conjunction with Massachusetts Department of Environmental Protection (DEP) for this wastewater facilities plan. This plan included: (1) sampling of groundwater, soil, and surface water, at locations throughout the Town; and (2) sludge sampling from the WWTF lagoons. Sampling locations were approved by DEP and are shown in **Figure 2-1**. Additionally, environmental studies of Aucoot Cove were conducted during facilities planning in response to agency concerns and NPDES permit renewal.

The main objectives of the sampling plan were to (1) evaluate the effects of the wastewater treatment facility on the surrounding environment, and (2) to evaluate the effects of on-site disposal systems (e.g., septic systems and cesspools) on the groundwater in the potential wastewater needs areas established in Section 2. This section discusses the results of the sampling program, including groundwater, soil, surface water, and sludge sampling. The laboratory data from the sampling program are included in **Appendix F**.

2.2 Groundwater Monitoring

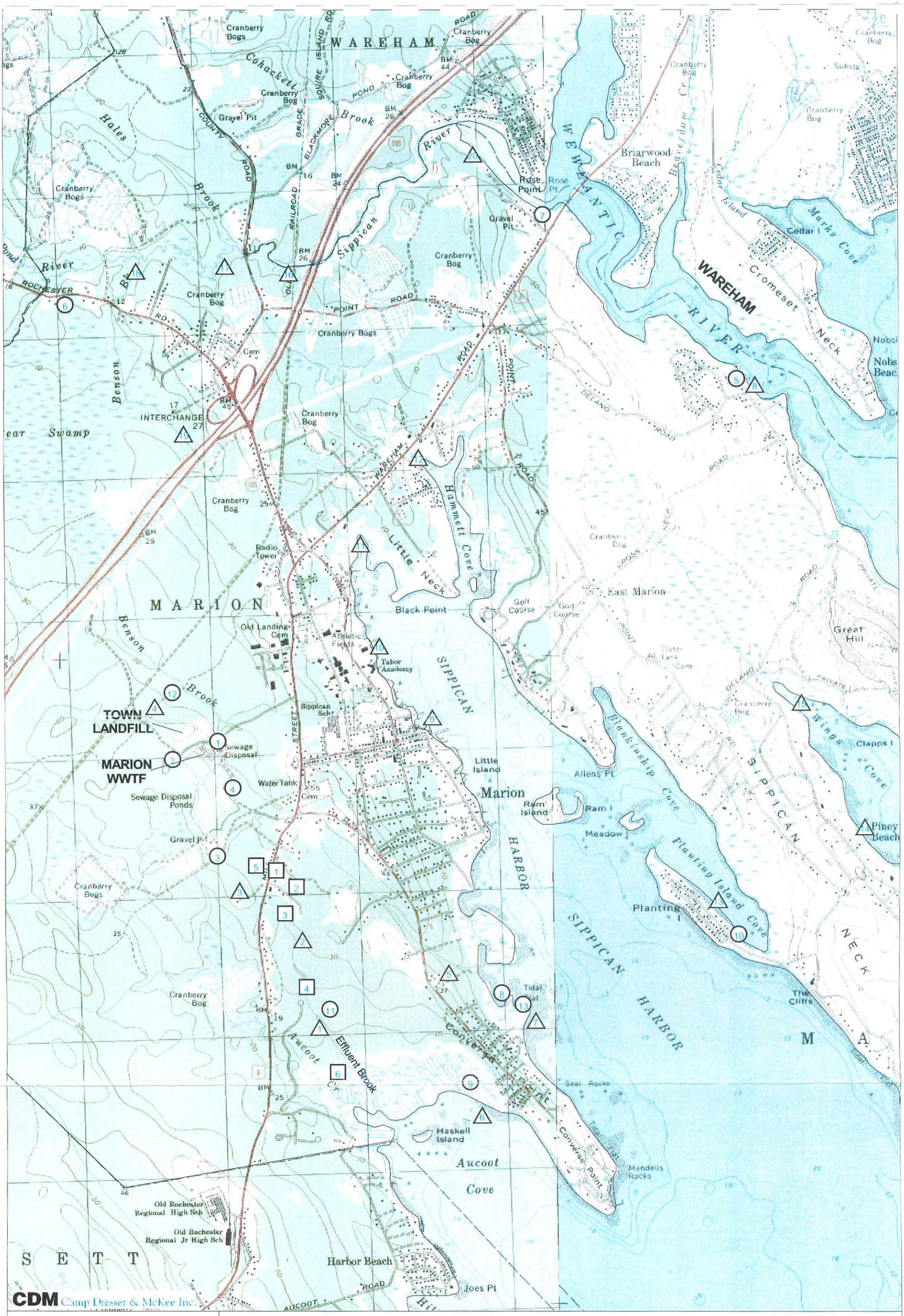
Twelve shallow borings were located throughout the Town, as shown in Figure 2-1, to identify impacts of the WWTF and septic systems and cesspools on the quality of the groundwater. Four of the 12 borings were located around the treatment facility (B-1 through B-4). The remaining eight borings were located in potential wastewater needs areas of the Town.

Nine of the 12 borings were completed as groundwater monitoring wells (Wells 1, 3 through 7, 10, 12 and 13), installed between June 24 and 26, 1991. The remaining three borings were dry holes, and thus, were not completed as wells. **Table F-7** presents drilling details from monitoring well installation and the depth to water measured during installation or on same date. The boring number corresponds to the monitoring well number (i.e., boring B-1 is monitoring Well 1).

2.2.1 Water Quality Sampling

Overview

Based on the DEP-approved sampling work plan, samples were obtained and analyzed from each of the nine monitoring wells. The results are presented in Table F-1 in Appendix F. The approved procedure for sampling and analyzing groundwater is described below:



○ Groundwater Sample
△ Surface Water Sample
□ Additional Surface Water Sample

2000 0 2000 Feet

Town of Marion, Massachusetts

Sample Program
Groundwater and Surface Water Locations

Figure 2-1

camd007474\F:\projects\marion\plots\5-4-01\fig2-1 MB bsize portrait proj1.apr

Groundwater from each of the nine monitoring wells was sampled and analyzed once for the following parameters: iron, sodium, alkalinity, total suspended solids (TSS), total dissolved solids (TDS), nitrate, nitrite, total Kjeldahl nitrogen (TKN), ammonia, phosphate, biological oxygen demand (BOD), total coliform, and fecal coliform. Groundwater from seven of these monitoring wells (Wells 1, 3, 4, 6, 10, 12 and 13) was also analyzed for Volatile Organic Compounds (VOCs) during this sampling event, the VOC results are discussed in Section 2.2.2.

- Four of the nine monitoring wells (Wells 1, 4, 10 and 13) were sampled two or three additional times for the above compounds, once during a rain event and once during dry weather. These wells were selected following a review of the initial data. Monitoring Well 3 was also scheduled for sampling two additional times, but a bailer became wedged in the well during the first sampling event and could not be removed. Two of the four selected wells were located around the treatment facility (Wells 1 and 4) to evaluate the impact of the WWTF on area groundwater. The other two wells were located on Planting Island (Well 10) and Quelle Lane (Well 13) to further evaluate potential wastewater needs areas. Due to the inability to complete the sampling during the summer of 1991, additional sampling was performed in the fall of 1992.

- Quality control and quality assurance procedures were conducted in accordance with the approved sampling work plan.

Potential WWTF Impacts on Groundwater

There were two possible sources of contamination from the WWTF: the wastewater lagoons and the septage lagoons. There are three unlined wastewater lagoons located at the WWTF. Leakage from these lagoons could have influenced the surrounding groundwater. There were also two septage lagoons at the WWTF that contained septage at the time of the sampling. The septage lagoons were unlined and were covered with wood chips. Rainfall could have seeped through the septage lagoons and influenced the surrounding groundwater. (Note: The Town plans to excavate and dispose of the material in the septage lagoons this winter).

The four wells around the WWTF were located where groundwater would be expected to be influenced by any groundwater migration from the WWTF. Three of the wells were located on the treatment plant site: at the WWTF gate along Benson Brook Road (Well 1), behind Lagoon No. 3 (Well 3), and behind Lagoon No. 2 (Well 4). The fourth well was located at the Town landfill (Well 12) adjacent to the WWTF. Although Well 12 could have been affected by the WWTF, it is likely to be predominantly affected by the landfill.

The WWTF is located on high ground. The groundwater flows away from the WWTF in all directions with the predominant flow heading east toward Benson Brook. Benson Brook flows northwest toward Bear Swamp. The locations of each well with

respect to the WWTF and landfill are shown in Figure 2-1. Results for the four monitoring wells are shown on **Table F-1** in Appendix F.

Total nitrogen, nitrate, BOD, and total and fecal coliform were used as indicators of contamination in the groundwater in these four wells. The analytical results for each parameter are discussed below:

Nitrogen – Primary drinking water standards for nitrate and nitrite are 10 mg/l and 1 mg/l, respectively. The groundwater samples from Well 1 were found to exceed the 10-mg/l nitrate standard, at 14.9 mg/l and 24.5 mg/l on November 4, 1992 (rain date). Groundwater sampled in all of the wells had concentrations of nitrite below the drinking water standard. Groundwater from two of the four monitoring wells had high concentrations of TKN. Well 1 had a TKN concentration of 19.4 mg/l on November 4, 1992 (rain date). Well 4 had consistently high TKN concentrations (mostly as ammonia) on each of the four sampling dates ranging from 13.0 to 18.5 mg/l. The concentration of TKN was not higher on the rain date than during dry weather sampling.

Biochemical Oxygen Demand – Groundwater in three of the four WWTF wells had high BOD concentrations on both dry and wet weather dates. For comparison, the NPDES permit average monthly limit for BOD is 10 mg/l. Any BOD concentration greater than 10 mg/l was considered high. All of the BOD samples taken during the fall 1992 sampling yielded very high BOD concentrations, often higher than typical influent wastewater.

- Well 1 had BOD concentrations of 17 mg/l on September 3, 1991; >340 mg/l on October 29, 1994; and 490 mg/l on November 4, 1992 (rain date).
- Well 4 had BOD concentrations of 22 mg/l on September 17, 1991; >700 mg/l on October 28, 1992; and 870 mg/l on November 4, 1992 (rain date).
- Well 12 had a BOD concentration of 12 mg/l on September 3, 1991.

Some of the BOD concentrations found in the groundwater from Wells 1 and 4 during the sampling program are higher than the influent WWTF concentration, which has a long-term average of about 125 mg/l.

Total and Fecal Coliform – For comparison, the NPDES permit average monthly limit for fecal coliform is 200 organisms/100 ml. Therefore, counts above this limit were considered high levels of coliform. Groundwater from all four monitoring wells had high counts of total coliform during the sampling program. The ratio of total coliform to fecal coliform varied greatly during the sampling program.

- Well 1 had high concentrations of total and fecal coliform of >16,000 and 2,400 organisms/100 ml on November 4, 1992 (rain date). During the dry sampling dates, Well 1 had slightly high total coliform counts, but low fecal coliform counts.

On September 3, 1991 and October 29, 1992, the total coliform counts levels were 500 and 300 organisms/100 ml, respectively. The fecal coliform counts for the same dates were 20 and 40 organisms/100 ml, respectively.

- Well 3 had a high total coliform count of 1,300 organisms/100 ml on September 17, 1991. The fecal coliform count for the same date was low at 70 organisms/100 ml.

- Well 4 had a high total coliform count of 5,000 organisms/100 ml and a very low fecal coliform count of <20 organisms/100 ml on September 17, 1991. On October 16, 1991 (rain date), the total and fecal coliform counts were both high at 500 and 300 organisms/100 ml, respectively. On October 28, 1992, the total and fecal coliform counts were both high at 2,400 and 300 organisms/100 ml, respectively. The total and fecal coliform counts for November 4, 1992 (rain date) were both very low at <20 organisms/100 ml.

- Well 12 had very high counts of total and fecal coliform on September 3, 1991. The total coliform count was >16,000 organisms/100 ml and the fecal coliform count was 2,400 organisms/100 ml.

Influence of Rain – Two of the four monitoring wells (Wells 3 and 12) were sampled only once, occurring on a dry sampling date. A bailer wedged in Well 3 during the first sampling date made further sampling impossible. The location of Well 12 was lost during the winter of 1991. With no rain date analytical results, the influence of rain on groundwater at these locations could not be determined.

- Groundwater in Well 1 appears to be significantly influenced by rain. Groundwater samples from Well 1 had significantly higher levels of the indicator compounds during the rain date than during dry weather sampling. The total nitrogen levels on the rain date were more than twice the levels observed on dry sampling dates. Fecal coliform counts in Well 1 were significantly affected by rain. The fecal count during rain dates was 2,400 organisms/100 ml, and during dry sampling dates the fecal coliform counts were 20 and 40 organisms/100 ml. The BOD concentration in Well 1 was significantly higher on the rain date than one day of dry weather sampling but not the second. On the rain date, the BOD concentration was 490 mg/l. During dry weather sampling the BOD concentrations were 17 mg/l and >340 mg/l.

- Groundwater in Well 4 does not appear to be influenced by rain. Nitrate concentrations are very low during the two dry weather sampling dates and one of the rain dates, the nitrate level on the second rain date was higher, but was still less than the primary drinking water standard. Total nitrogen concentrations were high for all four sampling days for both dry weather sampling and rain dates. Fecal coliform counts were high on one rain date and one dry weather date, and were very low on the other rain date and dry weather date. The BOD levels were extremely high on both dry weather and rain dates.

Potential Impacts of Onsite Systems on Groundwater in Wastewater Needs Areas

Four of the nine monitoring wells were installed in potential wastewater needs areas to evaluate the impacts of on-site disposal systems on groundwater in these areas. These wells were installed at Dexter Beach (Well 5), north Front Street (Well 6), Planting Island (Well 10), and south Converse Road on Quelle Lane (Well 13).

Analytical results for the four monitoring wells are shown on Table F-1 in Appendix F. Total nitrogen and nitrate, total and fecal coliform, and BOD are indicator compounds that were used to determine whether groundwater in these four wells has evidence of contamination patterns consistent with on-site system impacts.

Nitrogen – Primary drinking water standards for nitrate and nitrite are 10 mg/l and 1 mg/l, respectively. Groundwater from each well had nitrate and nitrite concentrations below the drinking water standards. Well 13 (south Converse Road area) had concentrations of nitrate ranging from 3.11 to 3.29 mg/l, which is considered elevated over natural background levels (typically <1-2 mg/l). The highest concentration of nitrate in the other wells was 0.85 mg/l. The nitrate concentration did not exceed the primary drinking water standard in any well. However, compared to the other groundwater wells in the sewer needs areas, Well 13 had higher chronic nitrate concentrations. Well 5 (Dexter Beach) had a high value of TKN on September 3, 1991 of 22.1 mg/l, which was mostly organic nitrogen. The remaining sewer need area wells had TKN concentrations of 9.6 mg/l or less.

Total and Fecal Coliform – Counts above 200 organisms/100 ml were considered high. Groundwater from each monitoring well had high levels of total coliform during the sampling program. The ratio of total coliform to fecal coliform varied greatly during the sampling program.

- Groundwater from Well 5 (Dexter Beach) had a high total coliform count of >16,000 organisms/100 ml on September 3, 1991. The fecal coliform count for the same date was low at 90 organisms/100 ml.

- Groundwater from Well 6 (North Front Street) had high total coliform counts on July 25, 1991 and September 3, 1991 of 5,600 and >16,000 organisms/100 ml, but only a high fecal coliform count on the July 25, 1991 dry sampling date of 4,800 organisms/100 ml. The replicate sample taken on July 25, 1991 had a fecal coliform count much lower than the original sample taken from Well 6 at 72 organisms/100 ml. The results are suspect because of the large difference between the results for the same well on the same date. The fecal coliform count was 40 organisms/100 ml on September 3, 1991. No samples were taken from Well 6 on a rain date.

- Groundwater from Well 10 (Planting Island) had high total and fecal coliform counts on three of four sampling dates and very low counts on the fourth date.

The total and fecal coliform counts on July 25, 1991 were 3,100 and 200 organisms/100 ml, respectively. Total and fecal coliform counts on September 3, 1991 were 3,000 and 500 organisms/100 ml, respectively. Total and fecal coliform counts on November 3, 1992 (rain date) were 16,000 organisms/100 ml. On October 29, 1992 (rain date), the total and fecal coliform counts were <20 organisms/100 ml.

- Groundwater in Well 13 (South Converse Road) had high total coliform counts and low fecal coliform counts on the two dry sampling dates. On September 3, 1991, total and fecal coliform counts were 1,400 and 70 organisms/100 ml, respectively. On October 28, 1992, the total and fecal coliform counts were 1,700 and <20 organisms/100 ml, respectively. On the two rain dates the results varied. On October 16, 1991 (rain date), total and fecal coliform counts were 800 and 70 organisms/100 ml, respectively, but the replicate had total and fecal coliform counts of 1,700 and 800, respectively. On November 3, 1992 (rain date) total and fecal coliform counts were high at >16,000 and 5,000 organism/100 ml, respectively.

Biochemical Oxygen Demand – BOD concentrations greater than 10 mg/l were considered high. Groundwater in three of the four monitoring wells (Wells 5, 10 and 13) had high BOD concentrations on both dry and wet weather dates. Each BOD sample taken during the fall 1992 sampling yielded very high BOD concentrations, often higher than typical WWTF influent. The possibility of an error in sampling or analysis should be considered.

- Groundwater from Well 5 (Dexter Beach) had a slightly elevated BOD concentration on September 3, 1991 of 21 mg/l. No samples were taken from Well 5 on a rain date.

- High BOD concentrations were found in the groundwater from Well 10 (Planting Island) on October 29, 1992 and November 3, 1992 (rain date) of >680 mg/l and 1,200 mg/l, respectively. On September 3, 1991, the groundwater had a BOD concentration of 5 mg/l.

- Groundwater from Well 13 (southern Converse Road) had high BOD concentrations on October 28, 1992 and November 3, 1992 (rain date) of >350 and 330 mg/l, respectively. The BOD concentrations for the two other dry sampling dates were 8 mg/l on July 25, 1991 and <2 mg/l on September 3, 1991. The BOD concentration for the other rain date, October 16, 1991, was 4 mg/l.

Influence of Rain – No rain date samples were taken from Well 5 (Dexter Beach) and Well 6 (north Front Street). Without rain date results, the influence of rain on the compounds cannot be determined. Groundwater in Well 10 (Planting Island) was influenced by the rain. The fecal coliform count was 16,000 organisms/100 ml on November 3, 1992 (rain date). On the dry sampling dates, fecal coliform did not exceed 500 organisms/100 ml; however, the rain did not influence the BOD or

nitrogen concentrations. There was no influence of rain on the groundwater in Well 13 (south Converse Road). The nitrogen levels were slightly higher on rain dates, but not significantly higher. The coliform counts were significantly higher on one rain date, but the other rain date counts were the same as the dry sampling dates. The BOD concentrations were not any higher on the rain date than the dry sampling dates.

2.2.2 Priority Pollutant and VOC Sampling

As noted above in Section 2.2.1, water quality samples for seven wells were analyzed for VOCs. Table F-1 in Appendix F presents VOC data for these samples.

The sampling work plan also required that groundwater samples from up to four of the wells around the WWTF be analyzed for priority pollutants. However, only two of the wells around the WWTF were accessible for sampling (Wells 1 and 4). Two wells from the potential wastewater needs areas were also selected for the priority pollutant scan. These two wells were located in the north Front Street (Well 6) and the Dexter Beach (Well 5) areas.

The two wells were sampled and analyzed for priority pollutants including: volatile organic compounds (VOCs), synthetic organic compounds (SOCs), pesticides, polychlorinated biphenyls (PCBs), and priority pollutant metals. **Table F-2** in Appendix F presents the results of the priority pollutant analyses.

VOCs were detected in only two wells: 1,2-dichloroethene (total) in Well 4 (WWTF) on both October 28 and 30, 1992, and carbon disulfide in Well 10 (Planting Island) on November 3, 1992. Both compounds were detected at levels below the quantitation limit; thus, the values are qualified as estimates.

The results show that the four groundwater wells included in the priority pollutant scan (Wells 1, 4, 5 and 6) have no detectable levels of any SOCs, pesticides, or PCBs.

Some priority pollutant metals were found above the detection limits. Cadmium and lead were the only metals that exceeded the drinking water standards. In the case of cadmium, Wells 1, 5, and 6 were slightly above the drinking water standard of 0.005 mg/l at 0.006, 0.011, and 0.007 mg/l, respectively. In the case of lead, Wells 1, 5, and 6 were slightly above the drinking water action level of 0.015 mg/l at 0.021, 0.018, and 0.017 mg/l, respectively. The lead concentration of the groundwater in Well 4 was 0.038 mg/l.

2.2.3 Conclusions

Based on the conventional and priority pollutant sampling of the groundwater, the following conclusions are made:

The groundwater in the treatment plant area has some evidence of contamination:

- Well 1 contained nitrate levels above the primary drinking standard, high total nitrogen concentrations, very high coliform counts, and very high BOD concentrations. The high concentrations of all parameters were only present on the rain date suggesting a significant influence due to rain.
- Well 4 had high coliform counts, high BOD concentrations, and a high concentration of lead. There was no significant influence due to rain.
- Well 12 had a high fecal coliform count on the only date sampled.

The results from testing groundwater in the sewer needs areas are as follows:

- In the north Front Street area (Well 6), a high fecal coliform count was found on one of the sampling dates and high total coliform counts were found on all of the sampling dates. BOD and nitrate levels were not elevated. No rain date samples were taken. The data are not conclusive.
- In the Dexter Beach area (Well 5), elevated TKN and very high total coliform was found on the only date sampled. BOD was slightly elevated. The data suggest contamination but are limited and inconclusive. No rain date samples were taken.
- In the Planting Island area (Well 10), several very high total and fecal coliform counts and very high BOD concentrations were found. The coliform counts may have been influenced by rain, but BOD concentrations were not. Nitrate levels were low. This suggests possible contamination from on-site systems, but is not conclusive.
- In the south Converse Road area (Well 13), nitrate concentrations were consistently elevated above normal background levels, a strong indication of pollution from on-site systems. Also, several very high total and fecal coliform counts and very high BOD concentrations were found. The coliform counts may have been influenced by rain; however, BOD concentrations were not.

2.3 Soil Monitoring

Soil samples were taken from four groundwater wells locations (Wells 3, 4, 5, and 13). Two of the soil samples were taken from the WWTF monitoring Wells 3 and 4. The two remaining samples were taken in the sewer needs area: Dexter Beach area (Well 5) and southern Converse Road area (Well 13). The soil samples were analyzed for volatile organic compounds, semi-volatile compounds, PCBs, pesticides, and priority pollutant metals.

The results of the soil analysis are presented in **Table F-3** in Appendix F. The only compounds detected were acetone and metals. The concentrations of these compounds were very low and were similar for all four samples. Based on these

results, the soils around the WWTF and in two of the sewer needs areas are not being adversely affected.

2.4 Surface Water Monitoring

2.4.1 Background and Potential Wastewater Needs Areas

The initial sampling of surface water occurred on July 24, 1991. Twenty surface water sampling locations (Locations 1 through 20) were selected to identify potential contamination adjacent to potential wastewater needs areas. Seven of these locations were not sampled on July 24, 1991 because they were dry (Location 2 through 5, 10, 17, and 19). Additional samples were collected at six locations on September 3, 1991 and seven locations on October 16, 1991. The October samples were rain influenced. Surface water sampling locations are shown in Figure 2-1.

Surface water samples collected in July were analyzed for TKN, ammonia-nitrogen, nitrate, nitrite, BOD, TSS, total coliform, fecal coliform, total dissolved solids, iron, alkalinity, sodium, phosphate, pH, specific conductivity, and VOCs. Samples collected in September and October were analyzed for the same parameters, excluding VOCs.

The results for the July, September, and October sampling rounds are presented in **Table F-4** in Appendix F. Many of the samples were collected in brackish or saltwater as evidenced by the high dissolved solids and specific conductivity readings. No VOCs were detected in any sample. Total nitrogen and nitrate, total and fecal coliform, and BOD are indicator compounds used here to suggest whether the WWTF effluent or septic tanks in the wastewater needs areas are influencing the surface water in these locations. The results for these compounds are discussed below.

Nitrogen – The total nitrogen concentrations were higher on July 24, 1991 than the other two sampling dates, September 3, 1991 and October 16, 1991 (rain event). Total nitrogen (summation of TKN, nitrate, and nitrite) ranged from 13.0 to 25.3 mg/l on July 24, 1991 and did not exceed 4.5 mg/l on the other sampling dates. When total nitrogen was elevated, 75 to 95 percent of the nitrogen was in the form of organic nitrogen.

Biochemical Oxygen Demand – There were five surface water locations in Marion with elevated BOD concentrations ranging from 28.0 to 41.1 mg/l. All were taken on July 24, 1991 (temperature of 85 °F). The surface water in Location 1 had a BOD concentration of 28.0 mg/l. Two of the locations are along Sippican Harbor (Locations 7 and 11), had BOD concentrations of 32.3 and 41.1 mg/l, respectively. The two remaining locations (Locations 14 and 15) had concentrations of 34.1 and 36.6 mg/l, respectively. Of these five locations, only two are located in potential wastewater needs areas (Location 7 in the southern Converse Road area and Location 1 in the Indian Cove Road area). The other three locations are not near the WWTF or in potential wastewater needs areas.

Total and Fecal Coliform – The fecal coliform surface water quality standard for Class B surface water is 200 organisms/100 ml. Eight of the 20 surface water locations (Locations 1, 2, 3, 5, 6, 7, 10, and 16) had fecal coliform counts exceeding the surface water standard.

- Fecal coliform count at Location 1 (Indian Cove Road) exceeded the surface water standard on October 16, 1991 (rain date) at 500 organisms/100 ml. Location 1 also had elevated counts of fecal coliform on two dry sampling dates, but were not above the surface water fecal coliform limit of 200 organisms/100 ml for Class B waters.

- High levels of coliform were also found in the Effluent Brook during the rain event on October 16, 1991 (rain date). The total and fecal coliform counts upstream of the WWTF discharge (Location 3) were 3,000 and 1,300 organisms/100 ml, respectively. The total and fecal coliform counts found downstream of the WWTP discharge (Location 2) were >16,000 and 9,000 organisms/100 ml, respectively. The total and fecal coliform counts found in the WWTF effluent on October 16, 1991 were both <20 organisms/100 ml. From these results, fecal coliform counts at locations in the brook that exceed the fecal limit appear to be caused by rain runoff into the brook.

- High levels of total and fecal coliform were found in the surface water samples obtained from the southern Converse Road wastewater needs area (Locations 5, 6, and 7) on October 16, 1991 (rain event). Fecal coliform counts at these locations were >16,000, 1,400, and 2,200 (>16,000 duplicate) organisms/100 ml, respectively. Fecal coliform counts in dry weather sampling at these locations did not exceed the surface water standard. The rainfall-related samples with elevated fecal coliform are probably attributable to rainfall runoff; however, the lower level chronic concentrations may indicate failing septic tanks.

Influence of Rain – The three areas of concern in which high levels of BOD and/or coliform were found are Effluent Brook, and the southern Converse Road and Indian Cove Road sewer need areas.

- Effluent Brook had high levels of coliform during the rain event. On September 3, 1991, Location 2 had a fecal concentration of <20 organisms/100 ml. This limited data indicates that the high levels of coliform during wet weather probably results from stormwater runoff. The effect of the WWTF effluent is discussed further in the additional surface water sampling analysis.

- The south Converse Road area (Locations 5, 6, and 7) had occurrences of both high BOD and coliform counts on the rain date. The BOD concentrations during the other sampling events were 6 mg/l or lower. The fecal coliform counts during the other sampling events, July 24 and September 3, 1991, were also elevated but did not exceed the 200 organisms/100 ml standard.

- The Indian Cove Road area (Location 1) had a high BOD concentration and a high level of coliform during the rain event. The BOD concentrations were <2 and <3 mg/l on the two other sampling days. The coliform counts were elevated but did not exceed the 200 organisms/100 ml standard on the two dry sampling events.

2.4.2 Effluent Brook Sampling

Six water quality sampling locations (Locations 1 through 6) were located along Effluent Brook in the vicinity of the WWTF outfall to further determine the effect that the WWTF discharge may have on Effluent Brook and Aucoot Cove. These locations are shown in Figure 2-1. Sampling at these locations was conducted on seven or more dates between May and October 1991, and was referred to as "Additional Surface Water" or ASW sampling. Surface water samples obtained at these locations were analyzed for TKN, ammonia-nitrogen, nitrate, nitrite, BOD, TSS, total coliform, and fecal coliform. The results of the sampling analyses are presented in **Table F-5** in Appendix F. These data were also used in conjunction with studies of Aucoot Cove; see Section 2.6.

Nitrogen – The total nitrogen concentrations are less than 10 mg/l for all six locations. The concentrations of total Kjeldahl nitrogen and ammonia-nitrogen in Effluent Brook are higher downstream of the WWTF outfall. For nitrate and nitrite, the concentrations downstream of the outfall are only slightly higher than those observed upstream. From **Table F-5** in Appendix F, it appears that TKN and ammonia are added by the WWTF effluent. Other studies conducted in Aucoot Cove indicate that these levels do not have a significant effect on cove; see Section 2.6.

Biochemical Oxygen Demand – The NPDES permit average monthly limit for BOD is 10 mg/l. BOD concentrations greater than 10 mg/l were considered high. High BOD concentrations were found on two sampling dates: July 24, 1991 and August 7, 1991. On July 24, 1991, the BOD concentration in Location 1 (location prior to WWTF discharge) was 12 mg/l. The BOD concentration at and downstream of the WWTF discharge were <2 mg/l. On August 7, 1991, the BOD concentrations of Locations 2 and 3 (at discharge and 100 meters downstream of discharge) were 14 and 16 mg/l, respectively. The BOD concentration at Location 1 (prior to discharge) was 8 mg/l, and the concentration at Location 4 (further downstream of the discharge 100 meters prior to tidal influence) was 6 mg/l on the same date.

Total and Fecal Coliform – Four of the Effluent Brook water samples had high levels of coliform during the sampling program. The NPDES permit average monthly limit for fecal coliform is 200 organisms/100 ml. The surface water quality limit for Class B waters for fecal coliform is also 200 organisms/100 ml. Coliform counts above this amount were considered high. Fecal coliform counts exceeded the NPDES permit limit on three sampling dates: August 7, 1991; October 8, 1991; and October 16, 1991 (rain date). Samples were taken on each of these dates from at least three locations along Effluent Brook – upstream of the WWTF discharge, at the WWTF discharge,

and downstream of the WWTF discharge. The WWTF's influence on effluent water quality can be evaluated with these three samples.

- On August 7, 1991, the fecal coliform present in the brook at Location 1 (upstream of the WWTF discharge) exceeded 200 organisms/100 ml at 300 organisms/100 ml. The fecal coliform count at Location 2 (at the WWTF discharge) was <20 organisms/100 ml. Further downstream of the WWTF discharge on the same date (Locations 4 and 5), fecal coliform counts of 80 organisms/100 ml were measured. From the data, the fecal coliform counts in the brook were greater than the fecal coliform counts in the WWTF effluent discharging into the brook.

- On October 8, 1991, the fecal coliform count at Location 1 (upstream of the WWTF discharge) was 80 organisms/100 ml. The fecal coliform count at both Locations 2 (at the WWTF discharge) and 3 (downstream of the WWTF discharge) were <20 organisms/100 ml. Further along the brook (Locations 4 and 5), the fecal coliform counts were 20 organisms/100 ml. While none of the samples on this date exceeded the NPDES permit limit, it is notable that the fecal coliform present in the brook was higher than the fecal coliform in the WWTF effluent discharging into the brook.

- On October 16, 1991 (rain date), the fecal coliform count at Location 1 (upstream of the WWTF discharge) exceeded the limit at 4,000 organisms/100 ml. The fecal coliform count at Location 2 (at the WWTF discharge) also exceeded the limit at 5,000 organisms/100 ml. Further down the brook at Location 4, the fecal coliform count exceeded the limit at 3,000 organisms/100 ml. From these results, the fecal coliform counts at all locations in the brook exceed the fecal limit and appear to be caused by rain runoff into the brook.

2.4.3 Conclusions

Based on the general and potential wastewater needs area surface water sampling results, the following conclusions can be made:

- All surface water locations have nitrate levels well below the Massachusetts surface water standard.

- Surface water samples with high BOD were observed in the southern Converse Road and Indian Cove Road sewer needs areas

- Fecal coliform counts exceeded the surface water quality standard at eight locations during the rain event. However, during dry weather fecal coliform counts were below the standard at these locations.

Based on the Effluent Brook water sampling results, the following conclusions can be made:

- Effluent Brook samples did not exceed the surface water quality standard for nitrate on any sampling date.
- Concentrations of TKN and ammonia-nitrogen in Effluent Brook are higher downstream of the WWTF discharge.
- Effluent Brook had high levels of fecal and total coliform during the rain event. This is assumed to be the result of rainfall runoff.
- Fecal coliform counts in Effluent Brook tend to exceed those of the WWTF effluent.
- BOD concentrations above the NPDES Permit limit were observed in Effluent Brook.

2.5 Sludge Monitoring

Sludge samples were collected from each of the three facultative lagoons on October 27 and 28, 1992. Composite sludge samples from each lagoon were collected by mixing samples from two locations: at the influent and effluent of the lagoon. Sludge samples were analyzed for VOCs, SOCs, pesticides, PCBs, priority pollutant metals, pH, TSS, total volatile solids, nitrate, TKN, ammonia-nitrogen, phosphate, and toxicity characteristic leaching procedure (TCLP) for pesticides and herbicides. The samples were analyzed as a water in mg/l and not as a sludge in mg/kg because of the low percent solids of the sludge. **Table F-6** in Appendix F presents the results of these analyses in mg/l.

One VOC and one SOC compound were found above detection limits in the sludge samples. Toluene was found at 0.148 mg/l and 4-methyl phenol was found at 0.056 mg/l in the Lagoon No. 2 sludge. Several pesticides were detected above and below the quantitation limits. The levels are generally low as evidenced by the TCLP results for pesticides, which only detected one compound (heptachlor) in the supernatant. The heptachlor value, 0.000013 mg/l, is well below the regulatory limit of 0.008 mg/l. No PCBs were detected in any sludge samples.

The U.S. Environmental Protection Agency (EPA) regulates ten metals, including: arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc. Massachusetts Department of Environmental Protection (DEP) regulates the same metals as EPA, with the exception of arsenic and selenium, plus boron. The analytical results show the sludge has very low concentrations of most metals by the federal or state regulations for disposal of sludge. Table F-7 in Appendix F presents the federal and state standards for sludge disposal and the results of the regulated metals converted to mg/kg.

The concentrations of metals tested were below regulatory limits, with the exception of copper. The concentrations of copper in Lagoon Nos. 1 and 2 are above the DEP limits for Types I and II sludge. The concentrations are also above the EPA's 503

pollutant concentration for unlimited land application. This has implications for disposal, if the lagoon sludge ever has to be removed; (at present, it does not appear to be accumulating). As a Type III sludge, EPA regulations would allow the sludge to be land applied (the ceiling concentration is 4300 mg/kg), if the cumulative copper loading rate did not exceed 1,500 kilograms per hectare. These regulations also prohibit the sludge from being applied to lawns or home gardens.

2.6 Effluent Brook and Aucoot Cove Water Quality Studies

Studies were conducted by the Buzzards Bay Project (BBP) and the Town of Marion (by CDM) to evaluate the water quality of Effluent Brook and Aucoot Cove, particularly any impacts of the WWTF discharge. The studies focused on dissolved oxygen, phytoplankton, and nitrogen.

Several coordinated water quality studies were undertaken in 1991. These included:

- Nitrogen and oxygen monitoring at various stations in Effluent Brook (CDM for Town of Marion)
- Water quality monitoring of 13 stations within Aucoot Cove, conducted on five cruises between July and September 1991 (Dr. Brian Howes, WHOI, for BBP)
- Dissolved oxygen continuous monitoring, sediment survey, and tidal cycle sampling (Dr. Brian Howes, WHOI, for BBP
- Evaluation of eelgrass abundance in Aucoot Cove (BBP)

Separately, a study of all Buzzards Bay embayments was conducted (Aubrey Consulting for Buzzards Bay Project). This study provides estimates of flushing rates for Aucoot Cove.

A report in 1991 summarized the data from the sampling program conducted for the Buzzards Bay Project (Dr. Brian Howes). These data were evaluated by CDM for the Town of Marion, and discussed in several memoranda. The Buzzards Bay Project also interpreted the data, the conclusions of which are included in a draft report issued in 1998 (Preliminary Evaluation of Nitrogen Loading of Watersheds within Marion as relates to Wastewater Disposal, Draft, Joseph E. Costa Ph. D., October 1998).

Note that since the time of the study, Marion has made several improvements at the WWTF (such as installing ultraviolet disinfection to replace chlorination). Further improvements (disk filters) are currently underway.

These memoranda and reports are included in **Appendix E.** Key findings are summarized and discussed below.

Aucoot Cove Water Quality
Aucoot Cove was found to have good water quality. The cove is deep and very well flushed.

Possible Impact of WWTF
CDM's findings concerning the water quality impact of the discharge are as follows:

Dissolved Oxygen

Effluent Brook – The brook sometimes exhibited low dissolved oxygen (DO), below the state surface water quality standard of 5.0 mg/L. At two sites above the discharge, DO ranged from 3.6 to 11.2 mg/L; the sites were dry on five of the nine sample dates. At the discharge and two downstream sites, DO ranged from 2.2 to 7.8 mg/L. Of 19 samples total at these three locations, 14 were over 5.0 mg/L and the average was 5.4 mg/L. The discharge, which itself had low DO, contributes to the low DO in the brook, especially when there is little or no upstream flow.

The brook also exhibits an oxygen sag (e.g., DO levels are sometimes lower at downstream locations). Oxygen dynamics were evaluated by several methods including applying a model, considering stream velocity, and reviewing measured BOD. These evaluations all suggest that the discharge is not the sole or primary cause of the oxygen sag in the brook. Other possibilities are BOD from the salt marsh at the mouth of the brook, stormwater runoff/rain, or groundwater seepage.

Aucoot Cove – Aucoot Cove is characterized by two subareas: the salt marsh area, and the outer cove. The salt marsh area has lower and more variable DO than the outer cove. The four salt marsh sites had DO ranging from 2.5 to 9.0 mg/L, with an average of 5.63 mg/L. The cove sometimes exhibited DO below state water quality standards (6.0 mg/L unless background conditions are lower). Of over 150 samples, the average DO in the outer cove was 7.1 mg/L, with a range from 5.1 to 8.6 mg/L. It appears that the salt marsh DO can sometimes influence cove DO on an outgoing tide. DO profiles show that the cove is oxygenated throughout the water column (e.g., is not subject to hypoxia).

The data suggest that the effluent discharge has little effect on oxygen in Aucoot Cove. There is no statistical difference among the sampling sites located in the salt marsh; the site that is influenced by the discharge is no different that the others.

Nitrogen

Effluent Brook – The brook has elevated ammonia from the discharge. The brook's ammonia concentration was always higher than that of the salt marsh sites.

Aucoot Cove -- Aucoot Cove nitrogen levels are generally not affected by the discharge; however, a confined area immediately around the mouth of Effluent Brook has slightly elevated nitrogen (ammonia and total inorganic nitrogen) levels.

Nitrogen levels in the salt marsh channel from Effluent Brook are only slightly higher than at the other salt marsh stations. This indicates there is either significant mixing or uptake by the salt marsh very close to the mouth of the brook.

The salt marsh nitrogen concentrations are generally higher than those of the outer cove. The concentrations of nitrogen at the various stations in Aucoot Cove are all similar, however, and there does not seem to be an effect of the salt marsh area on the cove's nitrogen levels. Additionally, the cove does not seem to be a net exporter of nitrogen to Buzzards Bay, as the Buzzards Bay stations were similar or higher than the Aucoot Cove stations.

Phytoplankton

It was also found that the discharge has no measurable impact on phytoplankton mass in Aucoot Cove, based on comparison of sampling stations.

Findings of 1998 BBP Report

The 1998 BBP report makes two main statements concerning the WWTF. First, the report states that the discharge is causing water quality degradation in Effluent Brook and in a confined area of Aucoot Cove immediately at the mouth of the brook. The report also suggests that future expansion of the WWTF could be coupled to enhanced nutrient removal. The 1998 report does not elaborate on the nature of, or refer to evidence concerning, water quality degradation.

In addition, the 1998 BBP report evaluates current and build-out nitrogen loading for Aucoot Cove and other subwatersheds in Marion. The report makes the following conclusions:

- Aucoot Cove is below the BBP recommended nitrogen limit, currently and at build out.
- Wings Neck is below the BBP recommended nitrogen limit, currently and at build out.
- Sippican Harbor is already above the BBP recommended nitrogen limit, and would benefit from additional sewering, such as in the Hammetts Cove area.
- Weweantic watershed is also already above the BBP recommended nitrogen limit; however, Marion's land area within this watershed is a relatively small proportion.

Other Relevant Studies

Subsequent to the 1998 BBP Report on Marion's coastal subwatersheds, BBP undertook reevaluation of nitrogen loading in the Buzzards Bay watersheds. BBP, with others, reevaluated nitrogen loading limits that were originally proposed in the 1990 Comprehensive Coastal Management Plan ("Managing Anthropogenic Nitrogen

Inputs to Coastal Embayments: Technical Basis and Evaluation of a Management Strategy Adopted for Buzzards Bay," Costa, Howes, Janik, Aubrey, Gunn, Giblin, Draft, September 24, 1999). The re-evaluation incorporated more site-specific information and refined assumptions, based on seven years' of monitoring data. The suggested TMALs (total maximum annual loads) were issued in a fact sheet (October 6, 1999). The suggested TMALs are consistent with previous findings concerning Marion's subwatersheds, in determining that Sippican Harbor and Weweantic River are each exceeding BBP's recommended loadings, while Aucoot Cove and Wings Cove are currently at a small fraction of the recommended loading. The suggested TMAL for Aucoot Cove is 255,000 kg/year. (BBP, 1999) The significance of nitrogen loading limits is discussed further in Section 6 (Wastewater Treatment).