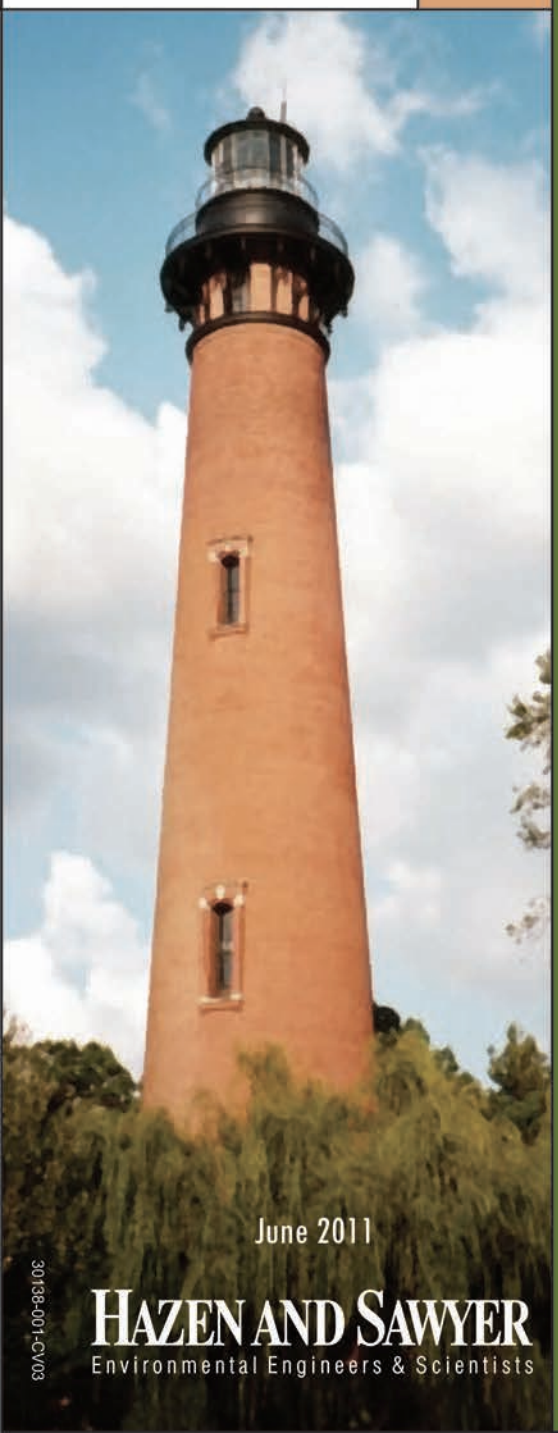
Final Report

Comprehensive Wastewater Master Plan for the Currituck County Southern Outer Banks

Currituck County, North Carolina &
Outer Banks Venture, North Carolina



June 2011

HAZEN AND SAWYER
Environmental Engineers & Scientists

30138-001-CV03

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Environmental Engineers & Scientists

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June 6, 2011

Project No.:
30138-000

Subject:
Executive Summary
Outer Banks Comprehensive Wastewater Master Plan

Introduction

The Currituck County Southern Outer Banks area is a popular summer vacation destination. The population of this area increases dramatically in the summer months; therefore, there is a significant increase in water and wastewater demands from June through August. The Mid-Currituck Bridge is planned for completion by 2016 and is expected to attract additional visitors since it will reduce travel time to the Currituck Outer Banks.

The Currituck County Outer Banks faces many challenges regarding wastewater management. The existing wastewater facilities do not have excess capacity to accommodate projected growth. The existing wastewater treatment plants (WWTP) do not meet the current regulations and therefore require major process upgrades to improve treatment and meet higher effluent standards. The lack of available land on the Outer Banks is another major limiting factor for the expansion of wastewater treatment capacity. The state-mandated non-discharge effluent disposal methods are land intensive. Many of the existing WWTPs have reached the end of their useful service life and require major rehabilitation or replacement to reliably serve customer needs. Most importantly, the asset that attracts visitors to the Currituck Outer Banks is the coastal environment. Current wastewater management does not maximize protection of the groundwater, surface waters, wetlands, and other features of the coastal environment.

Historically, wastewater on the Outer Banks has been managed by individual subdivisions. Due to the challenges and concerns, Currituck County and Outer Banks Ventures (OBV) have decided to evaluate the potential for regionalizing wastewater management on the Currituck Southern Outer Banks. The purpose of this Comprehensive Wastewater Master Plan is to evaluate the feasibility of a regional wastewater utility to serve the Currituck Southern Outer Banks.

Service Area and Projected Wastewater Flow

The primary focus of the Master Plan was to develop a 20-year plan for wastewater management for the Ocean Sands and Corolla Light developments. Other subdivisions were considered as possible service areas for the regional wastewater utility, including Monteray Shores, Corolla Village, Ocean Hill, and Whalehead. These potential service areas are illustrated in **Figure ES-1**.

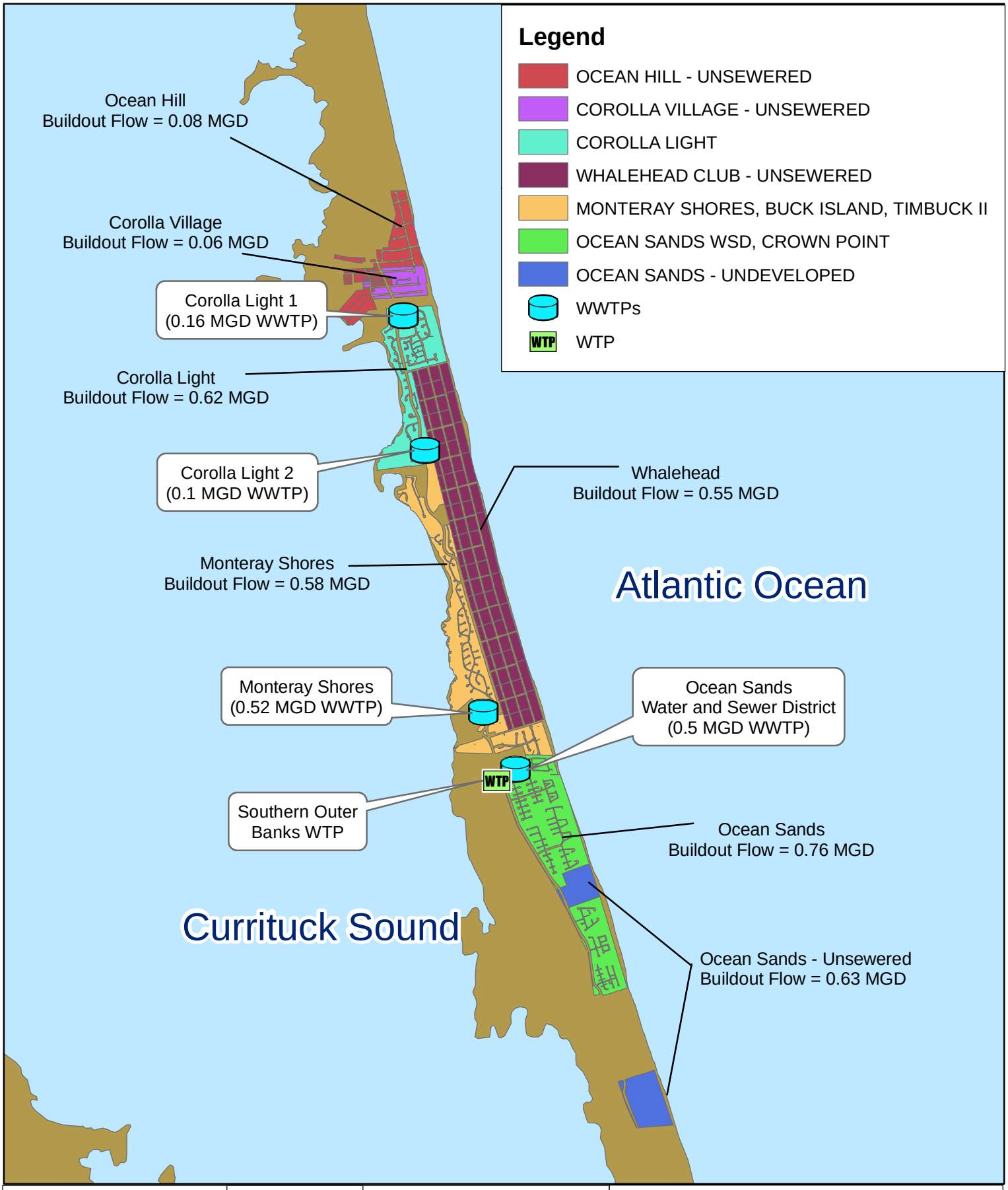
Wastewater flow was projected for each subdivision at build-out conditions based on the planned build-out number of residential units and the planned commercial and hotel density. **Figure ES-1** illustrates the subdivisions considered in this Master Plan and build-out wastewater flow for each. The Master Plan considered four service area options for the regional wastewater utility as summarized in **Table ES-1**.

Table ES-1: Summary of Build-out Wastewater Flows for Service Area Options

Service Area Option	Areas Served	Build-out Wastewater Flow (mgd)
1	Ocean Sands and Corolla Light	2.00
2	Ocean Sands, Corolla Light, and Monteray Shores	2.58
3	Ocean Sands, Corolla Light, Monteray Shores, Whalehead Subdivision, Corolla Village, and Ocean Hill	3.27
4	Ocean Sands, Corolla Light, Whalehead Subdivision, Corolla Village, and Ocean Hill	2.70

Regulatory Review

New rules governing wastewater management in coastal areas were promulgated in January 2009. These rules (North Carolina Administrative Code Title 15A, Subchapter 2T) are commonly referred to as the “2T” rules. The rules have specific requirements for non-discharge methods of wastewater management such as high-rate infiltration, and reuse. The 2T rules represent a watershed change in wastewater management for coastal areas and significantly increase costs and land requirements for wastewater management. The new rules include stringent standards for wastewater effluent quality, including nitrate, total nitrogen (TN) and total phosphorus (TP) as well as larger setbacks from wastewater infrastructure to property lines and surface water bodies. However, there are provisions to reduce required setbacks by achieving even lower effluent quality standards. Due to the limited amount and value of land on the Outer Banks, the effluent goals used in the Master Plan were total nitrogen < 4 mg/L and total phosphorus < 2 mg/L.



SCALE

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1 inch = 1 miles

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Figure ES-1: Buildout Wastewater Flows

Comprehensive Wastewater
Master Plan for the
Currituck County Southern Outer Banks

Existing Wastewater Treatment Facilities

There are four existing WWTPs in the Currituck Southern Outer Banks for the areas considered in this Master Plan: Corolla Light No. 1, Corolla Light No. 2, Ocean Sands, and Monteray Shores. The Monteray Shores WWTP was upgraded and expanded in 2009 and is capable of achieving the limits set forth by the 2T rules. The other WWTPs are designed under older standards and do not meet current 2T rules. These plants are package steel plants that have deteriorated in the harsh coastal environment. These plants have reached the end of their useful service life and require replacement or major rehabilitation.

Due to the condition of the Ocean Sands WWTP, Currituck County entered into a Special Order by Consent (SOC) in August 2010 with the Division of Water Quality (DWQ) to allow the County time to make improvements to the Ocean Sands facility on defined schedule. The SOC outlines milestones with final completion of upgrades being required by April 2015 (or October 2015 if a regional WWTP is constructed).

Recommended Treatment and Effluent Disposal Alternatives

The regional WWTP should be designed with biological nutrient removal capabilities to meet the new 2T rules and lower nitrogen and phosphorus effluent limits. Meeting more stringent effluent limits reduces required setbacks and land requirements for effluent disposal. The recommended treatment process is a membrane bioreactor process (MBR), which includes activated sludge with biological nutrient removal and submerged membrane filtration. The MBR process is capable of achieving the strict effluent quality standards and has a smaller footprint than other available BNR processes, which makes it ideal for coastal wastewater management.

The recommended site for the regional WWTP is at the existing Corolla Light No. 2 WWTP site with reject storage located on the DeGabrielle site (**Figure ES-2**). The Corolla Light No. 2 site can accommodate a WWTP with capacity up to 3.6 mgd. Given the limited amount of suitable effluent disposal sites on the Outer Banks, a priority was placed on any site suitable for high-rate effluent disposal. The Corolla Light No. 2 WWTP site was determined to have a lower infiltration rate due to presence of wetlands, which would affect the effectiveness of a groundwater management system. This site was selected for the regional WWTP site so other sites with higher infiltration rates could be reserved for effluent disposal.

The 2T rules require 5-day reject storage to store wastewater that does not meet effluent limits and to allow further treatment prior to disposal. For example, the required reject storage for Option 4 with a build-out wastewater flow of 2.7 mgd would be 13.5 million gallons. The aesthetic impact of large reject storage tanks was a key consideration in selecting sites for reject storage. It is recommended that the DeGabrielle site be acquired for reject storage since the tanks could be shielded from surrounding development while utilizing cost-effective storage tank designs. The recommended infrastructure for the regional wastewater utility is shown in **Figure ES-2**.

SCALE

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1 inch = 4,000 feet

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Figure ES-2: Recommended Effluent Effluent Disposal for Option 4 (Ocean Sands, Corolla Light and Unsewered Areas)

Comprehensive Wastewater Master Plan for the Currituck County Southern Outer Banks

High-rate infiltration with groundwater management is recommended as the effluent disposal method since it represents the most efficient disposal technique in terms of land requirements. High-rate infiltration includes disposing of treated effluent into dry basins of coarse sand. Subsurface drains will be installed around high-rate infiltration basins at a setback of 50 feet. The subsurface drains are intended to manage groundwater levels and maximize disposal capacity. Groundwater will be collected and pumped to existing ponds where it can be used for irrigation during the growing season, or diffused into Currituck Sound during the winter.

Sites throughout the Outer Banks were evaluated for potential effluent disposal capacity by a licensed hydrogeologist, Edwin Andrews & Associates. Preliminary groundwater modeling was conducted based on available data to evaluate effluent disposal capacity of each site. The recommended sites for high-rate infiltration and the expected disposal capacity for each site are provided in **Table ES-3**.

Collection System

The Master Plan evaluated the wastewater collection system infrastructure needed to serve each subdivision based on expected future growth. For the un-sewered areas (Ocean Hill, Corolla Village and Whalehead), the Master Plan evaluated several wastewater collection system alternatives: conventional gravity sewer, pressure sewer system, and a vacuum sewer system.

Based on a life cycle cost analysis, a conventional gravity collection system was deemed to be the most cost-effective for the un-sewered areas. **Table ES-2** outlines the capital costs for wastewater collection for each subdivision.

Table ES-2: Wastewater Collection Systems Capital Cost

Service Area	Probable Construction Cost (2010 Dollars)
Corolla Light	$534,000
Monteray Shores	$1,079,000
Existing OSWSD	$1,075,000
Ocean Sands Section G	$757,000
Ocean Sands Section T	$713,000
Whalehead	$8,168,000
Corolla Village and Ocean Hill	$3,352,000

Table ES-3: Recommended Effluent Disposal Sites and High-Rate Infiltration Capacity

	OPTION 1		OPTION 2		OPTION 3		OPTION 4	
Site Name	**Planned Disposal Capacity [1] (gpd)**	**GWL Pump Rate [2] (gpd)**	**Planned Disposal Capacity [1] (gpd)**	**GWL Pump Rate [2] (gpd)**	**Planned Disposal Capacity [1] (gpd)**	**GWL Pump Rate [2] (gpd)**	**Planned Disposal Capacity [1] (gpd)**	**GWL Pump Rate [2] (gpd)**
Corolla Light No. 1		0	200,000	300,000	650,000	975,000	325,000	487,500
Corolla Light Phase 12	325,000	487,500	325,000	487,500	325,000	487,500	325,000	487,500
Corolla Light No. 2 - West	300,000		700,000	1,050,000	700,000	1,050,000	700,000	1,050,000
Ocean Sands WWTP	750,000	1,125,000	750,000	1,125,000	750,000	1,125,000	750,000	1,125,000
Ocean Sands Section H/O	--	--		0		0		0
Ocean Sands Section E/F	--	--	--	--	300,000	450,000	--	--
Ocean Sands Section D/E	560,000	840,000	560,000	840,000	560,000	840,000	560,000	840,000
TOTAL	**5,350,000**		**3,015,000**		**3,825,000**		**4,650,000**	

[1] *Planned disposal capacity is a conservative estimate of permitted disposal capacity.*
[2] *Groundwater lowering system pump rate based on a ratio of groundwater pumped to effluent disposal of approximately 1.5:1.*

GWL = groundwater lowering system

Capital Costs

The capital costs for wastewater treatment, disposal and collection as well as O&M costs were developed for each of the service area options. The service areas are defined by the development areas that they served in **Table ES-1**. **Table ES-4** summarizes the total probable construction costs for each of the service area options over the 20-year planning horizon. Each option will be phased based on projected growth, and wastewater needs as outlined in *TM No. 4 – Capital Improvements Plan and Fiscal Plan*.

Table ES-4: Probable Cost Opinion Summary for Treatment, Effluent Disposal, and Wastewater Collection

Description	Option 1	Option 2	Option 3	Option 4
Acquisition of Corolla Light Wastewater System	$1,850,000	$1,850,000	$1,850,000	$1,850,000
Demolition	$569,000	$569,000	$569,000	$569,000
MBR Wastewater Treatment Plant	$25,718,000	$31,203,000	$33,159,000	$33,025,000
Reject Storage	$4,317,000	$4,786,000	$6,596,000	$5,060,000
Effluent Force Mains/Pumping	$1,655,000	$1,826,000	$1,909,000	$1,826,000
Effluent Disposal	$5,173,000	$6,989,000	$8,665,000	$5,742,000
Land acquisition	$4,837,000	$9,533,000	$16,921,000	$9,649,000
Wetlands Mitigation	$112,000	$182,000	$288,000	$288,000
Wastewater Collection	$3,586,000	$4,159,000	$15,678,000	$15,105,000
Total Project Cost[1]	***$47,817,000***	***$61,097,000***	***$85,635,000***	***$73,114,000***
Build-out Capacity (mgd)	2.0	2.58	3.27	2.7

1. Total project costs include 12 percent for engineering and technical services, and 25 percent contingency. Costs do not include legal and administration fees.

Rate Evaluation

An evaluation of the rates and fees required to support a regional wastewater utility was conducted for each service area option. The purpose of the rate evaluation is to compare service area options in terms of theoretical rates and impact fees. These rate evaluations are not intended to replace a rate setting process.

The Comprehensive Wastewater Master Plan evaluated two options that included Monteray

Shores (Options 2 and 3). The conclusion from the rate evaluations is that serving Monteray Shores from a regional public utility is not economically viable. The analysis did not include the cost for the Currituck County to acquire the Monteray Shores wastewater system from Carolina Water Services. At the time of this report, there have been no negotiations between Currituck County and Carolina Water Services. Therefore, these two options were excluded from the rate evaluation analysis under the Public-Private Partnership Approach.

Rate evaluations were conducted for service area options 1 and 4 under two different implementation scenarios:

- Public Utility Approach (PUA): Regional Outer Banks WWTP owned and operated by Currituck County

- Public-Private Partnership Approach (PPP): Cooperation between Currituck County and Outer Banks Ventures (and its affiliate, Currituck Utilities LLC).

The technical aspects and capital costs for both ownership alternatives are similar. The major difference is whether 1) land is acquired from OBV and dedicated solely for effluent disposal for unsewered areas as proposed for a County-owned system, or 2) the “dual use” approach is utilized where structures are constructed over the high-rate infiltration basins. The dual use approach is a new idea that does not have a precedent in North Carolina. Since remaining land suitable for high-rate infiltration is limited on the Outer Banks and strong growth is expected to return to the Outer Banks in the near future, relying on the dual use approach is not recommended until it is proven technically feasible.

If it is decided to utilize the Public-Private Partnership Approach, then the following actions are recommended:

- The initial planning and dedication of land for the regional utility should be based on the layouts presented in this Master Plan. The infrastructure planning in this Master Plan includes some conservatism and should be the basis for any legal or financial arrangements. There are some potential options to reduce land and/or capital requirements, but these options are contingent upon additional engineering design, technical investigations, and/or negotiations with state and federal regulatory agencies.

- The County should have a mechanism to allocate wastewater capacity to new customers rather than this function being the sole responsibility of OBV.

- Land required for the Phase 1 project for the WWTP, reject storage, effluent disposal, groundwater management, other infrastructure should be deeded to the County. The County should acquire easements for disposal of groundwater into irrigation ponds.

- The County should be directly involved in the planning and design for the regional system. The County should consider retaining an engineering firm to assist in design, technical reviews, and serve as a program manager throughout the design, permitting, and construction of the wastewater infrastructure.

- Project schedule should be based on the recommended schedule in this Master Plan. The schedule accounts for an environmental review process. OBV has indicated that the SEPA process would not be required under the PPP approach. However, if the County operates, maintains, and leases the regional system from OBV, this would be considered by the State as an "expenditure of public monies" and SEPA review would be required.

A summary of the projected rates and fees for Service Area Options 1 and 4 under both the PUA and the PPP approaches are provided in **Table ES-5**. Based on the rate evaluation, the financial implications of implementing the regional system as a publically owned utility or as a public-private partnership are similar. Under the PUA, monthly sewer bills would initially be higher as compared to the PPP approach. However, sewer bills could be reduced significantly once the debt for the Phase 1 project is retired in FY 2030 (16th year of operation). Impact fees would be significantly lower under the PPP approach initially but would increase rapidly and approach the projected impact fees under the Public Utility Approach.

The rate evaluation does illustrate that sewer rates and fees would be substantially higher as compared to current rates. This is partially due to the more technologically advanced treatment and disposal system required under the new State regulations and also impacted by the high costs of land that must be acquired for treatment, disposal, and reject storage. For comparison, Carolina Water Services, Inc. is proposing to increase sewer rates for Corolla Light customers to approximately $95 per month (based on average flow of 170 gpd) to pay for upgrades to the Monteray Shores WWTP. We understand that this rate increase will not fund any upgrades to the Corolla Light wastewater system in the short term. It is not known what the projected sewer rates would be when the Corolla Light WWTPs are upgraded.

Summary

For the long-term management of wastewater on the Currituck County Southern Outer Banks, development of a regional wastewater system is recommended. A regional approach to wastewater management will provide economies of scale in the significant costs facing the area to expand and upgrade wastewater facilities to meet future growth needs, upgrade and maintain condition of infrastructure, upgrade treatment processes to meet new regulatory standards, and protect the coastal environment. A regional system would provide a level of consistency and equity in regards to available wastewater capacity and service throughout the Southern Outer Banks. Although the financial and economic benefits to participating in a regional utility will vary by subdivision, there are advantages for the entire area to have access to central wastewater treatment to protect the environment and tourism industry on the Outer Banks.

The decision to pursue any of the Service Area Options will be based on many factors. Regardless

of the Service Area Option selected, it is recommended that Phase 1 of Service Area Option 1 be implemented, which includes 1.2 mgd regional wastewater system to serve the existing Ocean Sands and Corolla Light customers while providing 225,000 gpd excess capacity for future customers. The implementation schedule for Phase 1 is critical since Currituck County must meet a strict compliance schedule for the SOC negotiated with DWQ for the Ocean Sands WWTP. If Currituck County decides to proceed with a regional wastewater system, then it must be online by October 2015.

At this time, Currituck County cannot proceed with Service Area Option 4 until consultations with residents in the unsewered areas have taken place. Planning and design for Phase 1 can be accomplished to allow for future service to the unsewered areas if it is later decided to proceed with Option 4.

A projected schedule for implementation of the first phase is provided in **Table ES-6**. The schedule predicts a plant startup in May 2015, approximately 5 months before the milestone mandated in the SOC. This schedule includes some conservatism but should be considered targets for each milestone to provide some buffer for unexpected obstacles (e.g. permitting) that may cause a project delay.

Table ES-6: Implementation Schedule for Option 1 – Phase 1

Timeframe	Milestone
June 2011	Complete Comprehensive Wastewater Master Plan
August 2011	Begin Environmental Assessment and Preliminary Design
December 2011	Begin Final Design
July 2012	Environmental Review Completed (FONSI) Permitting
December 2012	Complete Final Design and Permitting
March 2013	Begin Construction
March 2015	End Construction
May 2015	Plant startup
October 2015	Special Order of Consent Deadline for Meeting Compliance Standards

Table ES-5: COMPARISON OF RATE EVALUATIONS FOR PUBLIC AND PUBLIC-PRIVATE OPTIONS - MODERATE GROWTH

COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK COUNTY SOUTHERN OUTER BANKS

Currituck County and Currituck Utilities

	Option 1 - Public Utility			Option 4 - Public Utility					Option 1 - Pubic-Private Partnership			Option 4 - Pubic-Private Partnership				
Fiscal Year	Average Monthly Sewer Bill	OS Customer Impact Fee	CL Customer Impact Fee	Average Monthly Sewer Bill	OS Customer Impact Fee	CL Customer Impact Fee	CV/OH Customer Impact Fee	WH Customer Impact Fee	Average Monthly Sewer Bill	OS Customer Impact Fee	CL Customer Impact Fee	Average Monthly Sewer Bill	OS Customer Impact Fee	CL Customer Impact Fee	CV/OH Customer Impact Fee	WH Customer Impact Fee
FY 2015	$161	$20,000	$23,000	$166	$17,000	$19,000	$31,000	$31,000	$151	$5,300	$4,000	$166	$5,300	$4,000	$18,700	$13,100
FY 2016	$165	$20,500	$23,575	$170	$17,425	$19,475	$31,775	$31,775	$155	$6,323	$5,023	$170	$6,323	$5,023	$19,723	$14,123
FY 2017	$169	$21,013	$24,164	$174	$17,861	$19,962	$32,569	$32,569	$158	$7,346	$6,046	$174	$7,346	$6,046	$20,746	$15,146
FY 2018	$173	$21,538	$24,768	$179	$18,307	$20,461	$33,384	$33,384	$162	$8,369	$7,069	$179	$8,369	$7,069	$21,769	$16,169
FY 2019	$177	$22,076	$25,388	$176	$18,765	$20,972	$34,218	$34,218	$161	$9,392	$8,092	$183	$9,619	$8,319	$23,019	$17,419
FY 2020	$182	$22,628	$26,022	$171	$19,234	$21,497	$35,074	$35,074	$161	$10,415	$9,115	$160	$10,869	$9,569	$24,269	$18,669
FY 2021	$186	$23,194	$26,673	$166	$19,715	$22,034	$35,950	$35,950	$161	$11,438	$10,138	$160	$12,119	$10,819	$25,519	$19,919
FY 2022	$191	$23,774	$27,340	$161	$20,208	$22,585	$36,849	$36,849	$161	$12,751	$11,451	$160	$13,369	$12,069	$26,769	$21,169
FY 2023	$196	$24,368	$28,023	$156	$20,713	$23,150	$37,770	$37,770	$161	$14,064	$12,764	$160	$14,619	$13,319	$28,019	$22,419
FY 2024	$201	$24,977	$28,724	$151	$21,231	$23,728	$38,715	$38,715	$161	$15,377	$14,077	$160	$15,869	$14,569	$29,269	$23,669
FY 2025	$206	$25,602	$29,442	$146	$21,761	$24,322	$39,683	$39,683	$161	$16,690	$15,390	$160	$17,319	$16,019	$30,719	$25,119
FY 2026	$208	$26,242	$30,178	$141	$22,305	$24,930	$40,675	$40,675	$161	$18,003	$16,703	$160	$18,769	$17,469	$32,169	$26,569
FY 2027	$200	$26,898	$30,932	$136	$22,863	$25,553	$41,692	$41,692	$161	$19,316	$18,016	$160	$20,219	$18,919	$33,619	$28,019
FY 2028	$192	$27,570	$31,706	$131	$23,435	$26,192	$42,734	$42,734	$161	$20,629	$19,329	$160	$21,669	$20,369	$35,069	$29,469
FY 2029	$184	$28,259	$32,498	$126	$24,021	$26,847	$43,802	$43,802	$161	$21,942	$20,642	$160	$23,119	$21,819	$36,519	$30,919
FY 2030	$76	$28,966	$33,311	$71	$24,621	$27,518	$44,897	$44,897	$161	$23,255	$21,955	$160	$24,569	$23,269	$37,969	$32,369
FY 2031	$68	$29,690	$34,144	$66	$25,237	$28,206	$46,020	$46,020	$161	$24,568	$23,268	$160	$26,019	$24,719	$39,419	$33,819
FY 2032	$60	$30,432	$34,997	$61	$25,868	$28,911	$47,170	$47,170	$161	$25,881	$24,581	$160	$27,469	$26,169	$40,869	$35,269
FY 2033	$52	$31,193	$35,872	$56	$26,514	$29,634	$48,349	$48,349	$161	$27,194	$25,894	$160	$28,919	$27,619	$42,319	$36,719
FY 2034	$52	$31,973	$36,769	$51	$27,177	$30,374	$49,558	$49,558	$161	$28,507	$27,207	$160	$30,369	$29,069	$43,769	$38,169

Notes:

OS = Ocean Sands

CL = Corolla Light

CV = Corolla Village

OH = Ocean Hill

WH = Whalehead

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March 28, 2011

Project No.:
30138-000

Subject:
Technical Memorandum 1 – Wastewater Flow Projections
Outer Banks Comprehensive Wastewater Master Plan

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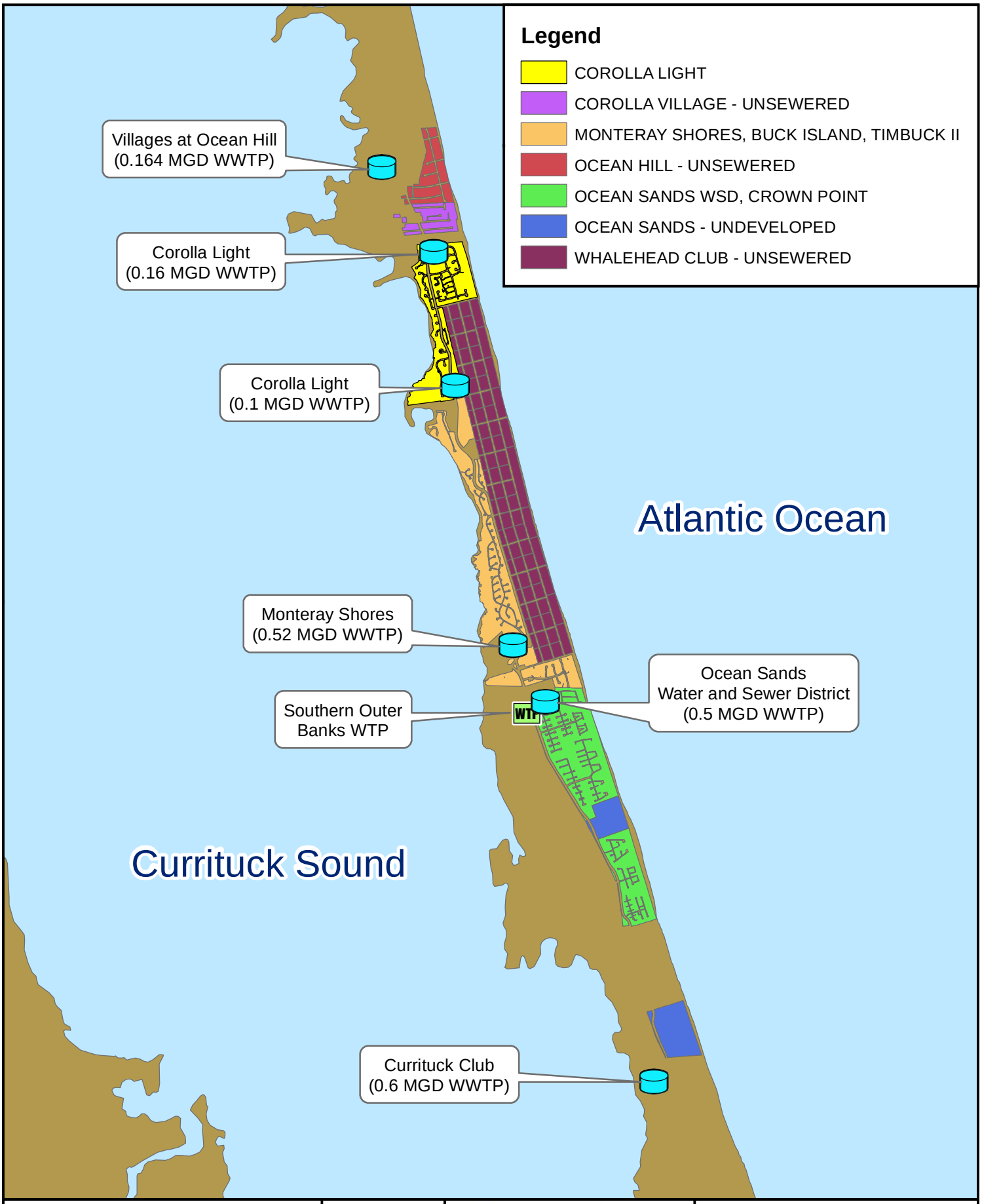
1. Introduction

Technical Memorandum No. 1 (TM 1) establishes projected wastewater demands for the anticipated service area for the Comprehensive Wastewater Master Plan for the Currituck County Southern Outer Banks. The purpose of this TM is to summarize the projected wastewater flows for the 25-year planning period ending in 2030 for the proposed Outer Banks service area, which includes the six planned subdivisions, as follows, and provided on **Figure 1**.

- Ocean Sands/Crown Point
- Corolla Light
- Monteray Shores/Buck Island/Timbuk II
- Ocean Hill
- Corolla Village
- Whalehead

This technical memorandum documents the methodologies and assumptions used to develop the projected wastewater flows under build-out conditions and provides flow estimates for each service area through 2036.



SCALE

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1 in = 1 mile

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FIGURE 1
Potential Service Areas of the Comprehensive Wastewater Master Plan for Currituck County - Southern Outer Banks

2. Background

The Currituck Outer Banks area is a popular beach vacation destination and consequently experiences a dramatic increase in water and wastewater demands during the summer months of June, July and August. Residential development consists primarily of single-family homes with limited multi-family units. Commercial development has been limited to the planned unit developments with sewer service and is typical of North Carolina beach communities including retail outlet stores, rental agencies, and restaurants. There is currently one hotel (Inn at Corolla Light) in the proposed Outer Banks service area and at least one planned hotel.

A summary of the number of developed residential lots and commercial properties and the projected number of lots and commercial properties at build-out for each of the six subdivisions is provided in **Table 1**. Due to the real estate market bubble and ongoing financial crisis which began in 2007, construction of new homes and certificates of occupancy have noticeably declined in recent years. However, beach vacations remain extremely popular and demand for retirement and vacation homes can reasonably be expected to return to a more normal rate over the next few years.

A brief description of each of the six subdivisions in the proposed service area is provided as follows:

Ocean Sands (excluding Ocean Sands A, B, C)

The Ocean Sands subdivision is the southernmost subdivision in the proposed Outer Banks wastewater service area. Ocean Sands consists of 1,946 approved residential and multi-family lots, with an additional 151 lots to be transferred for a total of 2,097 residential lots. In addition, hotels are planned on Sections G and T. Water and sewer service in Ocean Sands is provided by the Ocean Sands Water and Sewer District (OSWSD), which is owned and operated by Currituck County. OSWSD operates a 0.5-mgd WWTP operating under the Water Quality Permit No.WQ0000185 (Note: Ocean Sands A, B, C is served by individual septic systems, and is not included in this evaluation).

Corolla Light

The Corolla Light subdivision is located south of the Corolla Village subdivision, and north of the Monteray Shores and Whalehead subdivisions. The subdivision consists of 387 residential lots, 242 multifamily units, one 43 room hotel (the Inn at Corolla Light), and approximately 13 acres of commercial property. The commercial area includes 40 businesses (includes restaurants, gift shops, gas stations, real estate offices, etc.). Of the 242 multifamily units, 32 (26 existing, 6 proposed) are apartments in the commercial area. The total land area (excluding roads) is approximately 193.5 acres. Water and sewer utilities in Corolla Light are operated by a private utility, Carolina Water Service, Inc.

Table 1: Summary of Developed and Undeveloped Residential Lots and Commercial Properties

Subdivision	Approved Platted Lots	Developed Lots	Lots Remaining	% of Total Lots Improved
Ocean Hill - SF	113	111	2	98%
Corolla Village –SF	115	72	43	63%
Corolla Village –Comm.	15	15	0	100%
Total Corolla Village –SF	130	87	43	67%
Corolla Light – SF	387	383	4	99%
Corolla Light – MF	100	0	100	0%
Corolla Light – MF	110	110	0	100%
Corolla Light – MF	32	26	6	81%
Corolla Light – Comm.	41	40	1	98%
Corolla Light – Hotel.	1 (43 rms)	1 (43 rms)	0	100%
Total Corolla Light	689	578	111	84%
Monteray Shores Plaza/Timbuk II	88	88	0	100%
Buck Island –SF	121	106	15	87%
Monteray Shores – MF	48	48	0	100%
Monteray Shores Ph. 1&2 – SF	384	235	149	61%
Corolla Bay (Ph. 3) –SF	256	3	253	1%
Corolla Shores (Ph. 3) – MF	19	0	19	0%
Total Monteray Shores	916	480	436	52%
Whalehead – SF	858	824	34	96%
Ocean Sands – SF	1075	1120	-45	104%
Ocean Sands – SF (to be transferred)	151	0	151	0%
Ocean Sands – MF	871	0	871	0%
Ocean Sands– Comm.	285	0	285	0%
Ocean Sands – Hotel [1]	974 rms	0	542	0%
Total Ocean Sands	2924	1120	1804	38%

SF = Single Family Residences MF = Multi-Family Comm. = Commercial

[1] rms = hotel rooms

Wastewater is treated at two wastewater treatment facilities permitted to treat 0.16 mgd and 0.1 mgd designated as Corolla Light No. 1 and Corolla Light No. 2, respectively, for a total treatment capacity of 0.26 mgd. The two plants are interconnected to allow flow to be distributed between the two plants. The 0.16 mgd Corolla Light No. 1 facility operates under Water Quality Permit No. WQ0006254 administered by the Aquifer Protection Section of the North Carolina Division of Water Quality (DWQ). The Corolla Light No. 2 facility is permitted by the Currituck County Health Department under permit No. 15282A1.

Ocean Hill

The Ocean Hill subdivision is the northernmost subdivision in the project service area and consists of 113 residential lots all but two of which are located on the east side of NC Highway 12. The total land area (excluding roads) is approximately 66.3 acres. Water service in Ocean Hill is provided by the Southern Outer Banks Water System. Sewer service is by individual septic systems.

Corolla Village

The Corolla Village subdivision is located south of the Ocean Hill subdivision and north of the Corolla Light subdivision. Corolla Village consists of 115 residential lots and 15 businesses. This area is physically buffered from the Corolla Light subdivision by a conservation area owned by the State and the Outer Banks Conservationists. The total land area (excluding roads) is approximately 68.9 acres. Water service in Corolla Village is provided by the Southern Outer Banks Water System. Sewer service is by individual septic systems.

Whalehead

The Whalehead subdivision is located to the east of NC Highway 12. Whalehead is the oldest subdivision in the evaluated service area with development beginning in the mid to early 1980's. This subdivision is bordered on the north and west by the Corolla Light subdivision and to the south and west by the Monteray Shores subdivision. Whalehead consists of 858 residential lots. The total land area (excluding roads) is approximately 459.8 acres. Water service in Whalehead is provided by the Southern Outer Banks Water System. Sewer service is by individual septic systems.

Monteray Shores/Buck Island/Timbuk II

The Monteray Shores/Buck Island/Timbuk II subdivisions have been grouped together for this evaluation as they all currently served by the Monteray Shores WWTP. The 0.52 mgd facility operates under Permit No.WQ0009772. Monteray Shores is a mix of commercial and residential areas located primarily on the east side of NC Highway 12 across from Whalehead. Monteray Shores includes 640 approved residential lots, 67 approved multi-family units, and 31 businesses in the Monteray Shores Plaza. Timbuk II is a commercial development on the west side of NC Highway 12 with a total of 57 businesses. Buck Island is a residential property located on the east side of NC Highway 12 with 121 approved lots. Together, these three subdivisions include a combined 828 residential and multi-family lots and approximately 43 acres of commercial property. The total land area (excluding roads) is approximately 289.5 acres. Water service in Monteray Shores, Buck Island, and Timbuk II is provided by Carolina Water Service.

3. Existing Wastewater Flow

There are four existing wastewater plants in the proposed Outer Banks Service Area as follows: Corolla Light No.1, Corolla Light No. 2, Monteray Shores, and the Ocean Sands WWTPs. Treatment capacity, number of customers served, and the maximum month flow for each WWTP (for the years 2004 to 2009) is summarized in **Table 2**. The unit wastewater flow for each WWTP is also listed in terms of wastewater flow per customer served. In addition, **Table 2** includes the Villages at Ocean Hill WWTP which is not in the proposed Outer Banks Service Area but provides additional data on typical wastewater demands in the area.

Figures 2 through **5** depict the monthly average and peak daily flow per connection for the combined Corolla Light plants, Monteray Shores, Ocean Sands, and Villages at Ocean Hill over the past few years. These figures clearly show the seasonal increase in flows experienced during the summer months. In addition, the figures show that the monthly average and peak day gpd/connection can vary substantially from year to year. For example the monthly average gpd/connection in Corolla Light (**Figure 2A**) varied from about 195 gpd/connection in 2006 to 330 gpd/connection in 2007. Similarly, the monthly average gpd/connection in Monteray Shores (**Figure 3A**) varied from about 180 gpd/connection in 2007 to 450 gpd/connection in 2009. The spike in wastewater flow in August and September 2006 was due to Hurricane Ernesto and is not representative of typical flows as this storm event resulted in significant flooding in certain areas resulting in high infiltration/inflow rates to the sanitary sewer system.

As shown in **Table 2** and illustrated in **Figure 4A** the maximum month flow for Ocean Sands was approximately 360 gpd/connection in July 2005. The seasonal peak daily flows shown in **Figure 4B** are typically around 400 gpd/connection.

The maximum month unit wastewater flows for the sewered portions of the Outer Banks Service Area (Corolla Light, Monteray Shores, and Ocean Sands) are summarized in **Table 3**. Flow data from the Villages at Ocean Hill is also included and provides additional data on typical wastewater demands in the area. A review of **Table 3** shows that the unit wastewater flow per connection is not consistent between the subdivisions. The difference in unit flows is attributable to different characteristics of each sewered subdivision such as the number and types of commercial businesses, average house size, number of swimming pools, irrigation demands, etc.

Table 2: Outer Banks Wastewater Treatment Plants

WWTP	Capacity (mgd)	Permit #	Area Served	No. of Connections [1]	Max Month Flow (mgd) [2]	Max Month Flow Date (Month/Year)	No. of Connections Corresponding with Max Month Flow	Max Month Wastewater Flow per Connection (gpd per connection) [3]
Corolla Light No. 1	0.16	WQ0006254	Corolla Light	573	0.258	August 2006	573	335
Corolla Light No. 2	0.10	15282A1	Corolla Light					
Monteray Shores	0.52	WQ0009772	Monteray Shores	480	0.313	June 2005	480	453
Ocean Sands Water and Sewer District	0.50	WQ0000185	Ocean Sands	1120	0.521	August 2004	1077	359
Villages at Ocean Hill	0.164	WQ0015052	Villages at Ocean Hill	192	0.082	July 2005	173	474

[1] The number of connections shown in Table 2 is for both residential and commercial customers. The number of residential connections varies from year to year. The number of commercial connections was assumed to be constant.
[2] A maximum month flow of .083 mgd was observed in July 2008. However, the max flow per connection for July 2008 was 435 gpd/connection assuming 191 connections.
[3] Max flow per connection was calculated dividing maximum monthly flow (mgd) observed from 2004 to 2009 (with the exception of Corolla Light No.1 and No. 2 which is based on data from 2006 to 2009) by the number of connections.

Table 3: Maximum Month Unit Wastewater Flows by Planned Unit Developments

	January	February	March	April	May	June	July	August	September	October	November	December
Sewered Planned Unit Developments												
Corolla Light 1& 2	33	36	67	94	90	304	301	**335**	121	66	117	70
Monteray Shores	30	54	78	109	132	335	426	**453**	323	131	129	92
Ocean Sands	54	72	103	114	149	305	**359**	356	402	107	152	101
Villages at Ocean Hill	38	42	45	98	147	357	**474**	447	216	89	84	54
Un-sewered Planned Unit Developments												
Spindrift, Corolla Village, Ocean Hill, Ocean Sands A, B, C[1]	30	24	52	146	188	327	367	**450**	337	116	79	84
Whalehead[1]	46	33	42	118	163	385	436	**595**	407	165	61	48

[1] *Based on water billing data. Assumes 80% consumption and an infiltration and inflow factor of 1.2.*

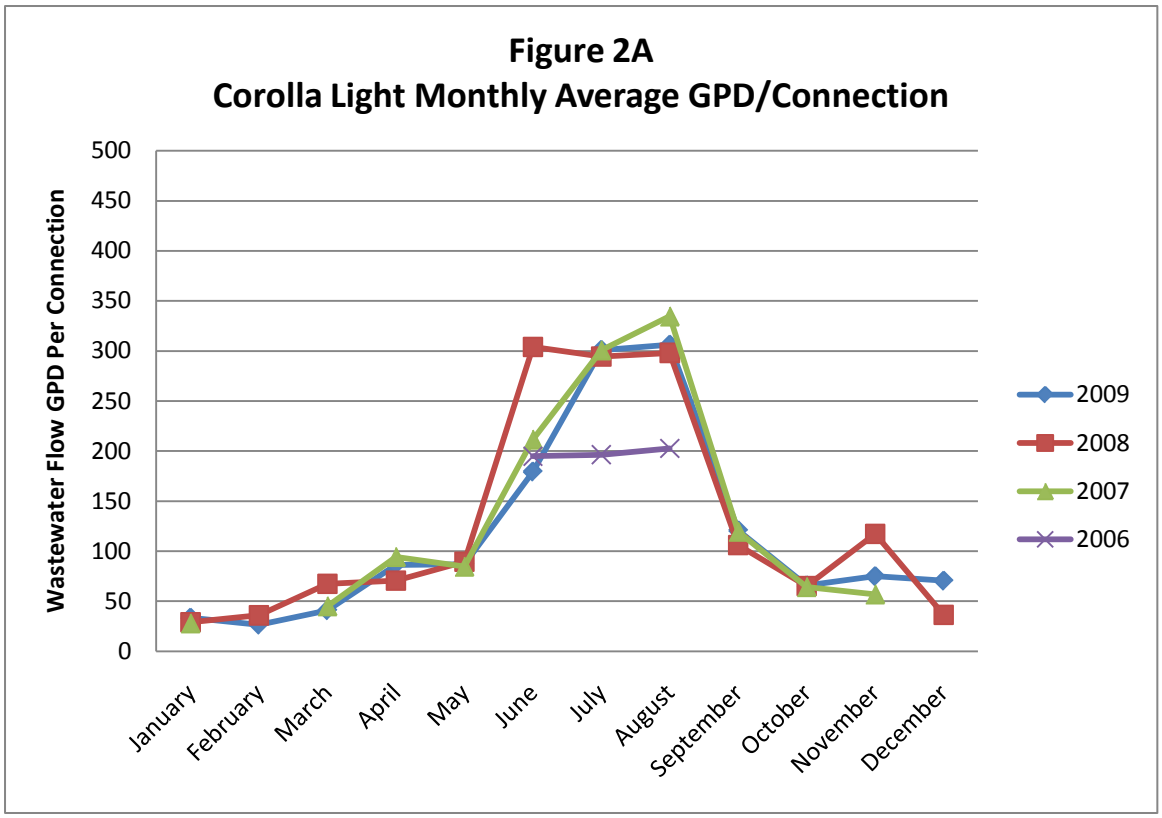


Figure 2A
Corolla Light Monthly Average GPD/Connection
Wastewater Flow GPD Per Connection
500
450
400
350
300
250
200
150
100
50
0
January
February
March
April
May
June
July
August
September
October
November
December
2009
2008
2007
2006

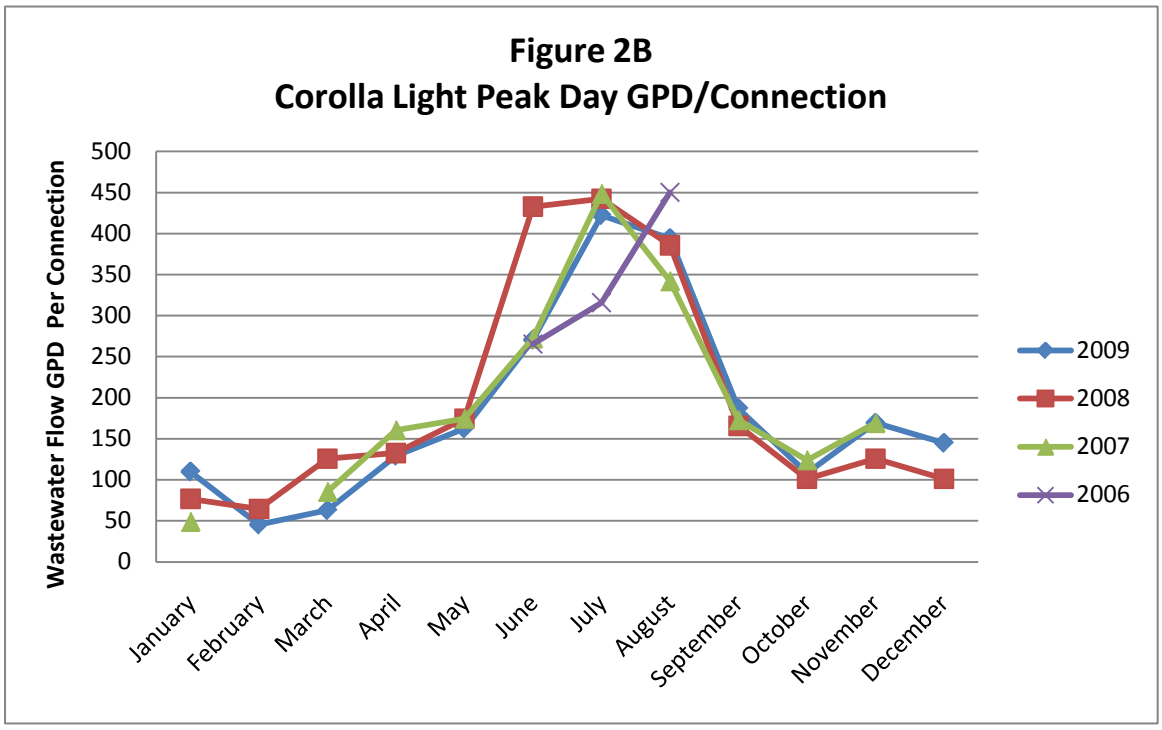


Figure 2B
Corolla Light Peak Day GPD/Connection
Wastewater Flow GPD Per Connection
500
450
400
350
300
250
200
150
100
50
0
January
February
March
April
May
June
July
August
September
October
November
December
2009
2008
2007
2006

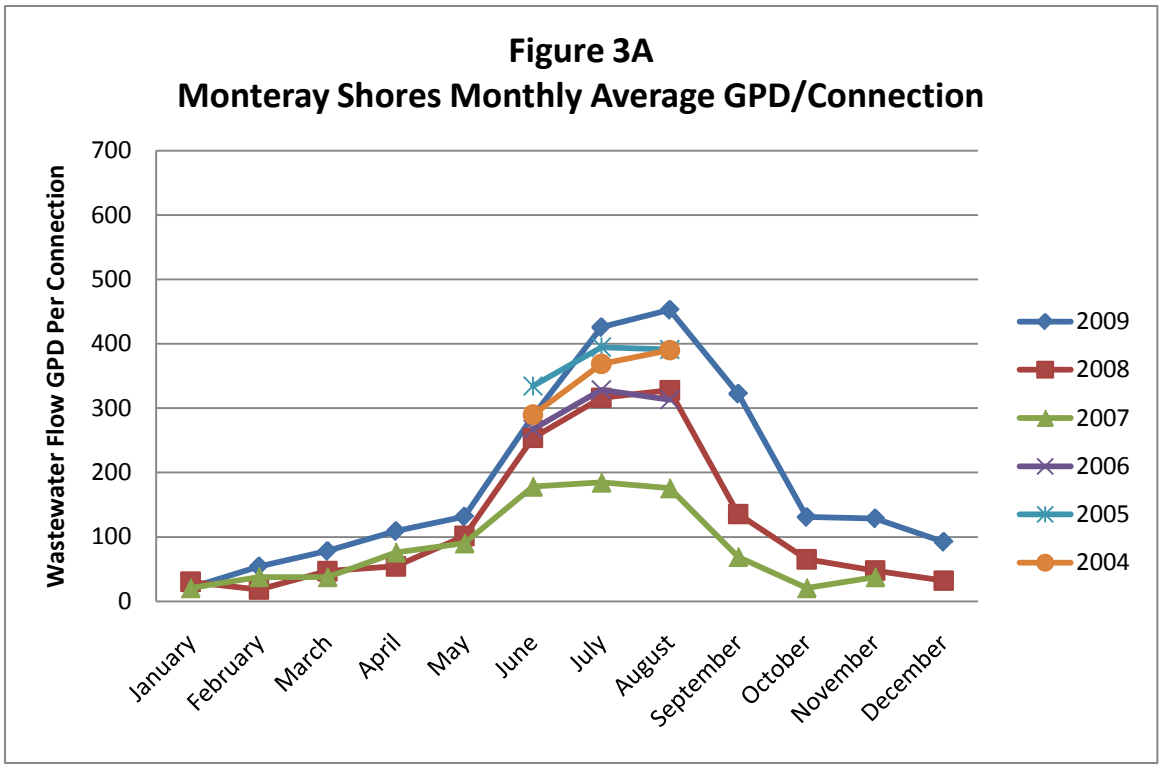


Figure 3A
Monteray Shores Monthly Average GPD/Connection
Wastewater Flow GPD Per Connection
700
600
500
400
300
200
100
0
January
February
March
April
May
June
July
August
September
October
November
December
2009
2008
2007
2006
2005
2004

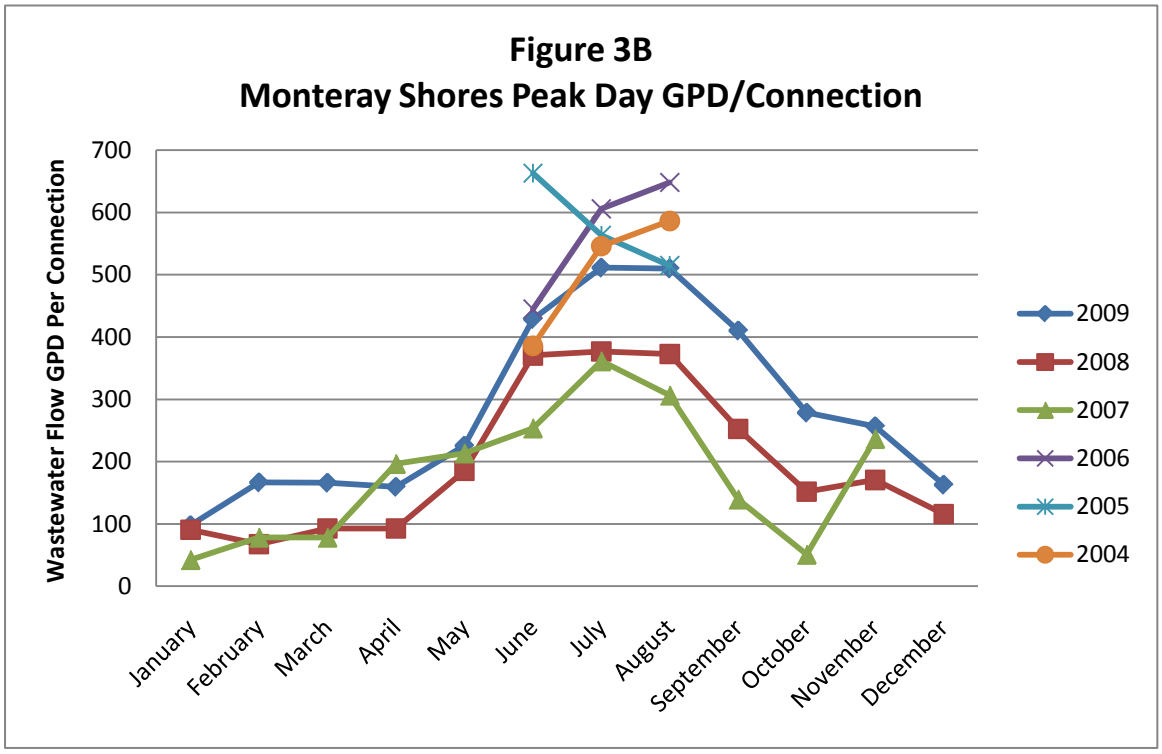


Figure 3B
Monteray Shores Peak Day GPD/Connection
Wastewater Flow GPD Per Connection
700
600
500
400
300
200
100
0
January
February
March
April
May
June
July
August
September
October
November
December
2009
2008
2007
2006
2005
2004

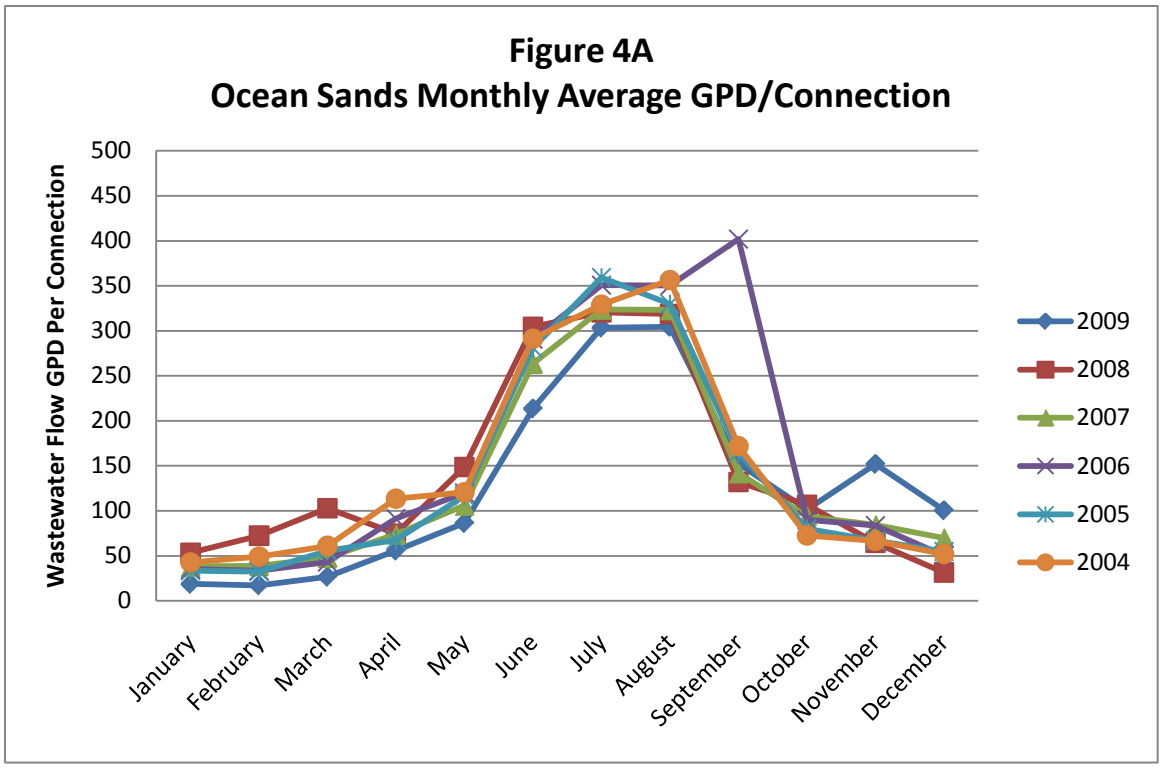


Figure 4A
Ocean Sands Monthly Average GPD/Connection
Wastewater Flow GPD Per Connection
500
450
400
350
300
250
200
150
100
50
0
January
February
March
April
May
June
July
August
September
October
November
December
2009
2008
2007
2006
2005
2004

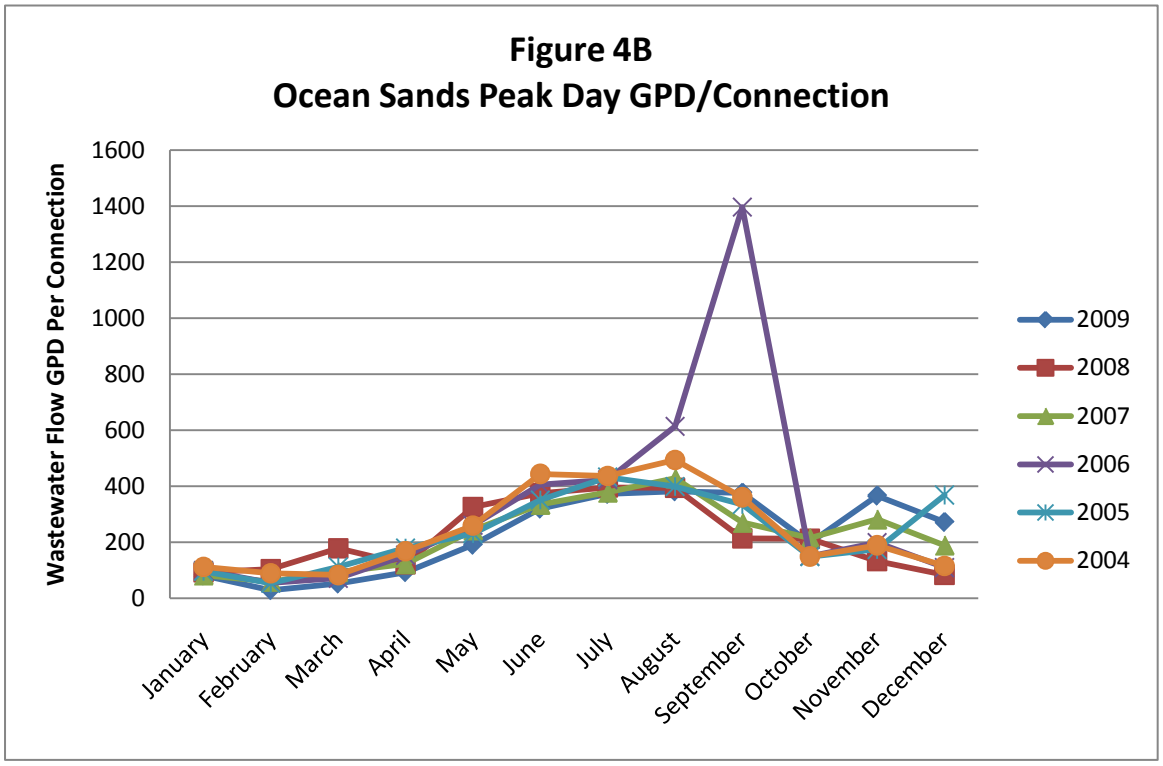


Figure 4B
Ocean Sands Peak Day GPD/Connection
Wastewater Flow GPD Per Connection
1600
1400
1200
1000
800
600
400
200
0
January
February
March
April
May
June
July
August
September
October
November
December
2009
2008
2007
2006
2005
2004

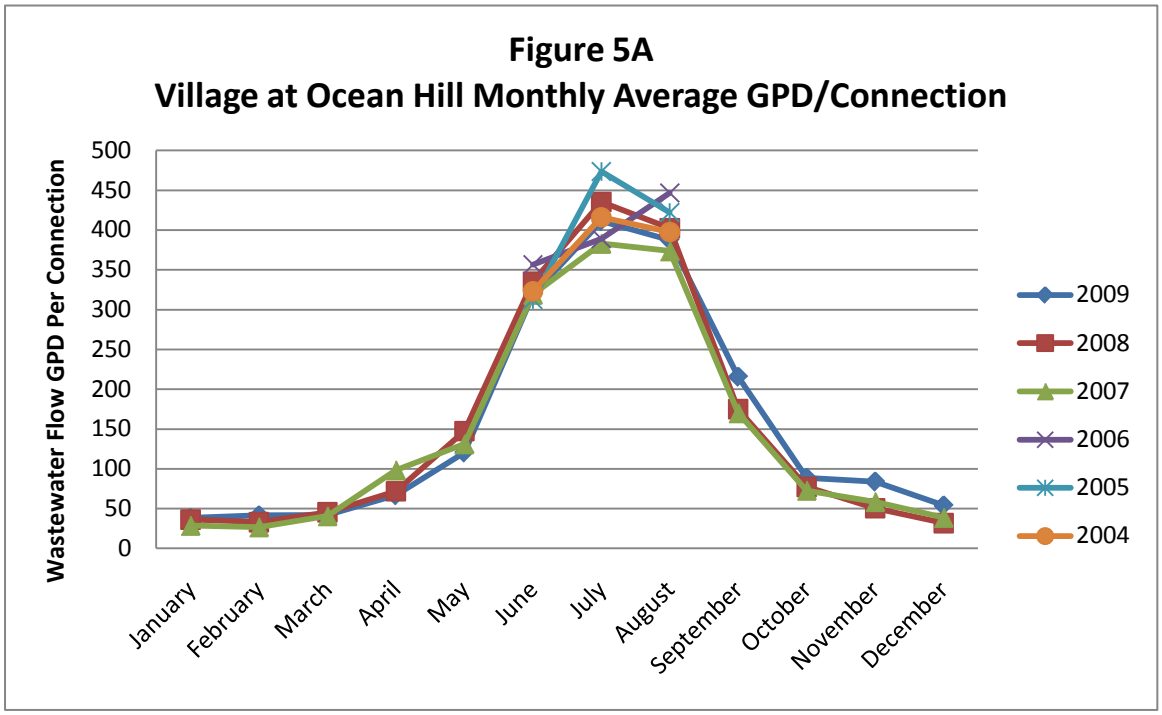


Figure 5A
Village at Ocean Hill Monthly Average GPD/Connection
Wastewater Flow GPD Per Connection
500
450
400
350
300
250
200
150
100
50
0
January
February
March
April
May
June
July
August
September
October
November
December
2009
2008
2007
2006
2005
2004

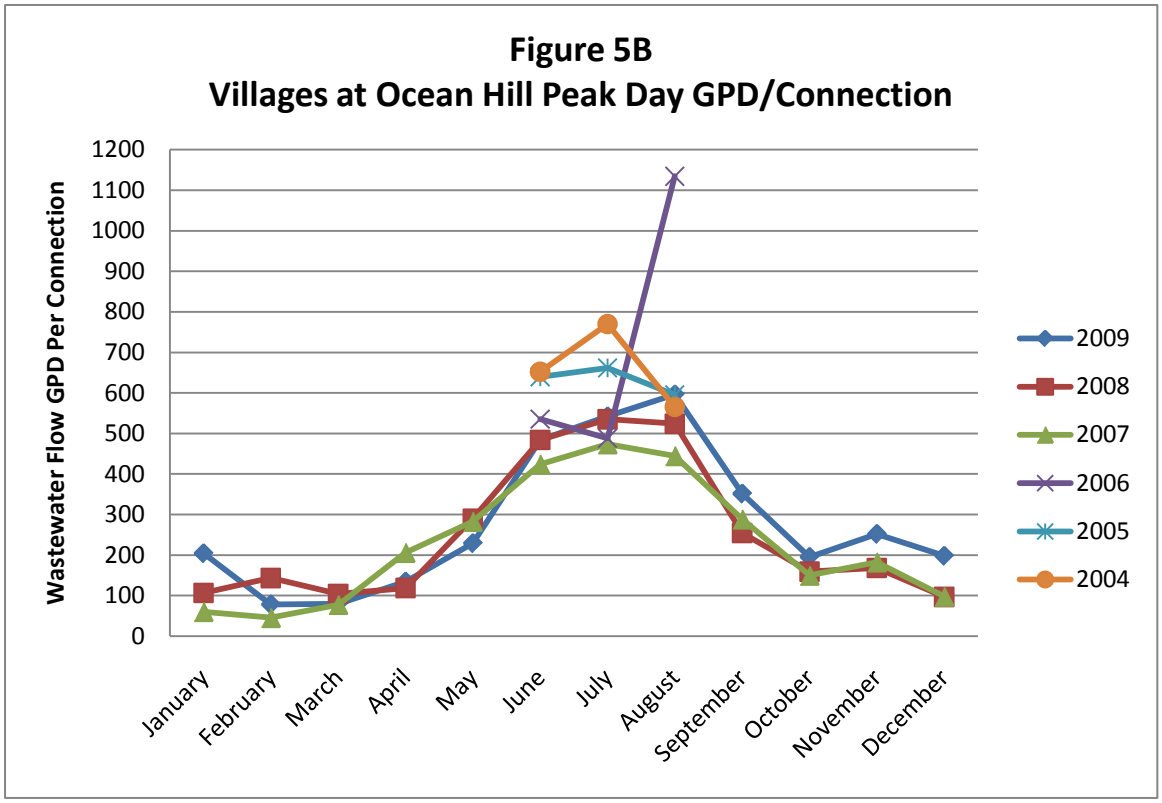


Figure 5B
Villages at Ocean Hill Peak Day GPD/Connection
Wastewater Flow GPD Per Connection
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
January
February
March
April
May
June
July
August
September
October
November
December
2009
2008
2007
2006
2005
2004

4. Wastewater Flow Projections

Currituck County is evaluating opportunities develop a regional approach for wastewater management on the Outer Banks. The four service area alternatives being evaluated are as follows.

- Option 1 – Ocean Sands and Corolla Light
- Option 2 – Ocean Sands, Corolla Light, and Monteray Shores
- Option 3 – Ocean Sands, Corolla Light, Monteray Shores, Whalehead, Corolla Village, and Ocean Hill
- Option 4 – Ocean Sands, Corolla Light, Whalehead, Corolla Village, and Ocean Hill

The build-out wastewater flow required for each individual subdivision is shown in **Table 4**. Future flows for the subdivisions with existing wastewater treatment were estimated by multiplying the number of new/future connections by the average number of bedrooms per house then by 120 gpd/bedroom (per 15A NCAC 02T .0114). This flow was then added to the existing wastewater treatment plant maximum month flow. Similarly, flows for the subdivisions without existing wastewater treatment plant were estimated by multiplying the build-out connections by the average number of bedrooms per house by 120 gpd/bedroom. Future commercial and hotel flows for the Ocean Sands and Monteray Shores subdivisions were estimated in the 2004 Hobbs & Upchurch report and the 2008 Ocean Sands Water and Sewer District Master Plan Update (ARCADIS, 2008).

Table 5 summarizes the required treatment capacity for each service area alternative. Based on discussions with the developer, future flows from planned redevelopment in the Corolla Light subdivision, which include a hotel and new commercial properties, are anticipated to be approximately 0.3 mgd. The required treatment capacities for the four evaluated options range from 2.00 mgd to 3.27 mgd. Options 3 and 4 include the currently unsewered subdivisions of Whalehead, Corolla Village, and Ocean Hill. Including the unsewered subdivisions adds 0.69 mgd in required treatment capacity. Option 4 assumes the Monteray Shores subdivision will continue to operate independently utilizing its existing 0.52 mgd treatment facility and expanding this facility to 0.58 mgd when needed.

The ARCADIS 2008 Master plan analyzed growth rates in the Ocean Sands subdivision from 1981 to 2007 using certificates of occupancy data provided the Currituck County planning department. A review of this data shows that the average growth rate for this period is approximately 3%. While there was a reduction in growth from 2004 to 2007, this downturn in development is likely due to hurricanes, an economic depression and the existing developed areas of Ocean Sands nearing their build-out capacities. Growth in Ocean Sands, though primarily residential, is representative of the larger service area. As the economy strengthens and additional areas of Ocean Sands and the other subdivisions included in the service area become available for development the growth curve is expected to recover to its average of 3%.

Table 4: Build-out Flow Projections for the Outer Banks Wastewater Service Area Subdivisions

Subdivision	Existing Connections	New / Future Connections	Build-out Connections	Average Bedrooms/ House	Future Residential Flow	Existing WWTP Flow[1] (mgd)	Future Commercial Flow[2] (mgd)	Future Hotel Flow[2] (mgd)	Build-out Flow Max Month per Area (mgd)
Ocean Sands / Crown Point	1120	978	2,098	4.76	0.559	0.521	0.056	0.25	**1.39**
Corolla Light	383	104	487	4.69	0.059	0.258	0.300	0	**0.61**
Monteray Shores	392	436	828	4.49	0.235	0.313	0.033	0	**0.58**
Corolla Village	72	43	115	4.5	0.062	N/A	0	0	**0.06**
Ocean Hill	111	2	113	5.5	0.075	N/A	0	0	**0.08**
Whalehead	824	34	858	5.3	0.546	N/A	0	0	**0.55**
								Total	**3.27**

[1]*Existing WWTP flow based on historical max month flow.*

[2]*Future commercial and hotel flow based up on 2004 Hobbs & Upchurch report with an additional 0.3 mgd for Corolla Light.*

Table 5: Required Wastewater Treatment Capacity for Each Service Area Alternative

Option	Service Area Alternative	Build-out Flow (mgd)
1	Ocean Sands and Corolla Light	2.00
2	Ocean Sands, Corolla Light, and Monteray Shores	2.58
3	Ocean Sands, Corolla Light, Monteray Shores, Whalehead Subdivision, Corolla Village, and Ocean Hill.	3.27
4	Ocean Sands, Corolla Light, Whalehead Subdivision, Corolla Village, and Ocean Hill.	2.70

Wastewater flow projections and the equivalent residential connection (ERCs) served for proposed service area alternatives Options 1 through 4 are depicted graphically on **Figures 6** through **9**, respectively. The flow projections were developed assuming a 3% growth rate. The average number of bedrooms for the subdivisions collectively is approximately 5 bedrooms per home. Each ERC represents 600 gpd (5 multiplied by 120 gpd/bedroom).

Option 1, shown on **Figure 6**, shows the number of ERCs and the equivalent flow for Ocean Sands and Corolla Light. The existing wastewater flow for these subdivisions is approximately 0.8 mgd and is projected to reach 1.0 mgd in 2020 and 1.6 mgd by 2035.

Similar to Option 1, Option 2 (**Figure 7**) shows the existing wastewater flow for Ocean Sands and Corolla Light of 0.78 mgd increasing due to the 3% growth through the year 2016 at which time the system will be merged with wastewater flow from the Monteray Shores subdivision. This results in an increase in the wastewater flow in 2016 from approximately 0.9 mgd to 1.2 mgd. The combined subdivisions are projected to reach 1.3 mgd in 2020 and 2.1 mgd by 2035.

In addition to merging the Ocean Sands and Corolla Light subdivisions flow with Monteray Shores in 2016, Option 3 (**Figure 8**) will add the unsewered subdivisions of Whalehead, Corolla Village and Ocean Hill in 2019. The addition of these unsewered subdivisions results in an increase in the wastewater flow in 2019 from approximately 1.3 mgd to 1.9 mgd. The combined subdivisions are projected to reach 2.0 mgd in 2020 and 2.7 mgd by 2035.

Option 4 (**Figure 9**) assumes Monteray Shores will continue to treat its wastewater separately, while the unsewered subdivisions of Whalehead, Corolla Village, and Ocean Hill will be treated with the Ocean Sands and Corolla Light flows beginning in 2019. Adding the unsewered subdivisions increases the wastewater flow from 1.0 mgd to 1.6 mgd. The combined subdivisions are projected to reach 1.7 mgd in 2021 and 2.2 mgd by 2035.

Figure 6: Wastewater Flow Forecasts Service Area Option 1 - Ocean Sands and Corolla Light

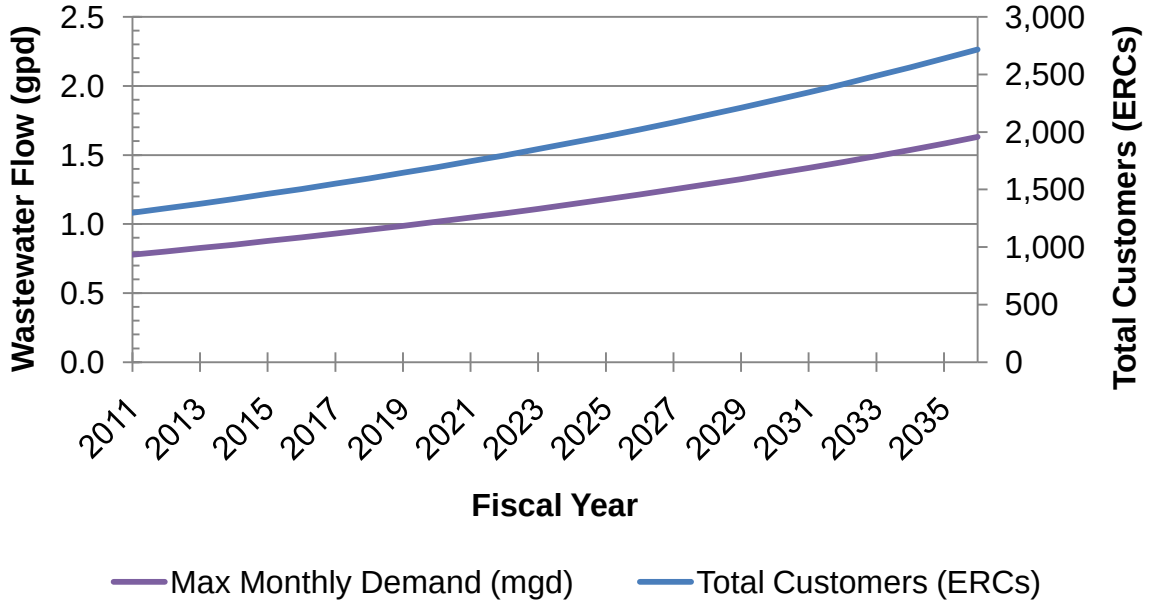


Figure 7: Wastewater Flow Forecasts Service Area Option 2 - Ocean Sands, Corolla Light, and Monteray Shores

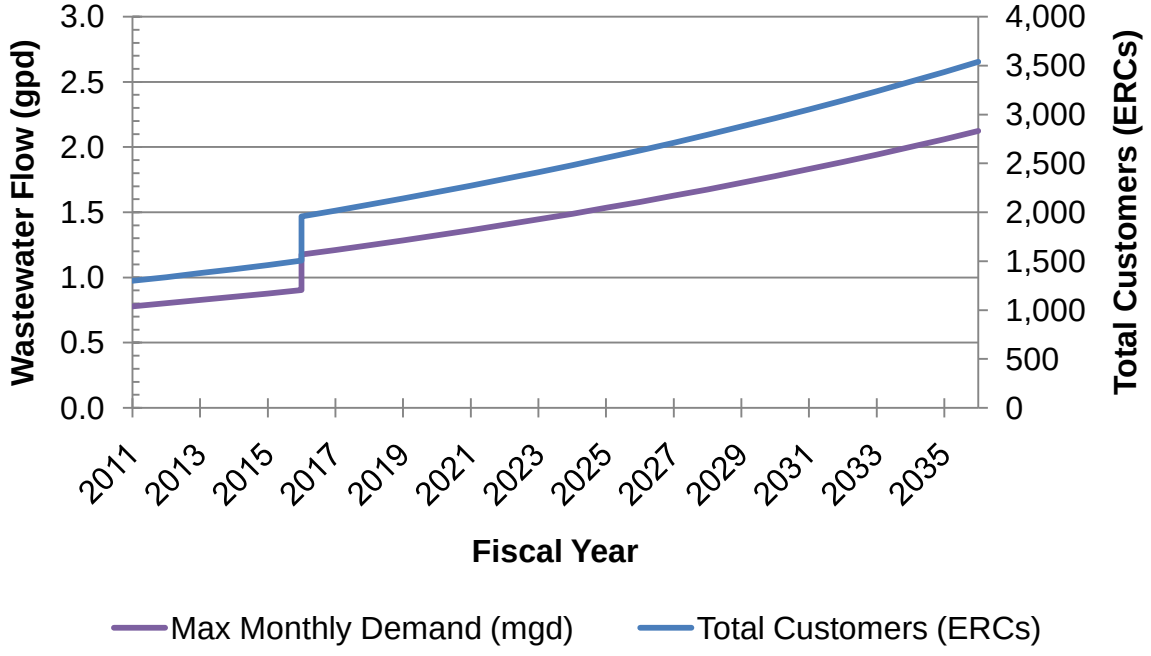


Figure 8: Wastewater Flow Forecasts Service Area Option 3 - Ocean Sands, Corolla Light, Monteray Shores, Whalehead, Corolla Village, and Ocean Hill

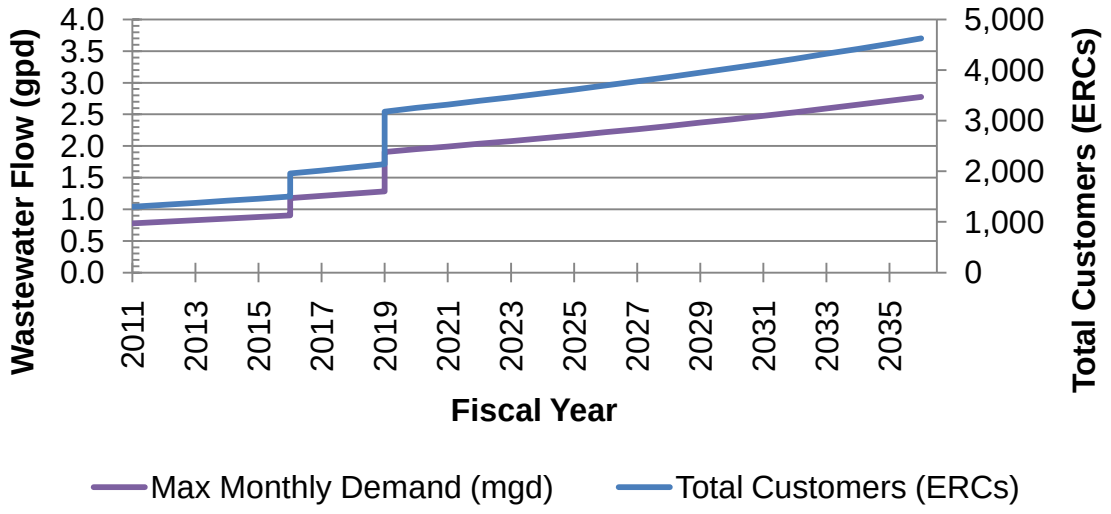
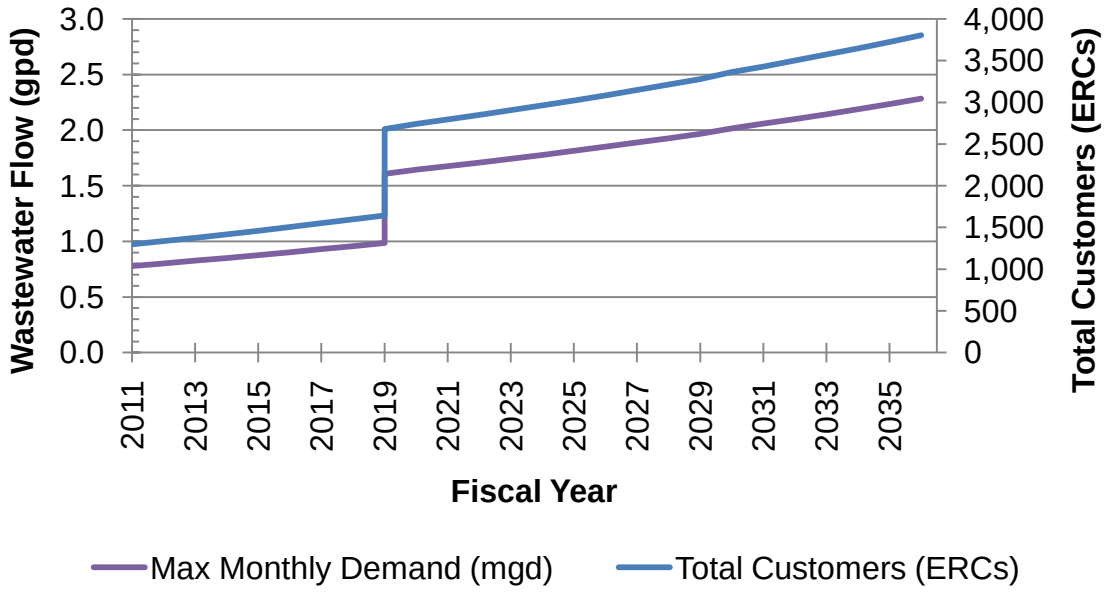


Figure 9: Wastewater Flow Forecasts Service Area Option 4 - Ocean Sands, Corolla Light, Whalehead, Corolla Village, and Ocean Hill



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Date:
June 6, 2011

Project No.:
30138-000

Subject:
Technical Memorandum 2 – Wastewater Treatment and Effluent Disposal Alternatives
Outer Banks Comprehensive Wastewater Master Plan

This technical memorandum (TM) is part of the master planning effort for the Southern Outer Banks in Currituck County. The purpose of this TM is to provide a summary of wastewater treatment technology alternatives, wastewater treatment site locations, effluent disposal alternatives, effluent disposal site locations and capacity, and capital costs for treatment and disposal. This TM also describes the location and condition of the existing wastewater treatment facilities on the Outer Banks.

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A Hydrogeologic and Soil Science Evaluation Alternatives for Wastewater Disposal in Corolla Light area and Ocean Sands Area, Currituck County Outer Banks Master Plan, Currituck County, North Carolina

1. Introduction

1.1 Background

Wastewater management on the Currituck County Outer Banks has historically been addressed in a decentralized arrangement. For areas with wastewater management, developers constructed wastewater collection, treatment, and disposal systems for each subdivision, which were then operated and maintained by a private utility. Several subdivisions were constructed with no centralized wastewater management and are currently served by septic tanks. The challenges in wastewater management facing the Currituck County Outer Banks include:

- Wastewater systems that are approaching their permitted capacity and do not have sufficient capacity to meet current needs as well as projected growth, particularly following construction of the Mid-Currituck Bridge.

- Treatment facilities that do not have nutrient removal capabilities and exceed either effluent permit limits or State groundwater standards. Many of the existing facilities have received Notices of Violation (NOV), moratoria on new construction, or are under Special Orders by Consent (SOC) due to performance issues.

- Potential changes in permit limits by the Division of Water Quality (DWQ) upon the next renewal to include effluent limits for nitrate and phosphorus.

- Potential risks to water quality and the sensitive coastal environment, which is the area's most valuable asset to promote tourism.

- Aging wastewater infrastructure that has not been maintained sufficiently to ensure reliable operation and performance in a demanding and severe environment.

- Wastewater systems that require major upgrades as part of their next expansion to comply with the 2T rules, which were promulgated in 2007.

- Limited effluent disposal alternatives for coastal areas of North Carolina.

- Limited availability and high cost of land on the Outer Banks for expansion of wastewater treatment and effluent disposal, or to provide for unsewered areas.

- Lack of consistency in wastewater management in terms of quality, condition, reliability and costs given the distributed nature of wastewater management

- High cost of wastewater management given the resort nature of the Outer Banks. Infrastructure must be constructed to meet summer peak demands but infrastructure is largely under-utilized in the offseason.

- Water quality concerns with unsewered areas given the volume of wastewater generated as these areas approach build-out.

- Limited options to address stormwater challenges due to poor water quality in unsewered areas.

Currituck County faces many of these challenges with the Ocean Sands Wastewater Treatment Plant (WWTP). This facility is owned by the County and operated by a contract operator. DWQ has issued several NOVs for exceedance of groundwater nitrate standards and for poor condition of the Ocean Sands WWTP.

Currituck County commissioned the preparation of the *Ocean Sands Water and Sewer District 2008 Master Plan Update* (ARCADIS, 2008) to develop a plan for expansion and upgrade of the WWTP to address these issues. The 2008 Master Plan recommended that one treatment train be converted to a Modified Ludzak-Ettinger (MLE) process to improve nitrate removal and serve as a full-scale demonstration test. Pending the results of this test, the plant would be upgraded to MLE to address high effluent nitrate concentrations. The Master Plan recommended an expansion to 600,000 gpd to provide needed capacity for build-out of the existing Ocean Sands WWTP and upgrades to improve the general condition of the facility. The capital cost for the recommended upgrades was $5,589,000 for the Phase 1 upgrades. Future replacement of the existing facilities was recommended for the 2013 to 2018 timeframe at a capital cost of $9,373,000 for a total 10 year capital investment of $14,962,000. Additionally, a phased expansion plan to a capacity of 1,200,000 gpd was outlined to meet future needs once undeveloped areas of Ocean Sands were developed (Sections G and T).

The high capital costs for upgrading and replacing aging wastewater infrastructure in addition to bringing the Ocean Sands WWTP in compliance with the new 2T regulations caused the County to consider other wastewater capacity alternatives. However, the County was continuing to receive NOVs for the Ocean Sands WWTP. In June 2010, Currituck County and DWQ entered into a SOC for the Ocean Sands WWTP. The purpose of the SOC was to provide DWQ with a schedule for making improvements to the WWTP. In light of the challenges facing the County, the SOC also grants the County some additional time to evaluate alternative strategies for centralized wastewater treatment. The SOC requires Currituck County to continue with repairs and rehabilitation to improve condition of the existing WWTP. The SOC includes milestones for the following options:

1. Upgrade the existing Ocean Sands WWTP in accordance with the 2008 Master Plan to meet compliance standards by April 2015.

2. Construct a regional WWTP pending the findings and recommendations of this Master Plan to meet compliance standards by October 2015.

Recognizing that these challenges are similar throughout the Outer Banks in the advantages to centralizing wastewater management, Currituck County partnered with Currituck Utilities LLC to evaluate opportunities to a regional approach for wastewater management. The goal of this Comprehensive Wastewater Master Plan for the Currituck County Southern Outer Banks is to evaluate wastewater treatment and effluent disposal options and major collection/conveyance requirements to meet long-term wastewater needs.

Wastewater demand projections for the service area were presented in TM 1. The build-out wastewater flows for each service area option being considered in this Master Plan are

summarized in **Table 1-1**. **Figure 1-1** illustrates the service areas being considered in this Master Plan and their projected build-out wastewater flow.

Table 1-1: Summary of Build-out Wastewater Flows for Service Area Options

Option	Service Area	Total Build-out Flow (mgd)
1	Ocean Sands and Corolla Light	2.00
2	Ocean Sands, Corolla Light, and Monteray Shores	2.58
3	Ocean Sands, Corolla Light, Monteray Shores, Whalehead Subdivision, Corolla Village, and Ocean Hill	3.27
4	Ocean Sands, Corolla Light, Whalehead Subdivision, Corolla Village, and Ocean Hill	2.70

1.2 Master Plan Objectives

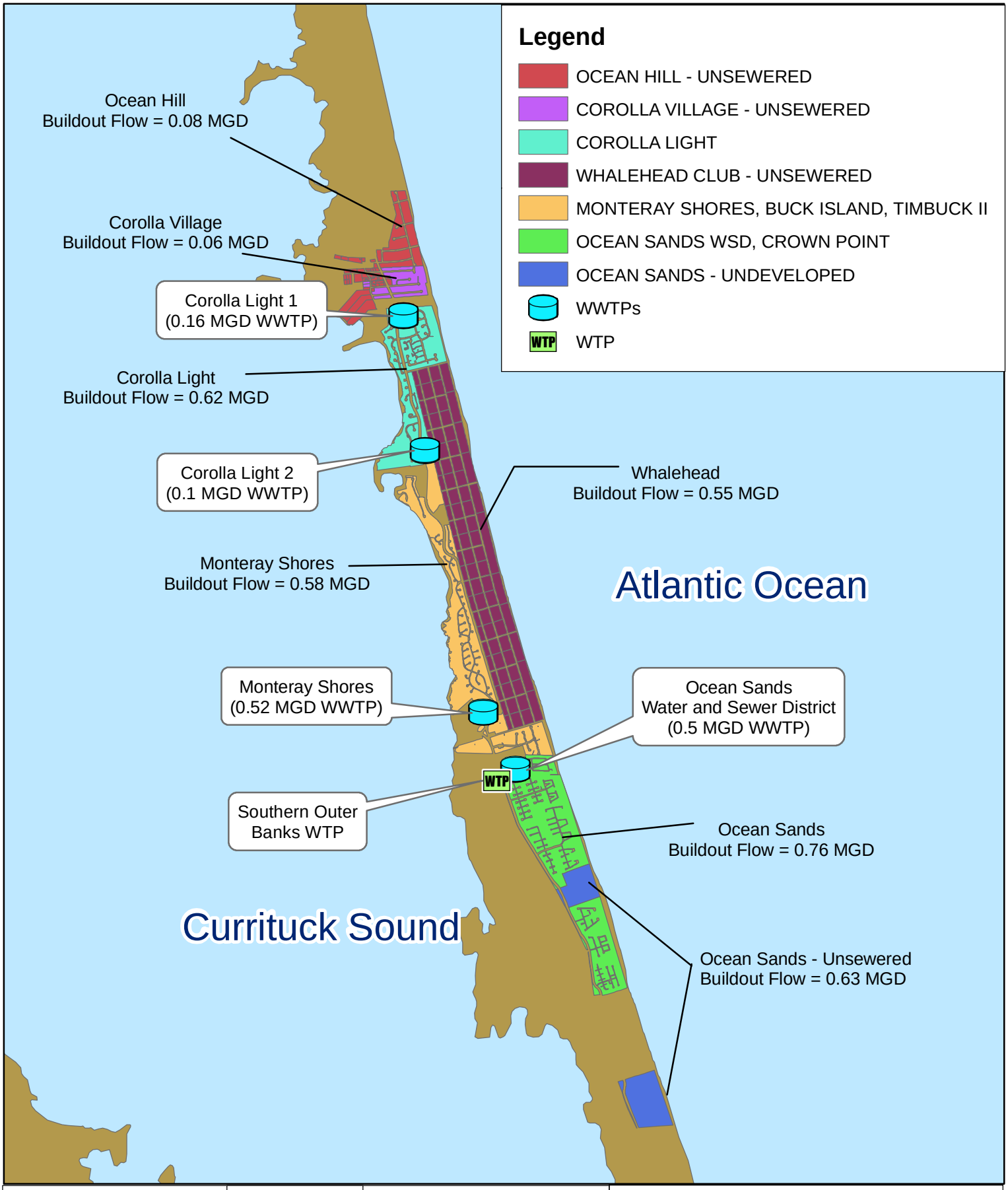
The objectives of this Master Plan are as follows:

- Evaluate development of a regional wastewater system for the following service area alternatives:
  - Option 1: Ocean Sands and Corolla Light
  - Option 2: Ocean Sands, Corolla Light, and Monteray Shores
  - Option 3: Ocean Sands, Corolla Light, Monteray Shores, Whalehead Subdivision, Corolla Village, and Ocean Hill
  - Option 4: Ocean Sands, Corolla Light, Whalehead Subdivision, Corolla Village, and Ocean Hill
- Identify feasible, reliable, and cost-effective wastewater management solutions for Currituck County that protect the sensitive environment of the Outer Banks.
- Evaluate alternative treatment technologies and set effluent goals to improve water quality and environmental protection, maximize use of existing infrastructure, and maximize use of existing land for effluent disposal, and provides for future growth and development.
- Determine wastewater treatment improvements needed to meet long-term capacity needs, provide for nutrient removal to meet 2T rules and expected permit changes, and restore condition of wastewater infrastructure.

- Evaluate options for expanding treated effluent disposal capacity considering land requirements, regulatory and permitting considerations, potential water quality impacts, and potential impacts to stormwater management.

- Estimate treated effluent disposal capacity at alternative sites based on previously published reports, hydrogeological evaluations, groundwater modeling, and other available information regarding subsurface and aquifer conditions.

- Determine planning-level capital costs for recommended system improvements.



SCALE

0 0.25 0.5 1 Miles

1 inch = 1 miles

N W E S

HAZEN AND SAWYER
Environmental Engineers & Scientists

Currituck County

Figure 1-1: Buildout Wastewater Flows

Comprehensive Wastewater
Master Plan for the
Currituck County Southern Outer Banks

2. Regulatory Overview and Effluent Quality Goals

The rules set forth by the North Carolina Administrative Code for the disposal of treated wastewater are listed under Title 15A, Subchapter 2T, and were effective January 1, 2009. The former set of rules, under Subchapter 2H, was repealed as 2T.

The 2T Rules have specific sections for wastewater irrigation systems, high rate infiltration systems, and reclaimed water systems each with subsections for design criteria. The 2H Rules do not specify effluent requirements for spray irrigation systems and high rate infiltration systems. Instead, the 2H Rules specify the effluent quality requirements for the reuse of treated wastewater. The effluent quality requirements for the repealed 2H rules are similar to the required effluent quality in the 2T Rules. Additionally, the requirements in the 2H Rules are the same for the case if reuse is the only discharge option implemented and for when wastewater reuse is utilized with other discharge options (such as a discharge via NPDES permit). **Table 2-1** summarizes the minimum degree of treatment for new and expanding municipal, domestic, and commercial facilities under the current 2T rules. **Table 2-2** provides a summary of the effluent requirements under the repealed 2H rules.

Table 2-1: Summary of Effluent Quality Requirements for Various Wastewater Disposal Methods per NCAC 2T Rules

Water Quality Parameter	Spray Irrigation Systems	Reuse	High Rate Infiltration (Per 2T Rules)	High Rate Infiltration per Alternative Design Criteria [2]
BOD_5	≤ 30 mg/l	≤ 10 mg/l	≤ 10 mg/l	≤ 10 mg/l (≤ 15 mg/l [3])
TSS	≤ 30 mg/l	≤ 5 mg/l	≤ 15 mg/l	≤ 5 mg/l (≤ 10mg/l [3])
NH_3	≤ 15 mg/l	≤ 4 mg/l	≤ 4 mg/l	≤ 4 mg/l (≤ 6 mg/l [3])
Fecal Coliform	≤ 200 colonies /100 ml	≤ 14 colonies /100 m	≤ 14 colonies /100 ml	≤ 14 colonies /100 ml (≤ 25 colonies/100 ml [2])
NO_3	NA	NA	≤ 10 mg/l	≤ 10 mg/l
Turbidity	NA	10 NTU	N/A	10 NTU [2]
Total Nitrogen	NA	NA	≤ 7 mg/l or ≤ 4 mg/l [3]	≤ 7 mg/l or ≤ 4 mg/l [3]
Total Phosphorus	NA	NA	≤ 3 mg/l or ≤ 2 mg/l [4]	≤ 3 mg/l or ≤ 2 mg/l [4]

[1] *Alternative Design Criteria per Division of Water Quality memo dated October 27, 2006.*
[2] *Daily maximum requirements.*
[3] *Setback requirements at 100 feet require effluent total nitrogen ≤ 7 mg/l. Setback requirements at 50 feet require effluent total nitrogen ≤ 4 mg/l.*
[4] *Setback requirements at 100 feet require effluent total phosphorus ≤ 3 mg/l. Setback requirements at 50 feet require effluent total phosphorus ≤ 2 mg/l.*

Table 2-3 provides the setback requirements for land application sites from habitable residences, surface water sources, groundwater lowering ditches, property lines, and wells set forth by the 2T Rules. The setback requirements provided by the 2H Rules are the same as those in the 2T Rules.

Table 2-2: Summary of Effluent Quality Requirements for Various Wastewater Disposal Methods per Repealed 2H Rules

Water Quality Parameter	Reuse (If Used as the Only Managed Option)	Reuse (If Used with Other Discharge Options)
BOD_5	$\leq$ 10 mg/l	$\leq$ 10 mg/l
TSS	$\leq$ 5 mg/l	$\leq$ 5 mg/l
NH_3	$\leq$ 4 mg/l	$\leq$ 4 mg/l
Fecal Coliform	$\leq$ 14 colonies / 100 ml	$\leq$ 14 colonies /100 ml
NO_3	NA	NA
Turbidity	10 NTU	10 NTU
Total Nitrogen	NA	NA

Table 2-3: Setback Requirements for Effluent Disposal Methods

Setback from:	Conventional Land Application [1]	Reclaimed Water	High Rate Infiltration	High Rate Infiltration per Alternative Design Criteria [2]
Habitable residence	400 feet	None required	400 feet	400 feet
Surface water	100 feet	100 feet from class SA waters 25 feet from non-class SA waters	100 feet [2]	50 feet [3]
Groundwater Lowering Ditches	100 feet	NA	100 feet [2]	50 feet [3]
Any property line	150 feet	None required	200 feet [2]	50 feet [3]
Any well with exception of monitoring wells	100 feet	100 feet	100 feet	100 feet

[1] *Assumes spray irrigation with limited secondary treated wastewater.*
[2] *Reduced setbacks are allowed as long as treatment units are designed to meet total nitrogen of 7 mg/l and total phosphorus of 3 mg/l effluent limit.*
[3] *Reduced setbacks are allowed as long as treatment units are designed to meet total nitrogen of 4 mg/l and total phosphorus of 2 mg/l effluent limit.*

3. Existing Wastewater Treatment Facilities at Southern Outer Banks

3.1 Ocean Sands WWTP

The Ocean Sands WWTP is owned by Currituck County and operated by a private operator, Enviro-Tech. The facility is located on the northern end of the Ocean Sands subdivision on NC Highway 12.

3.1.1 Facilities Description

The original Ocean Sands WWTP was constructed in 1978 (Permit No. WQ0000185) with a treatment capacity of 100,000 gallons per day (gpd) via two parallel treatment trains. The original structures were concrete basins. Over the last 15 years, treatment capacity has been expanded by the addition of eight parallel steel package plants with varying capacities, for a total of four parallel treatment trains. The current permitted capacity of the treatment plant is currently 500,000 gpd. A description of each expansion is provided in **Table 3-1**.

Table 3-1: Capacity Expansions for the Ocean Sands WWTP

Phase	Type	Number of Units	Capacity (gpd)
Original Construction	Concrete Basins	2	100,000
Expansion	Steel Package Plant	1	50,000
Expansion (1989)	Steel Package Plant	3	150,000
Expansion (1993)	Steel Package Plant	4	200,000
Total		10	500,000

Ocean Sands WWTP is a conventional extended aeration activated sludge plant designed for biochemical oxygen demand (BOD_5) removal and nitrification. The facility was designed under the repealed 2H rules, provided in **Table 3-2**. The treatment facilities include screening, grit removal, secondary clarification, tertiary filtration, and chlorine disinfection via tablets. The facility does not include influent equalization.

The southern Outer Banks of Currituck County experience resort trends in population and wastewater flow fluctuations. **Figure 3-1** shows the monthly effluent flows from the Ocean Sands WWTP. The flows in June, July, and August are often more than three times larger than the flows experienced during the off season.

Table 3-2: Summary of Effluent Disposal Limits for Ocean Sands WWTP

Parameter	Daily Maximum [1]	Monthly Average [1]
BOD_5	15 mg/l	10 mg/l
TSS	30 mg/l	20 mg/l
Fecal Coliform	43 colonies / 100 ml	--
Ammonia	6 mg/l	4 mg/l
Nitrate	--	--
Turbidity	--	--

[1] Reference repealed NCAC 2H Rule and Permit No. WQ0000185 (May 14, 2010).

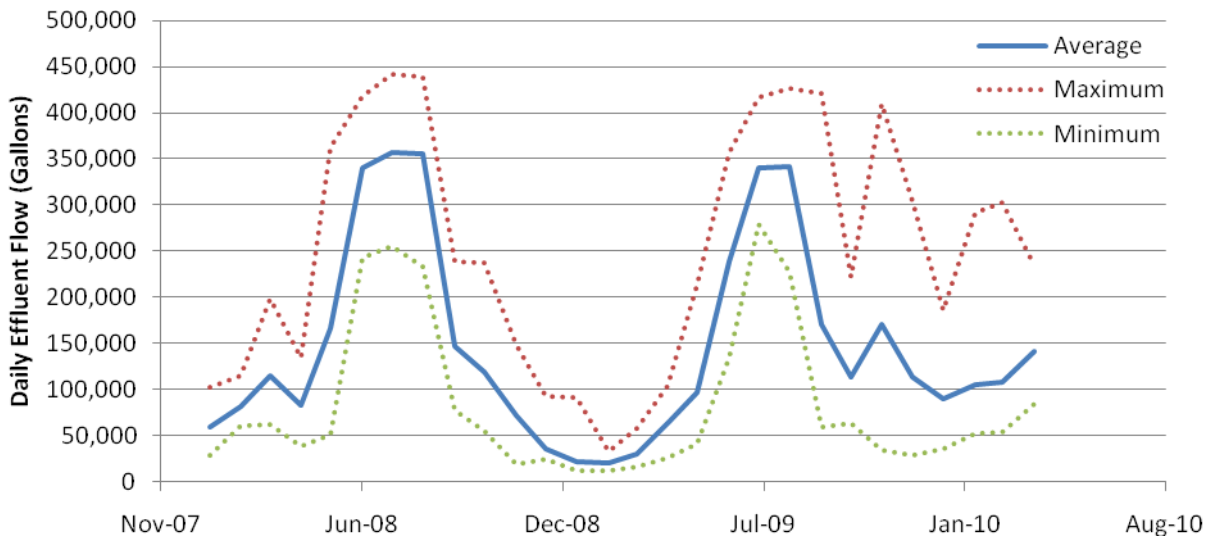


Figure 3-1: Ocean Sands WWTP Monthly Effluent Flow

Ocean Sands consistently meets the effluent standards set forth in permit No. WQ0000185. In the four years of DMRs available at the time of this study, only two daily maximum limits were violated. In April, 2008, the TSS concentration for one day was 114 mg/l. All other TSS concentration samples for 2008 were below the permit limit. On September 3, 2009, the TSS concentration at Ocean Sands was 54 mg/l, which exceeds the daily maximum permit limit of 30 mg/l. However, the monthly average effluent TSS for September 2009 was below the limit. An annual summary of the effluent quality from Ocean Sands is provided in **Table 3-3**. Ocean Sands WWTP does have many instances in which it exceeds the groundwater standard for nitrate. These exceedances are discussed in Section 3.1.2.

Table 3-3: Summary of Effluent Quality Data for Ocean Sands WWTP

Year	BOD_5 mg/l	Ammonia mg/l	Suspended Solids mg/l	Fecal Coliform / 100 ml	Nitrate mg/l
Average					
2008	2.12	0.31	7.08	1.11	13.53
2009	2.47	0.38	3.50	2.72	15.68
2010	2.73	0.21	2.96	1.27	16.69
Maximum					
2008	4.00	1.20	114.00	3.00	37.47
2009	7.00	5.30	54.00	40.00	31.61
2010	10.00	0.30	5.00	4.00	25.81
Minimum					
2008	2.00	0.20	1.00	1.00	0.18
2009	2.00	0.20	1.00	1.00	0.23
2010	2.00	0.20	1.10	1.00	7.43

Plant effluent is disposed of via high-rate infiltration located on the eastern end of the property. The high-rate infiltration system is a dry system whereby effluent is sprayed continuously over a dry sand bed and no ponding occurs. Originally, the infiltration system infrastructure consisted of ten rotary distributors. However, corrosion and wear of the rotary distributor assemblies was a significance maintenance problem. Currituck County replaced four of the rotary distributors in 2010 with fixed head sprayers. The groundwater level at this site is managed by a man-made canal that runs along the perimeter of the site. A pump station transfers groundwater via a force main to a drainage ditch on the southern side of the Timbuk II shopping center. The drainage ditch flows into Currituck Sound.

3.1.2 Facility Condition and Performance

Steel package treatment units typically have a lifespan of 20 years, but the harsh coastal environment has reduced the service life of these units. On a site visit that was conducted by ARCADIS in 2008, corrosion was observed on the steel tanks and the chlorine dosing equipment. Corrosion was also seen where the paint coating was damaged or peeling, such as control panels, piping, pipe hangers and handrails. There was evidence of spalling and leaks at the joints of the original concrete basins.

On May 21, 2008, Currituck County received a Notice of Violation (NOV) regarding the maintenance of the plant. The NOV cited corrosion, damaged paint, and damaged steel on the steel treatment basins. Rotary distributors 3 and 4 were noted as being in poor operating condition. The NOV also indicated that the sand bed in the rotary distributor was not at the specified elevation. Violations were issued once May 2008, twice in September 2008, and twice in January 2010. Each NOV specified the overall condition and state of disrepair of the plant. In response to the NOVs, Currituck County has commissioned $56,000 worth of improvements to the overall

condition of the treatment plant since March 2009, which include structural repairs to the concrete basins, walkway repairs, and electrical repairs.

Currituck County and DWQ entered into a SOC in June 2010. The SOC was issued as a response to the NOVs that the plant had continued to receive. The SOC provided a schedule to DWQ for the improvements to the Ocean Sands WWTP and gave the County additional time to evaluate their options regarding the dilapidation of the facility and centralized treatment options. According to the SOC, Currituck County must continue to make repairs to the existing plant.

Additionally, the Ocean Sands WWTP was issued a Notice of Regulatory Requirement in 2006 for elevated concentrations of nitrate (NO_3) in groundwater monitoring wells. The State Groundwater Quality Standard for nitrate is 10 mg/l. In May 2010, DWQ requested a written evaluation of the nitrate levels for the past 5 years and required that nitrates now be monitored monthly in the groundwater monitoring wells. **Table 3-4** provides the monitored groundwater nitrate levels at Ocean Sands from January through April 2010. Of the 11 samples, only two were in compliance with the groundwater standard. The current treatment process is not designed for nitrate removal (e.g., denitrification). Currituck County is not technically required to meet the nitrate groundwater standard as they are operating with permit limits specified under the older reclaimed water standard. However, a capacity expansion or major process modification will trigger the current NCAC 2T reclaimed water rule and all DWQ polices related to that rule, which includes nitrate and/or a total nitrogen effluent limit.

Table 3-4: Nitrate Concentration in Groundwater Monitoring Wells in Ocean Sands

Date	Nitrate (mg/l)
1/7/2010	18.65
1/21/2010	21.11
2/4/2010	13.54
2/11/2010	8.55
3/4/2010	19.65
3/9/2010	17.46
4/1/2010	7.43
4/8/2010	12.68
4/15/2010	15.3
4/22/2010	23.39
4/29/2010	25.81
Average	16.69
Minimum	7.43
Maximum	25.81

3.2 Corolla Light No. 1 WWTP

The Corolla Light No. 1 WWTP is owned and operated by Carolina Water Service, Inc. It is located in the northwestern portion of the Corolla Light subdivision. This treatment plant serves the Corolla Light subdivision and the Whalehead Club. This treatment facility is located on the northern end of Corolla Light to the east of the Whalehead Club.

3.2.1 Facilities Description

The Corolla Light No. 1 WWTP (Permit No. WQ0006254) is permitted for a capacity of 160,000 gpd. The plant was constructed in two phases. Each phase has a capacity of 80,000 gpd. The treatment process in each train includes a 20,000-gallon flow equalization tank, clarifiers, and tertiary filtration. Phase 1 has three aeration tanks and a tablet chlorinator. Phase 2 consists of one aeration tank, tablet hypochlorination, and a 1,680-gallon chlorine contact tank. Effluent from Corolla Light No. 1 is disposed of via three high-rate rotary distributors with a capacity of 40,000 gpd each (total capacity of 120,000 gpd). There is a 40,000 gpd low pressure pipe (LPP) system located on the Whalehead Club property. These disposal systems are operated under permit No. 0015282A1and WQ0001313. The groundwater quality surrounding the plant is monitored quarterly via seven monitoring wells.

A Compliance Inspection was conducted in September 2009 by the Washington Regional Office. No deficiencies were noted. The high rate infiltration spray beds were free of vegetation growth and showed no ponding.

3.2.2 Facility Condition and Performance

Table 3-6 provides a summary of the permit effluent limits for the facility. The facility is permitted under the new reclaimed water rule (NCAC 2T). The permit does not give a daily maximum limit for ammonia, BOD_5 or total suspended solids. These parameters are limited as monthly averages. Between January 2007 and January 2010, Corolla Light No. 1 exceeded the ammonia effluent limit three times. All other effluent limits were met. **Table 3-5** provides an annual account of the effluent quality from Corolla Light No. 1.

The 2009 Performance Annual Report indicates that Corolla Light No. 1 had three exceedances of groundwater standards as required by Permit No. WQ0006254. The groundwater monitoring wells exceeded limits for total dissolved solids, nitrate, chloride, and total organic carbon in each month that the wells were tested in March, June, and November 2009. **Table 3-6** provides the groundwater standards as set forth by the permit.

Table 3-5: Summary of Effluent Quality Data for Corolla Light No. 1 WWTP

Year	BOD_5 mg/l	Ammonia mg/l	Suspended Solids mg/l	Fecal Coliform / 100 ml	Nitrate mg/l	Total Phosphorus mg/l
Average						
2007	3.12	0.65	1.25	1.00	3.19	
2008	3.00	0.54	2.91	1.22	4.29	4.92
2009	3.04	1.23	2.57	1.00	4.41	1.29
2010	3	0.1	2	1	2.07	
Maximum						
2007	5.00	0.65	1.25	1.00	3.19	
2008	3.00	3.70	12.00	6.00	12.70	12.20
2009	4.00	6.40	8.00	1.00	50.20	2.60
2010	3	0.1	2	1	2.07	
Minimum						
2007	3.00	0.06	0.30	1.00	0.94	
2008	3.00	0.10	1.00	1.00	0.02	2.13
2009	3.00	0.10	2.00	1.00	0.02	0.48
2010	3	0.1	2	1	2.07	

Table 3-6: Summary of Effluent Limits for Corolla Light No. 1 WWTP

Parameter	Monthly Average [1]	Daily Maximum [1]	Groundwater Standard
Total Suspended Solids	20 mg/l	--	
Ammonia (as N)	4 mg/l	--	
BOD_5	10 mg/l	--	
Fecal Coliform	14 colonies / 100 ml	43 colonies / 100 ml	
Nitrate (as N)	no limit	--	10 mg/l
pH	--	--	8.5
Total Dissolved Solids	--	--	500 mg/l
Chloride (as Cl)	--	--	250 mg/l

[1] *Effluent Limits defined in permit No. WQ0006254.*

3.3 Corolla Light No. 2 WWTP

The Corolla Light No. 2 WWTP is owned and operated by Carolina Water Service and serves the Corolla Light subdivision. It is located in the southwest portion of the subdivision.

3.3.1 Facilities Description

Corolla Light No. 2 (Permit NC0015282A1) is a 100,000 gpd extended aeration type wastewater treatment plant. The plant consists of two parallel steel package trains rated at 50,000 gpd each. The effluent from this plant is disposed via a series of low pressure pipe (LPP) fields. One field is located on the WWTP site on the east side of NC Highway 12. A second LPP field is located on the west side of NC Highway 12 underneath a putt-putt facility.

3.3.2 Facility Condition and Performance

There is no available data for effluent ammonia or nitrate concentrations for Corolla Light No. 2 WWTP. The available BOD_5, TSS, and fecal coliform data indicate that the plant is operating within its permitted limits for these constituents. Since these plants serve a similar service area, influent characteristics for Corolla Light No. 2 should be similar to Corolla Light No. 1 WWTP.

3.4 Monteray Shores WWTP

Monteray Shores WWTP is owned and operated by Carolina Water Service and is located in the southern portion of the Monteray Shores subdivision. The facility was originally constructed in the early 1990s. The plant was upgraded and expanded in 2008. The facility serves the Monteray Shores subdivision, Buck Island, and Timbuck II.

3.4.1 Facilities Description

Monteray Shores WWTP (Permit No. WQ0009772) was originally constructed as an 180,000 gpd plant in the early 1990s. The plant was originally designed as an extended aeration facility with parallel treatment trains. The treatment process includes flow equalization, an influent surge tank, three aeration basins, two clarifiers, tertiary filtration, a tablet chlorinator, and a 12,500-gallon chlorine contact tank. The original facility was designed for BOD_5, ammonia, and suspended solids removal. Effluent disposal was originally designed with four rotary distributors, but was converted to fixed spray heads in spray irrigation fields.

The plant operating parameters for both the summer and winter months are found in **Table 3-7**. This area of Currituck County experiences resort-like variation in demand, so the operation of the plant varies greatly between the summer and winter months. **Figure 3-2** displays the seasonal effluent flow variation that Monteray Shores experiences. This figure also shows the increase in flow from 2007 to 2010.

In January 2002, a moratorium was imposed on the Monteray Shores system until improvements were made to address capacity limitations. The moratorium was voided and then reinstated in 2003. A NOV was received in August 2003 that stated the monthly average flow exceeded the 180,000 gpd capacity. In 2009, the Monteray Shores WWTP was expanded to a capacity of 520,000 gpd to address the capacity limitation and upgraded to include denitrification.

Table 3-7: Summary of Monteray Shores WWTP Process Parameters

Parameter	Summer	Winter
Total SRT, days	15 – 20	20 – 25
RAS, % of Influent	400 – 500	400 – 500
Anaerobic Recirculation, % of Influent	100	100
Internal Recirculation	300 – 400	300 – 400
Process Aeration Dissolved Oxygen, mg/l	2	2
Number of Membrane Tanks in Use	5	2 – 3
Flux rate, gfd	10 – 28.2	5 – 15

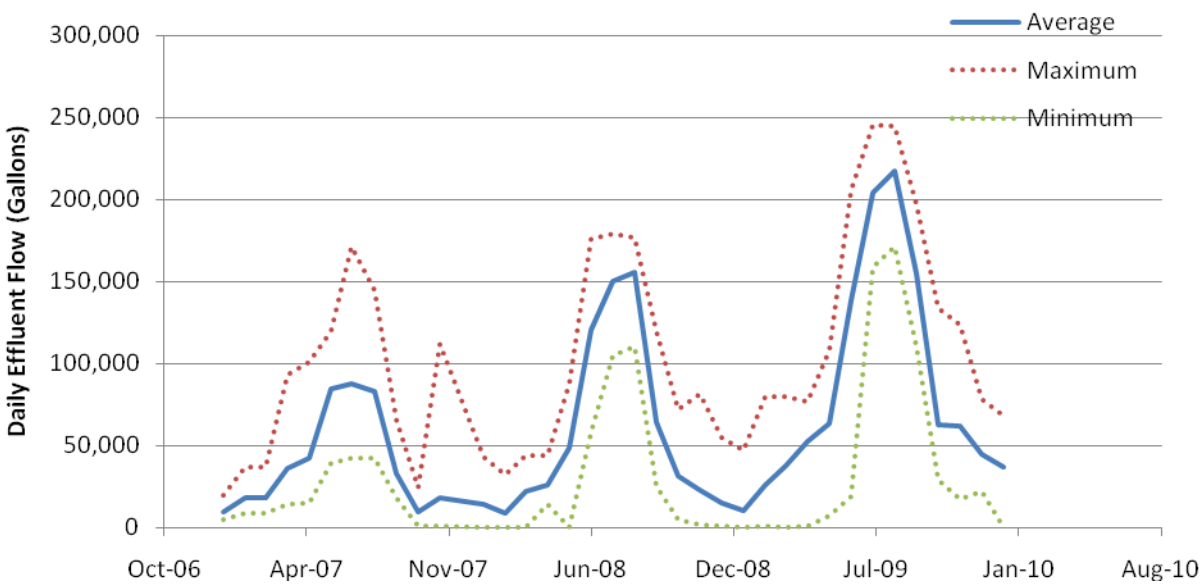


Figure 3-2: Monteray Shores Effluent Flow

The plant expansion triggered new effluent permit limits to conform to the new 2T rules (NCAC 2T .0700). The plant was completely re-configured with biological nutrient removal (BNR) to ensure compliance with new, more stringent regulatory requirements. The treatment facility was upgraded to a 4-stage activated sludge process for advanced nutrient removal followed by submerged membrane bioreactors. The membranes are the flat sheet type by Krüger with a nominal pore size of 0.08 µm. The plant was also upgraded to include ultraviolet disinfection.

The disposal system was converted from spray irrigation to a high-rate infiltration pond. Groundwater drains around the infiltration basin convey groundwater to a pump station and then to

a pond located on the DeGabrielle property to the south of the WWTP. A 5-day upset storage tank (bolted steel) was also constructed adjacent to the infiltration pond.

3.4.2 Facility Condition and Performance

According to the Wastewater Treatment and Collection Performance Annual Report, there were seven permit violations in 2009. From February to July 2009, total nitrogen, nitrate, and phosphorus limits were exceeded at various times. These violations of the permit were attributed to the gradual acclimation and adjustments to the new treatment facility process. It is noted in the Annual Report that no known environmental impacts took place in 2009. After the plant was fully operational, the fecal coliform standard was exceeded in September 2009. This permit violation was due to an issue with the ultraviolet disinfection equipment. No known effluent violations have occurred since September 2009. **Table 3-8** gives an annual summary of the effluent quality at Monteray Shores since 2007.

Table 3-8: Summary of Effluent Quality Data for Monteray Shores WWTP

Year	BOD_5 mg/l	Ammonia mg/l	Suspended Solids mg/l	Fecal Coliform / 100 ml	Nitrate mg/l	Total Phosphorus mg/l
Average						
2007	3.06	0.63	1.28	1.0	1.20	
2008	3.06	0.63	2.81	1.0	3.3	
2009	2.97	1.20	2.01	1.27	5.8	0.20
2010	3.0	1.39	2.0	1.0	2.3	
Maximum						
2007	4.0	6.8	3.0	1.0	1.94	
2008	4.0	2.3	7.0	1.0	4.46	
2009	4.0	21.7	3.0	29.0	28.1	0.20
2010	3.0	3.4	2.0	1	7.72	
Minimum						
2007	3.0	0.10	1.0	1.0	0.10	
2008	3.0	0.10	1.0	1.0	2.17	
2009	2.0	0.02	2.0	1.0	0.02	0.20
2010	3.0	0.2	2.0	1.0	0.02	

3.5 Treatment Recommendations for Future Wastewater Infrastructure

With the exception of the recently upgraded Monteray Shores WWTP, the other WWTPs in the area are extended aeration plants that meet the old standards but do not comply with the new 2T regulations. Any expansion of these WWTPs will require the entire facility to be upgraded to meet 2T requirements, including addition of 5-day reject storage and upgrades to denitrification to meet effluent nitrate limits. Also, each of the Corolla Light and Ocean Sands WWTPs are steel package

plants that are reaching the end of their useful service life. The Ocean Sands WWTP has received several NOVs and is now under a SOC to repair and rehabilitate the facility to restore condition and reliable operation by 2015. Each WWTP is approaching its permitted capacity, so significant capital expenditures to expand, upgrade, and rehabilitate or replace major components will be required for each facility within the next 5 to 10 years.

A regional approach to wastewater management could provide economies of scale in both capital as well as operating and maintenance costs by constructing one new facility in lieu of significant upgrades to three separate WWTPs. A regional wastewater system should be owned and operated by the County rather than private utilities. This would ensure equity in regards to wastewater availability and reliability throughout the Outer Banks rather than the current inequities created by multiple wastewater treatment plants and a lack of commitment to the funding for needed capital projects.

Given the lack of available land, particularly in the unsewered areas, the regional approach could also ensure that suitable sites for treatment, reject storage, and effluent disposal are available to expand sewer services. It is recommended that any new wastewater treatment facility be designed with denitrification with an effluent total nitrogen goal of 4 mg/l to take advantage of the reduced setbacks in the 2T rules, and reduce land requirements for wastewater management. The proposed effluent quality goals are presented in **Table 3-9**.

Table 3-9: Proposed Effluent Quality Goals for Outer Banks Regional WWTP

Water Quality Parameter	Monthly Average	Daily Maximum
BOD_5	$\leq$ 10 mg/l	$\leq$ 15 mg/l
TSS	$\leq$ 5 mg/l	$\leq$ 10mg/l
NH_3	$\leq$ 4 mg/l	$\leq$ 6 mg/l
Fecal Coliform	$\leq$ 14 colonies / 100 ml	$\leq$ 25 colonies / 100 ml
NO_3	$\leq$ 10 mg/l	NA
Turbidity	NA	10 NTU
Total Nitrogen	$\leq$ 4 mg/l	NA
Total Phosphorus	$\leq$ 2 mg/l	NA

4. Wastewater Treatment Technology Review

4.1 Conventional Activated Sludge for Advanced Nutrient Removal

Conventional activated sludge systems are primarily composed of an aerated, suspended growth bioreactor, liquid-solids separation (e.g., secondary clarifier), and a recycle stream for return activated sludge. A conventional activated sludge process consists of an aerated zone followed by a clarifier from which the recycle activated sludge is recycled back to the bioreactor. In the

bioreactor, microorganisms remove soluble and particulate organic matter. Secondary clarification separates the mixed liquor suspended solids (MLSS) from the treated water and to reduce the overall suspended solids concentration. The bioreactor design in conventional plug flow activated sludge systems are long and narrow.

Nitrogen and phosphorus are essential components of cells. Therefore, some nutrient removal occurs naturally in any biological treatment system, the amount depending on the quantity of sludge produced and its nutrient content. However, conventional biological treatment usually will remove approximately 20 to 30 percent of influent nutrients for metabolic growth. This phenomenon is due to the low concentration of carbonaceous organic matter in municipal influent that limits the amount of growth that will be produced, and therefore the nutrient content of that growth will be low.

An increase in biological nitrogen and/or phosphorus removal efficiency requires that the activated sludge process be modified to enhance nutrient uptake biologically or to accomplish removal through other mechanisms (e.g., chemical addition for phosphorus removal). Specifically, the control of internal recycles and the separation of reduction-oxidation zones in the activated sludge process is the widely accepted method to modify a conventional activated sludge process for advanced biological nitrogen and phosphorus removal. Several activated sludge processes can be employed with different recycle rates and locations, as follows:

- 5-stage process (Bardenpho©) – Influent to anaerobic zone followed by anoxic, aerobic, post-anoxic, aerobic process zones with a 4xQ internal recycle (aerobic ⇨ anoxic) and a 1 to 1.5xQ return activated sludge (RAS) rate (RAS ⇨ anaerobic).

- 4-stage process with sidestream – Influent to anoxic zone followed by aerobic, post-anoxic, aerobic process zones with a sidestream anaerobic zone (RAS ⇨ anaerobic), a 4xQ internal recycle (aerobic ⇨ anoxic), and a 1 to 1.5xQ RAS rate.

- Virginia Initiative Process (VIP) – Influent to anaerobic zone followed by anoxic, aerobic, post-anoxic, aerobic process zones with a 4xQ internal recycle (aerobic ⇨ anoxic), a 1xQ internal recycle (anoxic ⇨ anaerobic), and a 1 to 1.5xQ RAS rate (RAS ⇨ aerobic).

- A2O – Influent to anaerobic zone followed by anoxic and aerobic zones with a 4xQ internal recycle (aerobic ⇨ anoxic) and a 1 to 2xQ RAS rate (RAS ⇨ anaerobic).

- Modified Ludzak-Ettinger (MLE) – Influent to anoxic zone followed by an aerobic zone with a 4xQ internal recycle (aerobic ⇨ anoxic) and a 1 to 1.5xQ return activated sludge (RAS) rate (RAS ⇨ anaerobic).

- AO – Influent to anaerobic zone followed by an aerobic zone with a 1 to 1.5xQ RAS rate (RAS ⇨ anaerobic).

Typically, the 5-stage, 4-stage with sidestream, and VIP processes are the most common processes for advanced nitrogen and phosphorus removal. These three process all use a variation of the classic 5-stage process except for variations in internal recycle rates and locations. The A2O process is not as reliable as the 5-stage processes, but can achieve advanced nutrient removal with proper design and plant optimization. The MLE process is typically used for nitrogen removal only. The A2O process is typically used for high rate biological phosphorus removal only.

It should be noted that tertiary sand filtration is a critical component of advanced nutrient removal. Tertiary filters remove nutrients in the particulate phase up to 0.20 µm. Deep-bed tertiary filters can also be used for nitrate polishing via denitrification with a carbon source addition.

4.2 Integrated Fixed-Film Activated Sludge

An integrated fixed-film activated sludge (IFAS) process is an activated sludge system that contains fixed-film media in a suspended growth reactor. The fixed-film media provide biofilm growth within a suspended reactor, which increases the amount of biomass available. An increase in biomass increases nutrient removal with minimal increase in basin size or footprint. An IFAS system can be located in the anoxic zone, aerobic zone, or both zones. Secondary clarification and tertiary filtration processes are still required with an IFAS system and are designed similar to conventional and advanced activated sludge systems.

The IFAS configuration may vary by the type of activated sludge system and by the type of media used (e.g. fixed versus free-floating). Examples of activated sludge processes that have been used in conjunction with IFAS include conventional activated sludge (with or without advanced nutrient removal), the modified Ludzak-Ettinger (MLE) process, and step-denitrification. The different types of media include rope, sponge, plastic carrier, rotating biological contactor media, and trickling filter media. Additionally, the media may either be free-floating or located in a fixed frame in the bioreactor. IFAS systems are particularly popular for retrofitting plants to provide additional nitrification and BOD removal. IFAS will allow an increase in plant capacity without an increase in plant footprint. Plants with limited space for expansion, difficult subsurface conditions, or new permit limits with more stringent ammonia standards are candidates for IFAS systems.

An IFAS system is a maintenance intensive process. Free-floating systems require additional component installation over the fixed film media type, which include screens to contain the media within the tanks, screen-cleaning systems, and media recirculation pumps. Air diffusers are also required to provide mixing and to keep the free-floating media from clogging downstream screens. Sponge-type free-floating media require recycle airlift pumps and media cleaning pumps while plastic carriers do not. Additionally, free-floating media are more susceptible to hydraulic problems due to media clogging the screen. Free-floating media must be pumped to another tank during maintenance and cleaning, and redistributed afterwards.

Fixed media systems must be designed so that the media can be taken out or relocated during maintenance and cleaning. Odors are a significant concern when fixed film systems are dewatered as the media may quickly generate odors. Additionally, fixed media systems are generally more susceptible to supporting worm populations. The location of the media is more critical in fixed

media system than in free-floating systems due to the effect that substrate concentrations have on removal rates.

The purpose of an IFAS system is to increase biomass growth on the media in addition to the suspended biomass. The increase in biomass results in increased nitrification rates per unit volume and consequently will reduce the total volume required for nitrification. This phenomenon may provide more volume for denitrification and phosphorous removal processes. Typical MLSS concentrations range from 1,000 to 3,000 mg/l in IFAS systems, although concentrations as high as 5,000 mg/l have been used. The sludge volume indices (SVIs) of IFAS systems are similar to activated sludge systems with biological nitrogen removal systems.

4.3 Submerged Membrane Bioreactors

Membrane bioreactors (MBRs) use the combination of suspended growth activated sludge and membrane filtration separation processes. The use of membrane bioreactors is becoming more popular since membrane equipment costs have decreased and more stringent effluent limits are typically being required. Due to the small footprint, this technology is a viable option in land-constrained areas that are facing stricter nutrient limits or capacity upgrades. Examples of other common MBR applications include reclaimed water reuse and the development of satellite treatment plants.

MBRs must be preceded by a conventional activated sludge system, with or without advanced nutrient capabilities depending on the effluent disposal goals. The separation of reduction-oxidation zones and the use of internal recycles are still required to meet advanced nutrient removal goals. MBRs replace secondary clarification and filtration processes in conventional wastewater treatment and are typically followed by disinfection.

Different types of membranes are characterized by pore size and the pressure required to generate flow across a membrane, or the trans-membrane pressure (TMP). Micro-filtration, ultra-filtration, nano-filtration, and reverse osmosis are the four types of membrane processes in decreasing pore size and increasing TMP. Some of the major players in the MBR market in North America include GE/Zenon Environment Inc., Siemens/USFilter Corp., and Kubota/Enviroquip. Of the major players, Zenon has had the most experience and is the dominant manufacturer in this industry, especially for projects greater than 5 mgd. Some minor manufacturers that are not as common in North America include Mitsubishi, Kruger/Toray, and Koch/Puron.

The two different structures of membranes in MBRs include hollow fibers and flat plates. Hollow fiber membranes are long and narrow tubes grouped in bundles that are vertically mounted in frames and placed in a single module. They typically fall in the range of 0.04 to 0.1 micron nominal pore size. However, it should be noted that there are some hollow fiber membranes with pore sizes of 0.4 micron. Membrane flat platesare flat sheets of membranes with pore sizes between 0.08 to 0.4 micron that are separated by spacer skeletons.

While the effluent quality remains the same in both types of membranes, there are some differences concerning operational and maintenance processes. The first is that hollow fibers are more susceptible to solids buildup and do typically require more stringent screening in the pretreatment process than do flat plates. Stringy materials, such as hair, interfere with the efficiency of hollow fiber membranes and increase maintenance requirements. Hollow fiber systems have smaller MBR reactors but larger aeration basins than flat plate systems. However, for plant sizes less than 5 mgd, the overall footprint between MBR and aeration basins are approximately equal between the two types of membranes.

One of the primary advantages of MBR systems is the high quality effluent for turbidity, bacteria, and suspended solids. One common misconception of MBRs is that the technology will remove nutrients in the particulate and soluble phase. MBRs will remove nutrients in the particulate phase only, which will enhance the capability of the overall activated sludge process for nutrient removal. Submerged membranes are capable of producing high quality effluent (**Table 4-1**).

Table 4-1: Typical Effluent Quality from Submerged Membrane Bioreactor Technology

Parameter	Typical Concentration
BOD_5	< 3 mg/l
TSS	< 1 mg/l
NH3-N	< 0.5 mg/l
Total Nitrogen	< 3 mg/l
Total Phosphorus	< 0.05 mg/l
Turbidity	< 0.2 NTU

4.4 Recommendations for Wastewater Treatment Technology

The recommended technology for a new centralized wastewater treatment facility is conventional activated sludge with advanced nutrient removal and submerged membrane filtration. Stringent effluent quality limits will be required for a permit issued under the new 2T rule (15A NCAC 2T .0700), which will include total nitrogen removal, total phosphorus removal, and stringent disinfection and turbidity limitations (refer to **Table 3-1**). Real estate is at a market premium in the Southern Outer Banks area. Membrane technology is ideal due to the small footprint of the biological process and the elimination of real-estate consuming secondary clarifiers and tertiary filters. Membranes can reduce the total size of a conventional plant footprint by up to one-third. More real estate will remain for effluent disposal, open space requirements, or development.

5. Wastewater Treatment Site Alternatives Evaluation

5.1 Site Evaluation for Reject Storage

The advantages and disadvantages of alternative sites for a regional WWTP and reject storage are summarized in **Table 5-3**. Reject storage is of particular concern given its potential visual impact on the community due to the size of tanks required by the 2T Rules (5-day storage at design flow). The most cost-effective configuration for reject storage is to construct fewer, larger tanks.

The total reject storage needs for the service area (Service Area Option 3) could be met by locating reject storage on the west side of NC 12 in the existing Corolla Light No. 2 WWTP LPP fields by using tanks with wall height of approximately 26 feet. However, the visual impact of these tanks on the surrounding development would be considerable. Tanks could be designed with architectural features to minimize their visual impact but these improvements would be costly and marginally successful in softening the impact of 26 feet tall tanks. Another strategy would be to construct smaller but considerably moretanks. A cost comparison was prepared for two reject storage configurations and is provided in **Table 5-1**:

- Construct five 26 feet tall storage tanks on the DeGabrielle site.
- Construct seven 14 foot tall storage tanks on the CWS NC 12 well fields.

Table 5-1: Cost Comparison for Reject Storage Configurations

	Five 26 foot Tall Storage Tanks on DeGabrielle Site [1]	Seven 14 foot Tall Storage Tanks on CWS NC 12 Well Fields [1]
Construction Costs	$4,338,800	$5,314,000
Land acquisition	$1,400,000	$3,500,000
Wetlands Mitigation	$281,600	$0
Contingency	$1,084,700	$1,328,500
Engineering and Legal Fees	$520,700	$637,700
Total Project Costs	**$7,625,800**	**$10,780,200**

[1] *Open-top pre-stressed concrete tanks.*

Both alternatives provide a total reject storage volume of 16 MG, which is the storage requirement under Service Area Option 3. There are many other options for locating smaller 14 foot tall tanks as opposed to locating them all on the CWS NC 12 well field. However, capital costs increase significantly when reject storage is widely distributed due to piping costs to each tank site and a pump station needed at each site.

Opinions of probable construction costs are summarized in **Table 5-2**. Wetlands mitigation costs are included based on 2.0 acres of wetlands impacts on the DeGabrielle site at a 4:1 mitigation requirement. Mitigation costs are recent costs as published by N.C. Ecosystem Enhancement Program. Land acquisition costs for the DeGabrielle site are based on an estimated property value

of approximately $500,000 per acre of uplands. Land acquisition costs for the CWS NC 12 well fields are based on the acquisition cost for the CWS water system based on recent discussions between Currituck County and Carolina Water Services, Inc. Based on this analysis, it is recommended that reject storage be located on the DeGabrielle Site.

5.2 Treatment Site Evaluation

Several site alternatives were evaluated for the regional wastewater treatment plant. For each site, it was assumed that the plant will be an MBR plant utilizing flat plate membrane technology. Pretreatment includes fine screens (2 mm), grit removal, and influent equalization with a 12-hour capacity. The biological process will be a 5-stage process with internal recycles. Solids thickening or dewatering is not included in these layouts, but 14-day sludge storage is provided.

Each site plan shows an administrative building, an effluent pump station, a chemical facility, and a generator with fuel storage. Five-day reject storage will be provided in uncovered, pre-stressed concrete tanks.

The build-out capacity for the regional WWTP for each service area option is summarized in Table 1-1. Option 1 build-out is 2.0 mgd. Option 2 build-out is 2.6 mgd. Options 3 and 4 build-out flows are 3.3 mgd and 2.7 mgd, respectively.

5.2.1 Treatment at Ocean Sands and Reject Storage at DeGabrielle

One of the site alternatives for the regional facility includes locating the treatment facility at the Ocean Sands WWTP site and all of the reject storage on the DeGabrielle site. The proposed plant layout would allow for the continued operation of the existing Ocean Sands WWTP as the new plant is initially constructed. Upon completion of the first phase of the new facility, estimated at 1.2 mgd capacity, the existing Ocean Sands WWTP would be demolished to allow construction of the remaining plant or future phases. Effluent disposal on the site would be minimally affected since the regional WWTP would be constructed on the footprint of the existing plant.

Reject storage would be located on the DeGabrielle site in open-top, pre-stressed concrete tanks. A force main would convey reject to and from the reject storage tanks. The DeGabrielle site is desirable for reject storage since the maritime forest surrounding this site would conceal the tanks from view from surrounding development and Currituck Sound. Another advantage is the proximity to the Ocean Sands WWTP, located 0.5 miles to the south. The DeGabrielle site contains approximately 2.4 acres of uplands based on a wetlands delineation prepared in 2005. The remainder of this parcel is riparian wetlands. The footprint for the required reject storage is larger than 2.4 acres so wetlands impacts are unavoidable on this site. The wetlands impacts and the number of reject storage tanks are summarized in **Table 5-2**.

Table 5-2: Summary of Required Reject Storage and Wetland Impacts on DeGabrielle Site

Service Area Option	Required Reject Storage (MG)	Number of Tanks (~ 3.3 MG each)	Wetlands Impacts (acres)
1	10.0	3	0.6
2	12.9	4	1.1
3	16.3	5	1.8
4	13.4	4	1.1

5.2.2 Treatment at DeGabrielle and Reject Storage at Ocean Sands

Another alternative is to locate the WWTP on the DeGabrielle site and construct reject storage on the Ocean Sands WWTP site. This configuration would require wetland mitigation and the potentially filling in a portion of the stormwater pond on the DeGabrielle site. The inlet to this stormwater pond is located in an area of the pond that would need to be filled, and therefore would have to be relocated. Construction on the Ocean Sands WWTP site would be staged to allow the continued operation of the existing plant. The effluent disposal capacity on the Ocean Sands site would not be affected by the construction of the reject storage tanks.

5.2.3 Treatment at Corolla Light No. 2 and Reject Storage at DeGabrielle

In this alternative, the WWTP would be located on the Corolla Light No. 2 site. The existing 0.1 mgd of treatment capacity would be utilized through the first stage of construction. The existing treatment facility would then be demolished to allow for construction of the regional WWTP. Reject storage would be located at the DeGabrielle Site. The maritime forest that surrounds the DeGabrielle Site would hide the tanks from the view of NC-12. Wetlands impacts are unavoidable on this site, so some mitigation would be required. Wetland impacts are summarized on **Table 5-2**. The major disadvantage of locating the reject storage on the DeGabrielle Site is the longer distance from the Corolla Light No. 2 WWTP site.

5.3 Summary of Treatment and Effluent Disposal Options

The options for locating the regional WWTP include the existing Ocean Sands WWTP site, the DeGabrielle site, Corolla Light No. 2, and Corolla Light 1 are summarized in **Table 5-3**. The Corolla Light No. 1 WWTP site was not considered since this site was determined to have significant effluent disposal capacity and this was considered more important for disposal than as a WWTP site. The Corolla Light Phase 12 site cannot accommodate more than a 1.0 mgd WWTP if reject storage is co-located on the site and therefore could not provide the build-out treatment capacity for any of the service area options.

These options offer the advantage of isolating WWTP and reject storage tanks from surrounding development. The Ocean Sands site and Corolla Light 2 site are existing WWTP sites so they would avoid the land use and zoning impacts associated with utilizing a new site for wastewater

management. For two of these options, the WWTP and reject storage would be located within 0.5 miles and therefore reduces the cost associated with reject storage piping and pumping. The disadvantages to these options are that wetlands impacts will be incurred on the DeGabrielle site. Also, due to the presence of wetlands, low bearing soils may be prevalent which would require pile foundations to support structures. No soils information is available for this site to confirm the type of soils and whether poor soils may be limited to just the upper layers.

5.4 Recommended Wastewater Treatment Site Alternative

The recommended alternative is to locate the WWTP on the existing Corolla Light 2 WWTP site and reject on the DeGabrielle site. The alternative is preferred since larger reject storage tanks can be located on the DeGabrielle site, yet still remain isolated from surrounding development and likely from the proposed Mid Currituck Bridge. Also, acquisition of the DeGabrielle site would also be beneficial for effluent disposal since the existing pond could be used for storage of groundwater from groundwater lowering systems.

Another advantage in the regional approach considered in this Master Plan is that the land requirements for wastewater management are reduced within each subdivision. The benefit for Ocean Sands is locating reject storage on the DeGabrielle site preserves land on the existing Ocean Sands WWTP site to expand the existing effluent disposal system. This would reduce the amount of land required for effluent disposal on Sections G and T or on utility open space areas. The benefit for Corolla Light is that less land will be utilized for reject storage. Existing land designated for wastewater management would be re-configured for effluent disposal as discussed in Section 6.

Conceptual layouts for reject storage tank layouts on the DeGabrielle site for Options 1, 2 and 3 are shown on **Figures 5-1**, **5-2**, and **5-3**, respectively. Tank configuration for Option 4 would be very similar to what is shown for Option 2 in **Figure 5-2**. Option 3 would require the largest WWTP facility at 3.3 MGD treatment capacity. The conceptual layout for this option is shown in **Figure 5-4**. All other options would require a smaller footprint, and would therefore fit on the Corolla Light 2 WWTP site. **Figure 5-5** shows the overall piping plan from the regional WWTP to the reject storage site. This layout would require approximately 2.5 miles of pipeline from the WWTP to the reject storage tanks.

SCALE

0 25 50 100 Feet

1 inch = 100 feet

N W E S

HAZEN AND SAWYER
Environmental Engineers & Scientists

Currituck

Figure 5-1: Conceptual Reject Storage Layout for Option 1 (Ocean Sands and Corolla Light)

Comprehensive Wastewater
Master Plan for the
Currituck County Southern Outer Banks

SCALE

0 25 50 100 Feet

1 inch = 100 feet

N W E S

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Currituck

Figure 5-2: Conceptual Reject Storage Layout for Option 2 (Ocean Sands, Corolla Light and Monteray Shores

Comprehensive Wastewater
Master Plan for the
Currituck County Southern Outer Banks

SCALE

0 25 50 100 Feet

1 inch = 100 feet

N W E S

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Currituck

Figure 5-3: Conceptual Reject Storage Layout for Option 3 (Ocean Sands, Corolla Light, Monteray Shores and Unsewered Areas)

Comprehensive Wastewater Master Plan for the Currituck County Southern Outer Banks

SCALE

0 25 50 100 Feet

1 inch = 100 feet

N W E S

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Figure 5-4 : Conceptual WWTP Layout for Option 3 (Ocean Sands, Corolla Light, Monteray Shores, and Unsewered Areas)

Comprehensive Wastewater Master Plan for the Currituck County Southern Outer Banks

SCALE

0 750 1,500 Feet

1 inch = 1,500 feet

N W E S

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Figure 5-5 : Regional WWTP and Reject Storage

Comprehensive Wastewater Master Plan for the Currituck County Southern Outer Banks

Table 5-3: Advantages and Disadvantages of Alternative Regional WWTP Sites

WWTP Site	Reject Storage	Advantages	Disadvantages
Existing Ocean Sands WWTP Site	DeGabrielle Site	1. Reject storage isolated from surrounding development. 2. Proximity of reject storage to WWTP (~ 0.5 miles). 3. Regional WWTP uses existing WWTP site. 4. Use of DeGabrielle site for reject allows for reconfiguration and expansion of Ocean Sands disposal system. 5. Potentially frees up a portion of Corolla Light 2 site for re-development. Plan to use Corolla Light 1 and Phase 12 sites for disposal.	1. Wetlands impact on DeGabrielle site (0.6 – 1.8 acres depending upon service area option). 2. Unknown if reject storage presents a conflict with land use plan since DeGabrielle site is "Conservation Area." 3. Potential opposition from Coastland Development regarding use of site for regional WWTP. 4. May require pile foundations on DeGabrielle site depending upon presence of low bearing soils.
DeGabrielle Site	Ocean Sands WWTP Site	1. WWTP is isolated from surrounding development. 2. Proximity of reject storage to WWTP (~ 0.5 miles). 3. Reject storage isolated from development and view of NC 12. 4. Use of DeGabrielle site for WWTP allows for reconfiguration and expansion of Ocean Sands disposal system.	1. 0.6 ac wetlands impacts on DeGabrielle site and may require filling small portion of pond. 2. Land use plan restrictions regarding WWTP located in "Conservation Area." 3. Potential opposition from Coastland Development regarding use of site for reject storage. 4. Construction sequencing issue – cannot construct all reject until existing OSWWTP is demolished. 5. May require pile foundations on DeGabrielle site depending upon presence of low bearing soils.
Corolla Light 2 WWTP Site	DeGabrielle Site	1. WWTP uses existing wastewater site. 2. Reject storage isolated from development and view of NC 12. 3. Use of DeGabrielle site for WWTP allows for reconfiguration and expansion of Ocean Sands disposal system. 4. County can obtain rights to land for regional WWTP from Outer Banks Ventures 5. Corolla Light 2 WWTP Site not desirable for effluent disposal	1. WWTP is close to existing residential and commercial development. 2. Higher costs related to modifications to reduce visual, noise, and odor impacts from WWTP given its proximity to development. 3. Wetlands impact on DeGabrielle site (0.6 – 1.8 acres depending upon service area option)
Corolla Light 1			1. Site was not considered for treatment as this site has significant effluent disposal capacity.

6. Effluent Disposal Alternatives

This section provides a summary of effluent disposal alternatives available to Currituck County. Section 6.1 provides a discussion of the effluent disposal methods available to Currituck County and the reasons a particular disposal method is or is not viable in the county. Section 6.2 provides an explanation of the analysis required for the recommended effluent disposal option.

6.1 Evaluation of Effluent Disposal Methods in Currituck County

6.1.1 Conventional Land Application via Spray Irrigation

Land application via spray irrigation is a method for effluent disposal used for small municipal wastewater systems that have very limited treatment. Generally, only limited secondary treatment is provided prior to irrigation, and does not facilitate other effluent disposal options that require a high level of treatment, such as reuse or high rate infiltration. Additionally, land application systems do not maximize the value and service of the property due in part to the large buffer areas that are required. Research suggests that land application of secondary treated effluent may reduce the porosity of soil (i.e. clogging), and reduce the infiltration rate over time (Clanton and Slack, 1987). More land may therefore be required to dispose of the same quantity of effluent as the system ages. Given land costs in the Outer Banks and the large land requirements for this disposal alternative, land application via spray irrigation is not considered a viable option.

6.1.2 Reclaimed (Reuse) Water via Spray Irrigation

Treatment to reuse quality effluent requires a high level of secondary treatment (including tertiary filtration) to meet reuse effluent quality standards. Reuse quality effluent allows for greater utilization of spray irrigation acreage and the potential consideration of other effluent disposal methods, to include:

- Irrigation of golf courses, residential lawns, parks and school grounds.
- Irrigation of crops not for human consumption.
- Industrial Uses, such as cooling and washdown water.
- High rate infiltration.

Reuse application rates must be determined by a licensed soil scientist. Site selection requires analysis of soil depth, permeability, and depth to groundwater. Reuse is not considered viable as a standalone option given the significant land requirements. Ed Andrews & Associates evaluated the use of reclaimed water for irrigation for the Ocean Sands subdivision in 2000. Andrews determined that irrigation rates of 1.9 to 3.9 inches/week are possible depending upon soil conditions at the specific irrigation sites. Land requirements for reclaimed water irrigation are provided in **Table 6-1** based on the application rate of 1.75 inches/week in the proposed reclaimed water rules. Land required for Option 1 ranges from 132 to 272 acres. The total open space available in Corolla Light

and Ocean Sands is approximately 300 acres. At the application rate of 1.75 inches/week, nearly every acre of open space would be needed for reclaimed water irrigation. It is not practical or cost-effective to construct the infrastructure needed to irrigate every acre of open space.

Therefore, traditional "conjunctive use" reuse applications (via purple pipe) should be considered as new residential homes and/or commercial developments are planned in the Outer Banks to reduce potable water demands and reduce the demand on the effluent disposal system.

Table 6-1: Summary of Land requirements for Reclaimed Water Spray Irrigation

Service Area Option	Service Area Description	Build-out Flow (mgd)	Acreage Required for Reclaimed Irrigation (acres)
1	Ocean Sands and Corolla Light	2.00	295
2	Ocean Sands, Corolla Light, and Monteray Shores	2.58	380
3	Ocean Sands, Corolla Light, Monteray Shores, Whalehead Subdivision, Corolla Village, and Ocean Hill	3.27	481
4	Ocean Sands, Corolla Light, Whalehead Subdivision, Corolla Village, and Ocean Hill	2.69	396

6.1.3 Surface Water (Direct) Discharge

Direct discharge of wastewater to surface waters in Currituck County is not a viable option. DWQ does not allow ocean outfall discharges for oxygen-consuming wastes. Direct discharge of treated wastewater to Currituck Sound is not feasible due to DWQ concerns regarding toxicity of introducing freshwater into saltwater, nutrient loading into receiving waters, coliform contamination of public beaches or nursery areas, and other water quality concerns. Currituck County ordinances also prohibit discharge of wastes into surface waters (UDO 9.2.7.2).

6.1.4 Deep Well Injection

Currently, the NC Administrative Code (15A NC 02C .0209) and Section 143-214.2 of the General Statutes do not permit disposal of treated wastewater by deep well injection. The enabling legislation was enacted in reaction to an improperly designed deep well injection system in Wilmington, North Carolina. However, requirements have since been established by the Environmental Protection Agency (EPA) that require Class 1 injection wells be designed and constructed to restrict injection fluids from moving vertically toward an underground source of drinking water. An EPA report found that well failures affecting public health were due to historic practices that are no longer acceptable under the EPA regulations, and that current Class 1 regulations are protective of human health and the environment (USEPA, 2001).

An effort to change these rules to permit disposal of treated effluent by deep-well injection could result in millions of dollars of capital cost savings to Currituck County and provide an additional wastewater effluent disposal option. Although deep well injection is prohibited in North Carolina, a few other states (e.g. Florida) utilize this effluent disposal method due to similar challenges that currently affect Currituck County, including NPDES discharge restrictions related to nutrient sensitive waters and high costs associated with land application systems.

During the N.C. General Assembly short session (summer 2009), House Bill 643 was passed that authorized the Environmental Review Commission (ERC) to study issues related to the use and storage of reclaimed water, which includes deep well injection. The ERC has been authorized to study the non-consumptive uses, land requirements for spray irrigation, and aquifer storage as an effluent disposal alternative. A final report and recommendations are due to the General Assembly in the summer of 2011. A potential application for deep well injection is a salt water intrusion barrier.

6.1.5 High Rate Infiltration

Rapid infiltration is a method of effluent disposal that requires much less land than conventional land application systems. Rapid infiltration systems involve the application of highly treated wastewater effluent into shallow basins constructed in deep and permeable deposits of highly porous soils. These systems can be constructed with wet or dry pond configurations. These systems are typically classified by the presence of groundwater lowering devices (i.e. well pumps, ditches, etc.) which artificially lower the head in an infiltration pond, allowing a higher rate of disposal.

Infiltration rates for rapid infiltration must be determined by a licensed soil scientist or Professional Geologist. Site selection requires analysis of soil depth, permeability, and depth to groundwater. Higher infiltration rates and reduced buffer requirements can be utilized by treating effluent to reuse quality. Hydraulic control of area groundwater levels can yield more consistent performance of rapid infiltration basins. Advantages to rapid infiltration include the reduction of land area and energy requirements, thereby reducing operational costs.

In North Carolina, there are 34 existing rapid infiltration systems, located primarily in coastal counties. Currituck County currently owns two high rate infiltrations systems; one serving the Moyock Commons Sanitary District and another system serving the Ocean Sands WWTP. The Ocean Sands system is allowed to dispose of wastewater in excess of 1.75 inches of wastewater effluent per week (7.65 gpd/SF) due to its coastal area classification. High rate infiltration is the most economical and practicable effluent disposal alternative for the Southern Outer Banks.

6.2 Effluent Disposal Alternatives Analysis

6.2.1 Evaluation Methodology

Hazen and Sawyer subcontracted with Edwin Andrews & Associates, P.C. to provide hydrogeologic, agronomic, and soils consulting services to evaluate effluent disposal alternatives.

The full hydrogeological evaluation is included as Attachment A. This discussion provides a general evaluation of the following:

- Expansion of existing high-rate infiltration systems.
- New high-rate infiltration in open space or other available properties.
- Replacement of existing LPP fields with high-rate infiltration.

All of the activities relating to wastewater, stormwater, and some of the water resource activities appear to utilize the Surficial Aquifer, which is typically less than 60 feet thick. Existing high rate disposal sites are analyzed to in this evaluation using steady state MODFLOW simulations based on previously collected data for each area. Two regions were modeled using Visual MODFLOW™; the Corolla Light subdivision and the Ocean Sands subdivision. Each area was modeled at a maximum potential loading of 10 gpd/SF. The modeling efforts were a simplified transient state analysis based on historic and generally calibrated data to known water levels in 2008 in the Corolla Light area and 2010 at Ocean Sands area.

In the Corolla Light area, an average hydraulic conductivity for the surficial sand deposits of 45 feet per day was used in model simulations. The aquifer thickness varies with a low conductivity layer beneath areas where clay is suspected being set at 20 feet. Other areas consist of sand to more than 50 feet below land surface. Previous aquifer testing at five locations in the Corolla Light area determined hydraulic conductivities in the range from 30 to 50 feet per day.

In the Ocean Sands area, an average hydraulic conductivity for the surficial sand deposits of 45 feet per day was used in model simulations. The aquifer thickness varies with a low conductivity layer beneath areas where clay is suspected being set at 20 feet. Other areas consist of sand to more than 50 feet below land surface (eastern portion of the existing site). Based on previous aquifer testing at five locations in the Ocean Sands area, calculated hydraulic conductivities ranged from 28 to 60 feet per day.

6.2.2 Effluent Disposal Alternatives

The sites evaluated for as potential high-rate infiltration disposal sites are shown in **Figure 6-1**. This evaluation focused on the existing sites utilized for wastewater management in Corolla Light and Ocean Sands, as well as other available properties or open space areas. Possible land planning adjustments or final design considerations could affect the actual effluent disposal capacity from the modeled capacity stated herein. This analysis is intended to document the possible effluent disposal capacities. Table 6-1 summarizes modeled disposal capacity via high-rate infiltration for each site as well as an “estimated” disposal capacity that accounts for some uncertainty in final configuration of the disposal system. A thorough hydrogeologic and soils analysis would be required to validate these assumptions and findings in this report.

The MODFLOW™ model was calibrated to water level data collected in 2008 for the Corolla Light area. A loading model was performed simulating maximum loading of 10 gpd/SF at four alternative

sites in Corolla Light and estimated disposal capacity is summarized in **Table 6-2**. For each simulation, groundwater management drains were placed at -2.0 feet MSL at a distance of 50 feet of the high rate disposal area. Corolla Light Phase 12 site (Site B):

- LPP field at Corolla Light WWTP No. 2 on west side of NC 12 (Site C).
- LPP field at Corolla Light WWTP No. 2 on east side of NC 12 (Site D).

The existing Corolla Light WWTP No. 1 site (Site A) is desirable as an effluent disposal site given its high elevation and hydraulic gradient to the water table. This site was evaluated assuming that the existing WWTP was abandoned and the site would be re-configured to maximum available area for effluent disposal. The potential high-rate infiltration capacity of Site A is estimated simulated at approximately 900,000 gpd. The undeveloped Parcel 12 in Corolla Light (Site B) is located to the south of the Carolina Water Service water treatment plant. This site was estimated to have a maximum high-rate infiltration capacity of 400,000 gpd. The Corolla Light WWTP No. 2 sites were evaluated assuming the existing LPP fields were abandoned and re-configured as a high-rate infiltration system. The estimated disposal capacity of Site C (east side of NC 12) is 700,000 gpd and the estimated disposal capacity of Site D (west side of NC 12) is 1,100,000 gpd. There is a concern regarding the use of Site C for high-rate infiltration in that groundwater lowering systems are required to achieve the stated capacities herein. Groundwater lowering would impact the wetlands that exist to the south of Site C and could substantially reduce the capacity of high-rate infiltration on this site.

The model for the Ocean Sands area was calibrated to water levels collected in 2009 and 2010 at Section F. Using the calibrated model, a loading model was performed simulating maximum loading at ten sites. The estimated disposal capacity is summarized in **Table 6-2**. The existing Ocean Sands WWTP site (Site E) could be re-configured to provide 120,000 to 180,000 square feet of disposal area accounting for 50 foot setbacks from the existing canal and additional groundwater management drains. It is estimated that the Ocean Sands WWTP site could accommodate up to 1,000,000 gpd depending on the final configuration.

Open space areas within the Ocean Sands were also evaluated as potential high-rate infiltration sites. Site H is the open space area in Ocean Sands Section O and is estimated to have a high-rate infiltration capacity of 900,000 gpd. Site M is the open space area between Ocean Sands Sections D and E and is estimated to have a high-rate infiltration capacity of 700,000. Site K, the open space between Ocean Sands Sections E and F, could accommodate a high-rate infiltration system with approximately 112,260 SF and up to 1,000,000 gpd of effluent disposal. However, Section F currently experiences frequent flooding so a detailed evaluation would be required to confirm if the groundwater lowering system could manage water levels sufficiently to mitigate any potential flooding impacts.

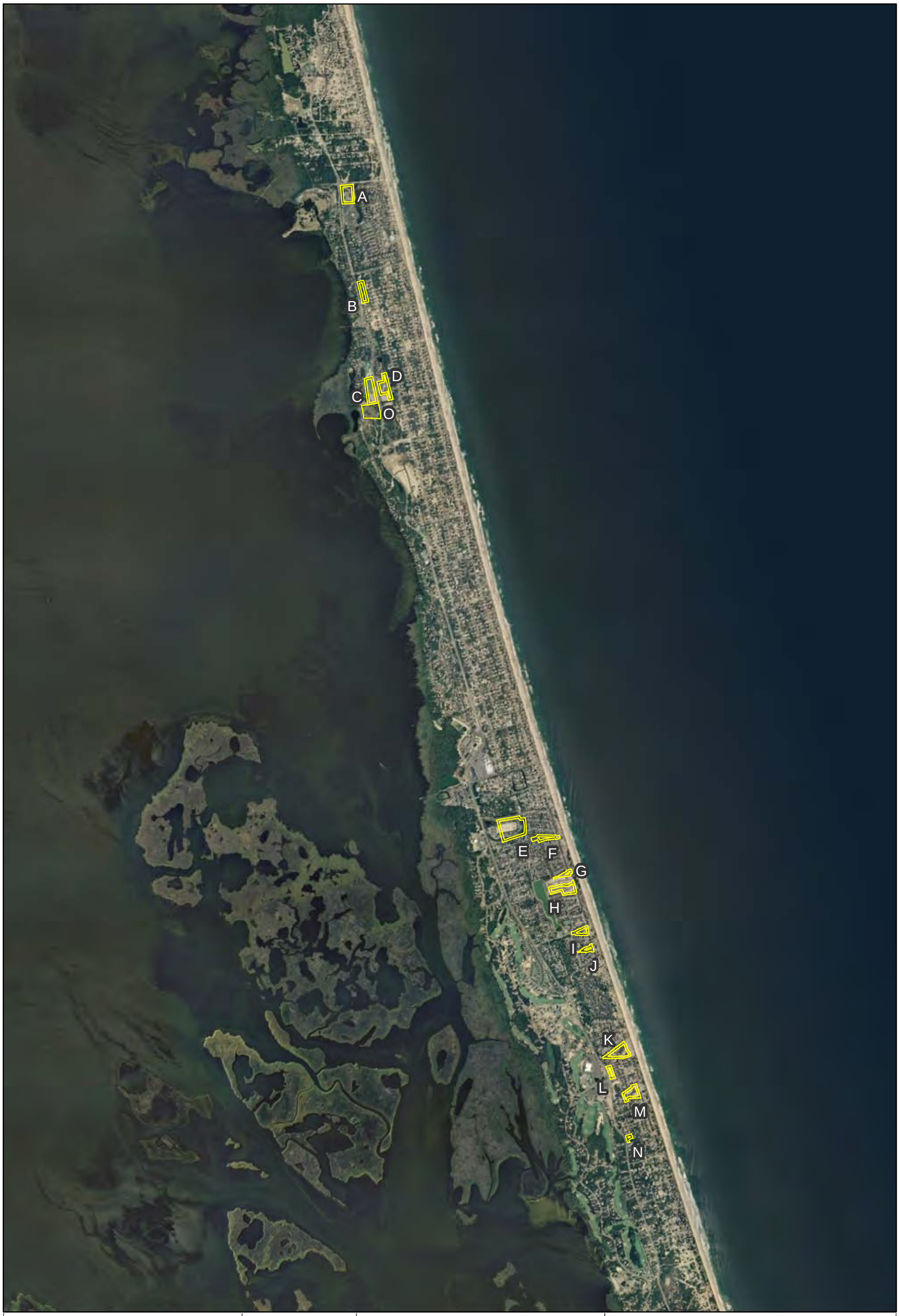

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Figure 6-1
Potential Effluent Disposal Sites

Comprehensive Wastewater Masterplan for the Currituck County Southern Outer Banks

6.3 Effluent Disposal Recommendations

The recommended sites for effluent disposal via high-rate infiltration are provided in **Table 6-2** for each service area option. **Table 6-3** includes the estimated disposal capacity for each site based on the modeling assumptions described in Section 6.2.2. For the sites recommended for effluent disposal, a "planned disposal capacity" is included based on a loading rate of 7.5 gpd/SF, which matches the permitted loading rate for the Ocean Sands WWTP. This is a more conservative estimate of the disposal capacity at each site for long-term planning purposes and represents the likely capacity to be permitted given the number of uncertainties at this stage of planning, including:

- Presence of clay, peat or other soils with low conductivity
- Actual hydraulic conductivity at each site
- Variability in conductivity within a particular site
- Impacts to adjacent wetlands
- Impacts on drainage and flooding in adjacent areas

6.3.1 Option 1 – Ocean Sands and Corolla Light

For Option 1 (Ocean Sands and Corolla Light), the recommendations for effluent disposal are shown in **Figure 6-2** and summarized as follows:

- **Site C:** Abandon existing LPP fields at Corolla Light WWTP No. 2 and develop a high-rate infiltration system with an infiltration capacity of 300,000 gpd.
- **Site E**: Re-configure the Ocean Sands WWTP disposal system to utilize more area (since setbacks are reduced) to provide a capacity of 750,000 gpd. Remove all remaining rotary distributors and utilize fixed spray heads. Water from the groundwater lowering system would be conveyed to the existing canal surrounding the site.
- **Site M**: Develop a high-rate infiltration system with a capacity of 560,000 gpd. Water from the groundwater lowering system would be conveyed to the pond on the DeGabrielle site for re-use for irrigation or infiltration into Currituck Sound.
- **Site O:** Develop a high-rate infiltration system with a capacity of 170,000 gpd on the uplands of the Food Lion Tract. Water from the groundwater lowering system would be conveyed to a pond within Corolla Light for re-use for irrigation or infiltration into Currituck Sound.

The recommended modifications would provide an estimated disposal capacity of 2,105,000 gpd to meet the build-out wastewater flow needs of 2.0 mgd. The effluent disposal capacity developed in each subdivision approximately balances with the wastewater needs for each area. Groundwater pumped from the groundwater lowering systems would be conveyed to existing ponds where they could be stored for irrigation use or infiltration into Currituck Sound. It is expected that groundwater from the GWL may have elevated levels of iron given high iron concentrations in the surficial aquifer.

Development of Site M would not be required until the undeveloped areas in Ocean Sands (Sections G and T) are developed. An advantage in conveying groundwater directly to ponds is that storage in the ponds will allow for some aeration and removal of iron prior to use for irrigation or if the ponds overflow into Currituck Sound.

Table 6-2: Summary of Estimated Disposal Capacity via High-Rate Infiltration

Site	Site Description	Net Disposal Area (SF)	Modeled Loading Rate (gpd/SF)	Modeled Disposal Capacity (gpd)	Estimated Disposal Capacity (gpd)
A	Corolla Light WWTP 1	116,888	10	1,168,880	0 - 900,000
B	Corolla Light Phase 12 Site	43,338	10	433,380	0 - 400,000
C	Corolla Light WWTP 2 – East	78,659	10	786,590	0 - 750,000 [1]
D	Corolla Light WWTP 2 – West	117,523	10	1,175,230	0 – 1,100,00
E	Existing Ocean Sands WWTP Site	121,345	10	1,213,450	0 - 1,000,000
F	OS Section Q – Open Space	19,836	10	198,360	0 – 150,000 [2]
G	OS Section O – Open Space	3,276	10	32,760	0
H	OS Section O – Open Space	97,700	10	977,000	0 – 900,000
I	OS Section H/O – Open Space	29,488	10	294,880	0 – 250,000
J	OS Section H – Open Space	7,931	10	79,310	0
K	OS Section E/F – Open Space	111,226	10	1,112,260	0 - 1,000,000
L	OS Section E – Open Space	8,542	10	85,420	0 – 75,000
M	OS Section D/E – Open Space	74,804	10	748,040	0 – 700,000
N	OS Section D – Open Space	1,704	10	17,040	0
O	Food Lion Site	17,000 [3]	10	170,000	170,000

[1] *Actual disposal capacity could potentially be much lower to avoid impacts to off-site wetlands.*
[2] *Impact of high-rate infiltration on flooding in Section F is not known.*
[3] *Net disposal are reflects size of modeled basin. Potential disposal area could be larger than modeled here because the total area of uplands is estimated to be greater than 4.5 acres. The modeled disposal capacity was used for planning of this site because actual could be higher.*

Table 6-3: Recommended High-Rate Infiltration Sites and Capacities

			OPTION 1		OPTION 2		OPTION 3		OPTION 4	
Site	**Site Name**	**Estimated Disposal Capacity [1] (gpd)**	**Planned Disposal Capacity [2] (gpd)**	**GWL Pump Rate [3] (gpd)**	**Planned Disposal Capacity [2] (gpd)**	**GWL Pump Rate [3] (gpd)**	**Planned Disposal Capacity [2] (gpd)**	**GWL Pump Rate [3] (gpd)**	**Planned Disposal Capacity [2] (gpd)**	**GWL Pump Rate [3] (gpd)**
A	Corolla Light No. 1	900,000	--	--	200,000	300,000	650,000	975,000	325,000	487,500
B	Corolla Light Phase 12	400,000	325,000	487,500	325,000	487,500	325,000	487,500	325,000	487,500
C	Corolla Light No. 2 - West	1,100,000	300,000	--	700,000	1,050,000	700,000	1,050,000	700,000	1,050,000
E	Ocean Sands WWTP	1,000,000	750,000	1,125,000	750,000	1,125,000	750,000	1,125,000	750,000	1,125,000
I	Ocean Sands Section H/O	250,000	--	--	--	--	--	--	--	--
K	Ocean Sands Section E/F	1,000,000	--	--	--	--	300,000	450,000	--	--
M	Ocean Sands Section D/E	700,000	560,000	840,000	560,000	840,000	560,000	840,000	560,000	840,000
O	Food Lion Tract	170,000	170,000	255,000	170,000	255,000	170,000	255,000	170,000	255,000
TOTAL		**6,120,000**	**2,105,000**	**2,707,500**	**2,705,000**	**4,057,500**	**3,455,000**	**5,182,500**	**3,430,000**	**5,145,000**

[1] *Estimated disposal capacity based on approximately 10 gpd/SF loading and assumptions outlined in Section 6.2.1.*
[2] *Planned disposal capacity is a conservative estimate of permitted disposal capacity.*
[3] *Groundwater lowering system pump rate based on a ratio of groundwater pumped to effluent disposal of approximately 1.5:1.*

GWL = groundwater lowering system

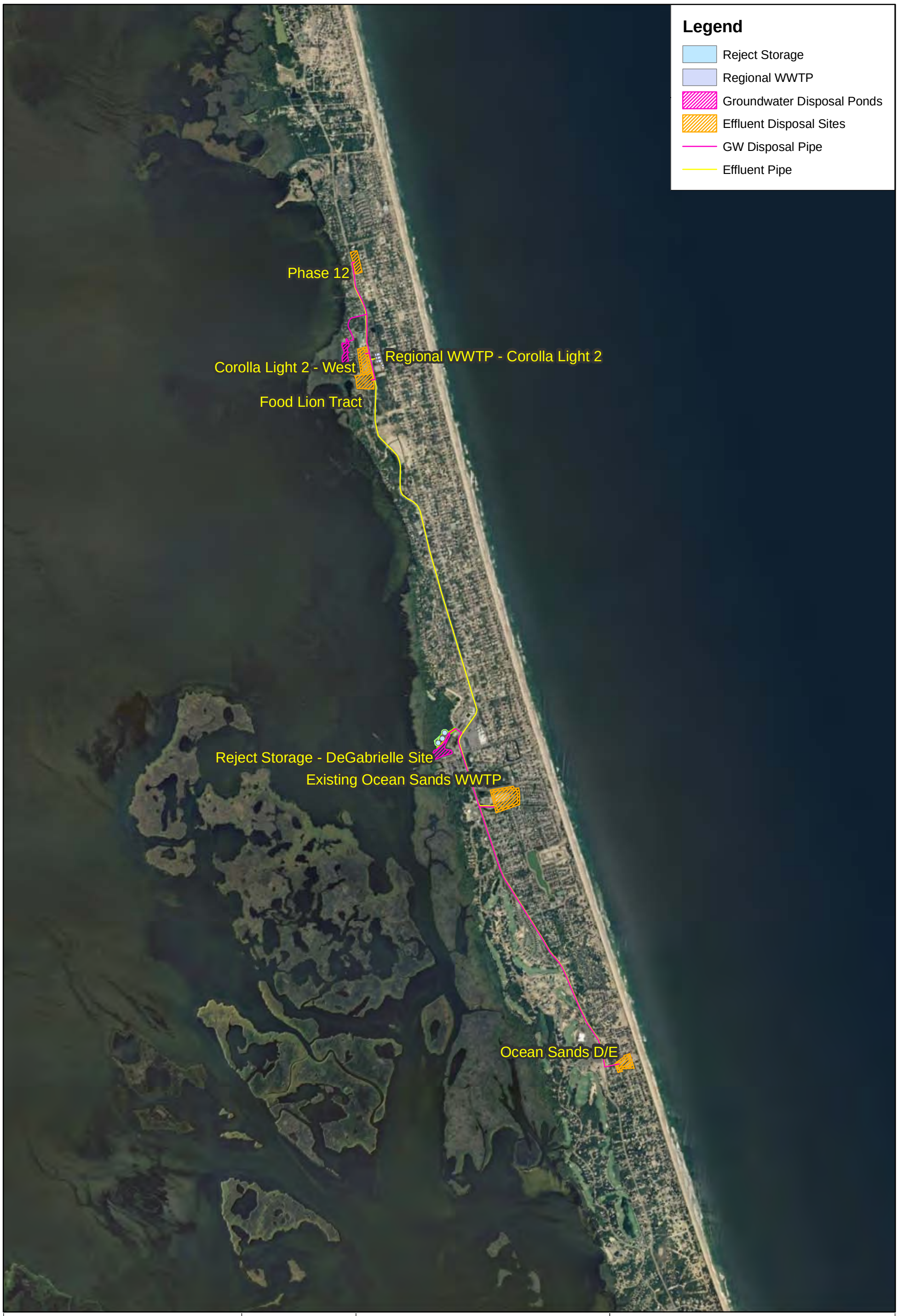

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Figure 6-2 : Recommended Effluent Disposal for Option 1 (Ocean Sands and Corolla Light)

Comprehensive Wastewater Master Plan for the Currituck County Southern Outer Banks

6.3.2 Option 2 – Ocean Sands, Corolla Light, and Monteray Shores

For Option 2 (Ocean Sands, Corolla Light, and Monteray Shores), the recommendations for effluent disposal are provided in **Figure 6-3** and summarized as follows:

- **Site A**: Demolish the existing Corolla Light WWTP No. 1 and re-configure site for high-rate infiltration at a capacity of 200,000 gpd. Water from the groundwater lowering system would be conveyed to a pond within Corolla Light for re-use for irrigation or infiltration into Currituck Sound.

- **Site B**: Develop a high-rate infiltration system with a capacity of 325,000 gpd at Phase 12 in Corolla Light. Water from the groundwater lowering system would be conveyed to a pond within Corolla Light for re-use for irrigation or infiltration into Currituck Sound.

- **Sites C**: Abandon existing LPP fields at Corolla Light WWTP No. 2 and develop a high-rate infiltration system with an infiltration capacity of 700,000 gpd.

- **Site E**: Re-configure the Ocean Sands WWTP disposal system to utilize more area (since setbacks are reduced) to provide a capacity of 750,000 gpd. Remove all remaining rotary distributors and utilize fixed spray heads. Water from the groundwater lowering system would be conveyed to the existing canal surrounding the site.

- **Site M**: Develop a high-rate infiltration system with a capacity of 560,000 gpd at Site M (open space between Ocean Sands Section D and E). Water from the groundwater lowering system would be conveyed to the pond on the DeGabrielle site for re-use for irrigation or infiltration into Currituck Sound.

- **Site O:** Develop a high-rate infiltration system with a capacity of 170,000 gpd on the uplands of the Food Lion Tract. Water from the groundwater lowering system would be conveyed to a pond within Corolla Light for re-use for irrigation or infiltration into Currituck Sound.

The recommended modifications would provide an estimated disposal capacity of 2,705,000 gpd to meet the build-out wastewater flow needs of 2.58 mgd. The effluent disposal capacity developed in each subdivision approximately balances with the wastewater needs for each area with the exception of Monteray Shores. These recommendations assume that Monteray Shores would be served but the existing facilities would not be available to the County.

Groundwater pumped from the groundwater lowering systems would be conveyed to existing ponds where the water could be stored for irrigation use or infiltration into Currituck Sound. It is expected that groundwater from the GWL may have elevated levels of iron given high iron concentrations in the surficial aquifer. An advantage in conveying groundwater directly to ponds is that storage in the ponds will allow for some aeration and removal of iron prior to use for irrigation or if the ponds overflow into Currituck Sound.

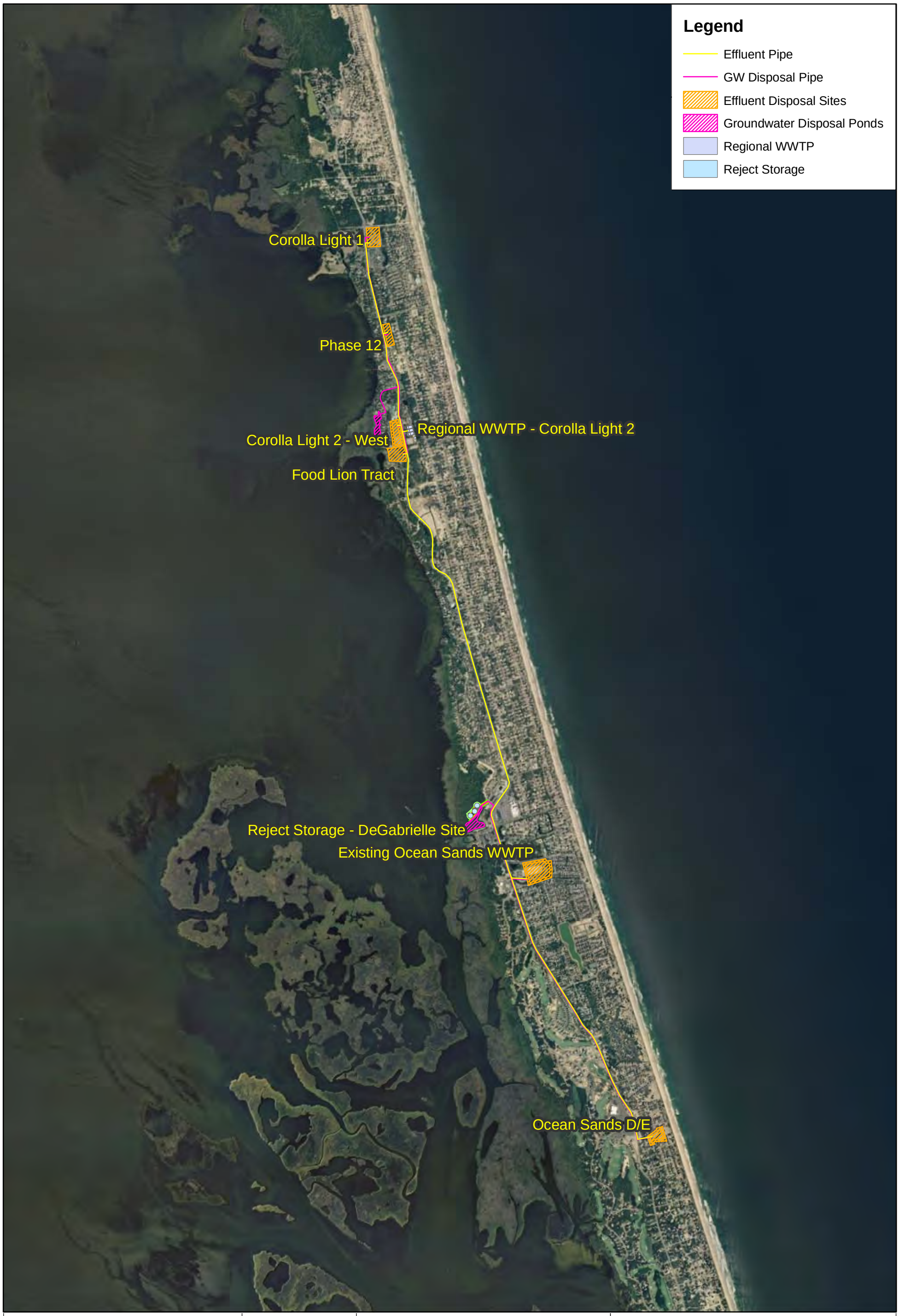

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Figure 6-3 : Recommended Effluent Disposal for Option 2 (Ocean Sands, Corolla Light and Monteray Shores)

Comprehensive Wastewater Master Plan for the Currituck County Southern Outer Banks

6.3.3 Option 3 – Ocean Sands, Corolla Light, Monteray Shores, Corolla Village, Ocean Hill, and Whalehead

For Option 3, recommendations for effluent disposal are shown in **Figure 6-4** and summarized as follows:

- **Site A**: Demolish the existing Corolla Light WWTP No. 1 and re-configure site for high-rate infiltration at a capacity of 650,000 gpd. Water from the groundwater lowering system would be conveyed to a pond within Corolla Light for re-use for irrigation or infiltration into Currituck Sound.

- **Site B**: Develop a high-rate infiltration system with a capacity of 325,000 gpd at Phase 12 in Corolla Light. Water from the groundwater lowering system would be conveyed to a pond within Corolla Light for re-use for irrigation or infiltration into Currituck Sound.

- **Site C**: Abandon the existing LPP fields at Corolla Light WWTP No. 2 and develop a high-rate infiltration system with a capacity of 700,000 gpd.

- **Site E**: Re-configure the Ocean Sands WWTP disposal system to utilize more area (since setbacks are reduced) to provide a capacity of 750,000 gpd. Remove all remaining rotary distributors and utilize fixed spray heads. Water from the groundwater lowering system would be conveyed to the existing canal surrounding the site.

- **Site K**: Develop a high-rate infiltration system with a capacity of 300,000 gpd at Site K (open space between Ocean Sands Sections E and F). Water from the groundwater lowering system would be conveyed to the pond on the DeGabrielle site for re-use for irrigation or infiltration into Currituck Sound.

- **Site M**: Develop a high-rate infiltration system with a capacity of 560,000 gpd at Site M (open space between Ocean Sands Section D and E). Water from the groundwater lowering system would be conveyed to the pond on the DeGabrielle site for re-use for irrigation or infiltration into Currituck Sound.

- **Site O:** Develop a high-rate infiltration system with a capacity of 170,000 gpd on the uplands of the Food Lion Tract. Water from the groundwater lowering system would be conveyed to a pond within Corolla Light for re-use for irrigation or infiltration into Currituck Sound.

The recommended modifications would provide an estimated disposal capacity of 3,455,000 gpd to meet the build-out wastewater flow needs of 3.27 mgd. These recommendations assume that Monteray Shores would be served by the existing Monteray Shores facilities and would not be available to the County. The effluent disposal capacity for the Ocean Sands sites is estimated at 2.075 mgd, which is sufficient to meet the build-out demands of Ocean Sands and Monteray Shores (2.0 mgd). The effluent disposal capacity for the Corolla Light sites is estimated at 1.3 mgd which is sufficient to meet the build-out demands of Corolla Light and the un-sewered areas (1.3 mgd).

Groundwater pumped from the groundwater lowering systems would be conveyed to existing ponds where they could be stored for irrigation use or infiltration into Currituck Sound. It is expected that groundwater from the GWL may have elevated levels of iron given high iron concentrations in the surficial aquifer. An advantage in conveying groundwater directly to ponds is that storage in the ponds will allow for some aeration and removal of iron prior to use for irrigation or if the ponds overflow into Currituck Sound.

Development of Site M would not be required until the undeveloped areas in Ocean Sands (Sections G and T) are developed. Re-configuration of the Corolla Light WWTP No. 1 site (Site A) could also be phased to match future needs.

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Figure 6-4 : Recommended Effluent Disposal for Option 3 (Ocean Sands, Corolla Light, Monteray Shores and Unsewered Areas)

Comprehensive Wastewater Master Plan for the Currituck County Southern Outer Banks

6.3.4 Option 4 – Ocean Sands, Corolla Light, Monteray Shores, Corolla Village, Ocean Hill, and Whalehead

Option 4 includes the same service area as Option 3, but assumes that Currituck County is able to acquire the existing wastewater infrastructure in Monteray Shores. The recommendations for Option 4 are similar to the recommendations for Option 3, but assume that the high-rate infiltration pond at Monteray Shores WWTP is used for effluent disposal. For this option, recommendations for effluent disposal are shown in **Figure 6-5** and summarized as follows:

- **Site A**: Demolish the existing Corolla Light WWTP No. 1 and re-configure site for high-rate infiltration at a capacity of 325,000 gpd. Water from the groundwater lowering system would be conveyed to a pond within Corolla Light for re-use for irrigation or infiltration into Currituck Sound.

- **Site B**: Develop a high-rate infiltration system with a capacity of 325,000 gpd at Phase 12 in Corolla Light. Water from the groundwater lowering system would be conveyed to a pond within Corolla Light for re-use for irrigation or infiltration into Currituck Sound.

- **Site C**: Abandon the existing LPP fields at Corolla Light WWTP No. 2 and develop a high-rate infiltration system with a capacity of 700,000 gpd.

- **Site E**: Re-configure the Ocean Sands WWTP disposal system to utilize more area (since setbacks are reduced) to provide a capacity of 750,000 gpd. Remove all remaining rotary distributors and utilize fixed spray heads. Water from the groundwater lowering system would be conveyed to the existing canal surrounding the site.

- **Site M**: Develop a high-rate infiltration system with a capacity of 560,000 gpd at Site M (open space between Ocean Sands Section D and E). Water from the groundwater lowering system would be conveyed to the pond on the DeGabrielle site for re-use for irrigation or infiltration into Currituck Sound.

- **Site O:** Develop a high-rate infiltration system with a capacity of 170,000 gpd on the uplands of the Food Lion Tract. Water from the groundwater lowering system would be conveyed to a pond within Corolla Light for re-use for irrigation or infiltration into Currituck Sound.

The recommended modifications would provide an estimated disposal capacity of 3,430,000 gpd to meet the build-out wastewater flow needs of 3.27 mgd. The effluent disposal capacity developed in Ocean Sands would meet the build-out needs for Ocean Sands subdivision. The effluent disposal capacity in Monteray Shores would meet the build-out needs for the Monteray Shores subdivision. The effluent disposal capacity in Corolla Light would meet the build-out needs for Corolla Light, and the unsewered areas (Corolla Village, Ocean Hill, and Whalehead).

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Figure 6-5 : Recommended Effluent Disposal for Option 4 (Ocean Sands, Corolla Light and Unsewered Areas)

Comprehensive Wastewater Master Plan for the Currituck County Southern Outer Banks

7. Capital Costs for Treatment, Reject Storage, and Effluent Disposal

Opinions of probable construction costs for each Service Area Option are presented in **Table 7-1**. Construction costs include wastewater treatment, reject storage, reject storage pump station and force main, effluent pump station and force main to the disposal sites, and modifications to effluent disposal sites. Cost opinions include 25 percent contingency and 12 percent for technical services. Detailed breakdowns of the cost opinions for each Service Area Option are provided in **Tables 7-2** through **7-5**.

Table 7-1: Summary of Opinion of Probable Cost for Service Area Options Treatment and Disposal

Service Area Option	Areas Served	Opinion of Probable Construction Cost	Unit Capital Cost ($/gpd)
1	Ocean Sands and Corolla Light	$44,231,000	$22.1
2	Ocean Sands, Corolla Light, and Monteray Shores	$56,938,000	$21.9
3	Ocean Sands, Corolla Light, Monteray Shores, Whalehead Subdivision, Corolla Village, and Ocean Hill	$69,957,000	$21.2
4	Ocean Sands, Corolla Light, Whalehead Subdivision, Corolla Village, and Ocean Hill	$58,009,000	$21.5

Table 7-2: Summary of Opinion of Probable Construction Cost for Service Area Option 1 (Ocean Sands and Corolla Light)

Description	Opinion of Probable Construction Cost
Purchase of Corolla Light Wastewater System	$1,850,000
Demolition (Ocean Sands WWTP, Corolla Light No 1 and 2)	$569,000
MBR Wastewater Treatment Plant	$25,718,000
Reject Storage	$4,317,000
Effluent Force Mains and Pumping	$1,655,000
Effluent Disposal	$5,173,000
Land acquisition	$4,837,000
Wetlands Mitigation (WWTP site)	$112,000
Total Project Cost	***$44,231,000***
Unit Cost ($/gpd)	***$22.1***

Table 7-3: Opinion of Probable Construction Cost for Service Area Option 2 (Ocean Sands, Corolla Light and Monteray Shores)

Description	Opinion of Probable Construction Cost
Purchase of Corolla Light Wastewater System	$1,850,000
Demolition (Ocean Sands WWTP, Corolla Light No 1 and 2)	$569,000
MBR Wastewater Treatment Plant	$31,203,000
Reject Storage	$4,786,000
Effluent Force Mains and Pumping	$1,826,000
Effluent Disposal	$6,989,000
Land acquisition	$9,533,000
Wetlands Mitigation (WWTP site)	$182,000
Total Project Cost	***$56,938,000***
Unit Cost ($/gpd)	***$21.9***

Table 7-4: Opinion of Probable Construction Cost for Service Area Option 3 (Ocean Sands, Corolla Light, Monteray Shores, Corolla Village, Ocean Hill and Whalehead)

Description	Opinion of Probable Construction Cost
Purchase of Corolla Light Wastewater System	$1,850,000
Demolition (Ocean Sands WWTP, Corolla Light No 1 and 2)	$569,000
MBR Wastewater Treatment Plant	$33,159,000
Reject Storage	$6,596,000
Effluent Force Mains and Pumping	$1,909,000
Effluent Disposal	$8,665,000
Land acquisition	$16,921,000
Wetlands Mitigation (WWTP site)	$288,000
Total Project Cost	***$69,957,000***
Unit Cost ($/gpd)	***$21.2***

Table 7-5: Opinion of Probable Construction Cost for Service Area Option 4 (Ocean Sands, Corolla Light, Corolla Village, Ocean Hill, and Whalehead)

Description	Opinion of Probable Construction Cost
Purchase of Corolla Light Wastewater System	$1,850,000
Demolition (Ocean Sands WWTP, Corolla Light No 1 and 2)	$569,000
MBR Wastewater Treatment Plant	$33,025,000
Reject Storage	$5,060,000
Effluent Force Mains and Pumping	$1,826,000
Effluent Disposal	$5,742,000
Land acquisition	$9,649,000
Wetlands Mitigation (WWTP site)	$288,000
Total Project Cost	***$58,009,000***
Unit Cost ($/gpd)	***$21.5***

8. Master Plan Recommendations and Challenges

8.1 Recommendations

For the long-term management of wastewater on the Currituck County Southern Outer Banks, development of a regional wastewater system is recommended. A regional approach to wastewater management will provide economies of scale in the significant costs facing the area to expand and upgrade wastewater facilities to meet future growth needs, upgrade and maintain condition of infrastructure, and upgrade treatment processes to meet new regulatory standards and protect the coastal environment. A regional system would provide a level of consistency and equity in regards to available wastewater capacity and service throughout the Southern Outer Banks.

A centralized wastewater treatment plant is recommended to take full advantage of the economies of scale in regards to capital costs and operating and maintenance costs. However, if Monteray Shores is served by this regional system, then it would be more cost-effective to maintain the existing Monteray Shores wastewater infrastructure in addition to the central wastewater system.

The new wastewater treatment plant should be designed with biological nutrient removal capabilities to meet the 2T Rules. To reduce land requirements for effluent disposal, the treatment plant should meet an effluent quality goal of 4 mg/l total nitrogen and 2 mg/l total phosphorus. The more stringent nutrient limits will reduce setbacks from high-rate infiltration systems to adjacent surface waters or groundwater lowering systems.

The recommended technology for the new centralized wastewater treatment facility is conventional activated sludge with advanced nutrient removal and submerged membrane filtration. Stringent effluent quality limits will be required for a permit issued under the new 2T rule (15A NCAC 2T .0700), which will include total nitrogen removal, total phosphorus removal, and stringent disinfection and turbidity limitations. Given the high property values and land costs associated with wastewater management, membrane technology is ideal due to the smaller footprint as compared to other available BNR technologies.

The recommended site for the centralized WWTP is on the existing Corolla Light No. 2 WWTP site with reject storage located on the DeGabrielle site. The alternative is preferred since a more cost-effective reject storage configuration can be utilized while isolating storage tanks from surrounding development. Another advantage in this approach is that the land requirements for wastewater management are lower for the Ocean Sands and Corolla Light subdivisions than if these areas continued to manage wastewater independently.

The decision to pursue any of the Service Area Options will be based on many factors, including capital costs, rates and fees, water quality and environmental protection, wastewater treatment availability, and consultation with the residents in those areas, particularly for unsewered areas. Regardless of the Service Area Option selected, it is recommended that the County pursue at least Phase 1 of Service Area Option 1, which includes Ocean Sands and Corolla Light. This TM does not include a phased construction plan for each Service Area Option. Phasing will be examined in more detail as rates and fees are evaluated and the financial impacts of serving the unsewered areas are better understood. Technical Memorandum 3 – *Wastewater Collection System Master Planning* includes capital costs for wastewater collection for the unsewered areas.

The Phase 1 project should have a minimum capacity of 1.0 mgd to meet the near term needs of Corolla Light and Ocean Sands. The existing maximum month wastewater flow for Corolla Light and Ocean Sands is 0.78 mgd.

8.2 Project Challenges

8.2.1 Influent Equalization

Influent equalization will be a significant challenge for the centralized treatment facility. The wastewater flow is seasonal due to the large transient population. Peak flow can exceed three times a plant's maximum flow in the peak tourist months and then drop down to the bare minimum between January and March. Proper influent equalization will be necessary to extend the life of the plant technology and reliability of the activated sludge process.

8.2.2 Influent Characterization

Due to the extreme variability in seasonal inflow flow, the influent characteristics to the plant also exhibit extreme swings. It has been noted at the Ocean Sands WWTP that influent nitrogen can

exceed twice a typical monthly influent wastewater average. Therefore, careful consideration in the process design will be critical to ensure effluent permit limits are reliably met.

8.2.3 Wetlands Permitting

Impacts to jurisdictional Waters of the U.S. are anticipated to occur from construction of the proposed project. These impacts will require Section 401/404 of the Clean Water Act permits to be obtained from the U.S. Army Corps of Engineers (USACE) and the DWQ. The type of permits required will be dependent upon the type and quantity of impacts to jurisdictional wetlands and streams. Impacts to 0.5 acres or less of jurisdictional wetlands and 300-feet or less of jurisdiction streams can be permitting through the Nationwide Permit program, which has designated Nationwide Permit 39 for impacts to jurisdictional Waters of the U.S. associated with construction activities for commercial and institutional facilities.

The Nationwide Permit program was instituted to provide a streamlined method with minimal paperwork to permit small impacts of similar types to jurisdictional Waters of the U.S. Permit applications submitted under the Nationwide Permit program are generally issued by the USACE and DWQ in 45 and 60 days from date of submittal, respectively. Activities that impact more than 0.5 acre of jurisdictional wetlands and more than 300 feet of jurisdictional streams require issuance of an Individual Permit from the USACE. The amount of labor associated with an Individual Permit application is significantly greater than the labor associated with a Nationwide Permit application. Receipt of Individual Permits from the regulatory agencies also requires significantly more time than permits issued under the Nationwide Permit program. Individual Permits usually require 6 to 12 months to receive and may take up to 24 months, depending on the impact amounts, the type of impacts, and the amount and availability of mitigation. Additionally, Individual Permits require Public Notification of the project and a public comment period. In summary, reducing impacts to jurisdictional Waters of the U.S. to the limits associated with the Nationwide Permit is advantageous from a scheduling and budget standpoint.

8.2.4 Environmental Assessment

The first phase of the regional WWTP should have a minimum capacity of 1.0 mgd to serve the near term needs for Ocean Sands and Corolla Light (Service Area Option 1). A new or expanded capacity of more than 0.5 mgd requires an environmental review according to the North Carolina State Environmental Policy Act (SEPA). It is expected that an Environmental Assessment (EA) would be required for this project. Approval of an EA and receipt of a Finding of No Significant Impact (FONSI) typically requires a 12 to 36 month duration. A duration of 12 months is more typical of SEPA review with projects that have few direct impacts, no threatened or endangers species impacts, and are perceived to have limited secondary and cumulative impacts. The regional WWTP should have limited secondary and cumulative impacts for some areas, like the Whalehead, while others (e.g., Ocean Sands) are projecting considerable growth.

The best approach towards SEPA review is to define the scope of the project and coordinate with the resource agencies involved in SEPA review early in the project. Some aspects of the project

that resource agencies may have objection to could be modified, altered, or removed from the project to help the project implementation stay on the faster track to meet impending deadlines with the County's SOC.

8.2.5 Project Schedule

If the County and Currituck Utilities elect to proceed with the regional approach, then the recommended improvements for Option 1 should be implemented to serve Ocean Sands and Corolla Light. If the County elects to serve a larger service area, then those areas could be included in a later phase. Currituck County is committed to a schedule to either upgrade the Ocean Sands WWTP by April 2015 or construct a regional WWTP by October 2015 per the SOC. This assumes that any legal or financial arrangements between the County and Currituck Utilities should be resolved such that the project can be implemented and meet the milestones mandated by the SOC. However, it is not anticipated that there is not sufficient time in the schedule to coordinate with other entities for the Phase 1 design of the regional system to serve areas outside of Corolla Light or Ocean Sands.

A projected schedule for implementation of the first phase is provided in **Table 8-1.** The schedule predicts a plant startup in May 2015, approximately 5 months before the milestone mandated in the SOC. This schedule includes some conservatism but should be considered targets for each milestone to provide some buffer for unexpected obstacles (e.g. permitting) that may cause a project delay.

Table 8-1: Implementation Schedule for Option 1 – Phase 1

Timeframe	Milestone
June 2011	Complete Comprehensive Wastewater Master Plan
August 2011	Begin Environmental Assessment and Preliminary Design
December 2011	Begin Final Design
July 2012	Environmental Review Completed (FONSI) Permitting
December 2012	Complete Final Design and Permitting
March 2013	Begin Construction
March 2015	End Construction
May 2015	Plant startup
October 2015	Special Order of Consent Deadline for Meeting Compliance Standards

ATTACHMENT A:

Hydrogeologic and Soil Science Evaluation Alternatives for Wastewater Disposal in Corolla Light Area and Ocean Sands Area, Currituck County, North Carolina

Edwin Andrews & Associates P.C.

Technical Memorandum:

Hydrogeologic, and Soil Science Evaluation of Alternatives for Wastewater Disposal Corolla Light Area and Ocean Sands Area, Currituck County Outer Banks Master Plan Currituck County, North Carolina

Prepared for:
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October 23, 2010

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Introduction:

Hazen and Sawyer contracted with Edwin Andrews & Associates, P.C. to provide hydrogeologic, agronomic and soils consulting services to assist in preparing Currituck County Outer Banks Wastewater Plan. Specifically, this applies to Task 2, Wastewater Treatment and Treated Effluent Disposal Master Planning and Task 4, Regional Solutions.

Hydrogeological, Agronomic and Soil Science:

Edwin Andrews & Associates, P.C. is providing an evaluation of options for expanding treated effluent disposal capacity on the Outer Banks. This evaluation will include a general discussion of various effluent disposal technologies including potential advantages, disadvantages, land requirements, regulatory and permitting considerations, water quality impacts, and impacts to storm-water management.

Basically, there are four methods of managing wastewater disposal; 1) Septic Tank Drain-field disposal; 2) Centralized Subsurface Disposal; 3) High Rate Infiltration Disposal; and 4) Water Reuse or Spray Irrigation. Currently, all of these methods are being utilized on the Currituck County Outer Banks. However, growth patterns, and the development of centralized water supply with significant water being derived from the semi-confined Middle Yorktown Aquifer has lead to the need to develop a wastewater disposal strategy that restores water to the hydrologic cycle. Because of limited land availability high rate infiltration poses the potential to beneficially restore wastewater to the hydrologic cycle. The North Carolina Department of Environment and Natural Resources, Division of Water Quality has encouraged the method of restoring wastewater using High Rate Infiltration with nutrient reduction, needed to protect the environment (15A NCAC 2T .0700).

This discussion provides a general evaluation of replacement of existing LPP fields with rapid or high-rate infiltration; providing high-rate infiltration in open space or other available properties; incorporation of reclaimed water irrigation of residential and commercial areas ("purple pipe" distribution system); consideration of reclaimed water irrigation of NC DOT rights-of-way, open space, or other available properties. The high rate infiltration system can use groundwater lowering systems to increase capacity of existing non-discharge disposal systems and restore water to the hydrologic cycle.. With the restored water, possible uses of the water could include deep-well injection of groundwater from groundwater lowering systems. Other options exist, such as utilization of existing drain fields for disposal of highly treated wastewater in the un-sewered areas. This could disperse water into suitable areas, while restoring water quality in the surficial aquifer.

The surficial aquifer is found in the deposited uppermost sediments forming the Coastal Plain of North Carolina. A brief description of the geologic framework from the lowest elevation upward:

Deep Aquifer Formations -Cretaceous and Early Tertiary Stratigraphy:

The regional geology of the Southern Currituck County Outer Banks evolved as sedimentary deposition on the Paleozoic basement complex. Several Cretaceous Formations are projected to be present beneath 1500 feet below land surface based on test wells from the City of Chesapeake at Northwest River; from Moyock, N.C.D.W.R.; from the Twiford oil test well near Aydlette; from the Kellog Test Well near Harbinger; and from the Ocean Sands Test Site. The basement complex ranges from approximately 4100 feet to more than 5300 feet through the region. The basement complex is un-conformably overlain by the Lower Cretaceous formations (Cape Fear Formation, Owens and Gohn (1985)). These formations have not been evaluated as a potential water resource in Northeastern North Carolina, because of suspected chloride concentrations. However, there may be

some future potential as an Aquifer Storage and Recovery reservoir in the future. The Cape Fear Formation is overlain by the Black Creek Formation and the Black Creek Formation is unconformably overlain by the Pee Dee Formation of the Late Cretaceous.

The water bearing sand deposits for the Cape Fear, Black Creek and Pee Dee Formations are utilized as drinking water aquifers in the Central Coastal Plain. However, the depths to these aquifers and chloride concentrations are projected to be relatively high on the Outer Banks of Currituck County. A 1500 foot test well was constructed at Ocean Sands to attempt to locate the upper portion of this Pee Dee Aquifer (June 1991). The well was not deep enough to reach the water bearing formations of the Cretaceous Formations.

The Paleocene Beaufort Formation was deposited unconformably on the Pee Dee Aquifer. The Beaufort Formation appears to function as a leaky confining layer in the Currituck Outer Banks Region. The Eocene Castle Hayne Formation overlays the Beaufort Formation at a depth of approximately 950 to 1500 feet below land surface at Ocean Sands. The Castle Hayne Formation appears to be cemented sand and very fine shell fragments at Ocean Sands ("Hydrologeologic Investigation, Water Resources of a 1500 Foot Deep Test Well, Ocean Sands Subdivision" June 1991, Russnow, Kane & Andrews, Inc.).

The regional evolution of the post Eocene deposits were formed in the Albermarle Embayment which extended landward during high sea level transgressions (glacial melting during global warming) and retreated seaward during low sea levels regressions (glacial periods during cooling). The Eastover Formation consists of Miocene marine clay deposits (Ward, Lauck W. and Blackwelder, Blake W., *Stratigraphic Revision of Upper Miocene and Lower Pliocene Beds of the Chesapeake Group, Middle Atlantic Coastal Plain*: 1980, U.S.G.S. Geological Survey Bulletin 1482 - D).

Deep Water Resource Aquifer Formation Yorktown Formation:

A initial transgression formed the Sunken Meadow member of the Yorktown Formation (middle early Pliocene 4.0 to 3.8 million years before present) (Ward, Lauck W. and Blackwelder, Blake W., 1980). The Sunken Meadow consists of finer warm water sediments in the vicinity of the Currituck Outer Banks, with the Sunken Meadow shoreline thirty to forty miles to the west. This was followed by a sea level regression, which eroded significant portions of the Sunken Meadow Formation (Ward, Lauck W., Bailey, Richard H. and Carter, Joseph G. Chapter 16, "Pliocene and Early Pleistocene Stratigraphy, Depositional History, and Molluscan Paleobiogeography of the Coastal Plain," from The Geology of the Carolinas, Carolina Geological Society Fiftieth Anniversary Volume, edited by J. Wright Horton, Jr and Victor A. Zullo, 1991, Tennessee Press) .

Following the erosion another extensive marine transgression deposited the Rushmere and Mogarts Beach Members of the early late Pliocene (3.4 to 3.0 million years before present). At the outcrop areas these formations are basically shelly sand deposits (Ward, Lauck W. and Blackwelder, Blake W., 1991). However, the deposits found in this investigation beneath the current Currituck Outer Banks are silty sand with some shell fragments reflecting deeper sea deposits. During a period of 3.0 to 2.8 million years before present, the upper portion of the Mogarts Beach Member was eroded by a regression. Afterwhich, a transgression extended to the vicinity of the Suffolk Scarp forming the Moore House Member of the Yorktown Formation. Being eastward of the previous transgressions, the sediment transport energy in the vicinity of the Currituck Outer Banks should have been greater, resulting is coarser sediments. The coarsest sands deposited in the Whalehead Club area may have been a reflection of an inlet channel perpendicular to the Late Pliocene coast line. These sediments are overlain by Late Pliocene transgressive deposits (2.2 to 2.0 million years before present). These finer, silts and clays appear to form the overlying leaky confining layer for the "Yorktown Aquifer."

After review of the lithologic samples collected on the Currituck Southern Outer Banks from January 2000 to July 2000, it appears that the Moore House Member actually forms the Yorktown Aquifer.

Surficial Aquifer Formations - Recent and Pliestocene Formations: The sea level fluctuations during the Pliestocene resulted in thin beds that were deposited and partially eroded. One of these deposits may have been the coarse sand/gravel bed encountered at a depth of 90 to 110 feet beneath much of the Currituck Outer Banks. A Pliestocene transgression resulted in shallow marine deposits above this thin layer.

After the last Pleistocene transgression, a Holocene to recent regression formed the current beach ridge complex. The beach ridge sediments consist of very well sorted fine to medium sand (0.15 to 0.2 mm median diameter sand). This sand is bimodal due to shore face deposition and aeolian redeposition of finer grained heavy mineral assemblages (0.08 to 0.12 mm median diameter heavy minerals) in a cross bedded pattern. These regressive beach ridge deposits extend from 15 feet in the Ocean Hill Development area to more than eighty feet in the Southern Monteray Shores area. The beach ridge deposits in the Ocean Hill area are underlain by fine grained marsh deposits. The marsh deposits extend from Ocean Hill to the middle of the Monteray Shores development and these deposits outcrop on the beach north of Ocean Hill (buried stumps on the beach north of Ocean Hill).

The stratigraphic framework described above was used to build a 3-Dimensional Computer Simulation (Visual MODFLOW™ with five layers. The model evaluates six layers, with the uppermost two layers representing the Surficial (Recent to Pliestocene deposits). The third and fourth layers represent confining layers. The fifth layer included the Middle Yorktown Aquifer and the sixth layer simulated a lower confining unit extending to 300 feet below land surface. This framework enables us to analyze alternatives that could eventually include activities in the Middle Yorktown well field.

Alternatives Analysis

All of the activities relating to wastewater, stormwater, and some of the water resource activities appear to utilize the Surficial Aquifer, which is typically less than 60 feet thick. Existing high rate disposal sites are analyzed to in this evaluation using steady state MODFLOW simulations based on previously collected data for each area. Two regions were modeled using Visual MODFLOW™ . First, the Corolla Light Area and second, the Ocean Sands Development Area are simulated for maximum potential loading (10 gallons per day per square foot – 15A NCAC 2T .0700). The modeling efforts were a very simplified transient state analysis based on historic and generally calibrated data to know water levels in 2008 at the Corolla Light area and 2010 at Ocean Sands area. Because the areas are currently developed and subdivided ownership this evaluation focuses on high rate disposal capacity determination.

High Rate Infiltration Capacity Analysis - Corolla Light Area

In the Corolla Light Area, an average hydraulic conductivity for the surficial sand deposits is initially set at 45 feet per day. The aquifer thickness varies with a low conductivity layer beneath areas where clay is suspected being set at 20 feet. Other areas consist of sand to more than 50 feet below land surface. Previous aquifer testing at five locations in the Corolla Light region determined hydraulic conductivities in the range from 30 to 50 feet per day.

The model was calibrated to water level data collected in 2008. Using the calibrated model, a loading model was performed simulating maximum loading at four sites. The four sites modeled were; the existing Corolla Light Wastewater Treatment Plant No. 1 (Site A); the vacant site south of the Corolla

Light Water Plant or Corolla Light Phase 12 site (Site B); The LPP fields located at the Corolla Light Wastewater Treatment Plant No. 2 at the southern end of the Corolla Light Subdivision. Site C is the LPP field on the west of NC Highway 12 and Site D is the LPP site on the east side of NC Highway 12. The loading rate of each site was 10 gallons per day per square foot for a capacity of 1,168,880 gallons per day with a maximum calculated water level at 18.53 feet above mean sea level (MSL) at Site A. The calculated water level at Site B at 433,380 gallons per day was 6.43 feet above mean sea level. The calculated water levels at Sites C and D were approximately 10.29 feet above mean sea level. All of these simulations placed the drains at -2 feet MSL of elevation at a distance of 50 feet of the high rate disposal area.

It appears that the site could accommodate the total of 1,602,260 gallons per day loaded onto only two of four selected wastewater disposal sites in the Corolla Light Area. Other sites may become available. Possible land planning adjustments will probably reduce this potential capacity, however, this analysis is configured to document possible capacities. A thorough analysis needs to be performed to validate any of these assumptions.

High Rate Infiltration Analysis - Ocean Sands Area

Like the Corolla Light area, the average hydraulic conductivity for the surficial sand deposits was initially set at 45 feet per day. The aquifer thickness varies with a low conductivity layer beneath areas where clay is suspected being set at 20 feet. Other areas consist of sand to more than 50 feet below land surface (eastern portion of the existing site). The aquifer testing that had been completed at five locations in the Ocean Sands region calculated hydraulic conductivities ranging from 28 to 60 feet per day.

The model was calibrated to water levels collected in 2009 and 2010 at Tract F. Using the calibrated model, a loading model was performed simulating maximum loading at six sites. The 11 sites modeled were shown in Table 1. The existing Ocean Sands Wastewater Treatment Plant site (Site E) contained over 120,000 square feet. The site could accommodate up to 1.2 million gallons per day, depending on the final configuration. Another large site is Site K with 112,260 square feet, which could accommodate 1.1 million gallons per day. Sites H and M can also accommodate more than 1.7 million gallons per day, with the smaller areas accommodating another half million gallons per day.

These sites may have the ability to accommodate the projected requirements for Option 3 or 3.27 million gallons per day (e-mail projection from Hazen & Sawyer, Mr. David Briley, P.E.) based on this preliminary evaluation. There are other sites, that provide potential capacity for high rate infiltration or water reuse, however, this analysis focuses on areas where the site information is generally understood. Actual site investigations will be needed to support final design of any of these sites. This analysis is to provide a basis for discussion in a Master Plan for Wastewater Management.

Site	Site Description	Net Disposal Area (sf)	Modeled Loading (gpd/s.f.)	Modeled Loading (gpd)	Recommended Loading (gpd)
A	Corolla Light WWTP 1	116,888	10	**1,168,880**	**0-900,000**
B	Corolla Light Phase 12 Site	43,338	10	**433,380**	**0-400,000**
C	Corolla Light WWTP 2 – East	78,659	10	786,590	0 -750,000
D	Corolla Light WWTP 2 - West	117,523	10	1,175,230	0 – 1,100,00
E	Existing Ocean Sands WWTP Site	121,345	10	**1,213,450**	**0-1,000,000**
F	OS Section Q – Open Space	19,836	10	198,360	0 – 150,000
G	OS Section O – Open Space	3,276	10	32,760	0
H	OS Section O – Open Space	97,700	10	977,000	0 – 900,000
I	OS Section H/O – Open Space	29,488	10	294,880	0 – 250,000
J	OS Section H – Open Space	7,931	10	79,310	0
K	OS Section E/F – Open Space	111,226	10	**1,112,260**	**0-1,000,000**
L	OS Section E – Open Space	8,542	10	85,420	0 – 75,000
M	OS Section D/E – Open Space	74,804	10	748,040	0 – 700,000
N	OS Section D – Open Space	1,704	10	17,040	0
TOTAL		**832,260**		**8,322,600**	**3,300,000**

Recommendations:

1) Manage Wastewater and Storm Water as a resource so that the hydrologic cycle can be used to reduce flooding, augment water supplies, and control salt water intrusion in the Surficial, Yorktown and deeper Aquifers.

2) Provide treatment with nutrient reduction and advanced filtration so that the surficial aquifer can reasonably be protected with total Nitrogen less than 4 milligrams per liter and phosphorous at less than 2 milligrams per liter.

3) Use High Rate Infiltration systems with shallow groundwater controls (est. -2 feet M.S.L.). Because of the high hydraulic conductivity values it is not necessary to use loading rates less than 10 gallons per day per square foot. Rather, each site should be evaluated to ensure that mound height is maintained at an acceptable elevation

4) The surficial supply has excess water during the winter months. Initially, the Surficial Aquifer could be used as an alternate source seasonally, providing water from the early fall through the late spring. Eventually, the Currituck County Southern Outer Banks Water System should consider "ASAR - Aquifer Storage and Recovery" using the excess water from the Surficial Aquifer during the winter months. Additionally, the summer months will receive waste water recharge that will add to the potential for Artificial Recharge in areas in order to reduce salt water intrusion in the Surficial and Yorktown Aquifers.

5) Because of the reliance on the surficial aquifer to establish sustainability, continued development of water reuse throughout the region should balance the recharge and limit the potential of contamination of well head susceptibility areas. Currently, Currituck Club is actively irrigating reclaimed water. Plans for water reuse have been considered for parts of Monteray Shores/TimBuck II, Ocean Hill and parts of Ocean Sands.

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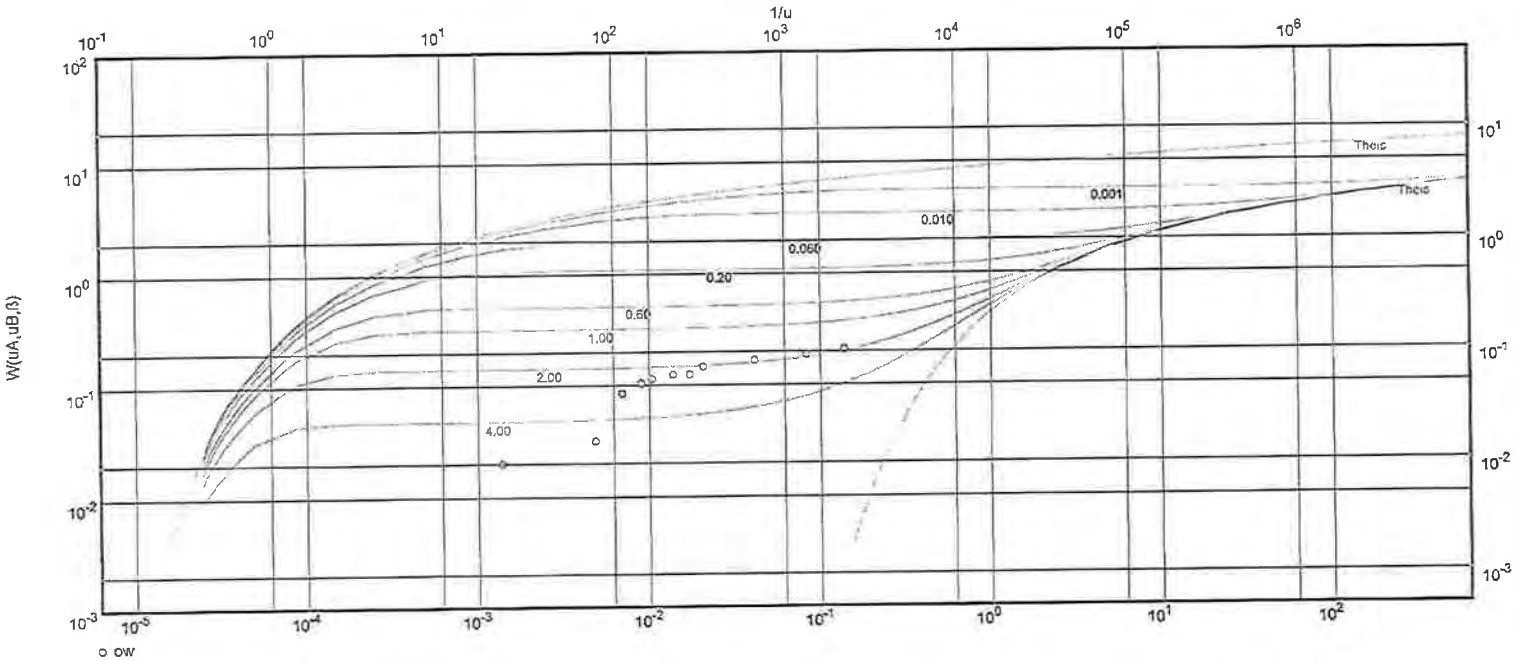
Currituck Outer Banks Master Plan
Table 1, Surficial Aquifer Charactistics

	Table No.	Date Report	Easting NAD 83 (ft)	Northing NAD 83 (ft)	Aquifer Thickness (ft)	Hydraulic Conductivity ft./day	Transmissivity sq. ft. / day
Corolla Light 1	1A	Nov-84	2933769	970519	18	33.9	611
Whalehead Club	1B	Aug-86	2933000	969750	35	49.2	1720
Corolla Light WP	1C	Feb-08	2934125	967691	40	36.4	1450
Ocean Hill	1D	Sep-07	2932581	973332	14	30.1	422
Corolla Bay	1E	Apr-04	2935580	961940	20	29.9	599
Ocean Sands	2A	Jun-88	2938168	951488	60	45.1	2700
Ocean Sands	2B	Feb-90	2940960	945429	60	48.2	2890
Monteray Shores	1F	Jul-04	2937213	954431	60	28.9	1730
Southern Ocean Sands	2C	Aug-08	2947050	929960	60	60.3	2710
Currituck Club	2D	Nov-00	2941410	940890	70	58.8	4120
Pine Island	2E	Feb-90	2944465	933276	30	17	511

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 26.08.2010	1A, Page 1
		Project: Corolla Light	
		Evaluated by: eea	

Pumping Test No. 1	Test conducted on: 11/84
Site 1 - North	
Discharge 20.00 U.S.gal/min	



Transmissivity [ft²/d]: 6.11×10^{2}

Hydraulic conductivity [ft/d]: 3.39×10^{1}

Hydraulic conductivity vertical [ft/d]: 1.57×10^{0}

Aquifer thickness [ft]: 18.00

Storativity: 1.08×10^{-5}

Specific yield: 1.08×10^{-1}

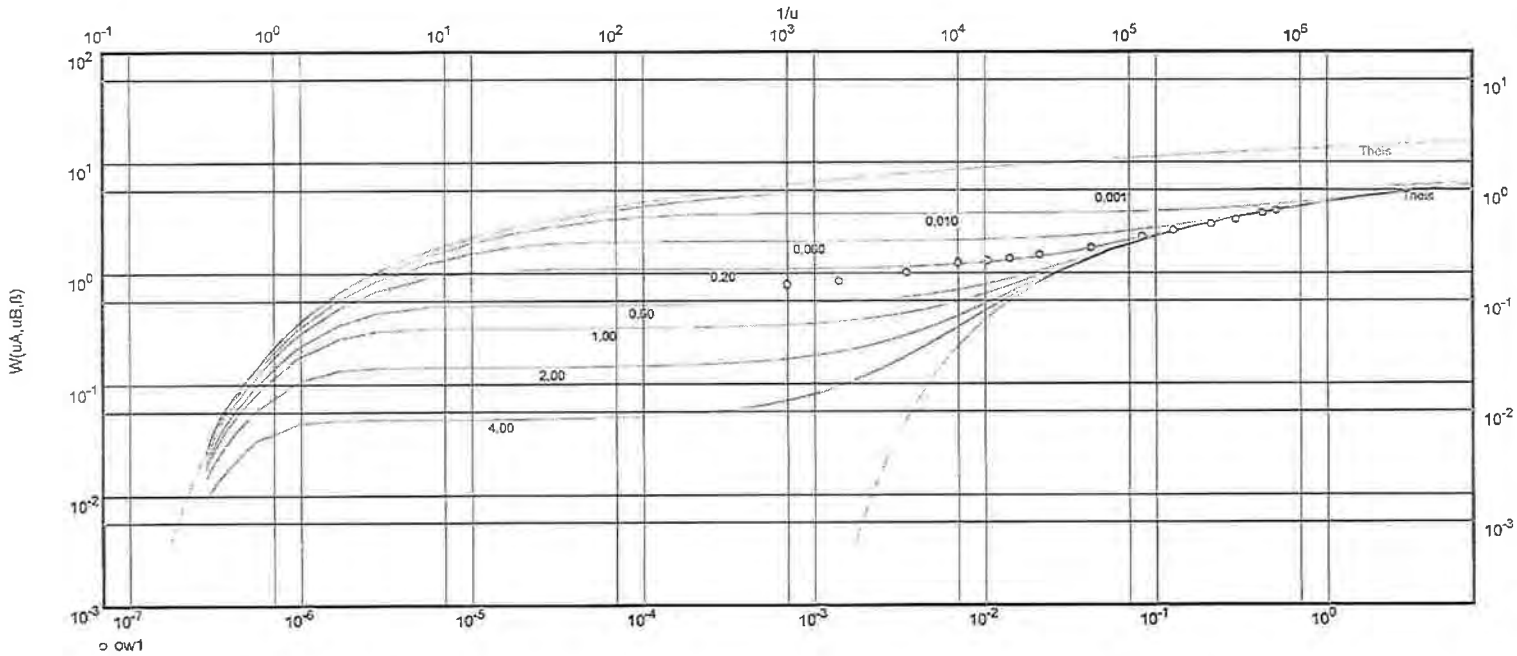
Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 26.08.2010	1A, Page 2
		Project: Corolla Light	
		Evaluated by: eea	

Pumping Test No. 1	Test conducted on: 11/84
Site 1 - North	ow
Discharge 20.00 U.S.gal/min	Distance from the pumping well 118.25 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]
2	0.00139	0.01	0.01
3	0.00486	0.02	0.02
4	0.00694	0.04	0.04
5	0.00903	0.05	0.05
6	0.01042	0.06	0.06
7	0.01389	0.06	0.06
8	0.01736	0.06	0.06
9	0.02083	0.07	0.07
10	0.04167	0.08	0.08
11	0.08333	0.09	0.09
12	0.13889	0.10	0.10

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 22.08.2010	1B, Page 1
		Project: Whalehead Club 1986	
		Evaluated by: eea	

Pumping Test No. 1	Test conducted on: August 1986
OW1	
Discharge 20.00 U.S.gal/min	



Transmissivity [ft²/d]: 1.72×10^{3}

Hydraulic conductivity [ft/d]: 4.92×10^{1}

Hydraulic conductivity vertical [ft/d]: 6.33×10^{1}

Aquifer thickness [ft]: 35.00

Storativity: 2.51×10^{-5}

Specific yield: 2.51×10^{-1}

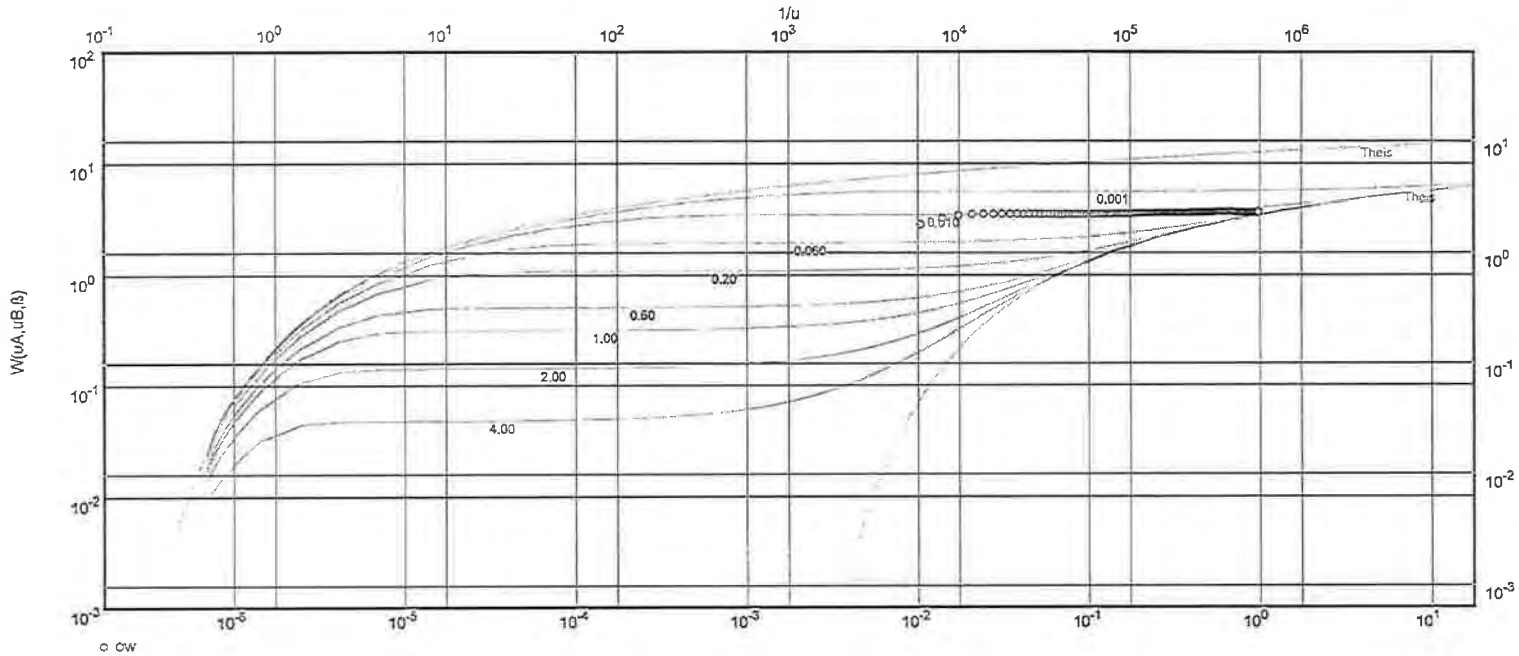
Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 22.08.2010	1B, Page 2
		Project: Whalehead Club 1986	
		Evaluated by: eea	

Pumping Test No. 1	Test conducted on: August 1986
OW1	ow1
Discharge 20.00 U.S.gal/min	Distance from the pumping well 13.80 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]
1	0.00069	0.14	0.14
2	0.00139	0.15	0.15
3	0.00347	0.18	0.18
4	0.00694	0.22	0.22
5	0.01042	0.23	0.23
6	0.01389	0.24	0.24
7	0.02083	0.26	0.26
8	0.04167	0.30	0.30
9	0.08333	0.38	0.38
10	0.12500	0.43	0.43
11	0.20833	0.49	0.49
12	0.29167	0.54	0.54
13	0.41667	0.62	0.62
14	0.50000	0.65	0.65

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 09.05.2008	1C, Page 1
		Project: Corolla Light Development	
		Evaluated by: eea	

Pumping Test No. 1	Test conducted on: 2/28/2008
Water Plant 1	
Discharge 60.00 U.S.gal/min	



Transmissivity [ft²/d]: 1.45×10^{3}

Hydraulic conductivity [ft/d]: 3.64×10^{1}

Aquifer thickness [ft]: 40.00

Storativity: 2.54×10^{-5}

Specific yield: 2.54×10^{-1}

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 09.05.2008	1C, Page 2
		Project: Corolla Light Development	
		Evaluated by: eea	

Pumping Test No. 1	Test conducted on: 2/28/2008
Water Plant 1	ow
Discharge 60.00 U.S.gal/min	Distance from the pumping well 20.00 ft

Static water level: 0.00 ft below datum

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]
2	0.01042	1.79	1.79
3	0.01389	2.04	2.04
4	0.01736	2.15	2.15
5	0.02083	2.20	2.20
6	0.02431	2.22	2.22
7	0.02778	2.22	2.22
8	0.03125	2.22	2.22
9	0.03472	2.22	2.22
10	0.03819	2.22	2.22
11	0.04167	2.21	2.21
12	0.04514	2.22	2.22
13	0.04861	2.22	2.22
14	0.05208	2.21	2.21
15	0.05556	2.21	2.21
16	0.05903	2.21	2.21
17	0.06250	2.21	2.21
18	0.06597	2.21	2.21
19	0.06944	2.20	2.20
20	0.07292	2.20	2.20
21	0.07639	2.20	2.20
22	0.07986	2.20	2.20
23	0.08333	2.21	2.21
24	0.08681	2.20	2.20
25	0.09028	2.20	2.20
26	0.09375	2.21	2.21
27	0.09722	2.21	2.21
28	0.10069	2.21	2.21
29	0.10417	2.21	2.21
30	0.10764	2.21	2.21
31	0.11111	2.22	2.22
32	0.11458	2.22	2.22
33	0.11806	2.22	2.22
34	0.12153	2.22	2.22
35	0.12500	2.22	2.22
36	0.12847	2.22	2.22
37	0.13194	2.22	2.22
38	0.13542	2.22	2.22
39	0.13889	2.23	2.23
40	0.14236	2.23	2.23
41	0.14583	2.23	2.23
42	0.14931	2.23	2.23
43	0.15278	2.23	2.23
44	0.15625	2.23	2.23
45	0.15972	2.23	2.23
46	0.16319	2.23	2.23
47	0.16667	2.24	2.24
48	0.17014	2.24	2.24
49	0.17361	2.24	2.24
50	0.17708	2.24	2.24

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 09.05.2008	1C, Page 3
		Project: Corolla Light Development	
		Evaluated by: eea	

Pumping Test No. 1	Test conducted on: 2/28/2008
Water Plant 1	ow
Discharge 60.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]	
51	0.18056	2.24	2.24	
52	0.18403	2.24	2.24	
53	0.18750	2.24	2.24	
54	0.19097	2.24	2.24	
55	0.19444	2.24	2.24	
56	0.19792	2.24	2.24	
57	0.20139	2.25	2.25	
58	0.20486	2.26	2.26	
59	0.20833	2.26	2.26	
60	0.21181	2.26	2.26	
61	0.21528	2.26	2.26	
62	0.21875	2.26	2.26	
63	0.22222	2.26	2.26	
64	0.22569	2.26	2.26	
65	0.22917	2.26	2.26	
66	0.23264	2.26	2.26	
67	0.23611	2.27	2.27	
68	0.23958	2.27	2.27	
69	0.24306	2.27	2.27	
70	0.24653	2.27	2.27	
71	0.25000	2.27	2.27	
72	0.25347	2.27	2.27	
73	0.25694	2.27	2.27	
74	0.26042	2.27	2.27	
75	0.26389	2.27	2.27	
76	0.26736	2.28	2.28	
77	0.27083	2.27	2.27	
78	0.27431	2.27	2.27	
79	0.27778	2.28	2.28	
80	0.28125	2.27	2.27	
81	0.28472	2.28	2.28	
82	0.28819	2.28	2.28	
83	0.29167	2.28	2.28	
84	0.29514	2.28	2.28	
85	0.29861	2.28	2.28	
86	0.30208	2.28	2.28	
87	0.30556	2.28	2.28	
88	0.30903	2.28	2.28	
89	0.31250	2.28	2.28	
90	0.31597	2.28	2.28	
91	0.31944	2.27	2.27	
92	0.32292	2.27	2.27	
93	0.32639	2.28	2.28	
94	0.32986	2.28	2.28	
95	0.33333	2.28	2.28	
96	0.33681	2.28	2.28	
97	0.34028	2.28	2.28	
98	0.34375	2.28	2.28	
99	0.34722	2.28	2.28	
100	0.35069	2.28	2.28	

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 09.05.2008	1C, Page 4
		Project: Corolla Light Development	
		Evaluated by: eea	

Pumping Test No. 1	Test conducted on: 2/28/2008
Water Plant 1	ow
Discharge 60.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]	
101	0.35417	2.28	2.28	
102	0.35764	2.28	2.28	
103	0.36111	2.28	2.28	
104	0.36458	2.28	2.28	
105	0.36806	2.28	2.28	
106	0.37153	2.28	2.28	
107	0.37500	2.28	2.28	
108	0.37847	2.28	2.28	
109	0.38194	2.28	2.28	
110	0.38542	2.28	2.28	
111	0.38889	2.28	2.28	
112	0.39236	2.29	2.29	
113	0.39583	2.29	2.29	
114	0.39931	2.29	2.29	
115	0.40278	2.29	2.29	
116	0.40625	2.29	2.29	
117	0.40972	2.29	2.29	
118	0.41319	2.30	2.30	
119	0.41667	2.29	2.29	
120	0.42014	2.29	2.29	
121	0.42361	2.29	2.29	
122	0.42708	2.30	2.30	
123	0.43056	2.30	2.30	
124	0.43403	2.30	2.30	
125	0.43750	2.29	2.29	
126	0.44097	2.30	2.30	
127	0.44444	2.30	2.30	
128	0.44792	2.30	2.30	
129	0.45139	2.30	2.30	
130	0.45486	2.30	2.30	
131	0.45833	2.29	2.29	
132	0.46181	2.30	2.30	
133	0.46528	2.30	2.30	
134	0.46875	2.30	2.30	
135	0.47222	2.29	2.29	
136	0.47569	2.29	2.29	
137	0.47917	2.29	2.29	
138	0.48264	2.29	2.29	
139	0.48611	2.29	2.29	
140	0.48958	2.29	2.29	
141	0.49306	2.30	2.30	
142	0.49653	2.30	2.30	
143	0.50000	2.29	2.29	
144	0.50347	2.30	2.30	
145	0.50694	2.31	2.31	
146	0.51042	2.30	2.30	
147	0.51389	2.31	2.31	
148	0.51736	2.31	2.31	
149	0.52083	2.31	2.31	
150	0.52431	2.31	2.31	

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 09.05.2008	1C, Page 5
		Project: Corolla Light Development	
		Evaluated by: eea	

Pumping Test No. 1	Test conducted on: 2/28/2008
Water Plant 1	ow
Discharge 60.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]	
151	0.52778	2.32	2.32	
152	0.53125	2.32	2.32	
153	0.53472	2.32	2.32	
154	0.53819	2.32	2.32	
155	0.54167	2.33	2.33	
156	0.54514	2.32	2.32	
157	0.54861	2.33	2.33	
158	0.55208	2.33	2.33	
159	0.55556	2.33	2.33	
160	0.55903	2.33	2.33	
161	0.56250	2.33	2.33	
162	0.56597	2.33	2.33	
163	0.56944	2.33	2.33	
164	0.57292	2.33	2.33	
165	0.57639	2.33	2.33	
166	0.57986	2.33	2.33	
167	0.58333	2.33	2.33	
168	0.58681	2.33	2.33	
169	0.59028	2.33	2.33	
170	0.59375	2.33	2.33	
171	0.59722	2.33	2.33	
172	0.60069	2.33	2.33	
173	0.60417	2.33	2.33	
174	0.60764	2.33	2.33	
175	0.61111	2.33	2.33	
176	0.61458	2.33	2.33	
177	0.61806	2.33	2.33	
178	0.62153	2.33	2.33	
179	0.62500	2.33	2.33	
180	0.62847	2.33	2.33	
181	0.63194	2.33	2.33	
182	0.63542	2.33	2.33	
183	0.63889	2.33	2.33	
184	0.64236	2.33	2.33	
185	0.64583	2.33	2.33	
186	0.64931	2.33	2.33	
187	0.65278	2.33	2.33	
188	0.65625	2.33	2.33	
189	0.65972	2.33	2.33	
190	0.66319	2.33	2.33	
191	0.66667	2.33	2.33	
192	0.67014	2.33	2.33	
193	0.67361	2.33	2.33	
194	0.67708	2.33	2.33	
195	0.68056	2.33	2.33	
196	0.68403	2.33	2.33	
197	0.68750	2.33	2.33	
198	0.69097	2.33	2.33	
199	0.69444	2.33	2.33	
200	0.69792	2.33	2.33	

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 09.05.2008	1C, Page 6
		Project: Corolla Light Development	
		Evaluated by: eea	

Pumping Test No. 1	Test conducted on: 2/28/2008
Water Plant 1	ow
Discharge 60.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]	
201	0.70139	2.33	2.33	
202	0.70486	2.33	2.33	
203	0.70833	2.33	2.33	
204	0.71181	2.33	2.33	
205	0.71528	2.32	2.32	
206	0.71875	2.32	2.32	
207	0.72222	2.32	2.32	
208	0.72569	2.32	2.32	
209	0.72917	2.32	2.32	
210	0.73264	2.32	2.32	
211	0.73611	2.32	2.32	
212	0.73958	2.32	2.32	
213	0.74306	2.31	2.31	
214	0.74653	2.31	2.31	
215	0.75000	2.31	2.31	
216	0.75347	2.31	2.31	
217	0.75694	2.31	2.31	
218	0.76042	2.31	2.31	
219	0.76389	2.31	2.31	
220	0.76736	2.31	2.31	
221	0.77083	2.31	2.31	
222	0.77431	2.31	2.31	
223	0.77778	2.31	2.31	
224	0.78125	2.31	2.31	
225	0.78472	2.32	2.32	
226	0.78819	2.32	2.32	
227	0.79167	2.31	2.31	
228	0.79514	2.31	2.31	
229	0.79861	2.31	2.31	
230	0.80208	2.31	2.31	
231	0.80556	2.31	2.31	
232	0.80903	2.31	2.31	
233	0.81250	2.31	2.31	
234	0.81597	2.31	2.31	
235	0.81944	2.31	2.31	
236	0.82292	2.31	2.31	
237	0.82639	2.31	2.31	
238	0.82986	2.31	2.31	
239	0.83333	2.30	2.30	
240	0.83681	2.31	2.31	
241	0.84028	2.30	2.30	
242	0.84375	2.31	2.31	
243	0.84722	2.30	2.30	
244	0.85069	2.31	2.31	
245	0.85417	2.31	2.31	
246	0.85764	2.31	2.31	
247	0.86111	2.31	2.31	
248	0.86458	2.31	2.31	
249	0.86806	2.30	2.30	
250	0.87153	2.30	2.30	

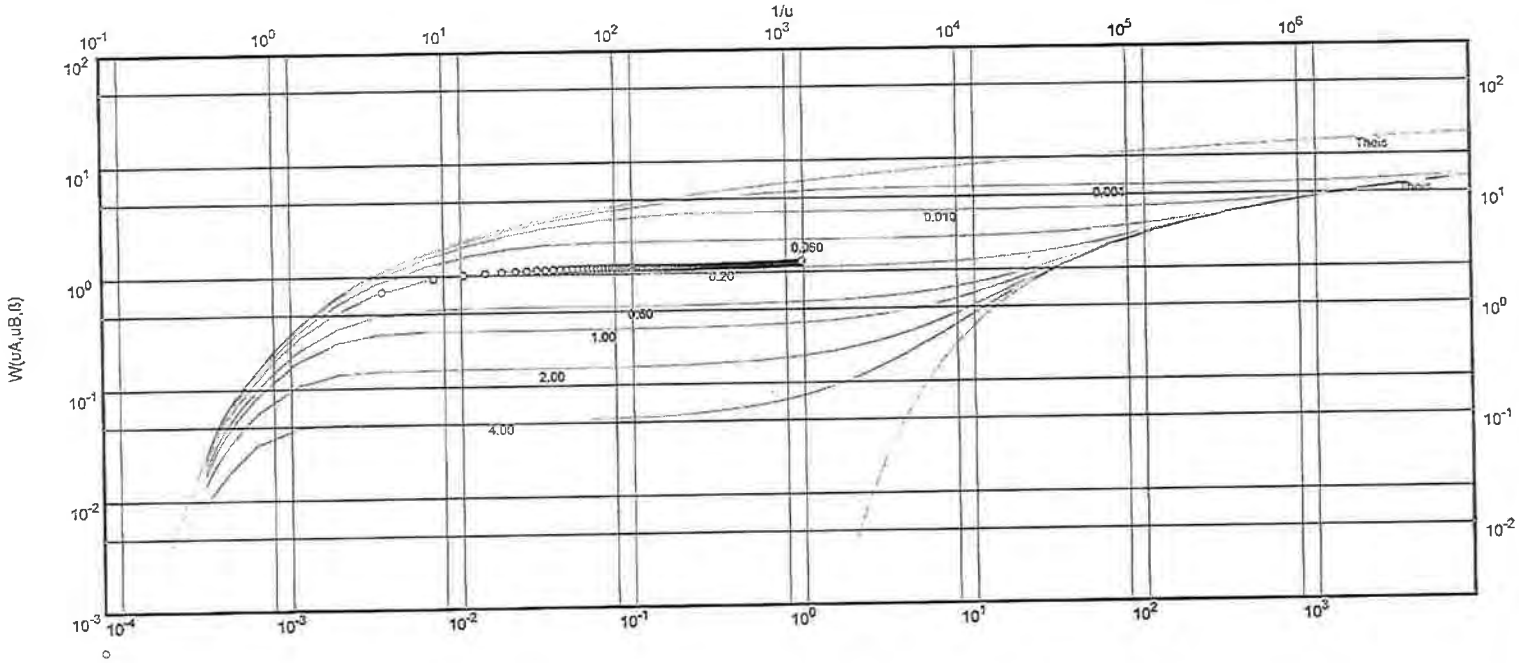
Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 09.05.2008	1C, Page 7
		Project: Corolla Light Development	
		Evaluated by: eea	

Pumping Test No. 1	Test conducted on: 2/28/2008
Water Plant 1	ow
Discharge 60.00 U.S gal/min	Distance from the pumping well 20.00 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]
251	0.87500	2.30	2.30
252	0.87847	2.30	2.30
253	0.88194	2.30	2.30
254	0.88542	2.29	2.29
255	0.88889	2.29	2.29
256	0.89236	2.29	2.29
257	0.89583	2.29	2.29
258	0.89931	2.28	2.28
259	0.90278	2.28	2.28
260	0.90625	2.28	2.28
261	0.90972	2.28	2.28
262	0.91319	2.28	2.28
263	0.91667	2.29	2.29
264	0.92014	2.28	2.28
265	0.92361	2.28	2.28
266	0.92708	2.28	2.28
267	0.93056	2.28	2.28
268	0.93403	2.28	2.28
269	0.93750	2.28	2.28
270	0.94097	2.28	2.28
271	0.94444	2.28	2.28
272	0.94792	2.28	2.28
273	0.95139	2.28	2.28
274	0.95486	2.28	2.28
275	0.95833	2.28	2.28
276	0.96181	2.28	2.28
277	0.96528	2.29	2.29
278	0.96875	2.29	2.29
279	0.97222	2.28	2.28
280	0.97569	2.29	2.29
281	0.97917	2.29	2.29
282	0.98264	2.29	2.29
283	0.98611	2.29	2.29
284	0.98958	2.30	2.30
285	0.99306	2.32	2.32
286	0.99653	2.32	2.32

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 05/04/07	1D, Page 1
		Project: Ocean Hill	
		Evaluated by: aht	

Pumping Test No. Test 1	Test conducted on: 04/21/07
PW1	
Discharge 60.00 U.S.gal/min	



Transmissivity [ft²/d]: 4.22×10^{2}

Hydraulic conductivity [ft/d]: 3.01×10^{1}

Aquifer thickness [ft]: 14.00

Storativity: 1.33×10^{-2}

Hydraulic conductivity vertical [ft/d]: 1.18×10^{0}

Specific yield: 1.33×10^{2}

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 05/04/07	1D, Page 2
		Project: Ocean Hill	
		Evaluated by: aht	

Pumping Test No. Test 1 — Test conducted on: 04/21/07

PW1

Discharge 60.00 U.S.gal/min — Distance from the pumping well 10.00 ft

Static water level: 0.00 ft below datum

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]
2	0.00347	1.56	1.56
3	0.00694	2.05	2.05
4	0.01042	2.19	2.19
5	0.01389	2.26	2.26
6	0.01736	2.31	2.31
7	0.02083	2.33	2.33
8	0.02431	2.34	2.34
9	0.02778	2.37	2.37
10	0.03125	2.38	2.38
11	0.03472	2.38	2.38
12	0.03819	2.40	2.40
13	0.04167	2.40	2.40
14	0.04514	2.42	2.42
15	0.04861	2.42	2.42
16	0.05208	2.42	2.42
17	0.05556	2.43	2.43
18	0.05903	2.43	2.43
19	0.06250	2.44	2.44
20	0.06597	2.44	2.44
21	0.06944	2.44	2.44
22	0.07292	2.45	2.45
23	0.07639	2.45	2.45
24	0.07986	2.45	2.45
25	0.08333	2.45	2.45
26	0.08681	2.44	2.44
27	0.09028	2.44	2.44
28	0.09375	2.44	2.44
29	0.09722	2.44	2.44
30	0.10069	2.43	2.43
31	0.10417	2.44	2.44
32	0.10764	2.44	2.44
33	0.11111	2.44	2.44
34	0.11458	2.44	2.44
35	0.11806	2.43	2.43
36	0.12153	2.43	2.43
37	0.12500	2.44	2.44
38	0.12847	2.43	2.43
39	0.13194	2.43	2.43
40	0.13542	2.44	2.44
41	0.13889	2.44	2.44
42	0.14236	2.44	2.44
43	0.14583	2.44	2.44
44	0.14931	2.44	2.44
45	0.15278	2.44	2.44
46	0.15625	2.44	2.44
47	0.15972	2.44	2.44
48	0.16319	2.44	2.44
49	0.16667	2.44	2.44
50	0.17014	2.44	2.44

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 05/04/07	1D, Page 3
		Project: Ocean Hill	
		Evaluated by: aht	

Pumping Test No. Test 1	Test conducted on: 04/21/07
PW1	
Discharge 60.00 U.S.gal/min	Distance from the pumping well 10.00 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]
51	0.17361	2.44	2.44
52	0.17708	2.44	2.44
53	0.18056	2.44	2.44
54	0.18403	2.44	2.44
55	0.18750	2.43	2.43
56	0.19097	2.44	2.44
57	0.19444	2.43	2.43
58	0.19792	2.44	2.44
59	0.20139	2.44	2.44
60	0.20486	2.45	2.45
61	0.20833	2.44	2.44
62	0.21181	2.44	2.44
63	0.21528	2.44	2.44
64	0.21875	2.44	2.44
65	0.22222	2.44	2.44
66	0.22569	2.44	2.44
67	0.22917	2.44	2.44
68	0.23264	2.44	2.44
69	0.23611	2.44	2.44
70	0.23958	2.44	2.44
71	0.24306	2.44	2.44
72	0.24653	2.46	2.46
73	0.25000	2.45	2.45
74	0.25347	2.44	2.44
75	0.25694	2.45	2.45
76	0.26042	2.45	2.45
77	0.26389	2.45	2.45
78	0.26736	2.47	2.47
79	0.27083	2.46	2.46
80	0.27431	2.46	2.46
81	0.27778	2.46	2.46
82	0.28125	2.46	2.46
83	0.28472	2.46	2.46
84	0.28819	2.46	2.46
85	0.29167	2.46	2.46
86	0.29514	2.47	2.47
87	0.29861	2.47	2.47
88	0.30208	2.47	2.47
89	0.30556	2.47	2.47
90	0.30903	2.47	2.47
91	0.31250	2.48	2.48
92	0.31597	2.48	2.48
93	0.31944	2.48	2.48
94	0.32292	2.48	2.48
95	0.32639	2.49	2.49
96	0.32986	2.48	2.48
97	0.33333	2.48	2.48
98	0.33681	2.49	2.49
99	0.34028	2.49	2.49
100	0.34375	2.49	2.49

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 05/04/07	1D, Page 4
		Project: Ocean Hill	
		Evaluated by: aht	

Pumping Test No. Test 1	Test conducted on: 04/21/07
PW1	
Discharge 60.00 U.S.gal/min	Distance from the pumping well: 10.00 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]
101	0.34722	2.48	2.48
102	0.35069	2.49	2.49
103	0.35417	2.49	2.49
104	0.35764	2.49	2.49
105	0.36111	2.49	2.49
106	0.36458	2.49	2.49
107	0.36806	2.50	2.50
108	0.37153	2.49	2.49
109	0.37500	2.49	2.49
110	0.37847	2.50	2.50
111	0.38194	2.49	2.49
112	0.38542	2.50	2.50
113	0.38889	2.50	2.50
114	0.39236	2.50	2.50
115	0.39583	2.50	2.50
116	0.39931	2.50	2.50
117	0.40278	2.51	2.51
118	0.40625	2.51	2.51
119	0.40972	2.51	2.51
120	0.41319	2.51	2.51
121	0.41667	2.51	2.51
122	0.42014	2.51	2.51
123	0.42361	2.51	2.51
124	0.42708	2.51	2.51
125	0.43056	2.51	2.51
126	0.43403	2.51	2.51
127	0.43750	2.51	2.51
128	0.44097	2.52	2.52
129	0.44444	2.51	2.51
130	0.44792	2.51	2.51
131	0.45139	2.51	2.51
132	0.45486	2.51	2.51
133	0.45833	2.49	2.49
134	0.46181	2.49	2.49
135	0.46528	2.51	2.51
136	0.46875	2.51	2.51
137	0.47222	2.51	2.51
138	0.47569	2.51	2.51
139	0.47917	2.51	2.51
140	0.48264	2.51	2.51
141	0.48611	2.51	2.51
142	0.48958	2.51	2.51
143	0.49306	2.52	2.52
144	0.49653	2.52	2.52
145	0.50000	2.51	2.51
146	0.50347	2.51	2.51
147	0.50694	2.49	2.49
148	0.51042	2.52	2.52
149	0.51389	2.52	2.52
150	0.51736	2.51	2.51

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 05/04/07	1D, Page 5
		Project: Ocean Hill	
		Evaluated by: aht	

Pumping Test No. Test 1	Test conducted on: 04/21/07
PW1	
Discharge 60.00 U.S.gal/min	Distance from the pumping well 10.00 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]
151	0.52083	2.52	2.52
152	0.52431	2.51	2.51
153	0.52778	2.53	2.53
154	0.53125	2.52	2.52
155	0.53472	2.52	2.52
156	0.53819	2.52	2.52
157	0.54167	2.50	2.50
158	0.54514	2.52	2.52
159	0.54861	2.52	2.52
160	0.55208	2.51	2.51
161	0.55556	2.53	2.53
162	0.55903	2.52	2.52
163	0.56250	2.51	2.51
164	0.56597	2.51	2.51
165	0.56944	2.53	2.53
166	0.57292	2.53	2.53
167	0.57639	2.52	2.52
168	0.57986	2.51	2.51
169	0.58333	2.51	2.51
170	0.58681	2.51	2.51
171	0.59028	2.50	2.50
172	0.59375	2.49	2.49
173	0.59722	2.51	2.51
174	0.60069	2.53	2.53
175	0.60417	2.54	2.54
176	0.60764	2.54	2.54
177	0.61111	2.52	2.52
178	0.61458	2.52	2.52
179	0.61806	2.52	2.52
180	0.62153	2.51	2.51
181	0.62500	2.53	2.53
182	0.62847	2.53	2.53
183	0.63194	2.52	2.52
184	0.63542	2.53	2.53
185	0.63889	2.54	2.54
186	0.64236	2.54	2.54
187	0.64583	2.54	2.54
188	0.64931	2.54	2.54
189	0.65278	2.53	2.53
190	0.65625	2.54	2.54
191	0.65972	2.54	2.54
192	0.66319	2.54	2.54
193	0.66667	2.54	2.54
194	0.67014	2.54	2.54
195	0.67361	2.52	2.52
196	0.67708	2.52	2.52
197	0.68056	2.54	2.54
198	0.68403	2.54	2.54
199	0.68750	2.54	2.54
200	0.69097	2.54	2.54

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 05/04/07	1D, Page 6
		Project: Ocean Hill	
		Evaluated by: aht	

Pumping Test No. Test 1	Test conducted on: 04/21/07
PW1	
Discharge 60.00 U.S.gal/min	Distance from the pumping well 10.00 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]
201	0.69444	2.53	2.53
202	0.69792	2.51	2.51
203	0.70139	2.52	2.52
204	0.70486	2.54	2.54
205	0.70833	2.54	2.54
206	0.71181	2.54	2.54
207	0.71528	2.55	2.55
208	0.71875	2.55	2.55
209	0.72222	2.55	2.55
210	0.72569	2.55	2.55
211	0.72917	2.55	2.55
212	0.73264	2.55	2.55
213	0.73611	2.56	2.56
214	0.73958	2.56	2.56
215	0.74306	2.55	2.55
216	0.74653	2.55	2.55
217	0.75000	2.56	2.56
218	0.75347	2.57	2.57
219	0.75694	2.56	2.56
220	0.76042	2.54	2.54
221	0.76389	2.57	2.57
222	0.76736	2.57	2.57
223	0.77083	2.57	2.57
224	0.77431	2.56	2.56
225	0.77778	2.57	2.57
226	0.78125	2.58	2.58
227	0.78472	2.57	2.57
228	0.78819	2.57	2.57
229	0.79167	2.58	2.58
230	0.79514	2.57	2.57
231	0.79861	2.58	2.58
232	0.80208	2.58	2.58
233	0.80556	2.58	2.58
234	0.80903	2.58	2.58
235	0.81250	2.58	2.58
236	0.81597	2.59	2.59
237	0.81944	2.59	2.59
238	0.82292	2.59	2.59
239	0.82639	2.58	2.58
240	0.82986	2.59	2.59
241	0.83333	2.59	2.59
242	0.83681	2.59	2.59
243	0.84028	2.59	2.59
244	0.84375	2.58	2.58
245	0.84722	2.59	2.59
246	0.85069	2.59	2.59
247	0.85417	2.59	2.59
248	0.85764	2.60	2.60
249	0.86111	2.60	2.60
250	0.86458	2.60	2.60

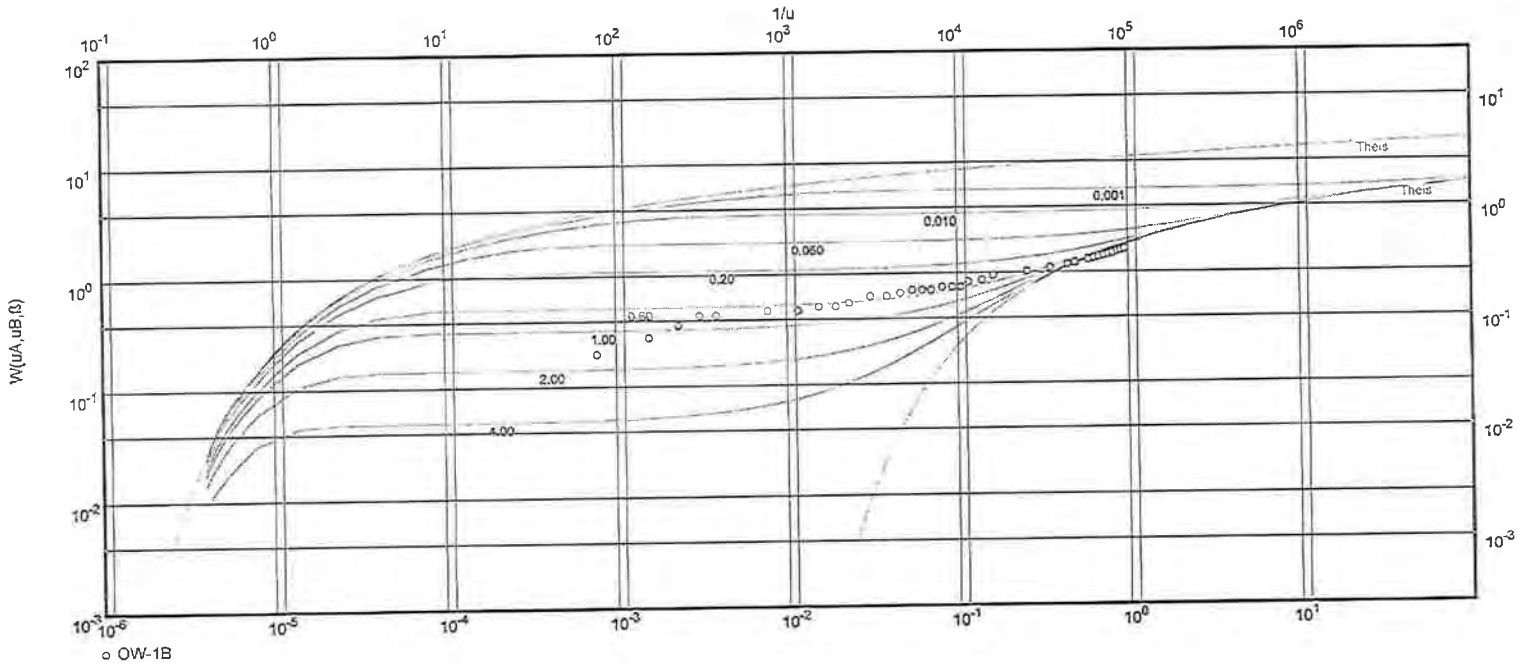
Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 05/04/07	1D, Page 7
		Project: Ocean Hill	
		Evaluated by: aht	

Pumping Test No. Test 1	Test conducted on: 04/21/07
PW1	
Discharge 60.00 U.S.gal/min	Distance from the pumping well 10.00 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]	
251	0.86806	2.59	2.59	
252	0.87153	2.60	2.60	
253	0.87500	2.59	2.59	
254	0.87847	2.60	2.60	
255	0.88194	2.60	2.60	
256	0.88542	2.60	2.60	
257	0.88889	2.60	2.60	
258	0.89236	2.60	2.60	
259	0.89583	2.60	2.60	
260	0.89931	2.61	2.61	
261	0.90278	2.60	2.60	
262	0.90625	2.60	2.60	
263	0.90972	2.61	2.61	
264	0.91319	2.59	2.59	
265	0.91667	2.61	2.61	
266	0.92014	2.60	2.60	
267	0.92361	2.60	2.60	
268	0.92708	2.60	2.60	
269	0.93056	2.60	2.60	
270	0.93403	2.60	2.60	
271	0.93750	2.60	2.60	
272	0.94097	2.60	2.60	
273	0.94444	2.60	2.60	
274	0.94792	2.60	2.60	
275	0.95139	2.60	2.60	
276	0.95486	2.59	2.59	
277	0.95833	2.63	2.63	
278	0.96181	2.60	2.60	
279	0.96528	2.60	2.60	
280	0.96875	2.62	2.62	
281	0.97222	2.61	2.61	
282	0.97569	2.66	2.66	
283	0.97917	2.66	2.66	
284	0.98264	2.72	2.72	

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 4-14-2004	1E, Page 1
		Project: COROLLA BAY	
		Evaluated by: EEA/EWT	

Pumping Test No. 2	Test conducted on: 4/7/04
SPRAY BED SITE	
Discharge 10.00 U.S.gal/min	



Transmissivity [ft²/d]: 5.99×10^{2}

Hydraulic conductivity [ft/d]: 2.99×10^{1}

Aquifer thickness [ft]: 20.00

Storativity: 5.07×10^{-5}

Hydraulic conductivity vertical [ft/d]: 5.70×10^{0}

Specific yield: 5.07×10^{-1}

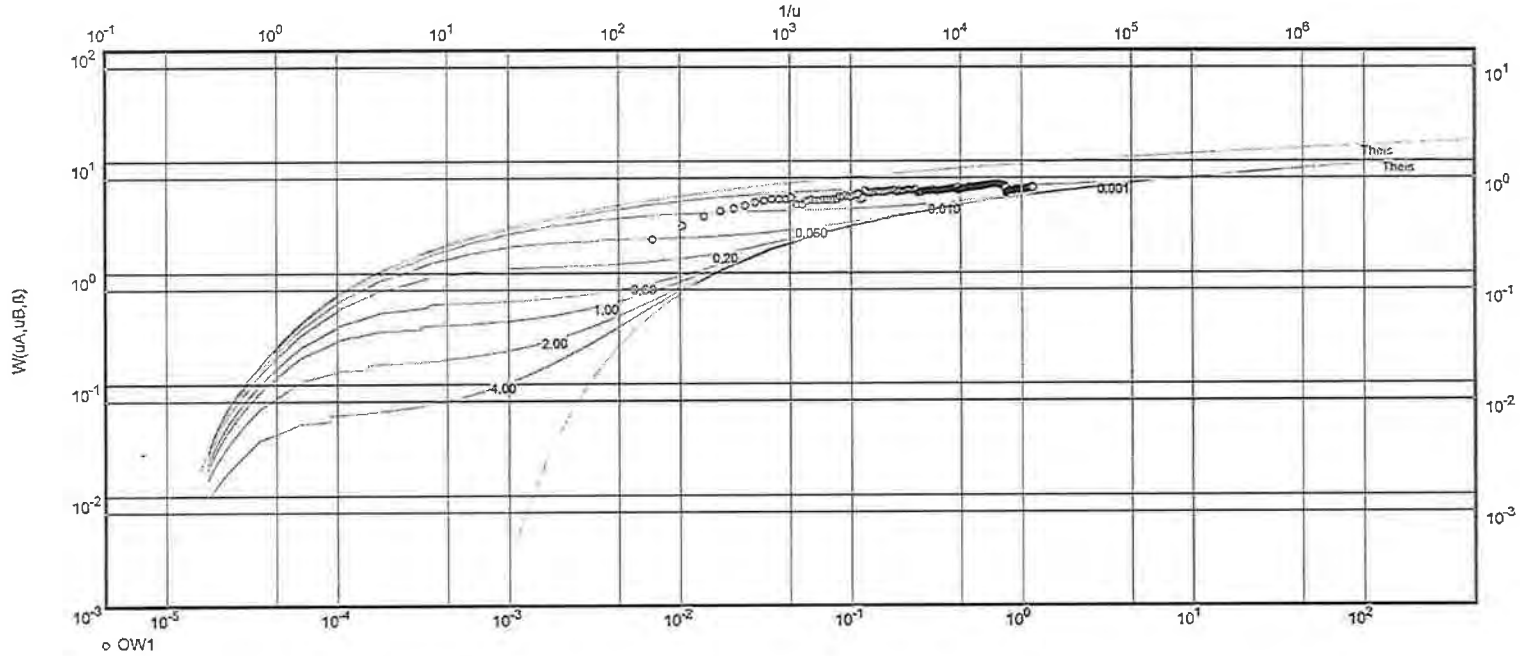
Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 4-14-2004	1E, Page 2
		Project: COROLLA BAY	
		Evaluated by: EEA/EWT	

Pumping Test No. 2	Test conducted on: 4/7/04
SPRAY BED SITE	OW-1B
Discharge 10.00 U.S.gal/min	Distance from the pumping well 20.50 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]
1	0.00069	0.05	0.05
2	0.00139	0.07	0.07
3	0.00208	0.09	0.09
4	0.00278	0.11	0.11
5	0.00347	0.11	0.11
6	0.00694	0.12	0.12
7	0.01042	0.12	0.12
8	0.01389	0.13	0.13
9	0.01736	0.13	0.13
10	0.02083	0.14	0.14
11	0.02778	0.16	0.16
12	0.03472	0.16	0.16
13	0.04167	0.17	0.17
14	0.04861	0.18	0.18
15	0.05556	0.18	0.18
16	0.06250	0.18	0.18
17	0.07292	0.19	0.19
18	0.08333	0.19	0.19
19	0.09375	0.19	0.19
20	0.10417	0.21	0.21
21	0.12500	0.22	0.22
22	0.14583	0.24	0.24
23	0.22917	0.26	0.26
24	0.31250	0.28	0.28
25	0.39583	0.30	0.30
26	0.43750	0.31	0.31
27	0.52083	0.33	0.33
28	0.56250	0.34	0.34
29	0.60417	0.35	0.35
30	0.64583	0.36	0.36
31	0.68750	0.37	0.37
32	0.72917	0.38	0.38
33	0.77083	0.39	0.39
34	0.81250	0.40	0.40
35	0.85417	0.41	0.41

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 04.07.2004	1F, Page 1
		Project: MONTERAY SHORES	
		Evaluated by: EEA	

Pumping Test No. 2	Test conducted on: 7/3/04
2004	
Discharge 16.00 U.S.gal/min	



Transmissivity [ft²/d]: 1.73×10^{3}

Hydraulic conductivity [ft/d]: 2.89×10^{1}

Hydraulic conductivity vertical [ft/d]: 5.31×10^{0}

Aquifer thickness [ft]: 60.00

Storativity: 1.55×10^{-3}

Specific yield: 1.55×10^{-1}

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 04.07.2004	1F, Page 2
		Project: MONTERAY SHORES	
		Evaluated by: EEA	

Pumping Test No. 2	Test conducted on: 7/3/04
2004	OW1
Discharge 16.00 U.S.gal/min	Distance from the pumping well 14.00 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]
1	0.00694	0.28	0.28
2	0.01042	0.37	0.37
3	0.01389	0.45	0.45
4	0.01736	0.50	0.50
5	0.02083	0.53	0.53
6	0.02431	0.56	0.56
7	0.02778	0.60	0.60
8	0.03125	0.62	0.62
9	0.03472	0.64	0.64
10	0.03819	0.64	0.64
11	0.04167	0.64	0.64
12	0.04514	0.66	0.66
13	0.04861	0.57	0.57
14	0.05208	0.57	0.57
15	0.05556	0.61	0.61
16	0.05903	0.63	0.63
17	0.06250	0.62	0.62
18	0.06597	0.62	0.62
19	0.06944	0.63	0.63
20	0.07292	0.63	0.63
21	0.07639	0.63	0.63
22	0.07986	0.63	0.63
23	0.08333	0.64	0.64
24	0.08681	0.67	0.67
25	0.09028	0.67	0.67
26	0.09375	0.69	0.69
27	0.09722	0.67	0.67
28	0.10069	0.67	0.67
29	0.10417	0.69	0.69
30	0.10764	0.70	0.70
31	0.11111	0.71	0.71
32	0.11458	0.63	0.63
33	0.11806	0.65	0.65
34	0.12153	0.76	0.76
35	0.12500	0.74	0.74
36	0.12847	0.73	0.73
37	0.13194	0.73	0.73
38	0.13542	0.74	0.74
39	0.13889	0.74	0.74
40	0.14236	0.75	0.75
41	0.14583	0.75	0.75
42	0.14931	0.74	0.74
43	0.15278	0.74	0.74
44	0.15625	0.75	0.75
45	0.15972	0.74	0.74
46	0.16319	0.75	0.75
47	0.16667	0.75	0.75
48	0.17014	0.76	0.76
49	0.17361	0.76	0.76
50	0.17708	0.77	0.77

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 04.07.2004	1F, Page 3
		Project: MONTERAY SHORES	
		Evaluated by: EEA	

Pumping Test No. 2	Test conducted on: 7/3/04
2004	OW1
Discharge 16.00 U.S.gal/min	Distance from the pumping well 14.00 ft

Static water level: 0.00 ft below datum

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]
51	0.18056	0.77	0.77
52	0.18403	0.76	0.76
53	0.18750	0.74	0.74
54	0.19097	0.75	0.75
55	0.19444	0.76	0.76
56	0.19792	0.76	0.76
57	0.20139	0.75	0.75
58	0.20486	0.75	0.75
59	0.20833	0.76	0.76
60	0.21181	0.77	0.77
61	0.21528	0.77	0.77
62	0.21875	0.78	0.78
63	0.22222	0.78	0.78
64	0.22569	0.77	0.77
65	0.22917	0.77	0.77
66	0.23264	0.77	0.77
67	0.23611	0.77	0.77
68	0.23958	0.78	0.78
69	0.24306	0.77	0.77
70	0.24653	0.73	0.73
71	0.25000	0.73	0.73
72	0.25347	0.74	0.74
73	0.25694	0.74	0.74
74	0.26042	0.74	0.74
75	0.26389	0.74	0.74
76	0.26736	0.75	0.75
77	0.27083	0.75	0.75
78	0.27431	0.75	0.75
79	0.27778	0.76	0.76
80	0.28125	0.76	0.76
81	0.28472	0.76	0.76
82	0.28819	0.76	0.76
83	0.29167	0.76	0.76
84	0.29514	0.76	0.76
85	0.29861	0.77	0.77
86	0.30208	0.77	0.77
87	0.30556	0.78	0.78
88	0.30903	0.76	0.76
89	0.31250	0.76	0.76
90	0.31597	0.76	0.76
91	0.31944	0.75	0.75
92	0.32292	0.76	0.76
93	0.32639	0.76	0.76
94	0.32986	0.76	0.76
95	0.33333	0.77	0.77
96	0.33681	0.77	0.77
97	0.34028	0.77	0.77
98	0.34375	0.77	0.77
99	0.34722	0.77	0.77
100	0.35069	0.77	0.77

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 04.07.2004	1F, Page 4
		Project: MONTERAY SHORES	
		Evaluated by: EEA	

Pumping Test No. 2	Test conducted on: 7/3/04
2004	OW1
Discharge 16.00 U.S.gal/min	Distance from the pumping well 14.00 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]
101	0.35417	0.77	0.77
102	0.35764	0.78	0.78
103	0.36111	0.77	0.77
104	0.36458	0.78	0.78
105	0.36806	0.78	0.78
106	0.37153	0.78	0.78
107	0.37500	0.78	0.78
108	0.37847	0.78	0.78
109	0.38194	0.79	0.79
110	0.38542	0.79	0.79
111	0.38889	0.79	0.79
112	0.39236	0.79	0.79
113	0.39583	0.79	0.79
114	0.39931	0.79	0.79
115	0.40278	0.79	0.79
116	0.40625	0.80	0.80
117	0.40972	0.79	0.79
118	0.41319	0.79	0.79
119	0.41667	0.79	0.79
120	0.42014	0.79	0.79
121	0.42361	0.81	0.81
122	0.42708	0.77	0.77
123	0.43056	0.76	0.76
124	0.43403	0.77	0.77
125	0.43750	0.77	0.77
126	0.44097	0.77	0.77
127	0.44444	0.78	0.78
128	0.44792	0.78	0.78
129	0.45139	0.79	0.79
130	0.45486	0.79	0.79
131	0.45833	0.79	0.79
132	0.46181	0.80	0.80
133	0.46528	0.80	0.80
134	0.46875	0.80	0.80
135	0.47222	0.80	0.80
136	0.47569	0.80	0.80
137	0.47917	0.80	0.80
138	0.48264	0.80	0.80
139	0.48611	0.81	0.81
140	0.48958	0.81	0.81
141	0.49306	0.81	0.81
142	0.49653	0.82	0.82
143	0.50000	0.83	0.83
144	0.50347	0.82	0.82
145	0.50694	0.81	0.81
146	0.51042	0.82	0.82
147	0.51389	0.81	0.81
148	0.51736	0.81	0.81
149	0.52083	0.82	0.82
150	0.52431	0.81	0.81

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 04.07.2004	1F, Page 5
		Project: MONTERAY SHORES	
		Evaluated by: EEA	

Pumping Test No. 2	Test conducted on: 7/3/04
2004	OW1
Discharge 16.00 U.S.gal/min	Distance from the pumping well 14.00 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]	
151	0.52778	0.81	0.81	
152	0.53125	0.81	0.81	
153	0.53472	0.82	0.82	
154	0.53819	0.82	0.82	
155	0.54167	0.82	0.82	
156	0.54514	0.83	0.83	
157	0.54861	0.83	0.83	
158	0.55208	0.83	0.83	
159	0.55556	0.83	0.83	
160	0.55903	0.83	0.83	
161	0.56250	0.83	0.83	
162	0.56597	0.83	0.83	
163	0.56944	0.83	0.83	
164	0.57292	0.83	0.83	
165	0.57639	0.84	0.84	
166	0.57986	0.83	0.83	
167	0.58333	0.83	0.83	
168	0.58681	0.83	0.83	
169	0.59028	0.83	0.83	
170	0.59375	0.84	0.84	
171	0.59722	0.84	0.84	
172	0.60069	0.84	0.84	
173	0.60417	0.84	0.84	
174	0.60764	0.84	0.84	
175	0.61111	0.85	0.85	
176	0.61458	0.85	0.85	
177	0.61806	0.84	0.84	
178	0.62153	0.85	0.85	
179	0.62500	0.85	0.85	
180	0.62847	0.86	0.86	
181	0.63194	0.86	0.86	
182	0.63542	0.86	0.86	
183	0.63889	0.86	0.86	
184	0.64236	0.86	0.86	
185	0.64583	0.87	0.87	
186	0.64931	0.86	0.86	
187	0.65278	0.86	0.86	
188	0.65625	0.87	0.87	
189	0.65972	0.87	0.87	
190	0.66319	0.87	0.87	
191	0.66667	0.87	0.87	
192	0.67014	0.87	0.87	
193	0.67361	0.87	0.87	
194	0.67708	0.87	0.87	
195	0.68056	0.88	0.88	
196	0.68403	0.88	0.88	
197	0.68750	0.88	0.88	
198	0.69097	0.88	0.88	
199	0.69444	0.88	0.88	
200	0.69792	0.88	0.88	

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 04.07.2004	1F, Page 6
		Project: MONTERAY SHORES	
		Evaluated by: EEA	

Pumping Test No. 2	Test conducted on: 7/3/04
2004	OW1
Discharge 16.00 U.S.gal/min	Distance from the pumping well 14.00 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]	
201	0.70139	0.88	0.88	
202	0.70486	0.88	0.88	
203	0.70833	0.88	0.88	
204	0.71181	0.88	0.88	
205	0.71528	0.88	0.88	
206	0.71875	0.88	0.88	
207	0.72222	0.87	0.87	
208	0.72569	0.87	0.87	
209	0.72917	0.88	0.88	
210	0.73264	0.88	0.88	
211	0.73611	0.88	0.88	
212	0.73958	0.87	0.87	
213	0.74306	0.86	0.86	
214	0.74653	0.85	0.85	
215	0.75000	0.86	0.86	
216	0.75347	0.86	0.86	
217	0.75694	0.87	0.87	
218	0.76042	0.86	0.86	
219	0.76389	0.86	0.86	
220	0.76736	0.86	0.86	
221	0.77083	0.85	0.85	
222	0.77431	0.86	0.86	
223	0.77778	0.86	0.86	
224	0.78125	0.86	0.86	
225	0.78472	0.85	0.85	
226	0.78819	0.86	0.86	
227	0.79167	0.85	0.85	
228	0.79514	0.83	0.83	
229	0.79861	0.81	0.81	
230	0.80208	0.79	0.79	
231	0.80556	0.80	0.80	
232	0.80903	0.80	0.80	
233	0.81250	0.73	0.73	
234	0.81597	0.74	0.74	
235	0.81944	0.74	0.74	
236	0.82292	0.74	0.74	
237	0.82639	0.74	0.74	
238	0.82986	0.75	0.75	
239	0.83333	0.75	0.75	
240	0.83681	0.75	0.75	
241	0.84028	0.75	0.75	
242	0.84375	0.75	0.75	
243	0.84722	0.75	0.75	
244	0.85069	0.76	0.76	
245	0.85417	0.76	0.76	
246	0.85764	0.76	0.76	
247	0.86111	0.76	0.76	
248	0.86458	0.76	0.76	
249	0.86806	0.76	0.76	
250	0.87153	0.77	0.77	

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed waterlable response	Date: 04.07.2004	1F, Page 7
		Project: MONTERAY SHORES	
		Evaluated by: EEA	

Pumping Test No. 2 — Test conducted on: 7/3/04

2004 — OW1

Discharge 16.00 U.S.gal/min — Distance from the pumping well 14.00 ft

Static water level: 0.00 ft below datum

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]
251	0.87500	0.76	0.76
252	0.87847	0.76	0.76
253	0.88194	0.76	0.76
254	0.88542	0.76	0.76
255	0.88889	0.76	0.76
256	0.89236	0.76	0.76
257	0.89583	0.76	0.76
258	0.89931	0.77	0.77
259	0.90278	0.76	0.76
260	0.90625	0.77	0.77
261	0.90972	0.76	0.76
262	0.91319	0.76	0.76
263	0.91667	0.77	0.77
264	0.92014	0.78	0.78
265	0.92361	0.78	0.78
266	0.92708	0.79	0.79
267	0.93056	0.78	0.78
268	0.93403	0.78	0.78
269	0.93750	0.78	0.78
270	0.94097	0.78	0.78
271	0.94444	0.78	0.78
272	0.94792	0.78	0.78
273	0.95139	0.78	0.78
274	0.95486	0.78	0.78
275	0.95833	0.77	0.77
276	0.96181	0.77	0.77
277	0.96528	0.77	0.77
278	0.96875	0.78	0.78
279	0.97222	0.79	0.79
280	0.97569	0.78	0.78
281	0.97917	0.79	0.79
282	0.98264	0.79	0.79
283	0.98611	0.79	0.79
284	0.98958	0.79	0.79
285	0.99306	0.79	0.79
286	0.99653	0.79	0.79
287	1.00000	0.79	0.79
288	1.00347	0.79	0.79
289	1.00694	0.79	0.79
290	1.01042	0.79	0.79
291	1.01389	0.79	0.79
292	1.01736	0.79	0.79
293	1.02083	0.79	0.79
294	1.02431	0.80	0.80
295	1.02778	0.79	0.79
296	1.03125	0.79	0.79
297	1.03472	0.79	0.79
298	1.03819	0.78	0.78
299	1.04167	0.78	0.78
300	1.04514		

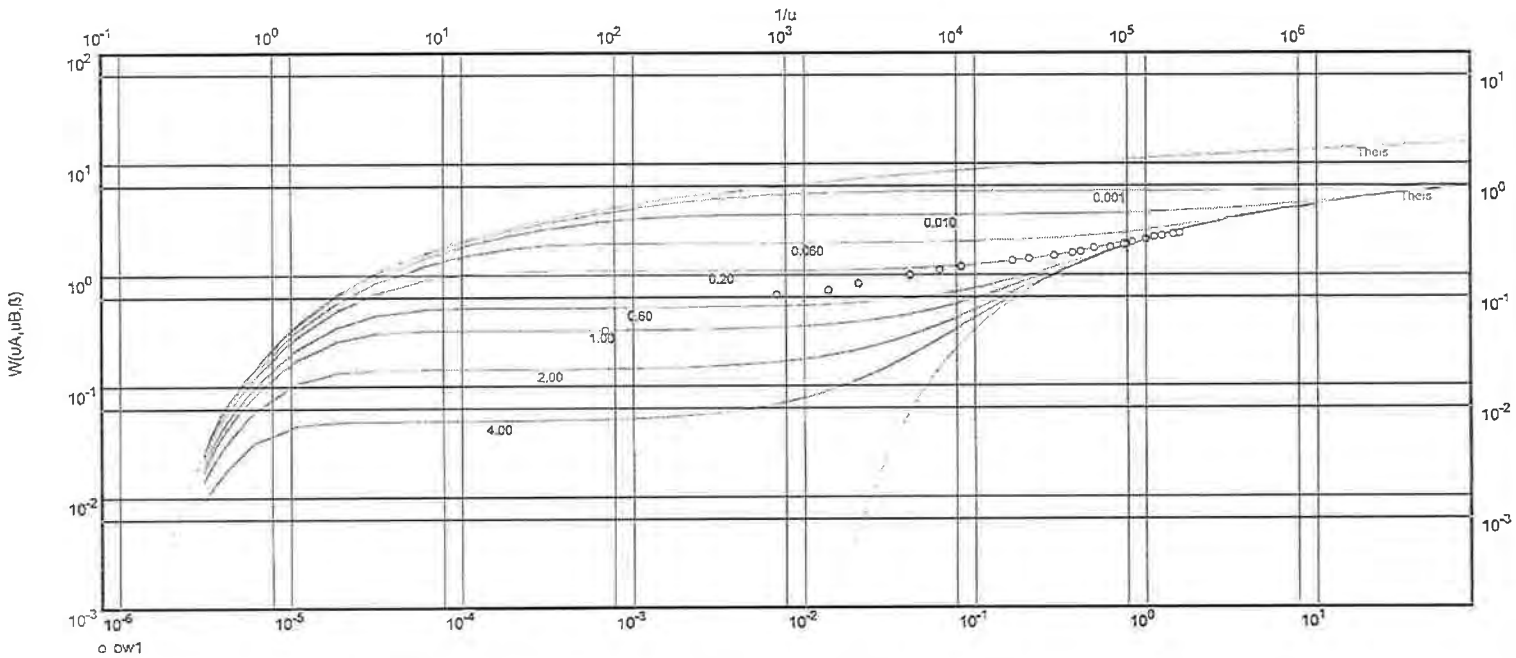
Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 04.07.2004	1F, Page 8
		Project: MONTERAY SHORES	
		Evaluated by: EEA	

Pumping Test No. 2	Test conducted on: 7/3/04
2004	OW1
Discharge 16.00 U.S.gal/min	Distance from the pumping well 14.00 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]	
301	1.04861	0.78	0.78	
302	1.05208	0.78	0.78	
303	1.05556	0.79	0.79	
304	1.05903	0.79	0.79	
305	1.06250	0.79	0.79	
306	1.06597	0.79	0.79	
307	1.06944	0.79	0.79	
308	1.07292	0.79	0.79	
309	1.07639	0.79	0.79	
310	1.07986	0.79	0.79	
311	1.08333	0.80	0.80	
312	1.08681	0.80	0.80	
313	1.09028	0.79	0.79	
314	1.09375	0.79	0.79	
315	1.09722	0.80	0.80	
316	1.10069	0.79	0.79	
317	1.10417	0.79	0.79	
318	1.10764	0.79	0.79	
319	1.11111	0.80	0.80	
320	1.11458	0.81	0.81	
321	1.11806	0.80	0.80	
322	1.12153	0.80	0.80	
323	1.12500	0.80	0.80	
324	1.12847	0.80	0.80	
325	1.13194	0.80	0.80	
326	1.13542	0.81	0.81	
327	1.13889	0.81	0.81	
328	1.14236	0.82	0.82	
329	1.14583	0.82	0.82	
330	1.14931	0.83	0.83	
331	1.15278	0.82	0.82	
332	1.15625	0.82	0.82	
333	1.15972	0.82	0.82	
334	1.16319	0.81	0.81	
335	1.16667	0.81	0.81	
336	1.17014	0.81	0.81	

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 28.08.2010	2A, Page 1
		Project: COB - Ocean Sands 1988	
		Evaluated by: eea	

Pumping Test No. 1	Test conducted on: 6/6/1988
WW1	
Discharge 28.00 U.S.gal/min	



Transmissivity [ft²/d]: 2.70×10^{3}

Hydraulic conductivity [ft/d]: 4.51×10^{1}

Hydraulic conductivity vertical [ft/d]: 3.49×10^{0}

Aquifer thickness [ft]: 60.00

Storativity: 3.02×10^{-5}

Specific yield: 3.02×10^{-1}

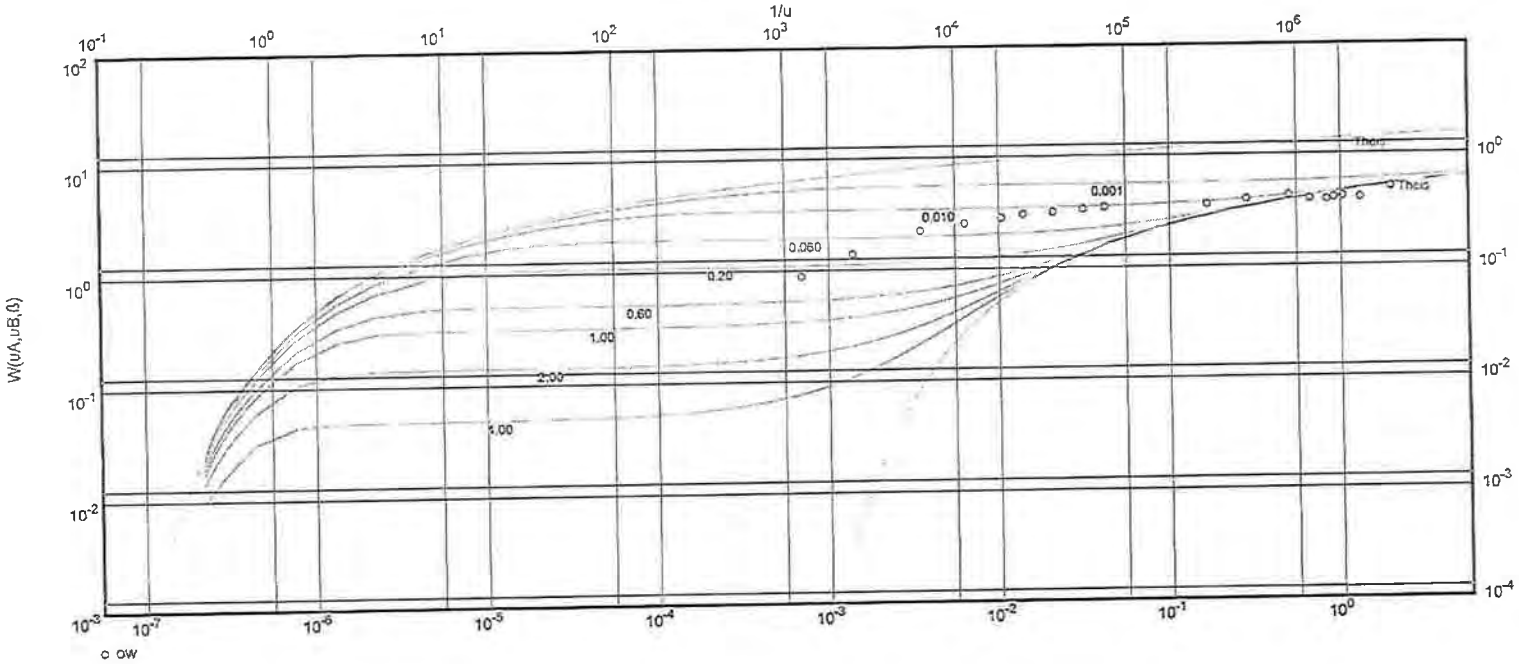
Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 28.08.2010	2A, Page 2
		Project: COB - Ocean Sands 1988	
		Evaluated by: eea	

Pumping Test No. 1	Test conducted on: 6/6/1988
WW1	ow1
Discharge 28.00 U.S.gal/min	Distance from the pumping well 52.80 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]
1	0.00069	0.05	0.05
2	0.00694	0.11	0.11
3	0.01389	0.12	0.12
4	0.02083	0.13	0.13
5	0.04167	0.16	0.16
6	0.06250	0.17	0.17
7	0.08333	0.19	0.19
8	0.16667	0.21	0.21
9	0.20833	0.22	0.22
10	0.29167	0.23	0.23
11	0.37500	0.25	0.25
12	0.41667	0.25	0.25
13	0.50000	0.27	0.27
14	0.62500	0.28	0.28
15	0.75000	0.30	0.30
16	0.83333	0.31	0.31
17	1.00000	0.33	0.33
18	1.12500	0.34	0.34
19	1.25000	0.35	0.35
20	1.45833	0.36	0.36
21	1.58333	0.37	0.37

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 28.08.2010	2B, Page 1
		Project: COB - Ocean Sands 1990	
		Evaluated by: eea	

Pumping Test No. 1	Test conducted on: 2/6/1990
Well 3 - Water	
Discharge 15.00 U.S.gal/min	



Transmissivity [ft²/d]: 2.89×10^{3}

Hydraulic conductivity [ft/d]: 4.82×10^{1}

Aquifer thickness [ft]: 60.00

Storativity: 2.83×10^{-5}

Specific yield: 2.83×10^{-1}

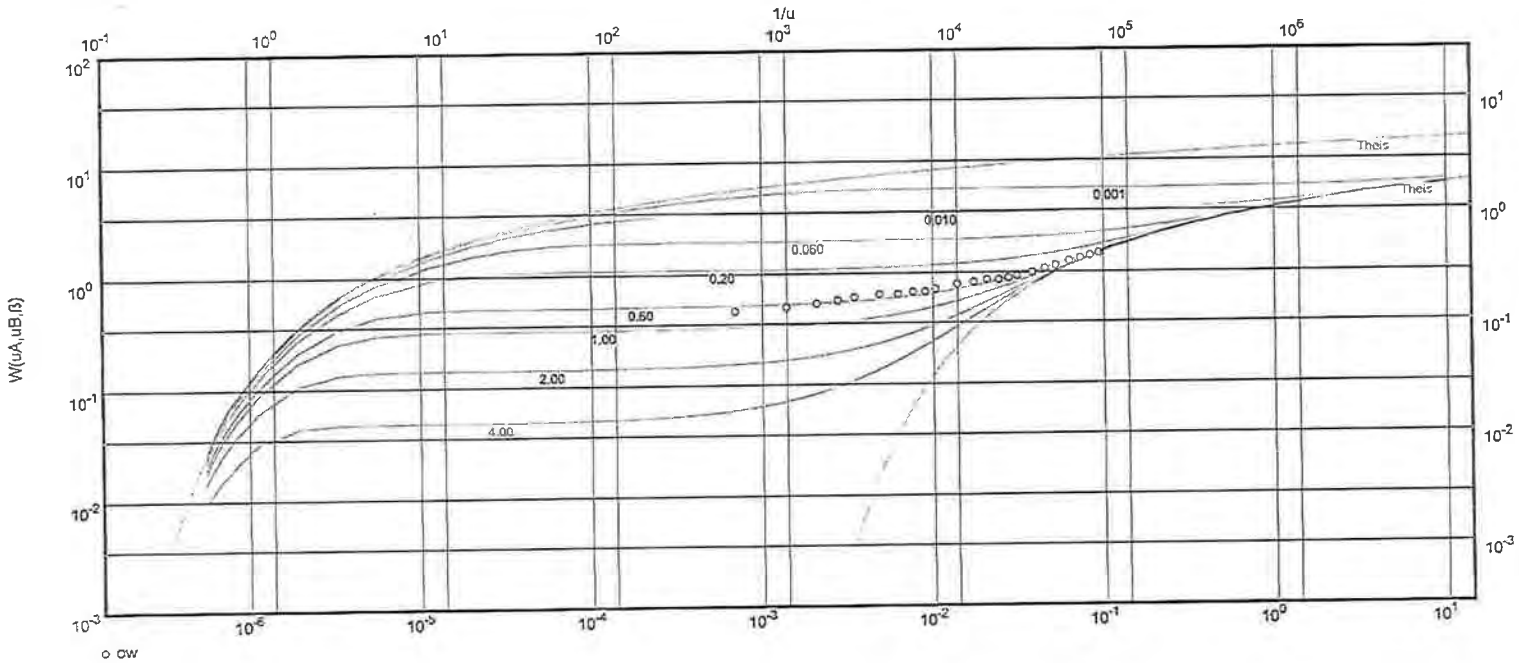
Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 28.08.2010	2B, Page 2
		Project: COB - Ocean Sands 1990	
		Evaluated by: eea	

Pumping Test No. 1	Test conducted on: 2/6/1990
Well 3 - Water	ow
Discharge 15.00 U.S.gal/min	Distance from the pumping well 15.00 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]
1	0.00069	0.07	0.07
2	0.00139	0.11	0.11
3	0.00347	0.17	0.17
4	0.00625	0.20	0.20
5	0.01042	0.22	0.22
6	0.01389	0.24	0.24
7	0.02083	0.25	0.25
8	0.03125	0.26	0.26
9	0.04167	0.28	0.28
10	0.16667	0.28	0.28
11	0.28403	0.32	0.32
12	0.50000	0.34	0.34
13	0.66667	0.32	0.32
14	0.83333	0.31	0.31
15	0.91667	0.32	0.32
16	1.03125	0.33	0.33
17	1.30208	0.32	0.32
18	1.96875	0.40	0.40

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 25.08.2009	2C, Page 1
		Project: Southern Area Shallow	
		Evaluated by: eea	

Pumping Test No. 1	Test conducted on: 8/24/2009
1	
Discharge 50.00 U.S.gal/min	



Transmissivity [ft²/d]: 2.71×10^{3}

Hydraulic conductivity [ft/d]: 6.03×10^{1}

Aquifer thickness [ft]: 45.00

Storativity: 6.69×10^{-5}

Hydraulic conductivity vertical [ft/d]: 5.43×10^{2}

Specific yield: 6.69×10^{-1}

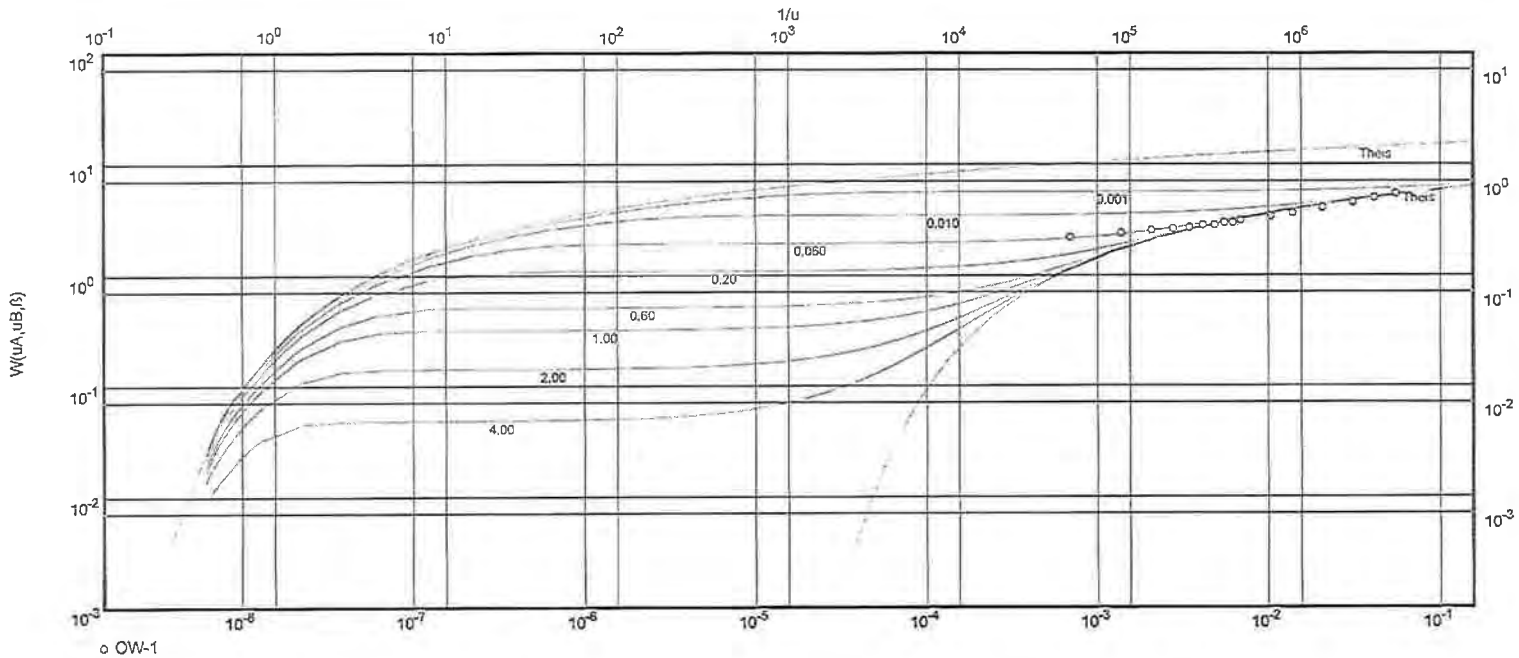
Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 25.08.2009	2C, Page 2
		Project: Southern Area Shallow	
		Evaluated by: eea	

Pumping Test No. 1	Test conducted on: 8/24/2009
1	ow
Discharge 50.00 U.S.gal/min	Distance from the pumping well 15.00 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]	
2	0.00069	0.13	0.13	
3	0.00139	0.14	0.14	
4	0.00208	0.15	0.15	
5	0.00278	0.16	0.16	
6	0.00347	0.17	0.17	
7	0.00486	0.18	0.18	
8	0.00625	0.18	0.18	
9	0.00764	0.19	0.19	
10	0.00903	0.19	0.19	
11	0.01042	0.20	0.20	
12	0.01389	0.22	0.22	
13	0.01736	0.23	0.23	
14	0.02083	0.24	0.24	
15	0.02431	0.24	0.24	
16	0.02778	0.25	0.25	
17	0.03125	0.26	0.26	
18	0.03819	0.28	0.28	
19	0.04514	0.30	0.30	
20	0.05208	0.32	0.32	
21	0.06250	0.35	0.35	
22	0.07292	0.37	0.37	
23	0.08333	0.39	0.39	
24	0.09375	0.41	0.41	

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 29.11.2000	2D, Page 1
		Project: CURRITUCK CO. R/0 OUT	
		Evaluated by: EEA	

Pumping Test No.	Test conducted on: 11/28/2000
OW-1	
Discharge 38.00 U.S.gal/min	



Transmissivity [ft²/d]: 4.12×10^{3}

Hydraulic conductivity [ft/d]: 5.88×10^{1}

Hydraulic conductivity vertical [ft/d]: 2.84×10^{1}

Aquifer thickness [ft]: 70.00

Storativity: 3.15×10^{-7}

Specific yield: 3.15×10^{-3}

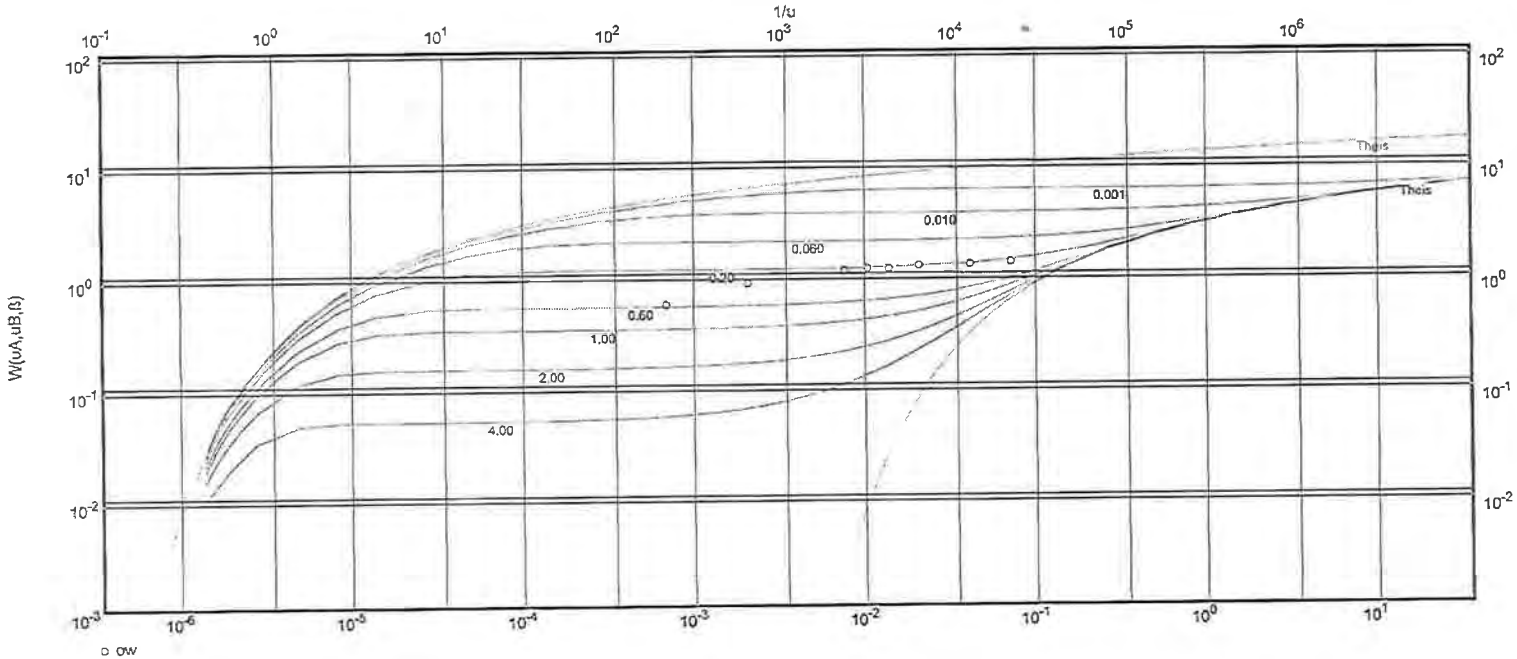
Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 29.11.2000	2D, Page 2
		Project: CURRITUCK CO. R/0 OUT	
		Evaluated by: EEA	

Pumping Test No.	Test conducted on: 11/28/2000
OW-1	OW-1
Discharge 38.00 U.S.gal/min	Distance from the pumping well 28.50 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]	
1	0.00069	0.31	0.31	
2	0.00139	0.34	0.34	
3	0.00208	0.36	0.36	
4	0.00278	0.37	0.37	
5	0.00347	0.38	0.38	
6	0.00417	0.40	0.40	
7	0.00486	0.40	0.40	
8	0.00556	0.42	0.42	
9	0.00625	0.42	0.42	
10	0.00694	0.44	0.44	
11	0.01042	0.48	0.48	
12	0.01389	0.51	0.51	
13	0.02083	0.57	0.57	
14	0.03125	0.64	0.64	
15	0.04167	0.70	0.70	
16	0.05556	0.76	0.76	

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 02.09.2010	2F, Page 1
		Project: Pine Island	
		Evaluated by: eea	

Pumping Test No. 1	Test conducted on: Feb 1990
1	
Discharge 37.50 U.S.gal/min	



Transmissivity [ft²/d]: 5.11×10^{2}

Hydraulic conductivity [ft/d]: 1.70×10^{1}

Hydraulic conductivity vertical [ft/d]: 1.36×10^{0}

Aquifer thickness [ft]: 30.00

Storativity: 1.05×10^{-5}

Specific yield: 1.05×10^{-1}

Edwin Andrews & Assoc. PC P.O. Box 30653 Raleigh, N.C. 27622	Pumping test analysis NEUMAN's method Unconfined aquifer with delayed watertable response	Date: 02.09.2010	2F, Page 2
		Project: Pine Island	
		Evaluated by: eea	

Pumping Test No. 1	Test conducted on: Feb 1990
1	ow
Discharge 37.50 U.S.gal/min	Distance from the pumping well 26.00 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [d]	Water level [ft]	Drawdown [ft]
2	0.00069	0.60	0.60
3	0.00208	0.92	0.92
4	0.00764	1.18	1.18
5	0.01042	1.22	1.22
6	0.01389	1.22	1.22
7	0.02083	1.30	1.30
8	0.04167	1.34	1.34
9	0.07222	1.40	1.40

Currituck Outer Banks Master Plan - Wastewater Disposal
Table 3, Area Summary

Site	Area	Loading	Modeled Loading	Recommended Loading	Area Description
	square feet	gallons per day per square foot	Gallons per day	Gallons per day	
1	116,888	10	**1,168,880**	**900,000**	Existing Corolla Light Site 1
2	43,338	10	**433,380**	**400,000**	Existing Corolla Light Vacant Parcel
3	78,659	10	786,590	0	
4	117,523	10	1,175,230	0	
A	121,345	10	**1,213,450**	**1,000,000**	Existing Ocean Sands Site 1
B	19,836	10	198,360	0	
C	3,276	10	32,760	0	
D	97,700	10	977,000	0	
E	29,488	10	294,880	0	
F	7,931	10	79,310	0	
G	111,226	10	**1,112,260**	**1,000,000**	Large Open Area
H	8,542	10	85,420	0	
I	74,804	10	748,040	0	
J	1,704	10	17,040	0	
	832,260		8,322,600	**3,300,000**	

Currituck Outer Banks Master Plan - Wastewater Disposal
Table 4, Water Level Data

Easting NAD 83 Feet	Northing NAD 83 Feet	Water Elevation Ft. M.S.L.	Water Depth Ft.	WELL	TOC Elevation Ft. M.S.L.	Ground Elevation Ft. M.S.L.	STICKUP Feet	DTW TOC Feet
2934420	964340	4.82	4.36	P1	10.39	9.18	1.21	5.57
2934980	964510	6.1	4.75	P2	12.13	10.85	1.28	6.03
2934880	965110	5.35	2.11	P3	8.87	7.46	1.41	3.52
2934200	967200	5.67	3.19	P4	10.95	8.86	2.09	5.28
2934220	967420	3.84	3.28	P5	7.66	7.12	0.54	3.82
2935400	968540	3.4	3.82	P6	8.46	7.22	1.24	5.06
2933950	970550	7.61	3.14	P7	11.67	10.75	0.92	4.06
2939772	951208	3.89	2.71	OS-WW-1	9.27	6.6	2.67	5.38
2939312	951215	4.05	1.65	OS -WW-2	8.48	5.7	2.78	4.43
2941164	947462	3.39	3.11	1-F	9.43	6.5	2.93	6.04
2940862	946773	4.27	1.43	2-F	8.55	5.7	2.85	4.28
2940160	947021	6.42	0.18	3-F	9.21	6.6	2.61	2.79
2941657	945875	4.34	1.66	4-F	10.4	6	4.4	6.06
2941050	945886	4.65	2.15	5-F	9.36	6.8	2.56	4.71
2942079	943571	5.24	1.66	1-D	10.92	6.9	4.02	5.68

Fig. 1 - Model Domain - Corolla Light Area

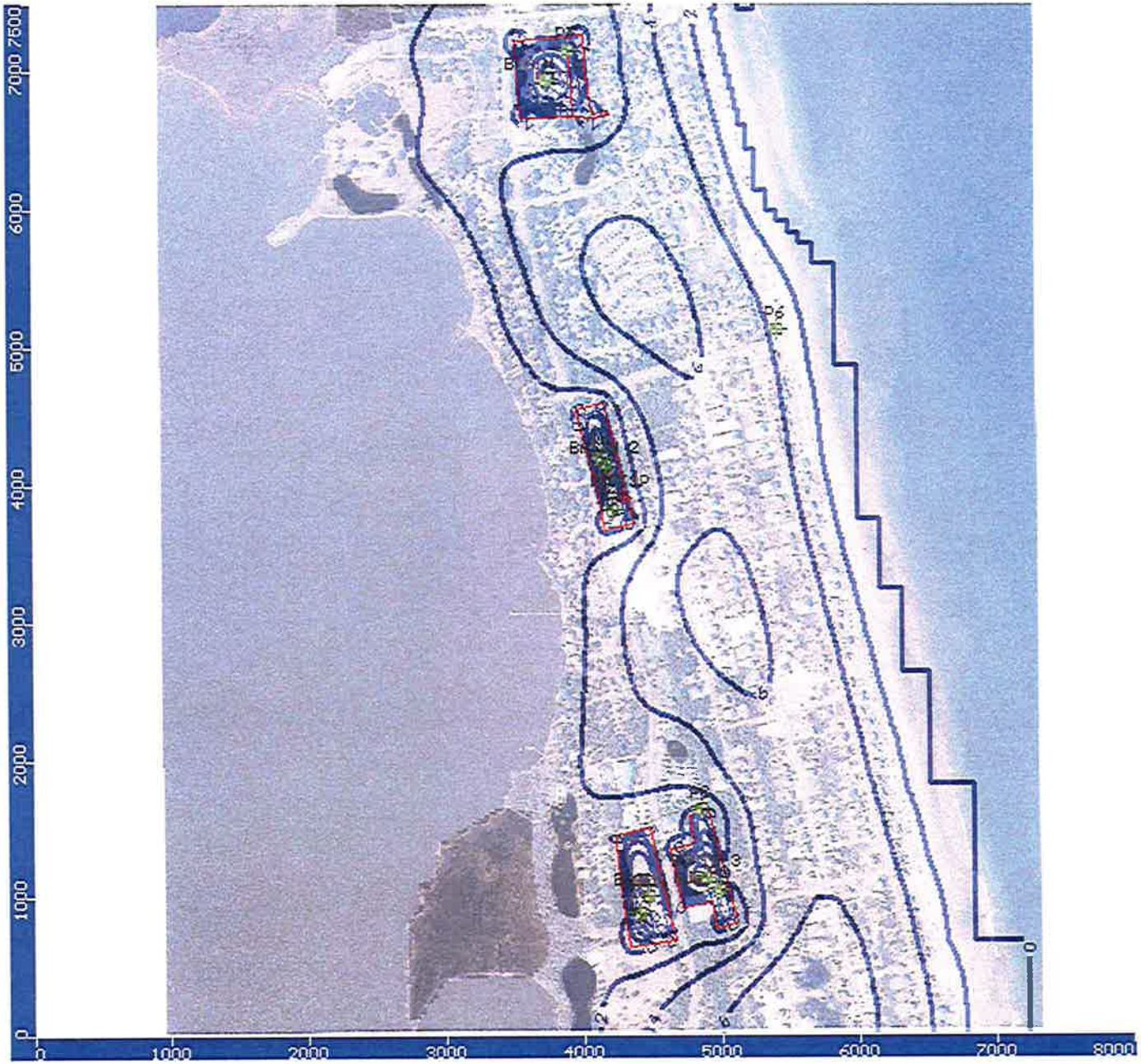


Fig. 2 - Model Grid - Corolla Light Area

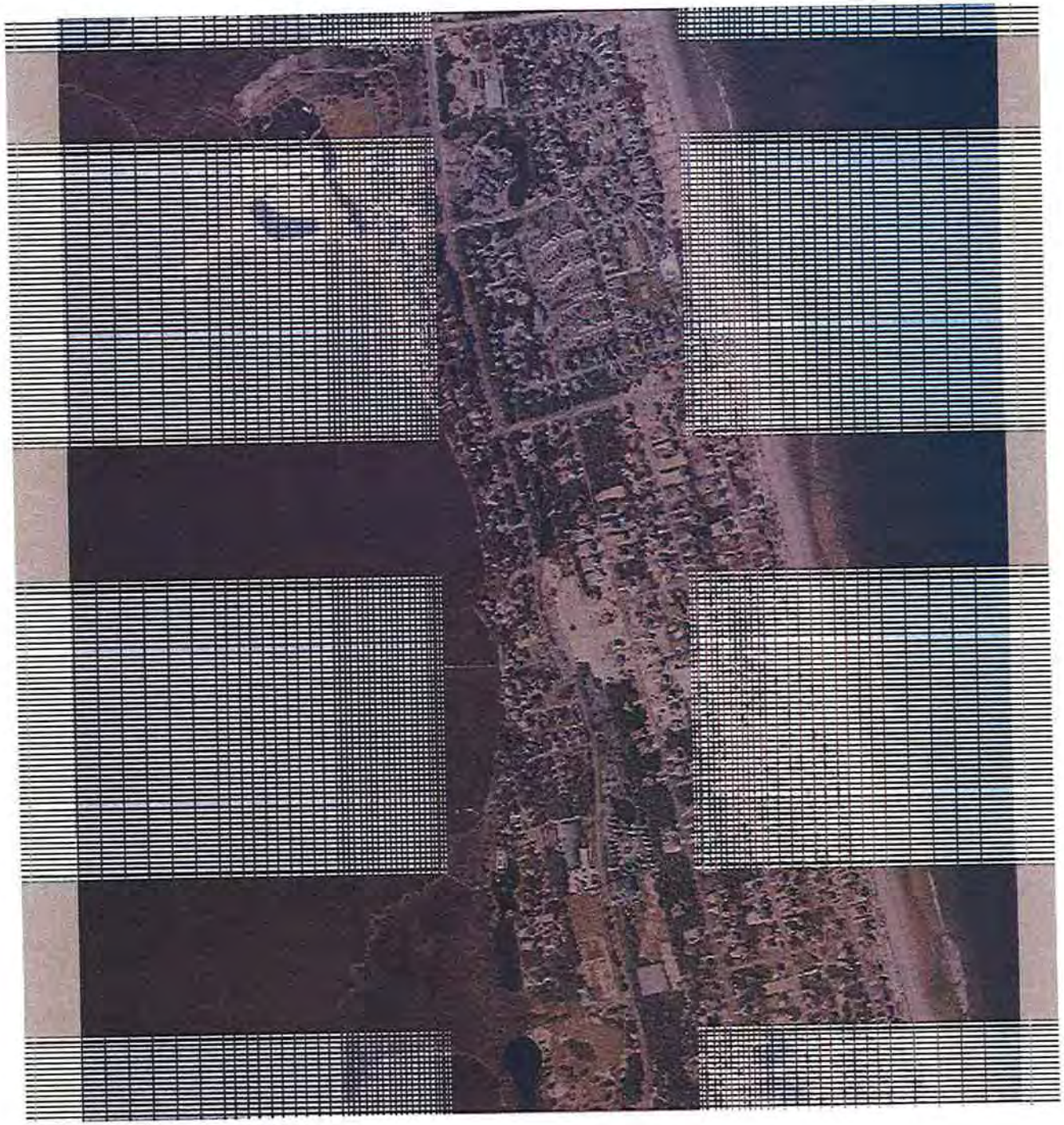
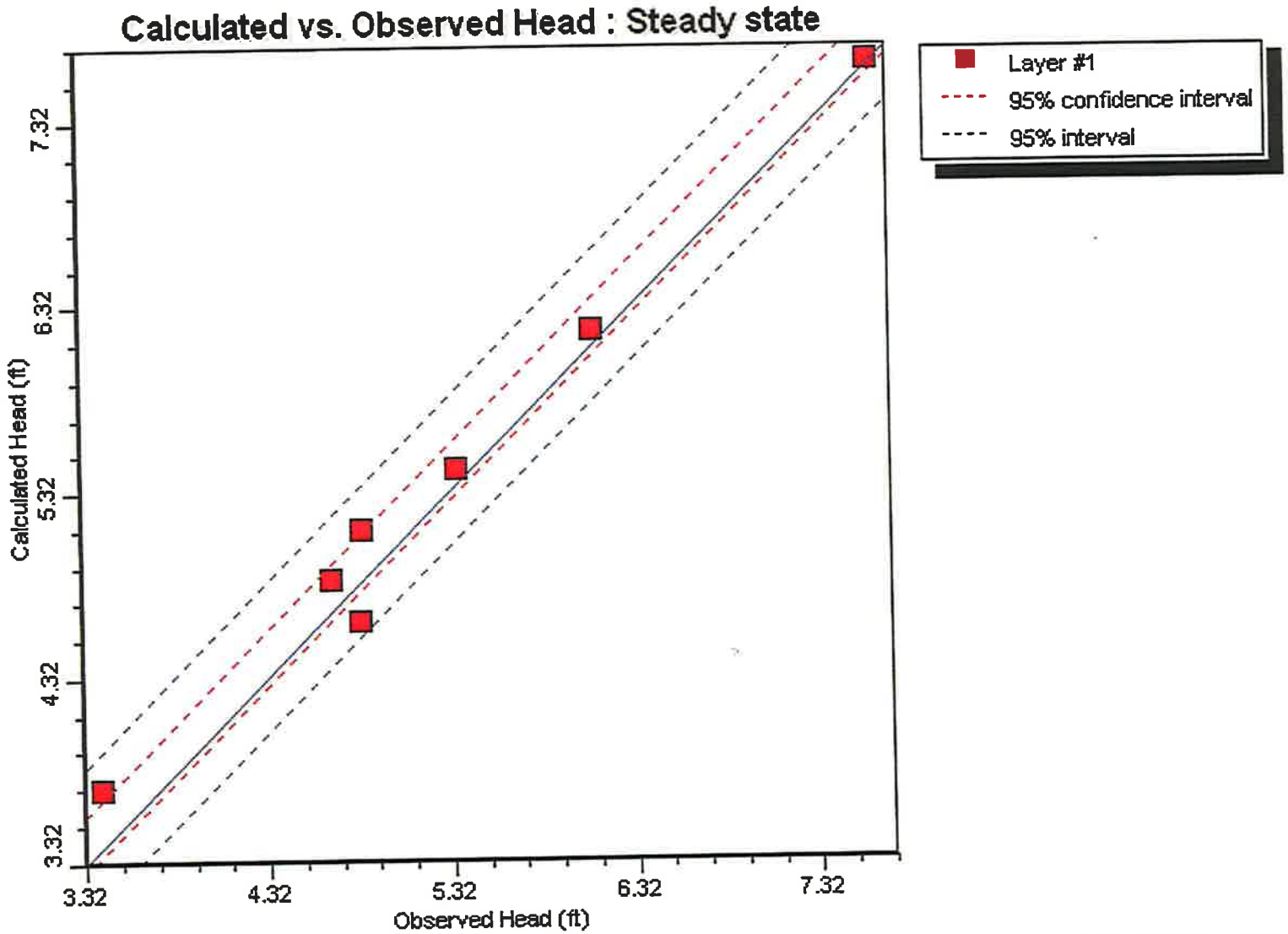


Fig. 3 - General Calibration - Corolla Light Area



Max. Residual: 0.315 (ft) at P6/A
Min. Residual: 0.027 (ft) at P7/A
Residual Mean : 0.11 (ft)
Abs. Residual Mean : 0.166 (ft)

Num. of Data Points : 7
Standard Error of the Estimate : 0.065 (ft)
Root Mean Squared : 0.193 (ft)
Normalized RMS : 4.575 (%)
Correlation Coefficient : 0.992

Fig 4 - Time vs. Water Level - Corolla Light Area

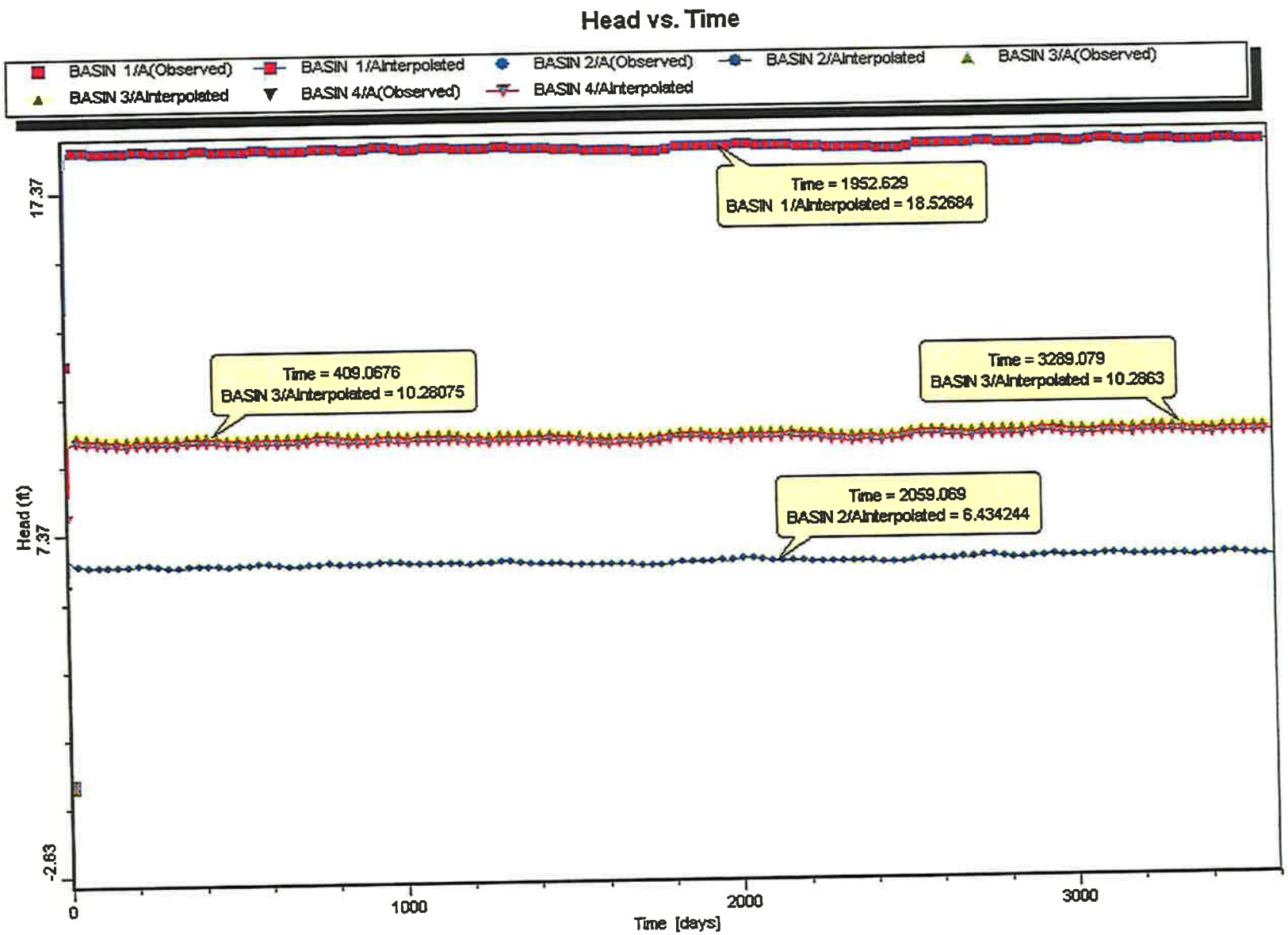


Fig 5 - Model Results - Corolla Light Area

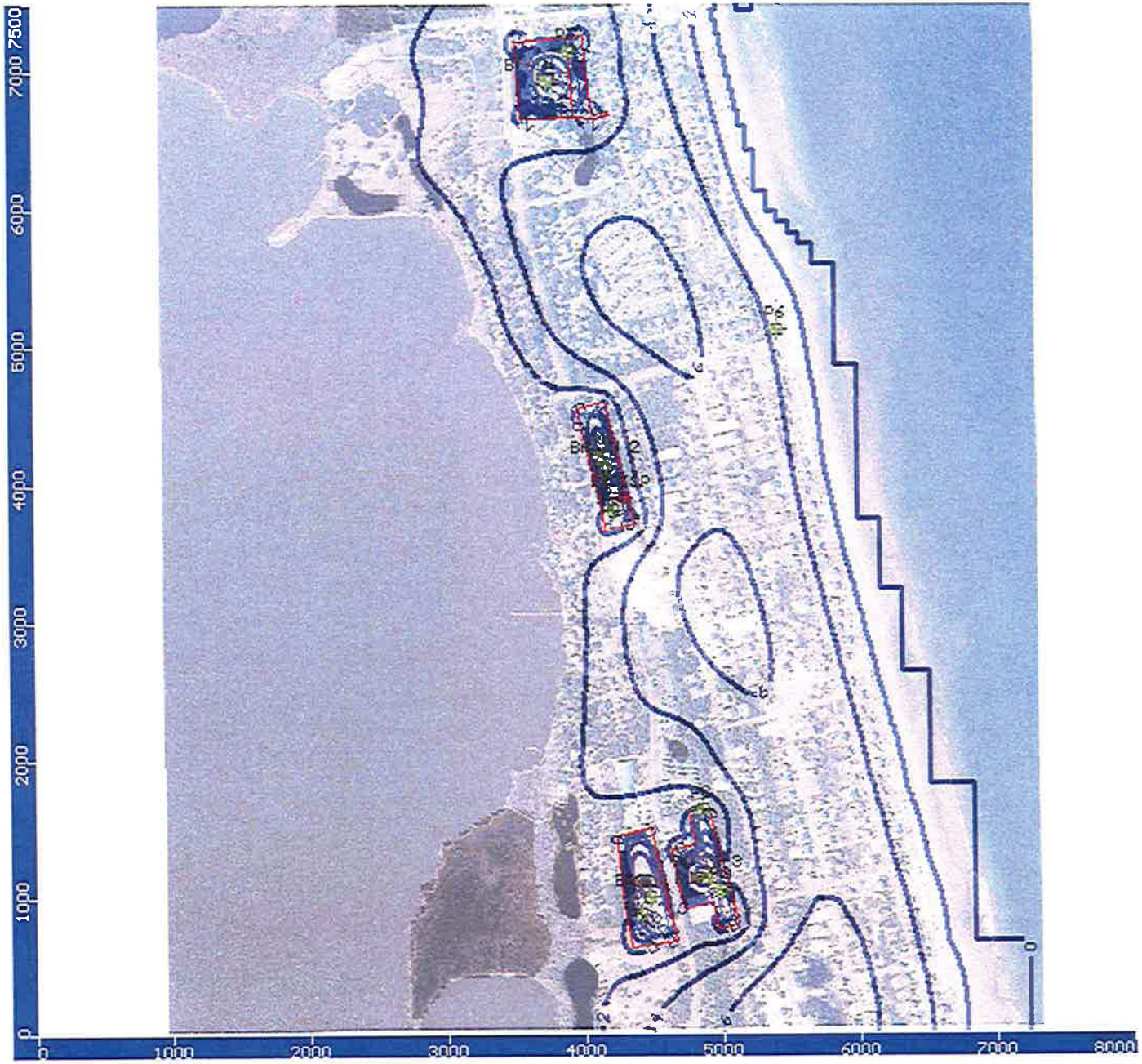


Fig 6 - Model Results - Corolla North Site

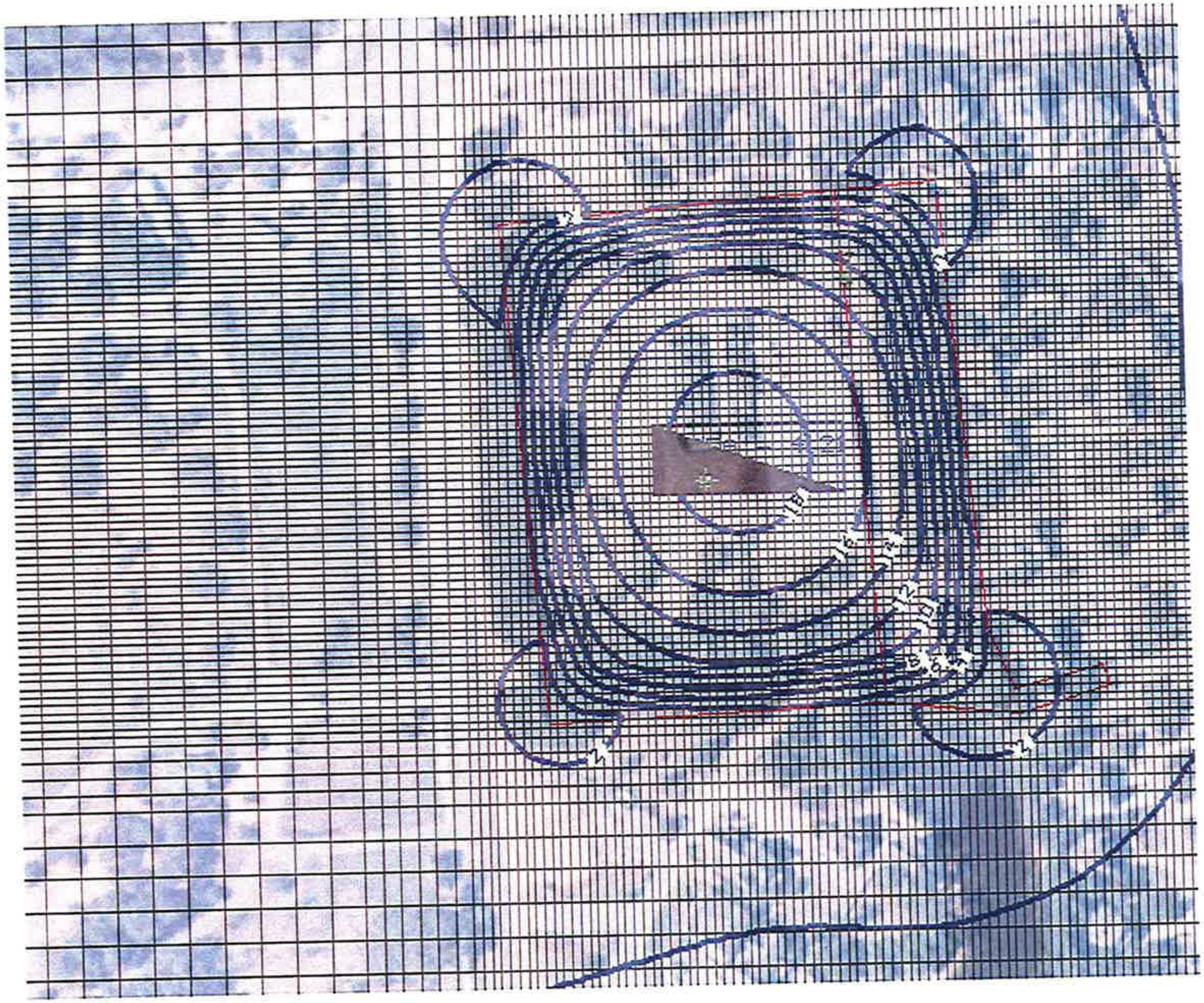


Fig 7 - Model Results - Middle Area

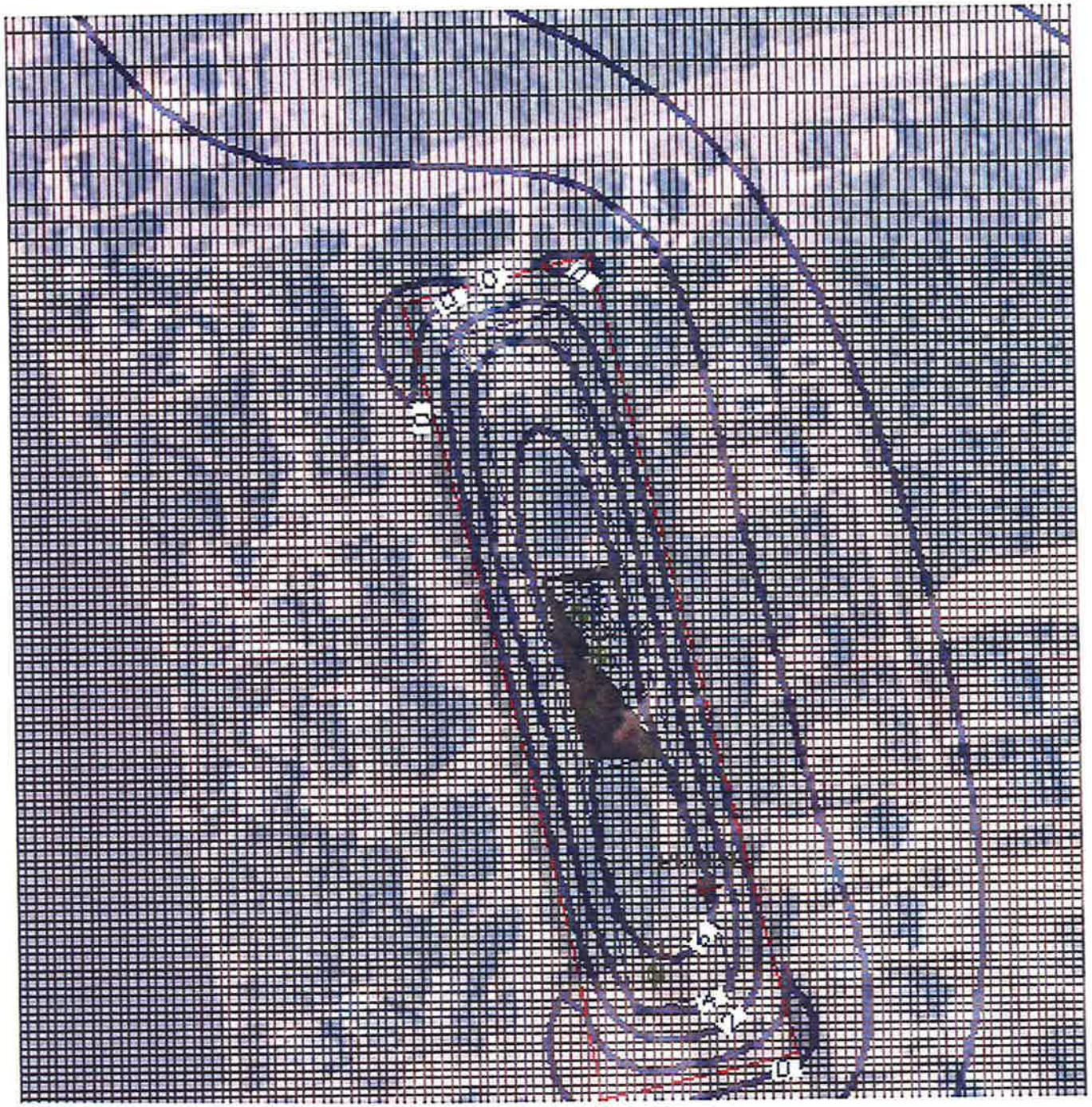


Fig 8 - Model Results - Southern (LPP) Area

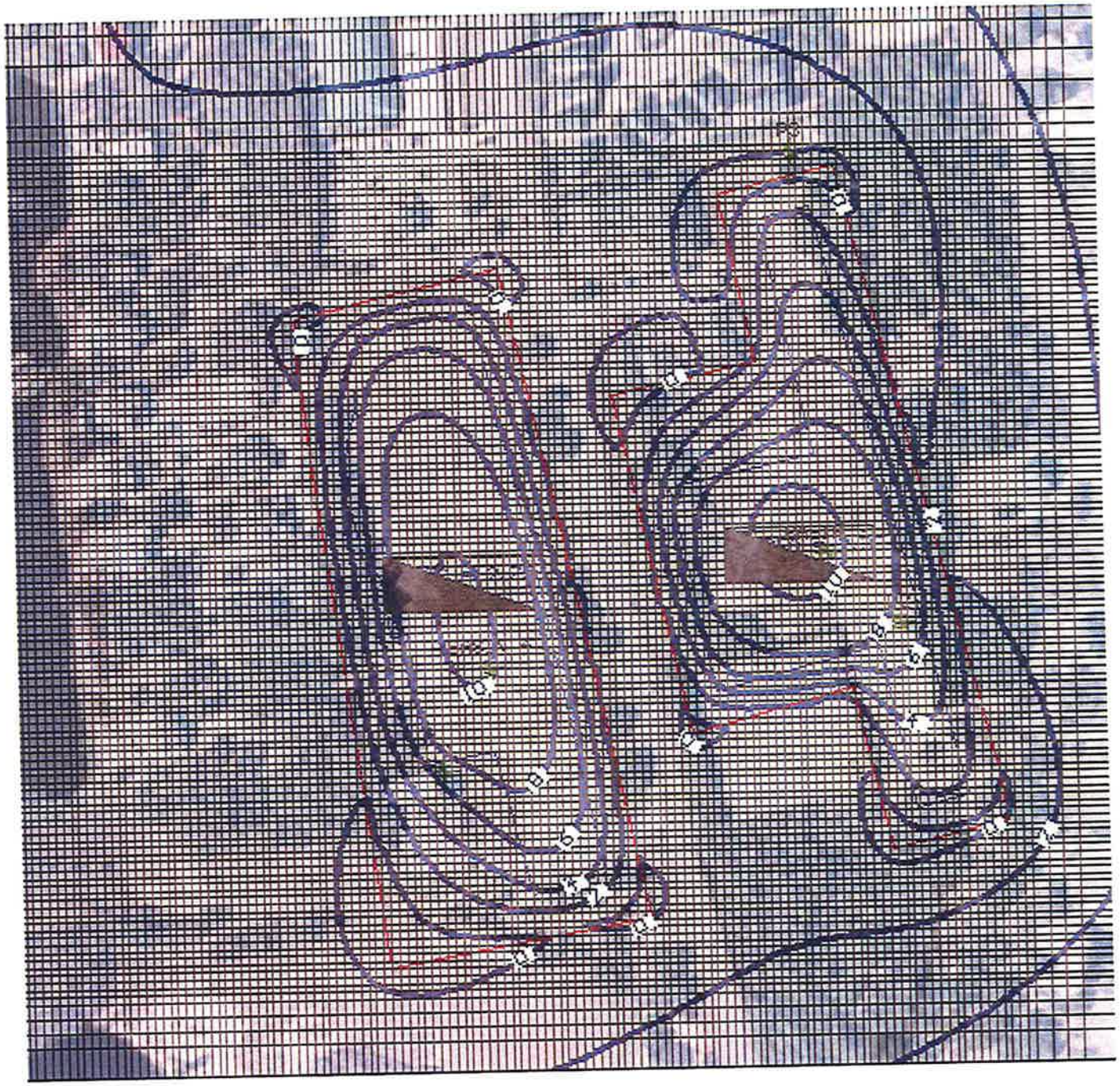


Fig 9 - Model Domain - Ocean Sands Area

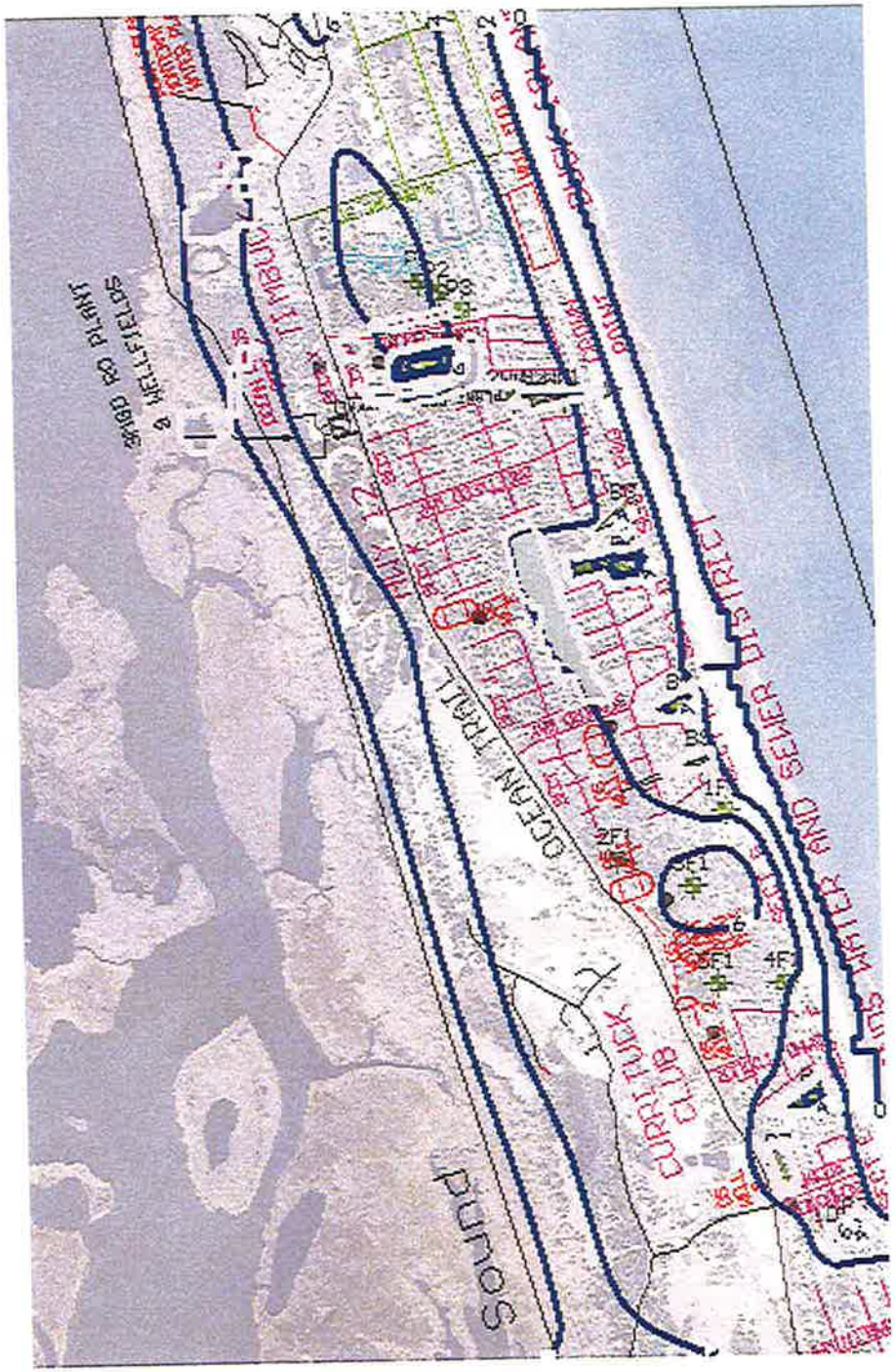
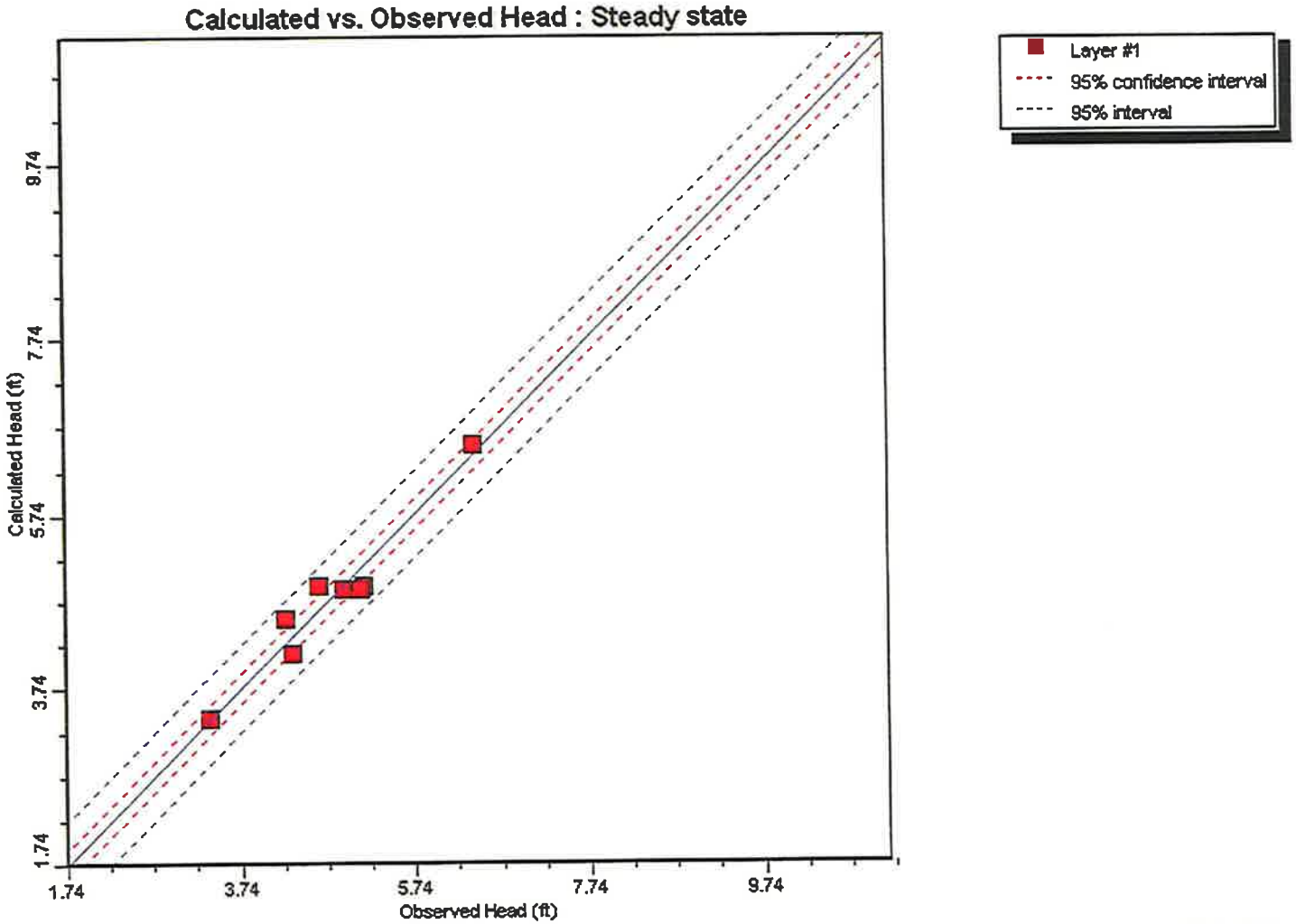


Fig 10 - Model Calibration - Ocean Sands Area



Max. Residual: 0.289 (ft) at 5F1/A
Min. Residual: 0.011 (ft) at 1F1/A
Residual Mean : -0.003 (ft)
Abs. Residual Mean : 0.174 (ft)

Num. of Data Points : 8
Standard Error of the Estimate : 0.076 (ft)
Root Mean Squared : 0.2 (ft)
Normalized RMS : 6.596 (%)
Correlation Coefficient : 0.971

Fig 11 - Model Grid - Ocedan Sands Area

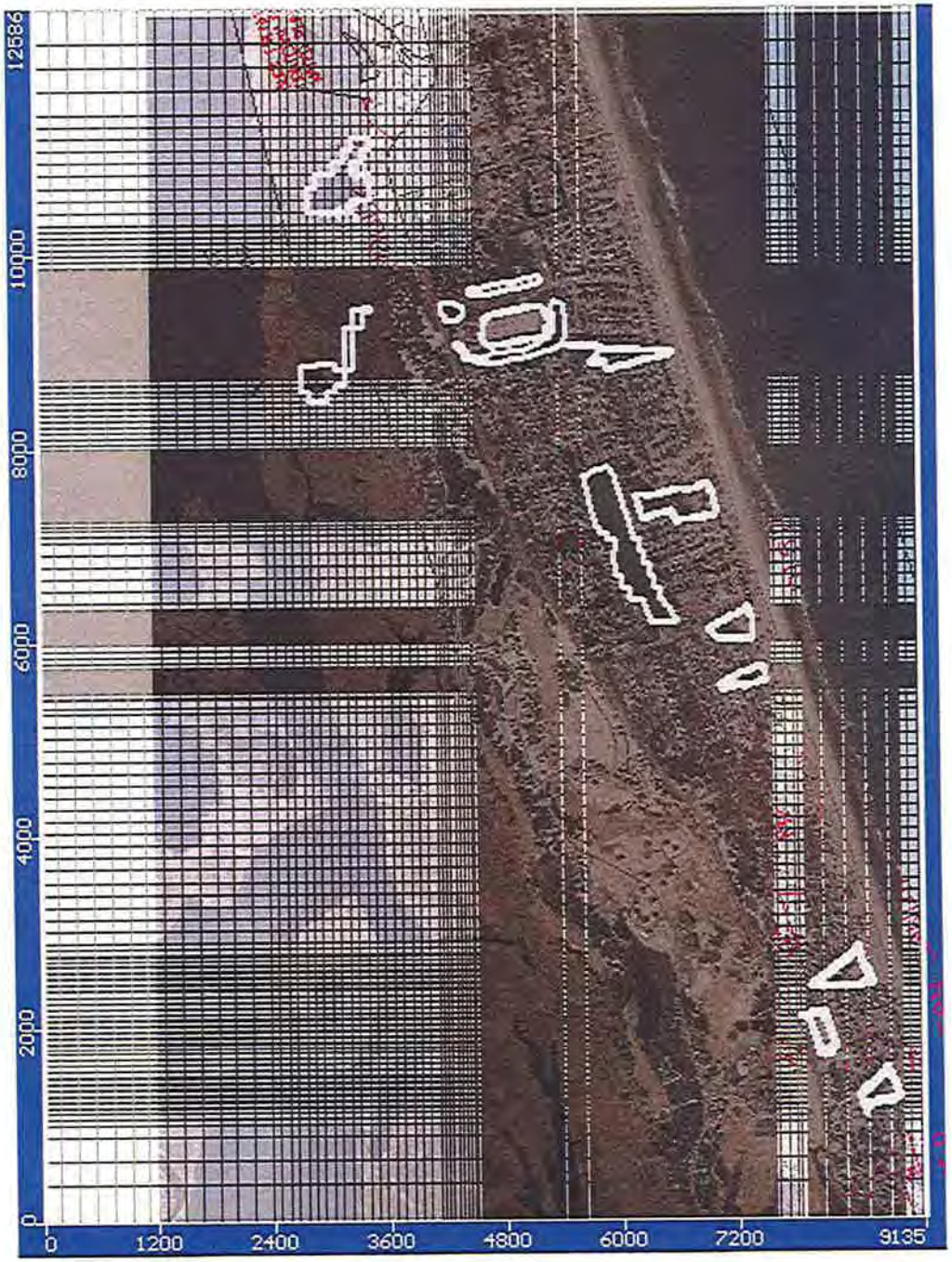


Fig 12 - Time vs Water Level - Ocean Sands Area

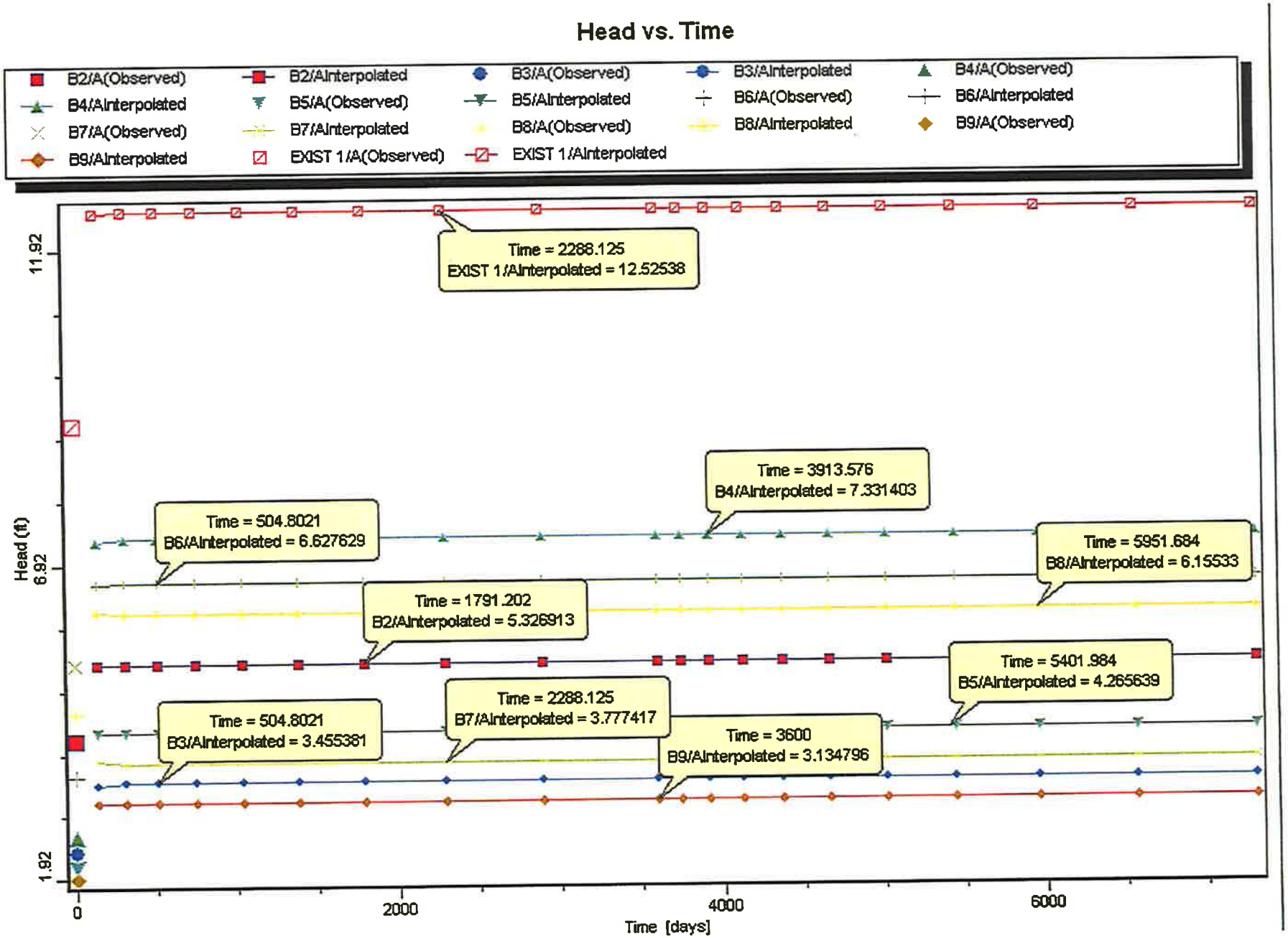


Fig 13 - Model Results - Ocean Sand (North) Area

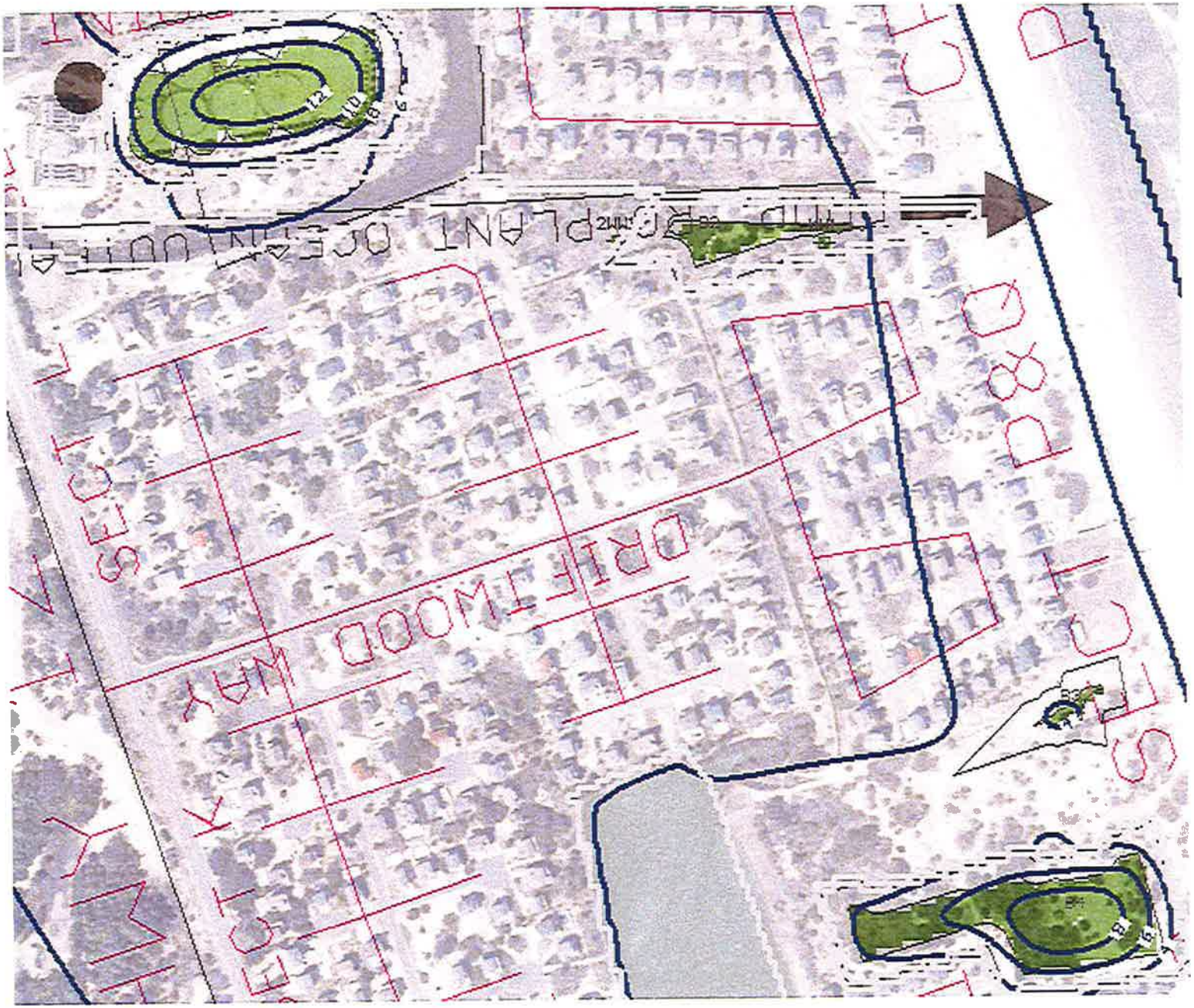
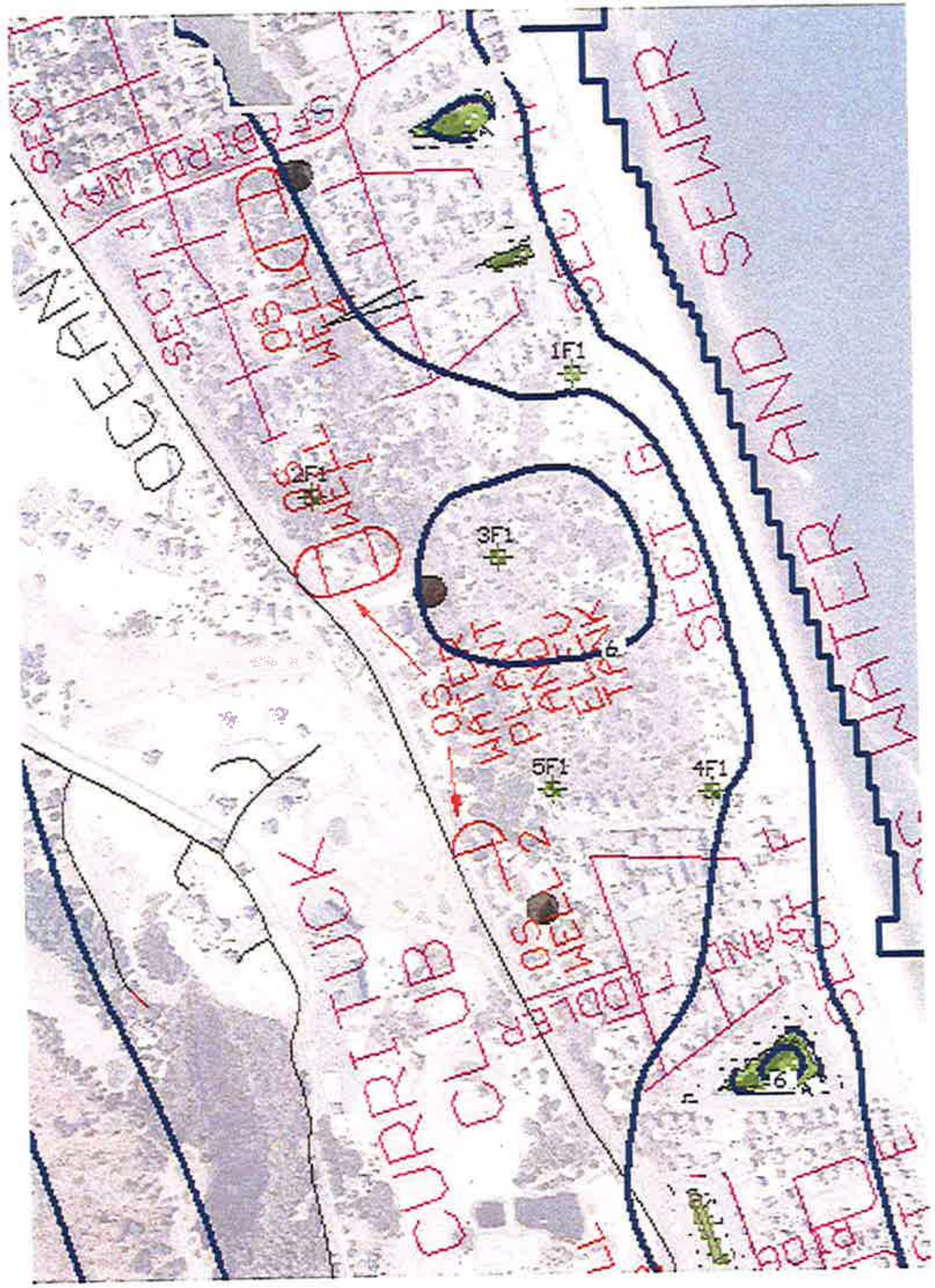


Fig 14 - Model Results - Ocean Sand (South) Area



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Currituck County
Currituck Utilities LLC

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From:
Mark Bissell, P.E., BPG
David Ryan, P.E., BPG

Date:
April 12, 2011

Project No.:
30138-000

Subject:
Technical Memorandum 3 – Wastewater Collection Alternatives
Outer Banks Comprehensive Wastewater Master Plan

This technical memorandum (TM) is part of the master planning effort for the Southern Outer Banks in Currituck County. The purpose of this TM is to provide a summary of wastewater collection alternatives for the Outer Banks.

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1. Introduction

1.1 Background

The goal of this Comprehensive Wastewater Master Plan for the Currituck County Southern Outer Banks is to evaluate wastewater treatment and effluent disposal options and major collection/conveyance requirements to meet long-term goals. The following sections will evaluate the existing and proposed wastewater collection needs for the Currituck Southern Outer Banks communities to create long-term and reliable solutions. Each community will be evaluated for its current situation and management needs in an effort to develop a program that can be supported by the local residents, protect public health and environment, and allow the community to grow and prosper in a sustainable manner consistent with land use and regulatory policies.

1.2 Wastewater Collection Planning Objectives

The objectives of the Wastewater Collection Portion of this Master Plan are as follows:

- Evaluate the existing conveyance and collection system to determine specific system improvements and/or expansion alternatives needed to meet needs through 2030. The scope of work does not include a detailed evaluation of hydraulic capacity or inflow/infiltration for the existing collection systems.
- Establish wastewater trunk-line corridors, including identification of estimated pipe sizes and locations for lift stations for raw sewage and treated effluent (as necessary) connecting the existing wastewater systems to form a regional wastewater system.
- Establish wastewater trunk-line corridors, including identification of estimated pipe sizes and locations for lift stations for providing regional wastewater treatment to the currently unsewered area.
- Identify collection and conveyance impacts for each wastewater treatment capacity expansion option.
- Evaluate alternatives such as vacuum sewer systems in new growth or un-sewered areas to control inflow/infiltration in the Outer Banks area.
- Develop cost estimates for the proposed wastewater collection infrastructure, including major collection trunk lines and lift stations.

2. Regulatory Overview

The rules set forth by the North Carolina Administrative Code for the disposal of treated wastewater are listed under Title 15A, Subchapter 2T, and were effective January 1, 2009. The former set of rules, under Subchapter 2H, were repealed as 2T was approved.

The 2T Rules have specific sections for sewer extensions including local programs for sewer systems, which describe the permitting, application and design criteria. In addition to the 2T rules are Title 15A, Subchapter 1C, which establishes procedures for Conformity with the North Carolina Environmental Policy Act. Depending on the determined wastewater collection alternative, program type, and funding sources, these rules may require an Environmental Assessment (EA) to be filed for this program. An application for a sewer extension involving an EA is not considered complete until either a Finding of No Significant Impact (FONSI) or Record of Decision (ROD) has been issued.

The design criteria for the construction of sewers and sewer extensions prescribe requirements such as design capacities and flows, vertical and horizontal setbacks to various site features and utilities, design details and construction standards, component reliability, quality assurance and control, and security and flood protection measures. All deeds, easements, and encroachment agreements to accommodate the collection facilities shall be secured prior to the operation of the system.

3. Existing Sewered Area Wastewater Collection Systems Evaluation Overview

This section evaluates the wastewater collection infrastructure for the existing sewered areas of the Currituck Outer Banks. The sewered areas consist of the following service areas and contributing tributary flow:

- Corolla Light Service Area – Corolla Light is a planned unit development (PUD) sited on 267 acres along the southern Currituck Outer Banks in Corolla, NC. This master planned development consists of a mix of residential and non-residential uses. The residential uses consist of a mix of single-family, multi-family and apartment units with the non-residential uses consisting of an Inn and Town Center which feature retail, restaurant and recreational facilities.
- Monteray Shores Service Area – The Monteray Shores service area consists of a combination of several developments including Monteray Shores PUD, Buck Island PUD, Timbuck II Shopping Center, and Monteray Shores Plaza. The makeup is similar to the Corolla Light PUD with a mix of residential and non-residential uses consisting of single-family and multi-family units in association with retail, restaurant and recreational facility components.
- Ocean Sands Service Area – Ocean Sands is a 678 acre ocean front PUD on the Currituck Outer Banks. The development consists primarily of residential uses to include single-family, multi-family or duplex dwelling units with smaller portions of area dedicated for commercial uses. Development Sections G, T, R, U and X are currently undeveloped, with the focus of this evaluation targeted on the undeveloped areas of sections G and T.

3.1 Existing Sewered Area Wastewater Facilities Overview

Each of the service areas identified above will be assessed for wastewater collection system improvements necessary to meet the infrastructure needs through the year 2030. It is assumed that the wastewater collection facilities currently in place adequately meet the existing demands. This evaluation focuses on the potential development expansion opportunities through the year 2030. The following sections provide a brief overview of the facilities currently in place for each of the aforementioned service areas.

3.1.1 Corolla Light Service Area

The wastewater needs of the Corolla Light PUD are currently serviced by a gravity collection system network connected to two separate wastewater treatment facilities: Corolla Light No. 1 and Corolla Light No. 2. The existing collection facilities consist of 8 inch gravity collection mains with individual service connections strategically sited throughout the development for the collection and conveyance of wastewater to the wastewater treatment facilities. Table 3-1 provides a summary of the tributary areas that are currently serviced by the collection system.

Table 3-1: Summary of Corolla Light Collection System

Development Section [1]	Method of Collection	Tributary Area Description
Phase 5E, 5F, 5G, 7A	8 inch diameter gravity collection line to Lift Station #6	Area served by gravity collection sewer to service single-family, multi-family and recreational development. Flow is conveyed, via gravity, to a centrally located pump station, Lift Station #6, which transports wastewater via a 4" force main to WWTP #2.
Phase 5B, 5C, 5D, 4	8" diameter gravity collection line to Lift Station #4	Area served by gravity collection sewer to service single-family and commercial development. Flow is conveyed, via gravity, to a centrally located pump station, Lift Station #4, which transports wastewater through a 6 inch force main along Ocean Trail to WWTP #2.
Phase 1A, 1, 2E, 9B, 9C	8 inch diameter gravity collection line to Lift Stations #7 and #4	Area served by gravity collection sewer to service single-family and commercial development. The northern portion of the development conveys flow to Lift Station #7 which transmits flow downstream to a collection system tributary to Lift Station #3. Lift Station #3 pumps wastewater flow to the east to WWTP #1, sited at the northern most extent of the development. Flow from the southern portion of the development is conveyed eastward to Lift Station #1.
Phase 1, 2B, 2C, 5A, P8, P6A, Town Center, Rec. Center	8 inch diameter gravity collection line to Lift Station #1 and Lift Station #2	Area served by gravity collection sewer to service single-family, multi-family and commercial development. The northern portion of the development conveys flow to LS #2 which transmits flow to WWTP #1. Lift Station #1 receives flow from the southern portion of the development to include portions of Phase 1 sound front properties for conveyance to WWTP #1.

[1] *Source: Corolla Light Water and Sewer Systems Composite As-Built, dated 3/10/2004*

The northern portions of the Corolla Light and Whalehead Club developments are currently served by the Corolla Light No. 1 WWTP (Permit No. WQ0006254), which is a 160,000 gpd package wastewater treatment plant. Corolla Light No. 2 (Permit NC0015282AI) is a 100,000 gpd extended aeration type wastewater treatment plant. The plant consists of two parallel steel package trains rated at 50,000 gpd each. Technical Memorandum 2 – *Wastewater Treatment and Effluent Disposal Alternatives* provides a detailed description of the existing facilities and conditions of Corolla Light No. 1 and Corolla Light No. 2.

3.1.2 Monteray Shores Service Area

The wastewater needs of the Monteray Shores PUD, Buck Island PUD, Monteray Shores Plaza, and Timbuck II are currently serviced by a gravity collection system network connected to a single centralized wastewater treatment facility. The existing collection facilities consist of 8 inch gravity collection mains with individual service connections strategically sited throughout the developments for the collection and conveyance of wastewater to the wastewater treatment facilities. Table 3-2 provides a summary of the tributary areas that are currently serviced by the collection system.

Table 3-2: Summary of Monteray Shores Collection System

Development Section	Method of Collection	Tributary Area Description
Phase 3, Corolla Bay	8 inch diameter gravity collection line to Lift Stations #8 and #9	Area served by gravity collection sewer to service single-family and future commercial development. Flow is conveyed, via gravity, to two pump stations, Lift Stations #8 and #9, which transport wastewater downstream via a 4 inch force main to an existing gravity collection network located in Phase 1.
Phase 1	8 inch diameter gravity collection line to Lift Stations #2 and #1	Area served by gravity collection sewer to service single-family and recreational development. The northern portion of the development conveys flow to Lift Station #2 which transmits flow downstream to a collection system tributary to Lift Station #1. Lift Station #1 pumps wastewater flow to the south, via a 6 inch force main to the WWTP, sited at the southern most extent of the development.
Phase 2	8 inch diameter gravity collection line to Lift Stations #3, #4, #5, and #6	Area served by gravity collection sewer to service single-family and commercial development. The northern portion of the development conveys flow via Lift Stations #3, #4, #5, and #6, which transmit flow upstream to a collection system tributary to Lift Station #1. Lift Station #1 pumps wastewater flow to the south via a 6 inch force main to the WWTP, sited at the southern most extent of the development.
Commercial Outparcels	8 inch diameter gravity collection line to WWTP	Area served by gravity collection sewer to service commercial development. Commercial properties serviced by collection network which conveys flow directly to wastewater treatment facility.
Timbuck II	8 inch diameter gravity collection line to Lift Station C	Area served by gravity collection sewer to service commercial development. Commercial properties serviced by collection network which conveys flow 6 inch force main which is routed to the Monteray Shores WWTP facility.
Buck Island	8 inch diameter gravity collection line to Lift Stations #2 and #1	Area served by gravity collection sewer to service single-family, multi-family and recreational development. The eastern portion of the development conveys flow to a pump station located at the intersection of Voyager Road and Orion's Way. The pump station transmits flow downstream to a collection system tributary to Lift Station #1 sited at the intersection of Ranger Road and Orion's Way. This pump station pumps wastewater flow to the west via a 6 inch force main to the WWTP.
Monteray Shores Plaza	8 inch diameter gravity collection line to Lift Stations #2 and #1	Area served by gravity collection sewer to service the commercial development. The collection network is located on the periphery of the site, accepting wastewater flows from the various commercial sources. The flow is conveyed to a Lift Station sited on the northern portion of the site which transmits flows across Ocean Trail through a 4 inch diameter force main. This is connected to the 6 inch diameter force main that serves the residential sections to the north for discharge to the Monteray Shores WWTP facility.

[1] *Source: Monteray Shores Water and Sewer Systems Composite As-Built, dated 5/28/2004.*

In 2009, the Monteray Shores WWTP was expanded to a capacity of 520,000 gpd to address the capacity limitation and upgraded to include denitrification. The plant was completely re-configured with biological nutrient removal (BNR) to ensure compliance with new, more stringent regulatory requirements. The treatment facility was upgraded to a 4-stage activated sludge process for advanced nutrient removal followed by submerged membrane bioreactors and ultraviolet disinfection. Technical Memorandum 2 – Wastewater Treatment and Effluent Disposal Alternatives provides a more detailed description of the treatment plant.

3.1.3 Ocean Sands Service Area

The wastewater needs of the Ocean Sands PUD are currently serviced by a gravity collection system network connected to a centralized wastewater treatment facility. For the purpose of this review, only the undeveloped Sections G and T have been evaluated, (**Figure 3-1**). Wastewater from Ocean Sands is treated at the Ocean Sands WWTP, a County-owned facility with a permitted capacity of 500,000 gallons per day. Technical Memorandum 2 – *Wastewater Treatment and Effluent Disposal Alternatives* contains a detailed description of the Ocean Sands WWTP processes and condition.

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OCEAN SANDS P.U.D.

FIGURE 3-1: OCEAN SANDS
OVERVIEW OF UNDEVELOPED
SECTIONS G & T

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3.2 Sewered Areas Wastewater Collection System Expansion Evaluation

TM #2 – *Wastewater Treatment and Effluent Disposal Alternatives* recommended approach to the development of a regional wastewater system to service the Southern Outer Banks. A similar approach is recommended to accommodate the receiving wastewater flows from the existing sewered areas. It is recommended that regional pump stations be established for the following service areas:

- Corolla Light 1
- Corolla Light 2
- Monteray Shores
- Ocean Sands, Section G
- Ocean Sands, Section T

The regional lift stations servicing Corolla Light No. 1, Monteray Shores, and Ocean Sands can be sited in close proximity to the existing wastewater treatment plant influent. Existing tankage and pump components may be able to be incorporated into the design, but will require further evaluation for final determination. Due to the unknown development plans for undeveloped sections of Ocean Sands G and T, regional lift stations have been located in a central location, adjoining Ocean Trail and the closest point of off-site conveyance. The existing sewer force mains were assumed to be at full capacity. Due to the variability in seasonal flows experienced on the Currituck Outer Banks, separate force mains were considered as part of the preliminary review: one combined force main to service northern Corolla Light, one force main to service the existing Ocean Sands development, and one force main to service Ocean Sands undeveloped sections G and T as well as Monteray Shores.

The force mains will be located along the existing 100-foot Ocean Trail right-of-way. Installation of the facilities can be conducted via trench or trenchless type construction methods to minimize surrounding impacts. Table 3-3 summarizes the opinion of probable construction costs associated with this approach. The costs include the installation of force mains, lift station installation, standby power, roadway and landscape restoration, electrical service, mobilization, and incidentals. Costs also include a 25 percent contingency and 12 percent for technical (engineering and design) services. A conceptual layout of this approach is provided in Figure 3-2.

Table 3-3: Summary of Opinion of Probable Construction Costs for Collection System Expansion

Capital Costs	Corolla Light	Existing Ocean Sands	Ocean Sands G and T	Monteray Shores
Construction Costs	$534,300	$1,075,500	$1,975,700	$1,079,300

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SEWERED AREA EXPANSION OVERVIEW

FIGURE 3-2: CONCEPTUAL LAYOUT FOR SEWERED AREA WASTEWATER COLLECTION SYSTEM EXPANSION

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4. Unsewered Area Wastewater Collection System Alternatives Evaluation

This section evaluates alternative wastewater collection system technologies. For the unsewered areas, Whalehead Club Subdivision, Ocean Hill and Corolla Village, each technology is described along with the relative advantages and disadvantages for each as they would apply to the unsewered areas.

4.1 Wastewater Collection System Technologies

Three wastewater collection system technologies were considered for evaluation:

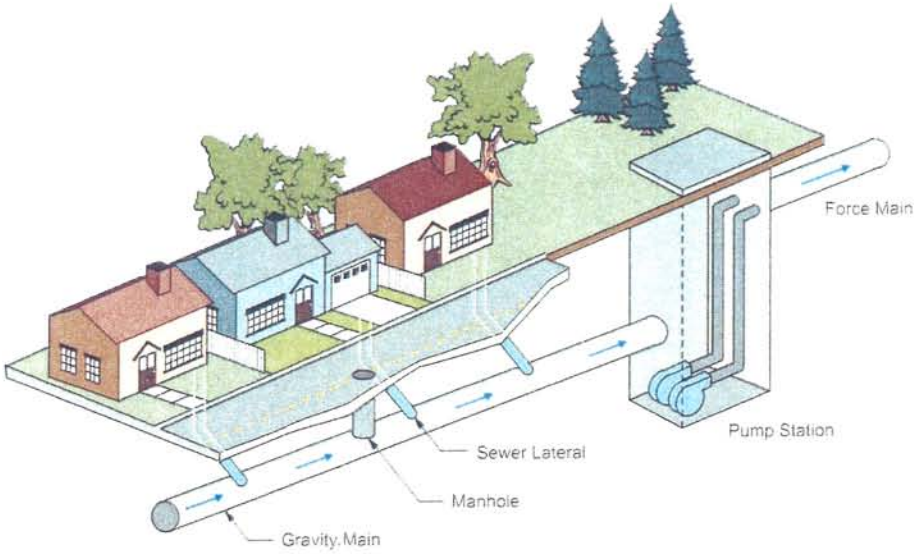
- Conventional gravity collection – Gravity sewer line convey wastewater to regional pump stations.
- Septic tank effluent pump (STEP) collection – Wastewater flows from the building drain to a septic tank on the property. Most of the wastewater solids remain in the septic tank. The clarified effluent from the tank is pumped into a pressurized sewer main using a high-pressure pump. The pressurized main conveys the clarified effluent to the wastewater treatment plant.
- Vacuum sewers – Vacuum sewers convey wastewater by use of vacuum stations and vacuum collection lines located in each neighborhood. Wastewater flows from the building drain into a sump (or vacuum pit) located on the property. When the sump fills, a valve opens and the wastewater is withdrawn into the vacuum main. Once the pit is empty, the valve closes. The wastewater is conveyed via small diameter vacuum pipes to the vacuum station where it is pumped to the wastewater treatment plant via force main.

4.2 Conventional Gravity Sewer Description

Conventional gravity sewers use a series of sloped pipes between manholes to collect and convey raw wastewater from the sewer connection to the wastewater treatment plant. The pipelines are a minimum of 8 inch diameter, are sloped at a minimum slope of 0.004 feet/foot, and are typically laid between 3 feet and 12 feet deep. A maximum depth of 12 feet was utilized as a benchmark due to the high groundwater conditions in the costal environment and the cost increases associated with dewatering operations to accommodate gravity sewer installation. Wastewater is collected within sewer mains and slope towards the wastewater treatment plant or to a regional pump station.

Each service connection to the wastewater treatment plant is achieved through a sloped pipe (service lateral) from the building's drain to the gravity sewer main in the street. The construction of the service lateral is typically the responsibility of the property owner from the property line to the building drain. A schematic of a typical gravity collection system layout is shown on Figure 4-1.

Figure 4-1: Schematic of Gravity Sewer Collection System



Within the street right-of-way, construction of the service connection from the sewer main to the property line is the responsibility of the representative sewer agency or utility. This type of collection system does not require any access and maintenance easements since maintenance of the service lateral on private property is the responsibility of the property owner.

In most instances, parts of the tributary service area are limited by local topography requiring the construction of a pump station to locally collect the wastewater for conveyance to the wastewater treatment plant. It is through a series of gravity collection lines and pump stations that wastewater within the service area is collected and pumped to the wastewater treatment plant.

A key strategy in the design of a gravity collection system is to utilize the contours of the existing terrain and development layout to maximize efficiency in the construction of pipelines towards the wastewater treatment plant. An efficient design strategy involves sewers excavated as shallow as possible while minimizing the number of pump stations. Sewer depth becomes pronounced in long pipe runs, necessitating the use of pump stations at deep junctures to lift sewage to shallower depths to avoid deep excavations downstream. In regions like the Currituck Outer Banks, were the land profile is relatively flat, opportunities to take advantage of the natural topography is limited resulting in increased frequency of lift station placement in an effort to avoid deeper gravity collection mains.

Maintenance for a gravity collection system involves pump station checks, routine maintenance of the pump station equipment, and flushing of the gravity collection lines. Operational costs for a typical gravity collection system involve electricity to operate the pump stations.

4.2.1 Conventional Gravity Sewer Design Criteria

The gravity collection system was developed using design criteria prescribed in the NCDENR Minimum Design Criteria for the permitting of Gravity Sewers in association with NCDENR Minimum Design Criteria for the permitting of Pump Stations and Force Mains and flow generation criteria developed in *TM No. 1 - Wastewater Flow Projections*. The key design criteria used in the development of the gravity collection system are as follows:

- Average Daily Flow (Q) = 530 gpd/connection or 8.83 persons per dwelling unit based upon 60 gallons/capita/day (for the determination of service population (thousands)), as per 15 A NCAC 02T. 0114
- Peak Flow – Ratio of Peak Hour flow to Average Daily flow based upon peaking factor in *Section 2.02 Number and Capacity NCDENR Minimum Design Criteria for the Permitting of Pump Stations and Force Mains.* The equation is as follows:

$$\frac{Q_{phf}\ \text{Peak Hourly Flow}}{Q_{ddf}\ \text{Design Daily Flow}} = \frac{18 + \sqrt{P}}{4 + \sqrt{P}}$$

- Minimum pipeline diameter = 8-inch.
- Minimum Pipeline Cover Depth = 3 feet, (unless ferrous material pipe is specified for sections less than 3' cover depth).
- Maximum Pipeline Cover Depth = 12 feet.
- Minimum Slope = 0.40 feet/100 feet. This is the minimum slope prescribed in *NCDENR Minimum Design Criteria for the permitting of Gravity Sewers* for an 8-inch diameter sewer with a minimum scouring velocity of 2 ft/s. Shallower slopes are allowed for larger diameter sewers, However, all pipes were laid out using the 0.40 slope to be conservative.
- Main pipelines sizing was calculated with capacity flowing at 80 percent full depth.
- The layout was based upon the upstream tributary areas conveying wastewater flow, via force main, to the downstream tributary areas.
- Main Lift Station sited at the intersection of Sailfish St. & Whalehead Drive
- Minimum Force Main scouring velocity of 2 ft/s
- Maximum Force Main scouring velocity of 7 ft/s
- Force Main Pipe sizing based upon receiving tributary flow to each lift station.

4.2.2 Conventional Gravity Sewer System Layout

Figures 4-2 through 4-4 describe the proposed gravity collection sewer, lift station and force main layout to service the unsewered areas of Whalehead Subdivision, Ocean Hill Subdivision, and Corolla Village. The proposed gravity collection sewer system layout was developed to service the existing unsewered communities of Whalehead Subdivision, Ocean Hill Subdivision, and Corolla Village. The approach was to identify the potential areas that may be suitable for the location of a lift station with consideration of land costs and collection capital improvement costs being key factors in the determination of the locations. For Ocean Hill Subdivision, two sites were identified as residual portions of rights-of-ways, which were currently undeveloped which could potentially accommodate a lift station. For the Corolla Village service area, the Currituck County satellite office site was identified as being a potential lift station location, and within the Whalehead service area, the existing parking areas, and Corolla Fire and Rescue properties were identified as potential sites.

The potential impacts to each of the identified sites would be minimized, to the maximum extent possible, with an approximate footprint of 600 SF and methods incorporated for transitioning into the surrounding landscape. With the potential lift station sites identified, preliminary sewer collection networks were established, maximizing each tributary service area while attempting to minimize surrounding impacts. A total of nine tributary service areas were established utilizing this methodology. Table 4-1 provides the total number of connections and resulting build-out flow projections breakdown for each tributary service area.

Figures 4-2 through 4-4 provide the proposed gravity collection sewer, lift station, and force main layout to the service area.

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OCEAN HILL 1 & COROLLA VILLAGE

FIGURE 4-2: CONCEPTUAL LAYOUT FOR GRAVITY COLLECTION SYSTEM ALTERANTIVE FOR OCEAN HILL SECTION ONE / COROLLA VILLAGE

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WHALE HEAD CLUB SUBDIVISION

FIGURE 4-3: CONCEPTUAL LAYOUT FOR GRAVITY COLLECTION SYSTEM ALTERANTIVE FOR WHALEHEAD CLUB SUBDIVISION (NORTHERN REGION)

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WHALE HEAD CLUB SUBDIVISION

FIGURE 4-4: CONCEPTUAL LAYOUT FOR GRAVITY COLLECTION SYSTEM ALTERANTIVE FOR WHALEHEAD CLUB SUBDIVISION (SOUTHERN REGION)

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Table 4-1: Summary of Build-Out Wastewater Flows for Tributary Service Areas

Tributary Service Area	# of Connections	GPD / Connection	Avg. Daily Flow (gpd)
WH1	34	530	18,020
WH2	226	530	119,780
WH3	141	530	74,730
WH4	202	530	107,060
WH5	155	530	82,150
WH6	104	530	55,120
CV1	134	530	71,020
OH1	51	530	27,030
OH2	62	530	32,860
		Total	587,770

4.2.3 Conventional Gravity Sewer System Advantages and Disadvantages

Advantages and disadvantages of gravity collection systems for wastewater collection to the Currituck County Southern Outer Banks are summarized in Table 4-2.

Table 4-2: Advantages and Disadvantages of Gravity Collection Sewer

Advantage	Disadvantage
Reliability – Most common type of wastewater collection system. This technology is widely used, construction methods are well established and equipment is widely available from numerous suppliers.	Installation – Deep sewers with intermediate pump stations are required in areas of flat terrain to provide a constant downward slope.
Length of Service – Will provide the longest reliable service life compared to other types of collection system technologies. There are no individual onsite mechanical installations required. The gravity collection lines can have a 50-year service life provided they can convey the anticipated future design flows	Initial Costs – Construction of the sewer mains may be more expensive due to deeper trench excavation.
Operation and Maintenance Costs – Has the lowest operation and maintenance costs compared to pressurized collection systems. This is because there are no on-site pumps or equipment at each service connection	Infiltration and Inflow – Gravity collection systems are more susceptible to infiltration and inflow through manholes and some joints in the pipeline system. Unlike a pressurized collection system, there is no back pressure within the pipes to prevent water from entering the collection system.
On-Site Equipment – Does not require on-site equipment. A gravity service lateral is required on the private property between the building drain and the service connection in the right-of-way. On site connection costs are less than for other technologies.	
Maintenance Easements – Since the property owner is responsible for maintenance of the service connection to the sewer, no maintenance easement is required.	
Life Cycle Costs – Cost of gravity conveyance is less over the life cycle of a project since the cost for on-site connections, operations, and maintenance are less than for pressurized sewers. Cost savings become significant as the population density increases and the on-site connection, operations, and maintenance costs per connection become a larger part of the total life cycle cost.	

4.3 Pressurized Wastewater Collection System Description

A STEP (Septic Tank Effluent Pressure) system uses pressurized sewer mains to collect and convey wastewater to the wastewater treatment plant. Typically, each service connection has an individual septic tank with a pump that pumps into the pressurized force main. For a STEP collection system, wastewater flows from the building drain to the septic tank where solids settle. Inside the tank is a pump chamber which houses a high head pump and control floats. The sewage is pumped from the septic tank into the force main. Sewage is conveyed through the pressurized main network to the wastewater treatment plant.

Routine and emergency maintenance and repair of each septic tank and pumping system are generally provided by the wastewater authority since the septic tanks and pumps are considered to be components of the wastewater infrastructure. The required regular septic tank pumping, pump maintenance, pump malfunction, control equipment malfunction and electrical supply malfunction cause the STEP system to often be expensive and labor intensive.

Figure 4-5 shows a typical service connection in a STEP collection system.

Figure 4-5: Typical Service Connection in a STEP Collection System

The principle advantage of pressure sewer systems are that they are better suited for areas with significant topography, unsuitable soil or high groundwater table conditions. Because lines are pressurized, sewer pipe installation can follow the surface topography and remain at a relatively constant depth below the soil surface. Pressure sewer systems are less expensive and obtrusive than gravity systems because they require smaller diameter pipes, are installed at shallower depths, require no manholes or lift stations requirements and can use longer sections of pipe.

4.3.1 Pressurized Wastewater Collection System Design Criteria

The pressurized sewer system layout was developed using design criteria prescribed in the EPA *Manual for Alternative Collection Systems, EPA/625/1-91/024, October 1991* and flow generation criteria

developed in *TM No. 1 - Wastewater Flow Projections.* The key design criteria used in the development of the pressurized collection system are as follows:

- Average Daily Flow (Q) = 530 gpd/connection or 8.83 persons per dwelling unit based upon 60 gallons/capita/day (for the determination of service population (thousands)), as per 15 A NCAC 02T.0114.
- Peak Flow – Ratio of Peak Hour flow to Average Daily flow based upon peaking factor in *Section 2.02 Number and Capacity NCDENR Minimum Design Criteria for the Permitting of Pump Stations and Force Mains.* The equation is as follows:

$$\frac{Q_{phf}\ \text{Peak Hourly Flow}}{Q_{ddf}\ \text{Design Daily Flow}} = \frac{18 + \sqrt{P}}{4 + \sqrt{P}}$$

- Minimum pipeline diameter = 28 inch.
- Minimum Pipeline Cover Depth = 3 feet.
- Minimum Force Main scouring velocity of 2 ft/s.
- Q = 0.5N +20.

Table 4-3 provides approximate force main sizes.

Table 4-3: Approximate Force Main Sizes

Pipe Diameter (inches) [1]	No. Homes Served
2	6
3	60
4	120
6	240
8	560

[1] Source: *EPA Manual for Alternative Collection Systems, EPA/625/1-91/024, October 1991.*

4.3.2 Pressurized Wastewater Collection System Layout

The proposed pressurized sewer collection system layout was developed to service the existing unsewered communities of Whalehead Subdivision, Ocean Hill Subdivision, and Corolla Village. The approach was to site the pressure mains along the existing rights-of-way adjoining the dwellings to be provided with sewer service. The service area will predominately consist of small diameter transmission lines, 6 inches diameter or less, installed at shallow depths (minimum 3 foot cover). The intent of the proposed network layout is to maximize the use of small diameter force mains and to minimize the associated installation costs by conveying the wastewater to a centrally located point. At this point, the

influent will be transmitted downstream where it will connect to the force main serving the downstream tributary area." Within the Ocean Hill and Corolla Village service area, the smaller diameter mains were utilized within the outer periphery for conveyance to a centrally located lift station sited adjacent to the Currituck County Satellite Offices and transmitted downstream via a larger transmission line. The Whalehead service area pipe network was designed in a similar manner with a centralized point of connection, adjacent to the intersection of Mackerel St. & Corolla Drive for transmission to the regional WWTP at Corolla Light. Figures 4-6 through 4-8 illustrate the proposed pressurized sewer collection layout with associative pipe main sizes.

The potential impacts for construction of the pressurized sewer system within the existing rights-of-way would be limited. Due to the smaller diameter pipe network, pipe installation would require narrower trench widths and shallower trench depths resulting in minimal surface disturbance and restoration. Directional boring can reduce roadway closures and other urban disruptions and reduce both time and capital costs. The small diameter piping is flexible and can be routed around obstacles and can be located along the shoulder of the road. Because the system is pressurized, it is inherently watertight and groundwater infiltration is typically not a significant issue.

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OCEAN HILL 1 & COROLLA VILLAGE

FIGURE 4-6: CONCEPTUAL LAYOUT FOR S.T.E.P. COLLECTION SYSTEM ALTERANTIVE FOR OCEAN HILL SECTION ONE / COROLLA VILLAGE

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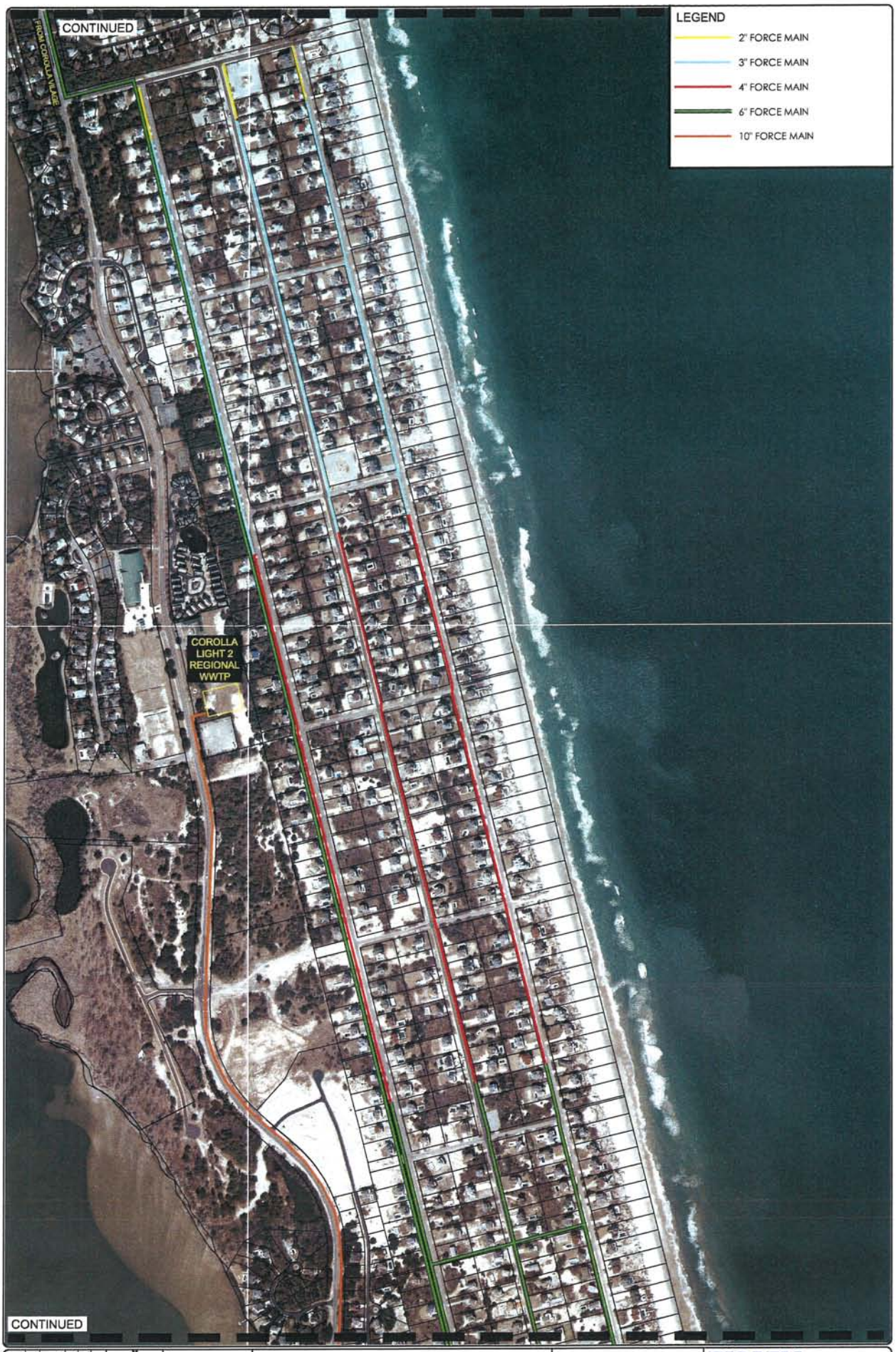

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WHALE HEAD CLUB SUBDIVISION

FIGURE 4-7: CONCEPTUAL LAYOUT FOR S.T.E.P. COLLECTION SYSTEM ALTERANTIVE FOR WHALEHEAD CLUB SUBDIVISION (NORTHERN REGION)

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WHALE HEAD CLUB SUBDIVISION

FIGURE 4-8: CONCEPTUAL LAYOUT FOR S.T.E.P. COLLECTION SYSTEM ALTERANTIVE FOR WHALEHEAD CLUB SUBDIVISION (SOUTHERN REGION)

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4.3.3 Pressurized Wastewater Collection System Advantages and Disadvantages

Advantages and disadvantages of pressurized collection systems are summarized in Table 4-4.

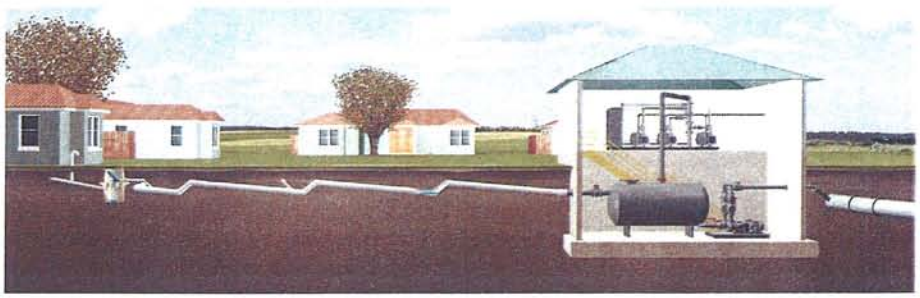
Table 4-4: Summary of Advantages and Disadvantages of Pressurized Collection Systems

Advantage	Disadvantage
Collection Network Capital Cost – Low initial cost and duration of construction of trunk mains due to shallow depths and pipe diameters,	Easements – Interceptor tanks sited on private property with perpetual easement and access required.
Collection Network Capital Cost – No additional property required for centralized pump station.	On-Lot Costs – Electrical connection, electrical panel, and control panel must be located on the property.
Performance – Not affected by Low Flow.	Life Cycle Costs – Increased cost for on-site connections, operations, and maintenance to include 10% inventory retained of active pumps, controls and appurtenances.
Inflow and Infiltration – Typically minimal due to pressurized mains.	O&M Costs – Settleable solids retained on individual property, requiring periodic removal and pumping of septic tanks
Power costs – Charged directly to homeowner.	

4.4 Vacuum Wastewater Collection Systems Description

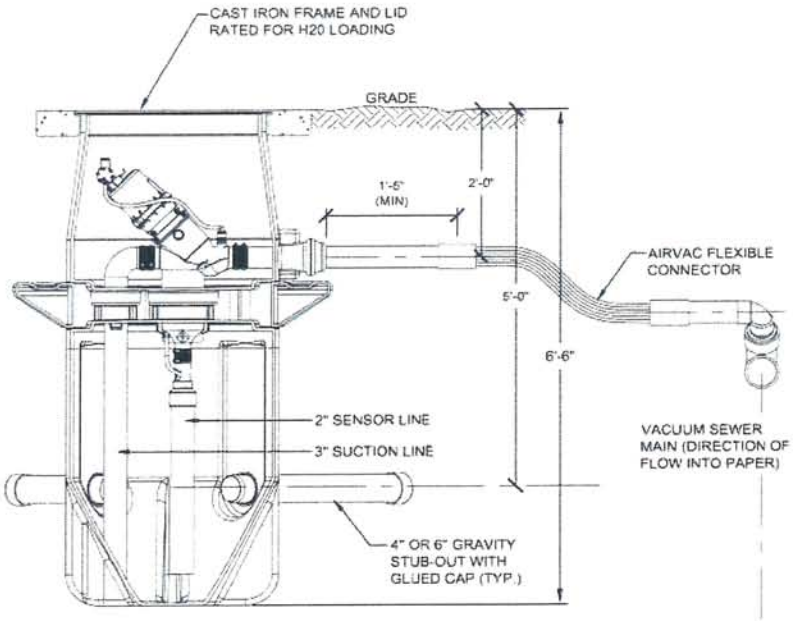
A vacuum sewer system is a mechanized system of wastewater collection and conveyance. Unlike gravity flow, vacuum sewers utilize differential air pressure to create flow, creating a negative pressure sewer system. A central source of power to operate vacuum pumps is required to maintain the vacuum, or negative pressure, on the collection system similar to a gravity lift station or pumping station. To maintain this vacuum, a valve at each sewage input point seals the system. The valve opens automatically when a given quantity of sewage accumulates in a collection sump. This valve is pneumatically controlled and operated. Differential pressure between local atmospheric pressure and the vacuum pressure provides the thrust needed to evacuate sewage from the collection sump. Figure 4-9 shows a typical service connection in a Vacuum collection system.

Figure 4-9: Typical Service Connection in a Vacuum Collection System



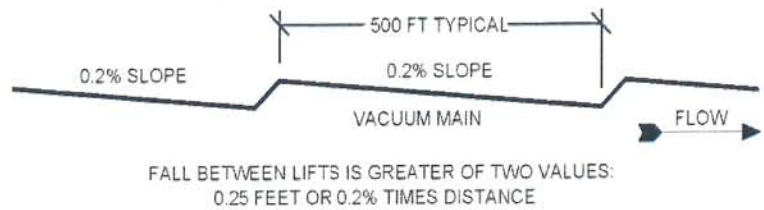
The valve pit, with two internal chambers, provides the vacuum/gravity interface. The upper chamber houses the vacuum valve. The bottom chamber collects sewage from the service laterals. These two chambers are sealed from each other. The valve pit-sump is typically made of a molded fiberglass enclosure and is located in the right-of-way between property lines and is able to withstand traffic loads. The most common arrangement consists of a single valve pit package serving two properties, although up to four connections is possible depending on collection sump size and influent flows. Figure 4-10 shows a typical valve pit installation in a Vacuum collection system

Figure 4-10: Valve Pit Installation in a Vacuum Collection System



Each valve pit is connected to the vacuum collection system by a 3 inch service lateral. Differential air pressure (7 to 10 psi) propels the sewage into the vacuum collection system. Turbulence disintegrates the solids and mixes them with the air and liquid to form aerobic foam, which scours the pipeline, preventing blockage. Unlike gravity sewers that must be laid with enough slope to create a scouring velocity, the vacuum lines are only slightly sloped (0.2 percent) toward the vacuum station because the vacuum provides adequate velocity. The vacuum mains are installed with a saw tooth profile to minimize burial depth. When the vacuum line exceeds the minimal cover by a foot or more, inserting two 45° fittings and a short section of pipe creates a lift back to minimum cover. Division valves are installed in the branch or main lines to allow portions of the piping system to be isolated for troubleshooting and maintenance. Figure 4-11 shows a transmission main installation in a Vacuum collection system.

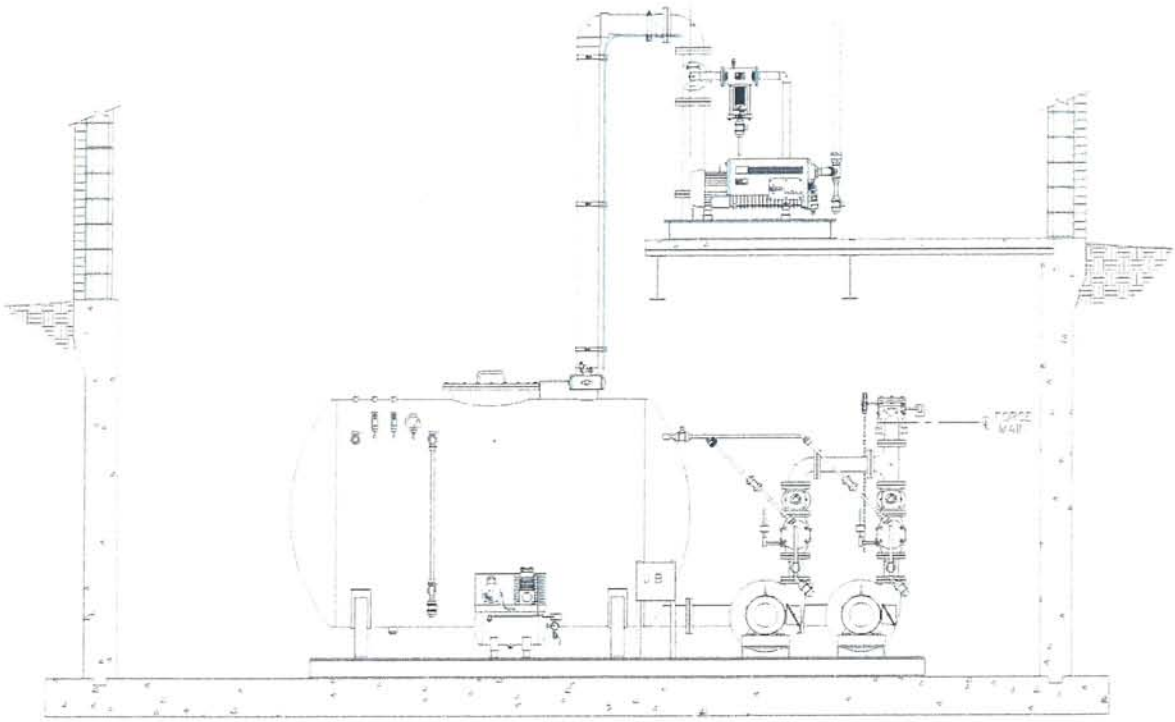
Figure 4-11: Typical Transmission Line Installation in a Vacuum Collection System



LEVEL GRADE TRANSPORT

The vacuum station functions as a central collection point for all vacuum sewer lines within a certain area. The vacuum station also houses pumps to convey raw sewage to the wastewater treatment plant via pressurized force mains. Vacuum pumps are required to produce the vacuum necessary for liquid-air transport for transfer to a collection tank. The wastewater is stored in a collection tank until a sufficient volume accumulates, at which point the tank is emptied via discharge pumps. Discharge pumps convey sewage to a downstream WWTP. Most modern vacuum systems utilize factory pre-fabricated collection stations mounted on skids for ease of installation. The vacuum station skid is typically housed in a two story structure with the vacuum pumps and control panel located on the top floor and the collection tank and sewage pumps on the lower floor. Figure 4-12 shows a typical Vacuum Station configuration.

Figure 4-12: Typical Vacuum Station Configuration



4.4.1 Vacuum Collection System Design Criteria

All of the major vacuum system components are sized according to peak flow. Flow rates have been determined by 530 gallons/connection, eight persons per service connection, and a peaking factor of 2.5. In order to properly size a vacuum station and collection system peak flow rates have been used. A summary of the system design flows is provided in Table 4-5.

Table 4-5: Projected Flow Rates for Vacuum Station Design

Vacuum Station	Connections	Peak Daily Flow (gpd)	Peak Flow (gpm)
1	243	321,975	224
2	858	1,136,850	790

4.4.2 Vacuum Wastewater Collection System Layout

The proposed vacuum sewer collection system layout was developed to service the existing unsewered communities of Whalehead Subdivision, Ocean Hill Subdivision, and Corolla Village. The approach was to site the vacuum mains along the existing rights-of-way adjoining the dwellings to be serviced. The service area will predominately consist of small diameter vacuum collection lines, 6 inch diameter or less, installed at shallow depths (minimum 3 foot cover).

Within the Ocean Hill / Corolla Village service area, the smaller diameter mains were utilized within the outer periphery for conveyance to a centrally located vacuum station sited adjacent to the Currituck County Satellite Offices and transmitted downstream via a larger transmission line. The Whalehead service area pipe network was designed in a similar manner with a centralized vacuum station, adjacent to the Bonito Street parking area for transmission to the regional WWTP at Corolla Light. Figures 4-13 through 4-15 describe the proposed vacuum sewer collection layout with associative pipe main sizes.

The potential impacts for construction of the vacuum sewer system within the existing rights-of-way would be the least intrusive. Due to the smaller diameter pipe network, the installation typically requires shallower trench width and depth resulting in minimal surface disturbance and restoration. The inherent nature of vacuum systems eliminates Infiltration/Inflow problems that are typically experienced with gravity systems. I/I is only possible if the integrity of the vacuum collection system is compromised. Since wastewater conveyance relies on vacuum, operators would be notified of a loss in vacuum and could investigate the cause. Additionally, odors are significantly reduced since no manholes or other openings existing within the vacuum collection system.

CONTINUED

PROJECT NO. 4434	CAD FILE 4434X001	SCALE 1" = 400'	DATE 11-15-10

PROJECT: COMPREHENSIVE WASTEWATER MASTER PLAN

SOUTHERN OUTER BANKS CURRITUCK COUNTY NORTH CAROLINA

OCEAN HILL 1 & COROLLA VILLAGE

FIGURE 4-13: CONCEPTUAL LAYOUT FOR VACUUM COLLECTION SYSTEM ALTERANTIVE FOR OCEAN HILL SECTION ONE / COROLLA VILLAGE

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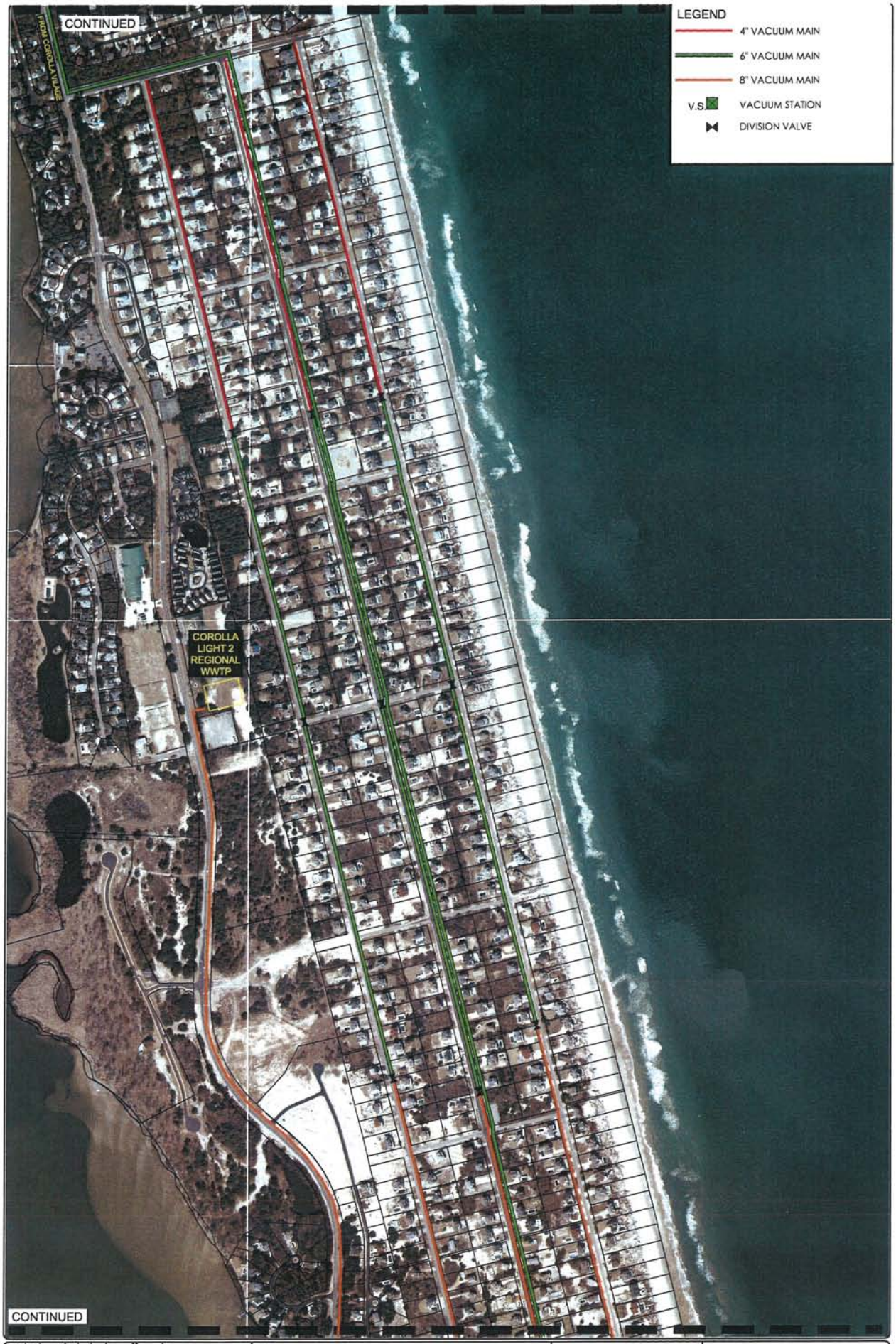

PROJECT NO. 4434	CAD FILE 4434OB1	SCALE 1" = 500'	DATE 11-15-10	REVD 4-11-11 DMK

PROJECT: COMPREHENSIVE WASTEWATER MASTER PLAN

SOUTHERN OUTER BANKS CURRITUCK COUNTY NORTH CAROLINA

WHALE HEAD CLUB SUBDIVISION

FIGURE 4-14: CONCEPTUAL LAYOUT FOR VACUUM COLLECTION SYSTEM ALTERANTIVE FOR WHALEHEAD CLUB SUBDIVISION (NORTHERN REGION)

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11-15-10

1" = 500'

4434

PROJECT: COMPREHENSIVE WASTEWATER MASTER PLAN

SOUTHERN OUTER BANKS CURRITUCK COUNTY NORTH CAROLINA

WHALE HEAD CLUB SUBDIVISION

FIGURE 4-15: CONCEPTUAL LAYOUT FOR VACUUM COLLECTION SYSTEM ALTERANTIVE FOR WHALEHEAD CLUB SUBDIVISION (SOUTHERN REGION)

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4.4.3 Vacuum Sewer Collection System Advantages and Disadvantages

A summary of the advantages and disadvantages of vacuum collection systems is included in Table 4-6.

Table 4-6: Summary of Advantages and Disadvantages of Vacuum Collection Systems

Advantage	Disadvantage
Collection Network Capital Cost – Low initial cost and duration of construction of trunk mains due to shallow depths and pipe diameters	Capital Cost – Higher capital costs associated with Vacuum Stations which require a large footprint and must be contained with a building with a basement. Difficult to phase capital costs to more closely watch growth in demands.
Easements – No private property encroachments necessary for system installation.	Capital Costs – Typically more intensive than a STEP system due to slightly larger pipe sizes and complexity of installation.
Performance – Easily identifiable mechanism for leak detection.	Life Cycle Costs – increased cost for operations and maintenance.
Inflow and Infiltration – Eliminated due to "closed" nature of system.	Reliability – Newest technology. Contractor experience with installation technologies is limited. Number of suppliers of valve pit components is limited.
Power costs – Fewer vacuum stations required as compared to number of pump station in gravity or STEP system.	

5. Unsewered Area Evaluation of Collection System Alternatives

Three distinct alternatives for wastewater collection were developed to include a gravity collection system, a pressurized sewer system (STEP), and a vacuum collection system.

5.1 Unsewered Area Evaluation Criteria

The following criteria were used to evaluate the collection system alternatives:

- Phasing – Does the system lend itself to phasing? Does it provide flexibility for expansion in the future?
- Easement Requirements – Are easements on private property required for installation and/or operation or maintenance?
- Constructability – Are there constructability issues associated with the alternative technology that would be a concern for the proposed service area? This could include issues such as pipe depth, depth to groundwater, extensive utility conflicts, etc. Are installation methods well established? Do contractors have experience with installation methods?
- Operation and Maintenance Requirements – What are the key operation and maintenance requirements which will be needed for the collection system on an ongoing basis? This will have a significant impact on the long term life cycle costs for the system. It also may affect the quality of service for the end user due to service calls and on-site pump malfunctions, etc.
- Present Worth Life Cycle Costs – What are the life cycle cost differences between the alternatives which include capital costs for collection and conveyance, on-site costs (on private property), and operation and maintenance (including equipment replacement, electricity, and other incidentals) Costs are compared on a 20-year life cycle.

5.2 Unsewered Area Life Cycle Cost Estimation

Total present worth and annualized costs were estimated for a 20-year period through the year 2030. A detailed breakdown of the estimates is provided in Table 5-1. Estimated costs were identified from the following sources:

- Price quotes from equipment suppliers/manufacturers.
- Bid tabulations from similar projects.

The capital cost represents the total project cost for implementation of each alternative. It includes equipment costs, installation costs for piping, electrical, and controls, site work, mobilization, demobilization, bonding, contractor overhead and profit, planning and construction contingencies (25%), engineering design and construction services (12%).

Annual O&M costs were estimated based on power consumption, equipment renewal and replacement costs, labor (general maintenance and cleaning) requirements and miscellaneous & administrative costs. Equipment renewal and replacement costs are included in the comparative life cycle costs. Replacement costs represent a dollar amount required each year to be set aside in order to replace system components based upon the assumed service life. Due to several unknown factors attributed with the annual operation and maintenance costs, a 12% contingency has been added to each collection system alternative. These amounts are reflected in the attached cost estimates which breakdown the projected costs based upon associative service area.

Table 5-1: Wastewater Collection System Projected 20-yr Life Cycle Costs

Capital Costs	Gravity Collection	STEP Collection	Vacuum Collection
Construction Costs			
Whalehead Service Area	$8,167,543	$8,053,230	$6,758,347
Corolla Service Area	$3,351,472	$2,722,327	$3,187,558
Subtotal	$11,519,015	$10,775,557	$9,945,905
Cost per connection	$10,462	$9,787	$9,034
20-year Present Worth Costs (O&M + replacement)			
Whalehead Service Area	$2,844,365	$8,129,330	$8,319,720
Corolla Service Area	$828,546	$2,059,898	$2,377,760
Subtotal	$3,672,911	$10,189,228	$10,697,480
Cost per connection	$3,335.98	$9,254.52	$9,716.15
Total	**$15,191,926**	**$20,964,785**	**$20,643,385**

5.3 Life Cycle Cost Assumptions

5.3.1 Gravity Collection Sewers

Construction Costs – The figures described above account for installation of gravity collection lines, manholes, lift stations with remote telemetry, force mains, service connection installation, roadway and landscape restoration, electrical service, mobilization and incidentals. Costs excludes construction of sewer lateral from gravity main to customer.

20-yr Costs – These figures described above account for annual service contracts, annual lift station maintenance, records administration, annual force main and collection line maintenance, electrical costs and annual component replacement cost allocations.

5.3.2 Pressurized Sewer Collection

Construction Costs – The figures described above account for installation of collection mains, STEP system installation, force mains, service connection installation, roadway and landscape restoration, mobilization and incidentals. Excludes electrical connection costs, and easement acquisition costs.

20-yr Costs – These figures described above account for annual service contracts, annual STEP maintenance, records administration, annual force main and collection line maintenance, annual solids removals, annual inventory upkeep, and annual component replacement cost allocations.

5.3.3 Vacuum Sewer Collection

Construction Costs – The figures described above account for installation of collection mains, vacuum system installation, force mains, service connection installation, roadway and landscape restoration, mobilization and incidentals. Excludes building to sewer service connection, (valve pit), connection costs.

20-yr Costs – These figures described above account for annual service contracts, annual vacuum pit and station maintenance, records administration, annual force main and collection line maintenance, and annual component replacement cost allocations.

5.4 Unsewered Area Evaluation of Alternatives

Each of the alternatives was evaluated against the above described criteria. Table 5-2 is a summary of the evaluation of the alternatives against the criteria.

Table 5-2: Summary of Unsewered Area Sewer Collection Alternatives

Evaluation Criteria	Gravity Sewer	Pressurized Sewer	Vacuum Sewer
Phasing and Integration	Provides the highest degree of flexibility. The system can receive wastewater from subsequent phases employing gravity or pressurized sewers. Phasing can be easily adapted. Most compatible with existing infrastructure.	Moderately Flexible. The system can receive wastewater from subsequent phases employing pressurized sewers only. Phasing can be adapted to gravity sewer receiving pressurized sewer.	Least flexible- Can receive wastewater from subsequent phases employing vacuum sewer only. Phasing can be easily adapted with like systems.
Easement Requirements	No private easements required.	Private easements required for installation and access onsite pumping equipment.	No private easements required for collection system. May be necessary for vacuum station building.
Constructability [1, 2]	Highest off-site impact sewers would require deep trenches resulting in increased disruption and restoration. No on-site impacts required.	Lowest off-site impact sewers would require shallow trenches resulting in minimal disruption and restoration. Greatest on-site impacts required for STEP installation.	Moderate off-site impact sewers would require increased complexity in installation, minimal disruption and restoration. Requires building construction for vacuum station. No on-site impacts required.
Operation and Maintenance	Fewest operation and maintenance requirements. Required, preventative and emergency maintenance of system components, electrical power costs, equipment renewal and replacement costs, and administrative costs.	High operation and maintenance costs. Costs would involve servicing of pumps at individual connections, pump replacement, service calls for pump malfunctions, and pumping and disposal of septic tank solids, and administrative costs.	Highest operation and maintenance costs. Costs would involve required, preventative, and emergency maintenance of system components, electrical power costs, equipment renewal and replacement costs, and administrative costs.
Comparative Costs[3]	**$15,191,926**	**$20,964,785**	**$20,643,385**

[1] *On-Site Impacts – Include those impacts associated with service connection from house and all other applicable equipment and appurtenances on private property (STEP tank, control equipment, electrical connection, abandonment, restoration, etc.).*
[2] *Off-Site Impacts – Include those impacts associated with sewer collection facilities sited within public rights-of-way and dedicated easements.*
[3] *Costs do not include WWTP costs associated with I/I*

5.5 Unsewered Area Collection System Alternative Recommendation

It is recommended that a gravity collection system be selected as the preferred collection system technology to service the existing unsewered communities of Whalehead Subdivision, Ocean Hill Subdivision, and Corolla Village. The gravity collection system was recommended based upon the following key reasons:

- Lowest 20-year life cycle cost. The 20-year service area can be economically developed to planned densities at a lower cost than for pressure sewers. This is because the individual onsite costs and additional space requirements for a gravity collection system are less than for a STEP or grinder pump system.
- Provides the highest degree of flexibility for system expansion. The core area can be implemented as a gravity system and the County then has the flexibility to implement pressure sewers within the outlying areas in the future, as needed. If a pressure sewer is implemented in the core area, gravity sewers cannot be installed in the outlying areas. This is because pressure sewers can discharge into a gravity collection system, but gravity sewers cannot discharge into a pressurized sewer system.
- Fewer operational and maintenance requirements.
- No maintenance-and-access easements are required except for pump stations.
- Can be designed with additional watertight measures and testing requirements to address potential inflow and infiltration.

HAZEN AND SAWYER
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From:
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Date:
June 6, 2011

Project No.:
30138-000

Subject:
Technical Memorandum 4 – Capital Improvements Plan and Fiscal Plan
Comprehensive Wastewater Master Plan for the Currituck Southern Outer Banks

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This technical memorandum (TM) is part of the Comprehensive Wastewater Master Plan for the Currituck Southern Outer Banks. The purpose of this TM is to define phasing for wastewater capital improvements for each service area option and present evaluation of rate and fees. This TM also presents two implementation alternatives; a publicly owned regional utility and a public/private partnership.

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A: Blueprint for the Development of a Regional Wastewater System in Currituck County's Southern Outer Banks, Outer Banks Ventures, March 2011.

1. Recommended Capital Phasing

1.1 Recommended Capital Phasing – Option 1

Wastewater treatment capacity was phased to meet projected customer demands. Per TM 1, historic growth rates as well as economic factors and trends were considered in the development of future projections. The Ocean Sands Water and Sewer Master Plan (ARCADIS 2008) projected future water and sewer connections to grow linearly based on data from 1981 until 2007. The Ocean Sands Master Plan projected water and sewer connections to increase at an average rate of 3.0 percent per year from 2009 to 2020 and 2.2 percent per year from 2012 to 2030.

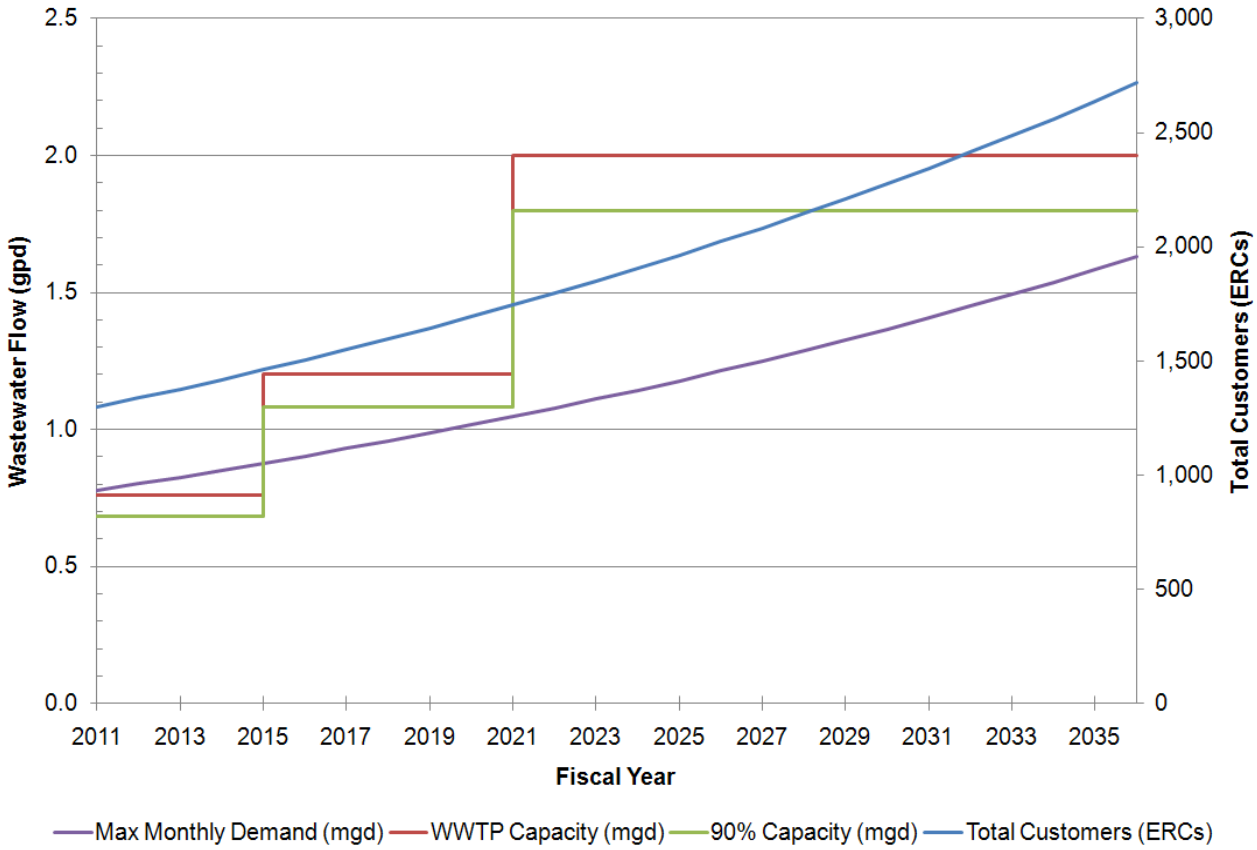
Currituck County is currently experiencing a slowdown in development similar to the rest of the country. The rate of new development in Ocean Sands has slowed dramatically since 2004 due to hurricanes, economic recession, and the existing developments reaching build-out capacities. For purposes of the Comprehensive Wastewater Master Plan, it is assumed that growth rates in new connections and/or growth in wastewater flow on the Outer Banks will recover to at least 3 percent per annum due to:

- General economic recovery and increased vacation rentals.
- Available land is developed (e.g. Ocean Sands Sections G and T).
- Completion of Mid Currituck Bridge.
- Broader mix of development is planned (more commercial and hotel developments).

For Option 1, the projected growth in wastewater customers and resulting growth in wastewater flow (in terms of maximum month flow) is illustrated in **Figure 1-1**. The existing wastewater flow for Ocean Sands and Corolla Light is 779,000 gpd and is projected to increase to 1,016,000 gpd by 2020 and to 1,583,000 gpd by 2035. Growth projections as well as the rate evaluations presented later in this TM define a typical wastewater customer as an equivalent residential connection (ERC). An ERC was determined to have a peak wastewater flow of 600 gpd, which is based on an average of five bedrooms per house and a wastewater flow of 120 gpd/bedroom. There are approximately 1,298 ERCs currently in Ocean Sands and Corolla Light and 3,338 ERCs at build-out.

Generally, it is desirable to phase capacity expansions such that the time between upgrades is approximately 8 to 10 years. Accounting for two years of permitting and engineering and up to two years for construction, an upgrade can require at least four years to implement. Therefore, planning for capacity expansions on a cycle shorter than 8 to 10 years could result in a continuous state of upgrading and construction at a wastewater treatment plant (WWTP), which makes it challenging for operators to operate and maintain the WWTP to meet compliance standards.

Figure 1-1: Wastewater Flow Forecasts and Capacity Phasing for Option 1



Based on operating records, the combined maximum month flow for Ocean Sands and Corolla Light was determined to be 779,000 gpd. In order to comply with the Department of Environment and Natural Resource (DENR) "80/90 Rule", the minimum capacity of the Phase 1 WWTP would be 975,000 gpd to meet the needs of existing customers. The capacity of the Phase 1 WWTP was set at 1.2 mgd to provide excess capacity for future growth. The recommended WWTP capacity phasing for Option 1 is shown in **Figure 1-1**. Construction of Phase 1 will begin late in FY 2013, and the plant will go online late in FY 2015. In FY 2021, the regional WWTP will be expanded to 2.0 mgd, which is sufficient to meet wastewater needs through FY 2036. Phase 2 is proposed in FY 21, which is six years after the completion of Phase 1. This phasing scheme is accelerated in lieu of a typical recommendation to offset the financial burden of the upfront capital costs for the regional WWTP.

A breakdown of the capital costs for each phase of Option 1 is shown in **Table 1-1**. Opinions of probable construction costs for each Service Area Option were presented in *TM No. 2 – Wastewater Treatment and Effluent Disposal Alternatives*. Construction costs include wastewater treatment, reject storage, reject storage pump station and force main, treated effluent pump station and force mains, and high-rate infiltration basins for effluent disposal. Cost opinions include 25 percent contingency and 12 percent for technical services.

The overall capital cost to construct Phase 1 (1.2 mgd) is estimated at approximately $31.77 million and the capital cost for the Phase 2 construction is estimated at approximately $12.46 million. The overall unit cost for Option 1 is estimated at $22.1 per gallon of capacity.

Table 1-1: Opinion of Probable Construction Cost for Service Area Option 1 (Ocean Sands and Corolla Light)

Description	Total	Phase 1	Phase 2
Purchase of Corolla Light Wastewater System	$1,850,000	$1,850,000	--
Demolition (Ocean Sands WWTP, Corolla Light No 1 and 2)	$569,000	$569,000	--
MBR Wastewater Treatment Plant	$25,718,000	$17,605,000	$8,113,000
Reject Storage	$4,317,000	$3,154,000	$1,163,000
Effluent Force Mains and Pumping	$1,655,000	$607,000	$1,047,000
Effluent Disposal	$5,173,000	$3,031,000	$2,142,000
Land acquisition	$4,837,000	$4,837,000	--
Wetlands Mitigation (WWTP site)	$112,000	$112,000	--
Total Project Cost	***$44,231,000***	***$31,766,000***	***$12,465,000***
Unit Cost ($/gpd)	***$22.1***	***$26***	***$16***
Wastewater Collection	$3,585,000	$1,610,000	$1,976,000
Total Project Cost	***$47,817,000***	***$33,376,000***	***$14,441,000***

1.2 Recommended Capital Phasing – Option 2

Wastewater flow was projected for Option 2 using the same assumptions and methodology as described in Section 2.2 for Option 1. Projected wastewater flows and recommended WWTP capacity phasing for Option 2 which provides wastewater service to Ocean Sands, Corolla Light and Monteray Shores is shown in **Figure 1-2**. This figure also shows the increase in treatment capacity associated with the completion of each phase of construction.

Phase 1 of the WWTP will be designed to treat 1.80 mgd. Construction for Phase 1 will begin late in FY 2013 and will finish two years later. Phase 1 is sized to be able to serve Corolla Light, Ocean Sands, and Monteray shores customers for ten years based on an expected growth rate of 3 percent. The Phase 2 expansion will increase capacity to 2.6 mgd and is projected to be online in FY 2026. The phasing of these upgrades may be rescheduled based on actual growth patterns.

Figure 1-2: Wastewater Flow Forecasts and Capacity Phasing for Option 2

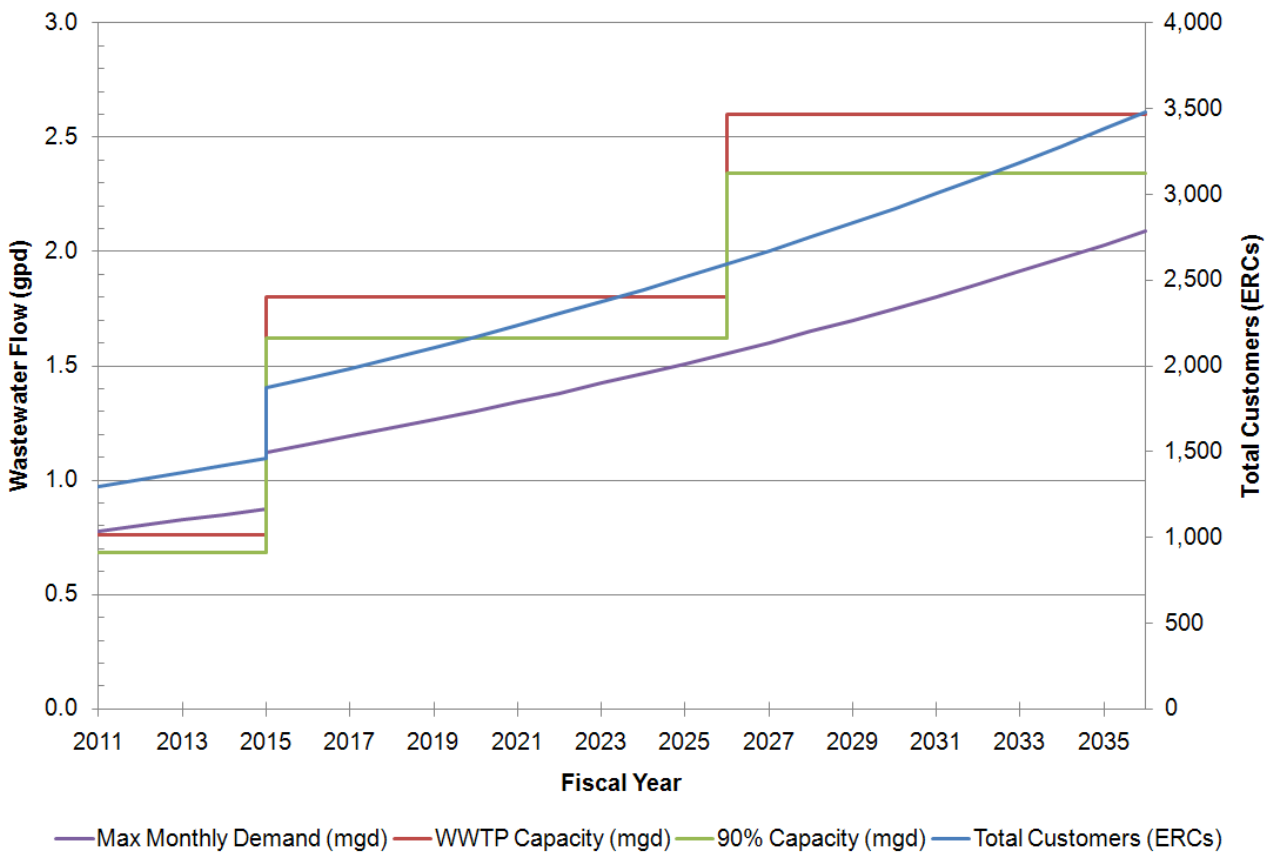


Table 1-2 provides the costs for each phase for Option 2, including treatment, disposal and collection. The overall capital cost to construct Phase 1 (1.2 mgd) is estimated at approximately $42.94 million and the capital cost for the Phase 2 construction is estimated at approximately $11.79 million. The overall unit cost for Option 1 is estimated at $21.1 per gallon of capacity.

Table 1-2: Opinion of Probable Construction Cost for Service Area Option 2 (Ocean Sands, Corolla Light and Monteray Shores)

Description	Opinion of Probable Construction Cost	Phase 1	Phase 2
Purchase of Corolla Light Wastewater System	$1,850,000	$1,850,000	--
Demolition (Ocean Sands WWTP, Corolla Light No 1 and 2)	$569,000	$569,000	--
MBR Wastewater Treatment Plant	$31,203,000	$24,263,000	$6,939,000
Reject Storage	$4,786,000	$3,651,000	$1,134,000
Effluent Force Mains and Pumping	$1,826,000	$719,000	$1,108,000
Effluent Disposal	$6,989,000	$4,382,000	$2,608,000
Land acquisition	$7,326,000	$7,326,000	--
Wetlands Mitigation (WWTP site)	$182,000	$182,000	--
Total Project Cost	***$54,731,000***	***$42,942,000***	***$11,789,000***
Unit Cost ($/gpd)	***$21.1***	***$23.9***	***$15***
Wastewater Collection	$4,159,000	$1,610,000	$2,549,000
Total Project Cost	***$58,890,000***	***$44,552,000***	***$14,338,000***

1.3 Recommended Capital Phasing – Option 3

Growth projections were developed for Option 3 using the same assumptions described in Section 2.2 for Option 1. **Figure 1-3** illustrates the projected growth in wastewater customers and maximum month wastewater flow for Option 3, which provides wastewater service to Ocean Sands, Corolla Light, Monteray Shores, Whalehead, Corolla Village, and Ocean Hill. This figure also shows the recommended phasing for WWTP capacity associated with the completion of each phase of construction.

The recommended capacity for Phase 1 is 1.80 mgd. This capacity will be sufficient to serve Ocean Sands, Corolla Light, and Monteray Shores through FY 2019. Phase 2 is scheduled to be completed in FY 2019. This allows eight years for the County to determine the level of interest in central sewer and to construct collection systems for the currently unsewered service areas (Whalehead, Corolla Village, and Ocean Hill). Once these collection systems are online, the WWTP would be expanded to 2.60 mgd, which is sufficient to serve the entire service area until FY 2026. The Phase 3 expansion will increase WWTP capacity to 3.40 mgd, which is the build-out capacity for the service area.

Table 1-3 summarizes the capital costs for each phase of Option 3. The overall capital cost to construct Phase 1 (1.8 mgd) is estimated at approximately $41.63 million and the capital cost for the Phase 2 construction is estimated at approximately $19.63 million. The overall unit cost for Option 3 is estimated at $21.2 per gallon of capacity.

Figure 1-3: Wastewater Flow Forecasts and Capacity Phasing for Option 3

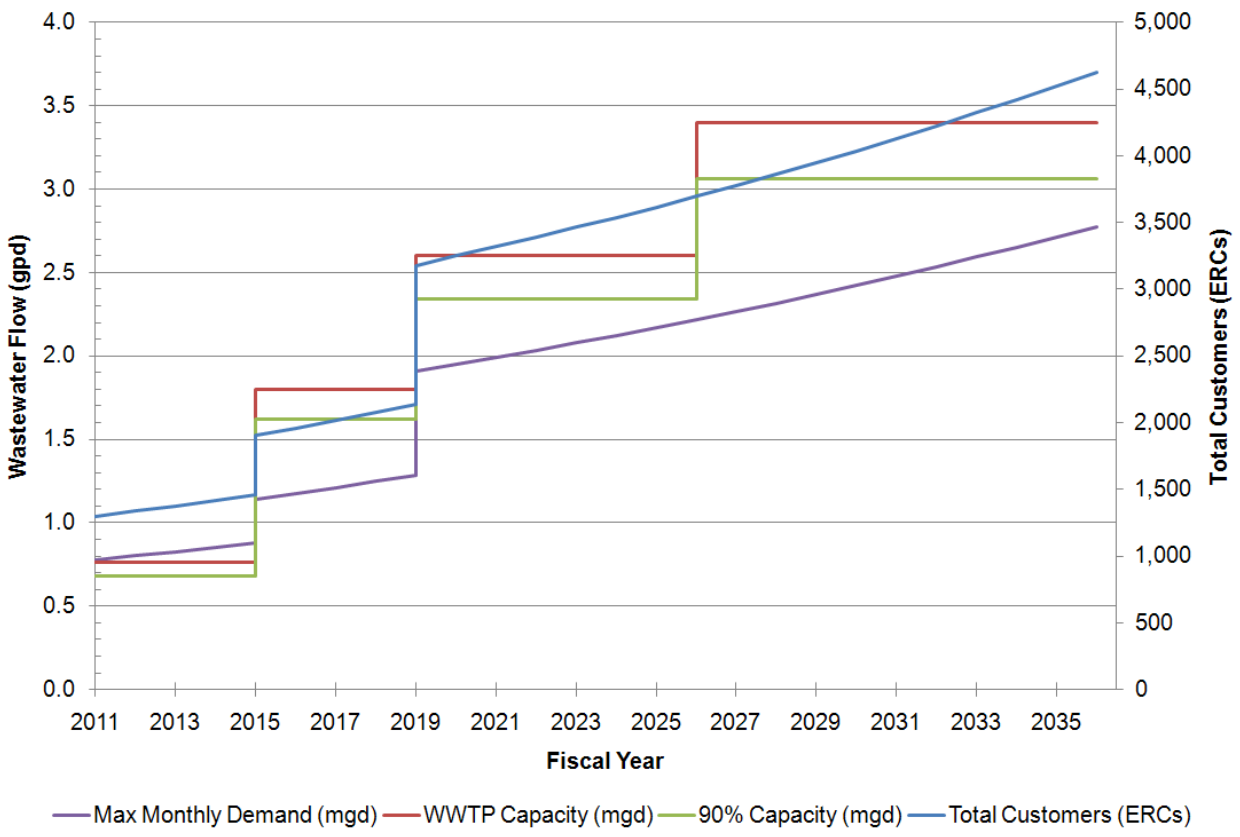


Table 1-3: Opinion of Probable Construction Cost for Service Area Option 3 (Ocean Sands, Corolla Light, Monteray Shores and Unsewered Areas)

Description	Opinion of Probable Construction Cost	Phase 1	Phase 2	Phase 3
Purchase of Corolla Light Wastewater System	$1,850,000	$1,850,000	--	--
Demolition (Ocean Sands WWTP, Corolla Light No 1 and 2)	$569,000	$569,000	--	--
MBR Wastewater Treatment Plant	$33,159,000	$20,191,000	$6,484,000	$6,484,000
Reject Storage	$6,596,000	$4,250,000	$1,173,000	$1,173,000
Effluent Force Mains and Pumping	$1,909,000	$766,000	$1,143,000	--
Effluent Disposal	$8,665,000	$4,382,000	$3,261,000	$1,022,000
Land acquisition	$16,957,000	$9,354,000	$7,567,000	--
Wetlands Mitigation (WWTP site)	$288,000	$288,000	--	--
Total Project Cost	***$69,957,000***	***$41,628,000***	***$19,628,000***	***$8,679,000***
Unit Cost ($/gpd)	***$21.2***	***$23.1***	***$24.5***	***$10.8***
Wastewater Collection	$15,678,000	$1,610,000	$14,068,000	--
Total Project Cost	***$85,635,000***	***$43,260,000***	***$33,696,000***	***$8,679,000***

1.4 Recommended Capital Phasing – Option 4

Growth projections were developed for Option 4 using the same assumptions described in Section 2.2 for Option 1. **Figure 1-4** illustrates the projected growth in wastewater customers and max month wastewater flows for Option 4, which provides wastewater service to Ocean Sands, Corolla Light, Whalehead, Corolla Village and Ocean Hill. This figure also shows the recommended phasing for WWTP capacity associated with the completion of each phase of construction.

The recommended capacity for Phase 1 is 1.20 mgd to serve Ocean Sands and Corolla Light. When the collection systems in the unsewered areas are completed, the WWTP will be expanded to 2.20 mgd. The Phase 2 expansion is planned for completion in FY 2019. Phase 2 will be able to serve the service area until FY 2026 assuming a growth rate of 3 percent. In the Phase 3 expansion, capacity will be expanded to 2.70 mgd, which represents the build-out of the service area. The timing of Phase 3 may be adjusted based on actual growth patterns.

Table 1-4 summarizes the probable construction costs for each phase of Option 4. The capital cost to construct Phase 1 (1.2 mgd) WWTP is estimated at approximately $32.12 million for a unit cost of $27.8/gpd. Including wastewater collection, the overall capital cost for Phase 1 is $33.73 million. The capital cost for the Phase 2 WWTP is estimated at approximately $20.85 million. The Phase 2 project includes wastewater collection for the unsewered areas to provide sewer service to Corolla Village, Ocean Hill, and Whalehead. Capital cost for the Phase 3 WWTP expansion to build-out capacity is $5.04million. The unit WWTP cost for Option 4 is estimated at $21.5 per gallon of capacity.

Figure 1-4: Wastewater Flow Forecasts and Capacity Phasing for Option 4

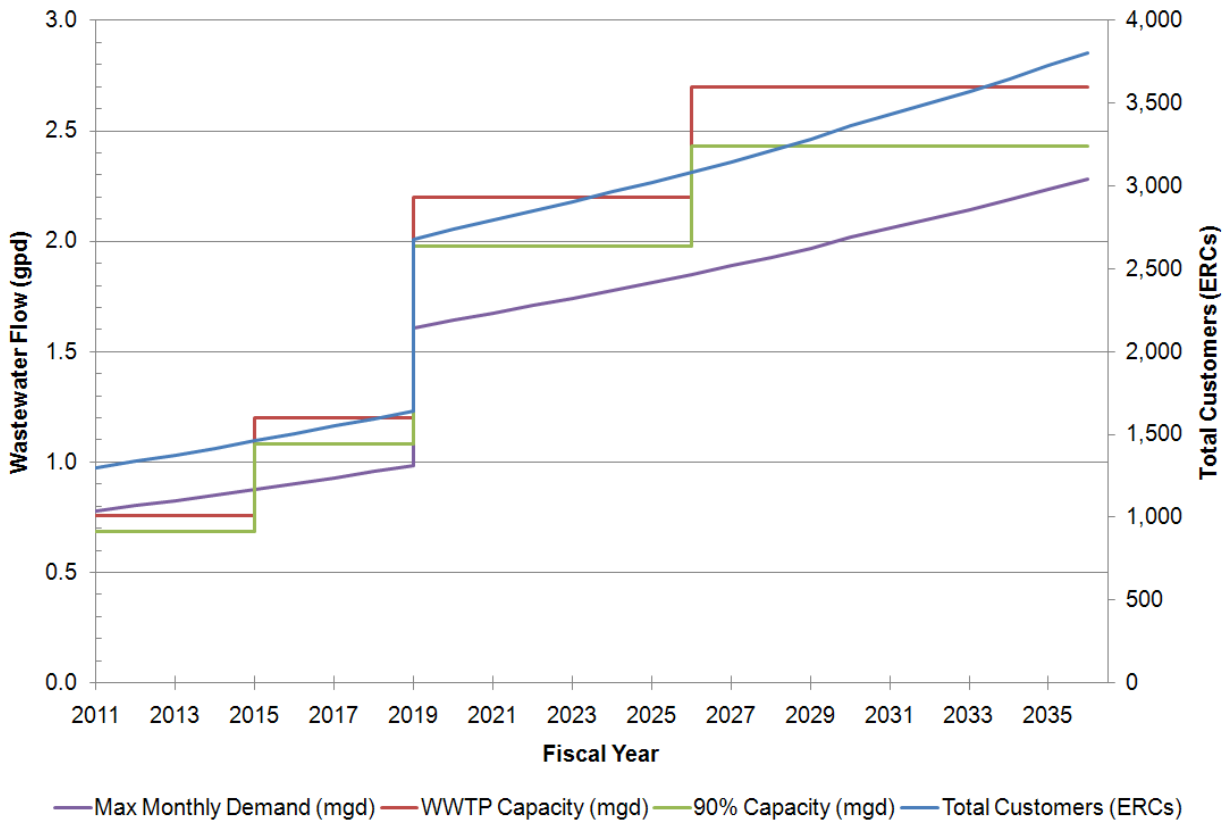


Table 1-4: Opinion of Probable Construction Cost for Service Area Option 4 (Ocean Sands, Corolla Light and Unsewered Areas)

Description	Opinion of Probable Construction Cost	Phase 1	Phase 2	Phase 3
Purchase of Corolla Light Wastewater System	$1,850,000	$1,850,000	--	--
Demolition (Ocean Sands WWTP, Corolla Light No 1 and 2)	$569,000	$569,000	--	--
MBR Wastewater Treatment Plant	$33,025,000	$17,906,000	$10,079,000	$5,040,000
Reject Storage	$5,060,000	$3,857,000	$1,203,000	--
Effluent Force Mains and Pumping	$1,826,000	$719,000	$1,108,000	--
Effluent Disposal	$5,742,000	$2,936,000	$2,806,000	--
Land acquisition	$9,649,000	$5,213,000	$4,436,000	--
Wetlands Mitigation (WWTP site)	$288,000	$288,000	--	--
Total Project Cost	***$58,009,000***	***$32,119,000***	***$20,851,000***	***$5,040,000***
Unit Cost ($/gpd)	***$21.5***	***$26.8***	***$20.9***	***$10.1***
Wastewater Collection	$15,105,000	$1,610,000	$13,495,000	--
Total Project Cost	***$73,114,000***	***$33,729,000***	***$34,346,000***	***$5,040,000***

1.5 Capital Cost Summary

A summary of capital costs for all service area options are summarized in **Table 1-5.**

Table 1-5: Summary of Opinion of Probable Cost for Service Area Options Collection, Treatment and Disposal

Service Area Option	Areas Served	Opinion of Probable Construction Cost
1	Ocean Sands and Corolla Light	$47,817,000
2	Ocean Sands, Corolla Light, and Monteray Shores	$61,097,000
3	Ocean Sands, Corolla Light, Monteray Shores, Whalehead Subdivision, Corolla Village, and Ocean Hill	$85,635,000
4	Ocean Sands, Corolla Light, Whalehead Subdivision, Corolla Village, and Ocean Hill	$73,114,000

2. Rate Evaluations – Public Regional Wastewater Utility

The intent of these rate evaluations is to compare the service area options considered in this Master Plan. Each option varies in service area, treatment capacity, and phasing. Rate evaluations allow for a more direct comparison in terms of projected rates and impact fees. The rate evaluations are based on the assumptions selected for this evaluation and are not intended to replace the rate setting process. The County could select alternative rate and fee structures that would also meet the financial obligations of the regional wastewater utility.

2.1 Assumptions Used In the Rate Evaluation

In order to project future revenue requirements, as well as revenues to be derived from sewer rates, several assumptions were made for the rate evaluation as follows:

1. A new regional utility will be formed to serve Corolla Light and the Ocean Sands Water and Sewer District. Additional service areas were considered in Options 2, 3, and 4.

2. Construction costs have been escalated by 2.5 percent per year to the mid-point of construction.

3. Impact fees will be paid at the time that wastewater flow allocation is made by the County to a developer or customer.

4. Capital costs for major wastewater collection infrastructure are included. Costs for wastewater collection within a development are not included and will be borne by the developer to extend collection systems to individual customers.

5. Plant expansions will be timed so that construction will be completed when the demand equals 90 percent of the current plant capacity. Planning for each expansion should begin when wastewater flows equal 80 percent of the current plant capacity per 15A NCAC 02H.0223.

6. No grants or low-interest loans will be obtained.

7. Estimated average household consumption allowance was set at 600 gallons per day (gpd) per Equivalent Residential Connection (ERC) for purposes of determining capacity requirements. Cash flow projections show the average monthly sewer bill based on an average flow of 170 gpd.

8. Cash reserves – Rates and fees were set to maintain a minimum of 90 days of operating budget.

9. Capital Reserve Fund – Provides for major capital and equipment replacement and infrastructure rehabilitation. Cash flow projections include funding of capital reserve fund beginning in third year of operation at a rate of approximately 25 percent of annual O&M costs.

10. The rate of inflation used for monthly service charges and user rates was assumed to be 2.5 percent per year, which represents the 10-year average.

11. Rate of inflation for operation and maintenance costs was assumed to be 1.0 percent per year.

12. The interest rate on new financing was assumed to be 5 percent with a cost of issuance of 2.5 percent. The term of financing varies between options.

13. It was assumed that there is no existing debt to be taken on by the regional wastewater utility.

2.2 Operating and Maintenance Costs

Operation and maintenance (O&M) costs of the Outer Banks Regional WWTP projected for each phase of each option. The O&M costs include daily operation items such as administration, billing, engineering, operations, and maintenance. The actual O&M costs of other similar facilities were used as the basis for projecting future O&M expenses. Historical O&M data for the Ocean Sands Water and Sewer District was evaluated (**Table 2-1**). O&M costs for the Ocean Sands WWTP and

collection system averaged $7.5 per 1,000 gals. over the last 5 years. We understand the historical O&M data to be similar for Corolla Light. A unit cost of $8.00 per 1000 gals. was used to estimate O&M costs. Additional costs were added when significant additions were made to the sewer utility systems in terms of additional collection systems. The costs were calculated based on 2010 costs and then escalated at 1 percent annually to keep pace with inflation and account for economies of scale.

Table 2-1: Ocean Sands Historical O&M Costs

Fiscal Year	Annual O&M Budget	Total Flow (gallons)	O&M ($/1,000 gallons)
2006	$322,019	55,301,558	$5.82
2007	$336,127	63,347,893	$5.31
2008	$499,965	60,590,487	$8.25
2009	$499,168	47,621,023	$10.48
2010	$481,665	61,817,100	$7.79

2.3 Proposed Reserves

Good management practices dictate that cash reserves be accumulated to provide for contingencies and unplanned major expenses. An operating reserve is important to provide funds for unplanned minor repairs and other significant cash outlays encountered in the course of operation of a system. It is recommended that the County establish and maintain a minimum operating reserve equal to 90 days operating expenses for the sewer utilities.

A Capital Reserve Fund is also recommended to provide the money necessary to pay for unexpected major repairs, equipment replacement, and planned rehabilitation of other infrastructure. The annual contribution to the Capital Reserve Fund was set at approximately 25 percent of annual O&M costs.

Due to the significant yearly cash outlays required for the projects, this report assumes that all projects scheduled in this report will be funded by the issuance of debt. There will likely be additional minor projects which will be funded from cash on hand or cash derived from operations that have not been included in this analysis. To the extent that the County can pay for relatively small projects in size or there is cash on hand from prior years, additional long term debt will be avoided thus avoiding interest expenses.

2.4 Rate Evaluation – Option 1

2.4.1 Existing and Planned Capital Costs

The capital costs for each phase of wastewater infrastructure for Option 1 to serve Ocean Sands and Corolla Light are provided in **Table 2-2**. Land acquisition costs are summarized in **Table 2-3**. These costs include only the land that will be purchased from OBV. Construction costs were escalated to the midpoint of construction and used to determine financing costs (**Table 2-2**). The amount financed for Phase 1 would be approximately $33.63 million. The remaining amount comes from balance from the OSWSD Fund ($4.0 million). Phase 1 is assumed to be financed for a term of 15 years with annual debt service of $3,321,000. The total cost of Phase 2 was assumed to be financed for a term of 15 years annual debt service of $1,984,000.

Table 2-2: Capital Costs and Funding – Option 1

Description	FY Scheduled for Construction	FY 10 Construction Costs	Escalated Construction Costs	Financed Construction Costs
Treatment and Disposal				
Phase 1 WWTP (1.2 mgd)	FY 2015	$31,766,000	$35,816,000	$53,816,000
Phase 2 WWTP (0.8 mgd)	FY 2021	$12,465,000	$17,338,000	$25,056,000
	SUBTOTAL	**$44,231,000**	**$53,154,000**	**$78,872,000**
Wastewater Collection				
Ocean Sands - Phase 1	FY 2015	$1,075,000	$1,213,000	$1,752,000
Corolla Light - Phase 1	FY 2015	$534,000	$602,000	$871,000
Ocean Sands - Phase 2	FY 2021	$1,976,000	$2,748,000	$3,971,000
	SUBTOTAL	**$3,585,000**	**$4,563,000**	**$6,594,000**

Table 2-3: Land Acquisition Costs for Option 1

Description	Additional Land Required for Disposal (ac)	Land Acquisition Costs (Disposal)	Land Acquisition Costs (WWTP)	Total Land Acquisition Costs
Ocean Sands	N/A	$0	$3,438,000	$3,438,000
Corolla Light	N/A	$0	$0	$0

Note: Costs reflect land acquisition for sites in Corolla Light only and do not include land acquisition for reject storage site.

2.4.2 Sewer Rates and Fees

A rate evaluation was conducted to assess user rates and impact fees required to cover debt service for wastewater infrastructure and O&M costs with a moderate population growth rate of 3.0 percent. A projection of O&M costs for Option 1 is shown in **Table 2-4**, and a cash flow analysis for the 20-year period is shown in **Table 2-5**. This rate evaluation assumes a monthly base charge of $120 and a service charge of $8.00 per 1,000 gallons for an average monthly sewer bill of $161 in FY 2015. The service charge increases annually with inflation until FY 2026; after which it is held constant at $10.50 per 1,000 gallons. . The monthly base charge increases with inflation until FY 2026. After FY 2026, the monthly base charge is reduced $10 each year until FY 2029 when the debt on Phase 1 is paid. In FY 2030 the monthly base charge is reduced to $40/month and decreases by $10 annually. The monthly base charge and service charge are reduced to prevent an accumulation of excess funds.

There is no impact fee for existing customers in Ocean Sands and Corolla Light. Impact fees for new customers were set at $20,000 per ERC in Ocean Sands and $21,000 per ERC in Corolla Light. Impact fees were assumed to increase annually at 2.5 percent.

The projected monthly sewer bill and impacts fees are summarized in **Table 2-6** for the 20-year period under moderate growth conditions. Monthly sewer bills were calculated based on average wastewater flows and should represent typical non-summer monthly bill per ERC.

Table 2-6: Yearly Rates and Fees – Public Utility Option 1 – Moderate Growth

Fiscal Year	Average Monthly Sewer Bill	Ocean Sands Customer Impact Fee	Corolla Light Customer Impact Fee
FY 2015	$161	$20,000	$21,000
FY 2016	$165	$20,500	$21,525
FY 2017	$169	$21,013	$22,063
FY 2018	$173	$21,538	$22,615
FY 2019	$178	$22,076	$23,180
FY 2020	$182	$22,628	$23,759
FY 2021	$187	$23,194	$24,354
FY 2022	$191	$23,774	$24,962
FY 2023	$196	$24,368	$25,587
FY 2024	$201	$24,977	$26,226
FY 2029	$184	$28,259	$29,672
FY 2034	$54	$31,973	$33,572

Per request of the County, a low-growth scenario was also evaluated. The growth rate was reduced to 1.5 percent annual growth. The phasing of the plant expansions was adjusted to account for the reduced growth in wastewater flows. As part of this scenario, Phase 2 would be completed in FY 2033. A projection of O&M costs for Option 1 – Low Growth is shown in

Table 2-7, and a cash flow analysis for the 20-year period is shown in **Table 2-8**. The average monthly sewer bill and impact fees for Ocean Sands and Corolla Light customers are shown below in **Table 2-9**.

Table 2-9: Yearly Rates and Fees – Public Utility Option 1 - Low Growth

Fiscal Year	Average Monthly Sewer Bill	Ocean Sands Customer Impact Fee	Corolla Light Customer Impact Fee
FY 2015	$197	$20,000	$21,000
FY 2016	$202	$20,500	$21,525
FY 2017	$207	$21,013	$22,063
FY 2018	$212	$21,538	$22,615
FY 2019	$217	$22,076	$23,180
FY 2020	$216	$22,628	$23,760
FY 2021	$212	$23,194	$24,354
FY 2022	$208	$23,774	$24,962
FY 2023	$204	$24,368	$25,586
FY 2024	$201	$24,977	$26,226
FY 2029	$186	$28,259	$29,672
FY 2034	$116	$31,973	$33,572

2.5 Rate Evaluation – Option 2

2.5.1 Existing and Planned Capital Costs

The capital costs for each phase of wastewater infrastructure for Option 2 to serve Ocean Sands, Corolla Light, and Monteray Shores are shown in **Table 2-10**. Construction costs were escalated to the midpoint of construction and used to determine financing costs. The amount financed for Phase 1 would be approximately $32.86 million. Balance from the OSWSD Fund ($4.0 million) would be utilized to offset financing costs. Phase 1 is assumed to be financed for a term of 15 years with annual debt service of $4,978,000. The total cost of Phase 2 was assumed to be financed for a term of 15 years annual debt service of $2,116,000.

Capital costs listed in **Table 2-10** include land acquisition costs of $5,657,000 for Monteray Shores to acquire land for effluent disposal and to reimburse OBV for the portion of land required at the WWTP site to treat the flow from Monteray Shores.

Table 2-10: Capital Costs and Funding – Option 2

Description	FY Scheduled for Construction	FY 10 Construction Costs	Escalated Construction Costs	Financed Construction Costs
Treatment and Disposal				
Phase 1 WWTP (1.8 mgd)	FY2015	$45,149,000	$50,905,000	$78,672,000
Phase 2 WWTP (0.8 mgd expansion)	FY2026	$11,789,000	$19,052,000	$27,533,000
	SUBTOTAL	**$56,938,000**	**$69,957,000**	**$106,205,000**
Wastewater Collection				
Ocean Sands - Phase 1	FY2015	$1,075,000	$1,177,000	$1,701,000
Corolla Light - Phase 1	FY2015	$534,000	$585,000	$845,000
Monteray Shores – Phase 1	FY2026	$1,079,000	$1,744,000	$2,521,000
Ocean Sands - Phase 2	FY2026	$1,470,000	$2,376,000	$3,434,000
	SUBTOTAL	**$4,159,000**	**$5,881,000**	**$8,499,000**

Table 2-11 summarizes required land acquisition required for Option 2, but these costs do not include the cost for the DeGabrielle Site that is dedicated for reject storage. This assumes that the County cannot acquire the existing Monteray Shores system and must construct wastewater capacity elsewhere. Land acquisition costs are based on the acreage required for effluent disposal based on build-out wastewater flow and an average land cost of $925,000 per acre. Ocean Sands and Corolla Light have sufficient land for effluent disposal and require no additional land acquisition. Oceans Sands will reimburse OBV for the portion of land on the WWTP site according to the portion of flow from Ocean Sands.

Table 2-11: Land Acquisition Costs for Option 2

Description	Additional Land Required for Disposal (ac)	Land Acquisition Costs (Disposal)	Land Acquisition Costs (WWTP)	Total Land Acquisition Costs
Ocean Sands	N/A	$0	$2,754,000	$2,754,000
Corolla Light	N/A	$0	$0	$0
Monteray Shores	4.7	$4,392,000	$987,250	$5,379,000

Note: Costs reflect land acquisition for sites in Corolla Light only and do not include land acquisition for reject storage site.

2.5.2 Sewer Rates and Fees

A rate evaluation was conducted to assess user rates and impact fees required to cover debt service for wastewater infrastructure, and O&M costs. A projection of O&M costs for Option 2 is shown in **Table 2-12**, and a cash flow analysis for the 20-year period is shown in **Table 2-13**. This rate evaluation assumes a monthly base charge of $135 and a service charge of $8.00 per 1,000 gallons for a monthly sewer bill of $177 in FY 2015. These values will increase annually with inflation through FY 2022. From FY 2023 through FY 2034, annual increases in monthly service charge were not necessary to meet financial obligations. After FY 2023, usage charges were held constant at $9.25 per 1,000 gallons through the end of study period and the base rate is reduced by $5.00 annually to prevent the accumulation of excess fund balance.

Impact fees for new Ocean Sands and Corolla Light customers were set at $12,500 and $14,000 per ERC, respectively. Impact fees for Monteray Shores customers were set at $21,000 per ERC. Impact fees were assumed to increase annually at 2.5 percent.

The projected monthly sewer bill and impacts fees are summarized in **Table 2-14** for the 20-year period for Option 2. Monthly sewer bills were calculated based on average wastewater flow and should represent typical non-summer monthly bill per ERC. The projected FY 2034 fund balance is projected to be $1.94 million.

It is important to note that costs for acquiring the Monteray Shores wastewater system from Carolina Water Services were not included in this analysis. No discussions or negotiations have occurred between Carolina Water Services and Currituck County at the time of this report.

Table 2-14: Yearly Rates and Fees – Public Utility Option 2

Fiscal Year	Average Monthly Sewer Bill	Ocean Sands Customer Impact Fee	Corolla Light Customer Impact Fee	MS Customer Impact Fee
FY 2015	$179	$12,500	$14,000	$21,000
FY 2016	$183	$12,813	$14,350	$21,525
FY 2017	$188	$13,133	$14,709	$22,063
FY 2018	$193	$13,461	$15,076	$22,615
FY 2019	$197	$13,798	$15,453	$23,180
FY 2020	$202	$14,143	$15,840	$23,760
FY 2021	$207	$14,496	$16,236	$24,354
FY 2022	$213	$14,859	$16,642	$24,962
FY 2023	$192	$15,230	$17,058	$25,586
FY 2024	$179	$15,611	$17,484	$26,226
FY 2029	$162	$17,662	$19,782	$29,672
FY 2034	$57	$19,983	$22,381	$33,572

2.6 Rate Evaluation – Option 3

2.6.1 Existing and Planned Capital Costs

The capital costs for each phase of wastewater infrastructure for Option 3 to serve Ocean Sands, Corolla Light, Monteray Shores, and the unsewered areas (Corolla Village, Ocean Hill, and Whalehead) are shown in **Table 2-15**. Construction costs were escalated to the midpoint of construction and used to determine financing costs. The amount financed for Phase 1 would be approximately $45.96 million. The remaining amount would be collected from balance in the OSWSD Fund ($4.0 million). The Phase 1 system would have a capacity of 1.8 mgd and was assumed to be financed for a term of 15 years with annual debt service of $4,538,000.

The amount financed for Phase 2 would be approximately $16.08 million. The remaining amount would be collected in impact fees from existing customers in the unsewered areas ($28.5 million) and used to offset financing costs. Phase 2 was assumed to be financed for a term of 15 years with annual debt service of $1,588,000. The total cost of Phase 3 was assumed to be financed for a term of 15 years annual debt service of $1,427,000.

Table 2-15: Capital Costs and Funding – Option 3

Description	FY Scheduled for Construction	FY 10 Construction Costs	Escalated Construction Costs	Financed Construction Costs
Treatment and Disposal				
Phase 1 WWTP (1.8 mgd)	FY 2015	$41,650,000	$46,960,000	$72,074,000
Phase 2 WWTP (0.8 mgd expansion)	FY 2019	$19,628,000	$24,952,000	$37,644,000
Phase 3 WWTP (0.8 mgd expansion)	FY 2028	$8,679,000	$14,453,000	$20,887,000
	SUBTOTAL	**$69,957,000**	**$86,365,000**	**$130,605,000**
Wastewater Collection				
Ocean Sands - Phase 1	FY 2015	$1,076,000	$1,213,000	$1,753,000
Corolla Light - Phase 1	FY 2015	$534,000	$602,000	$871,000
Monteray Shores – Phase 1	FY 2019	$1,079,000	$1,191,000	$1,706,000
Ocean Sands - Phase 2	FY 2019	$1,470,000	$1,869,000	$1,869,000
Corolla Light and Ocean Hill – Phase 2	FY 2019	$3,352,000	$4,261,000	$4,261,000
Whalehead – Phase 2	FY 2019	$8,168,000	$10,383,000	$10,383,000
	SUBTOTAL	**$15,678,000**	**$19,509,000**	**$20,842,000**

Capital costs listed in **Table 2-15** include land acquisition costs for effluent disposal for Monteray Shores and the unsewered areas. Land acquisition costs are based on the acreage required for effluent disposal based on build-out wastewater flows for each subdivision and an average land cost of $925,000 per acre (**Table 2-16**). Ocean Sands and Corolla Light have sufficient land for effluent disposal and require no additional land acquisition. Land acquisition costs listed in **Table 2-16** do not include costs for reject storage site, which will be borne by all regional utility customers, nor do they include the proportional cost of the WWTP site land.

Table 2-16: Land Acquisition Costs for Option 3

Description	Additional Land Required for Disposal (ac)	Land Acquisition Costs (Disposal)	Land Acquisition Costs (WWTP)	Total Land Acquisition Costs
Ocean Sands	N/A	$0	$2,185,000	$2,185,000
Corolla Light	N/A	$0	$0	$0
Monteray Shores	5.4	$4,986,000	$783,000	$5,769,000
Corolla Village	0.7	$681,000	$107,000	$788,000
Ocean Hill	0.7	$693,000	$109,000	$802,000
Whalehead	5.6	$5,167,000	$812,000	$5,979,000

Note: Costs reflect land acquisition for sites in Corolla Light only and do not include land acquisition for reject storage site.

2.6.2 Sewer Rates and Fees

A rate evaluation for Option 3 was conducted to assess user rates and impact fees required to cover debt service for wastewater infrastructure and O&M costs. A projection of O&M costs for Option 3 is provided in **Table 2-17**, and a cash flow analysis for the 20-year period is shown in **Table 2-18**. This rate evaluation assumes a monthly base charge of $150 and a service charge of $8.00 per 1,000 gallons for a monthly sewer bill of $191 in FY 2015. These values will increase annually with inflation through FY 2020. From FY 2021 through FY 2034, annual increases in monthly service charge and user rates were not necessary to meet financial obligations. Beginning in FY 2021, the user charge is held constant at $9.00 per 1,000 gallons and the monthly base rate is reduced by $8.00 annually to prevent accumulation of excess fund balance. The monthly base rate is reduced significantly in FY 2030 after the debt for Phase 1 is retired.

Impact fees for Monteray Shores customers were set at $18,000 per ERC. Impact fees for unsewered areas are significantly higher due to capital cost of new wastewater collection systems. Impact fees for Corolla Village and Ocean Hill customers were set at $31,000 per ERC and impact fees Whalehead customers were set at $26,000 per ERC. Impact fees were assumed to increase annually at 2.5 percent.

The projected monthly sewer bill and impacts fees are summarized in **Table 2-19** for the 20-year period. Monthly sewer bills were calculated based on average wastewater flow and should represent typical non-summer monthly bill per ERC.

Table 2-19: Yearly Rates and Fees – Public Option 3

Fiscal Year	Average Monthly Sewer Bill	Ocean Sands Customer Impact Fee	Corolla Light Customer Impact Fee	Monteray Shores Customer Impact Fee	Corolla Village / Ocean Hill Customer Impact Fee	WH Customer Impact Fee
FY 2015	$191	$10,500	$12,500	$18,000	$31,000	$26,000
FY 2016	$196	$10,763	$12,813	$18,450	$31,775	$26,650
FY 2017	$200	$11,032	$13,133	$18,911	$32,569	$27,316
FY 2018	$205	$11,307	$13,461	$19,384	$33,384	$27,999
FY 2019	$211	$11,590	$13,798	$19,869	$34,218	$28,699
FY 2020	$216	$11,880	$14,143	$20,365	$35,074	$29,417
FY 2021	$208	$12,177	$14,496	$20,874	$35,950	$30,152
FY 2022	$200	$12,481	$14,859	$21,396	$36,849	$30,906
FY 2023	$192	$12,793	$15,230	$21,931	$37,770	$31,678
FY 2024	$184	$13,113	$15,611	$22,480	$38,715	$32,470
FY 2029	$144	$14,836	$17,662	$25,434	$43,802	$36,737
FY 2034	$61	$16,768	$19,983	$28,776	$49,558	$41,565

It is important to note that costs for acquiring the Monteray Shores wastewater system from Carolina Water Services were not included in this analysis. No discussions or negotiations have occurred between Carolina Water Services and Currituck County at the time of this report. If the County selected to proceed with this option, then the impact fees for each Monteray Shores customer could be expected to increase in an amount proportional to the acquisition cost.

2.7 Rate Evaluation – Option 4

2.7.1 Existing and Planned Capital Costs

The capital costs for each phase of wastewater infrastructure for Option 4 to serve Ocean Sands, Corolla Light, and the unsewered areas (Corolla Village, Ocean Hill, and Whalehead) are shown in **Table 2-20**. Construction costs were escalated to the midpoint of construction and used to determine financing costs. The amount financed for Phase 1 would be approximately $34.03 million. The remaining amount will be funded from balance from the OSWSD Fund ($4.0 million). The Phase 1 system would have a capacity of 1.2 mgd and was assumed to be financed for a term of 15 years with annual debt service of $3,360,000.

The amount financed for Phase 2 would be approximately $7.28 million. The remaining amount would be collected in impact fees from existing customers in the unsewered areas ($36.38 million) and used to offset financing costs. Phase 2 was assumed to be financed for a term of 10 years with annual debt service of $966,000. The total cost of Phase 3 was assumed to be financed for a term of 15 years annual debt service of $854,000.

Table 2-20: Capital Costs and Funding – Option 4

Description	FY Scheduled for Construction	FY 10 Construction Costs	Escalated Construction Costs	Financed Construction Costs
Treatment and Disposal				
Phase 1 (1.2 mgd)	FY2015	$32,119,000	$36,214,000	$54,406,000
Phase 2 (1.0 mgd expansion)	FY2019	$20,851,000	$26,507,000	$28,891,000
Phase 3 (0.5 mgd)	FY2028	$5,040,000	$8,649,000	$12,498,000
	SUBTOTAL	**$58,010,000**	**$71,369,000**	**$95,795,000**
Wastewater Collection				
Ocean Sands - Phase 1	FY2015	$1,075,000	$1,212,000	$1,752,000
Corolla Light - Phase 1	FY2015	$534,000	$602,000	$871,000
Ocean Sands – Phase 2	FY2019	$1,976,000	$2,512,000	$2,512,000
Corolla Village & Ocean Hill - Phase 2	FY2019	$3,352,000	$4,261,000	$4,261,000
Whalehead – Phase 2	FY2019	$8,168,000	$10,383,000	$10,383,000
	SUBTOTAL	**$15,105,000**	**$18,970,000**	**$27,415,000**

The capital costs listed in **Table 2-20** include land acquisition costs for effluent disposal for the unsewered areas. Land acquisition costs are based on the acreage required for effluent disposal based on build-out wastewater flows for each subdivision and an average land cost of $925,000 per acre (**Table 2-21**). Ocean Sands and Corolla Light have sufficient land for effluent disposal and require no additional land acquisition. Land acquisition costs listed in **Table 2-21** do not include costs for reject storage site, which will be borne by all regional utility customers. Ocean Sands and the unsewered areas will reimburse OBV for a portion of the WWTP site land.

Table 2-21: Land Acquisition Costs

Description	Additional Land Required for Disposal (ac)	Land Acquisition Costs (Disposal)	Land Acquisition Costs (WWTP)	Total Land Acquisition Costs
Ocean Sands	N/A	$0	$2,594,000	$2,594,000
Corolla Light	N/A	$0	$0	$0
Corolla Village	0.50	$462,000	$127,000	$489,000
Ocean Hill	0.51	$470,000	$129,000	$599,000
Whalehead	3.79	$3,505,000	$963,000	$4,468,000

Note: Costs reflect land acquisition for sites in Corolla Light only and do not include land acquisition for reject storage site.

2.7.2 Sewer Rates and Fees

A rate evaluation for Option 4 was conducted to assess user rates and impact fees required to cover debt service for wastewater infrastructure, and O&M costs. A projection of O&M costs for Option 4 is shown in **Table 2-22** and a cash flow analysis for the 20-year period is shown in **Table 2-23.** This rate evaluation assumes a monthly base charge of $125 and a service charge of $8.00 per 1,000 gallons for an average monthly sewer bill of $166 in FY 2015. These values will increase annually with inflation through FY 2017. In FY 2018, the base charge is set at $135 and is reduced by $5 annually until FY 2030. IN FY 2030, the base charge is set at $25 and is reduced by $5 annually until FY 2034.

Impact fees for new customers were set at $19,000 per ERC for Corolla Light customers and $17,000 per ERC for Ocean Sands customers. Impact fees for unsewered areas are significantly higher due to capital cost of new wastewater collection systems. Impact fees for Corolla Village and Ocean Hill customers were set at $31,000 per ERC and impact fees Whalehead customers were set at $31,000 per ERC. Impact fees were assumed to increase annually at 2.5 percent.

The projected monthly sewer bill and impacts fees are summarized in **Table 2-24** for the 20-year period. Monthly sewer bills were calculated based on average wastewater flow and should represent typical non-summer monthly bill per ERC.

Table 2-24: Yearly Rates and Fees – Public Utility Option 4 – Moderate Growth

Fiscal Year	Average Monthly Sewer Bill	OS Customer Impact Fee	CL Customer Impact Fee	CV/OH Customer Impact Fee	WH Customer Impact Fee
FY 2015	$166	$17,000	$19,000	$31,000	$31,000
FY 2016	$170	$17,425	$19,475	$31,775	$31,775
FY 2017	$174	$17,861	$19,962	$32,569	$32,569
FY 2018	$179	$18,307	$20,461	$33,384	$33,384
FY 2019	$176	$18,765	$20,972	$34,218	$34,218
FY 2020	$171	$19,234	$21,497	$35,074	$35,074
FY 2021	$166	$19,715	$22,034	$35,950	$35,950
FY 2022	$161	$20,208	$22,585	$36,849	$36,849
FY 2023	$156	$20,713	$23,150	$37,770	$37,770
FY 2024	$151	$21,231	$23,728	$38,715	$38,715
FY 2029	$126	$24,021	$26,847	$43,802	$43,802
FY 2034	$51	$27,177	$30,374	$49,558	$49,558

Per request of the County, a low-growth scenario was evaluated with a 1.5 percent per annum growth rate in wastewater flows. The phasing of the plant expansions was adjusted to account for the reduced growth rate. As part of this scenario, Phase 2 would go online in FY 2019 and Phase 3 would be completed in FY 2029. A projection of O&M costs for Option 4 – Low Growth is shown in **Table 2-25**, and a cash flow analysis for the 20-year period is shown in **Table 2-26**. The average monthly sewer bill and impact fees for Ocean Sands, Corolla Light, Ocean Hill, Corolla Village and Whalehead customers are shown below in **Table 2-27**.

Table 2-27: Yearly Rates and Fees – Public Utility Option 4 – Low Growth

Fiscal Year	Average Monthly Sewer Bill	OS Customer Impact Fee	CL Customer Impact Fee	CV/OH Customer Impact Fee	WH Customer Impact Fee
FY 2015	$206	$17,000	$19,000	$31,000	$31,000
FY 2016	$211	$17,425	$19,475	$31,775	$31,775
FY 2017	$216	$17,861	$19,962	$32,569	$32,569
FY 2018	$222	$18,307	$20,461	$33,384	$33,384
FY 2019	$217	$18,765	$20,972	$34,218	$34,218
FY 2020	$209	$19,234	$21,497	$35,074	$35,074
FY 2021	$201	$19,715	$22,034	$35,950	$35,950
FY 2022	$193	$20,208	$22,585	$36,849	$36,849
FY 2023	$185	$20,713	$23,150	$37,770	$37,770
FY 2024	$177	$21,231	$23,728	$38,715	$38,715
FY 2029	$137	$24,021	$26,847	$43,802	$43,802
FY 2034	$56	$27,177	$30,374	$49,558	$49,558

TABLE 2-4: ANNUAL O&M COSTS

OPTION 1 - OCEAN SANDS AND COROLLA LIGHT - MODERATE GROWTH

COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK OUTER BANKS

Operational Year #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**15**	**20**
Fiscal Year	**FY 15**	**FY 16**	**FY 17**	**FY 18**	**FY 19**	**FY 20**	**FY 21**	**FY 22**	**FY 23**	**FY 24**	**FY 29**	**FY 34**
Summer Monthly Demand (gpd)	779,000	802,370	826,441	851,234	876,771	903,075	930,167	958,072	986,814	1,016,418	1,178,307	1,365,981
Annual Demand (gallons)	116,850,000	120,355,500	123,966,165	127,685,150	131,515,704	135,461,176	139,525,011	143,710,761	148,022,084	152,462,747	176,746,109	204,897,182
Unit WWTP O&M Costs ($/1000 gals)	$8.00	$8.08	$8.16	$8.24	$8.32	$8.41	$8.49	$8.58	$8.66	$8.75	$9.20	$9.66
Annual WWTP O&M	$934,800	$972,472	$1,011,663	$1,052,433	$1,094,846	$1,138,968	$1,184,869	$1,232,619	$1,282,294	$1,333,970	$1,625,321	$1,980,305
Collection System O&M	-	-	-	-	-	-	-	-	-	-	-	-
Total O&M New Plant and Facilities	**$934,800**	**$972,472**	**$1,011,663**	**$1,052,433**	**$1,094,846**	**$1,138,968**	**$1,184,869**	**$1,232,619**	**$1,282,294**	**$1,333,970**	**$1,625,321**	**$1,980,305**

Table 2-5: CASH FLOW PROJECTION
OPTION 1 - OCEAN SANDS AND COROLLA LIGHT - MODERATE GROWTH
COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK OUTER BANKS

	Operational Year #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**15**	**20**
	Fiscal Year	**FY 15**	**FY 16**	**FY 17**	**FY 18**	**FY 19**	**FY 20**	**FY 21**	**FY 22**	**FY 23**	**FY 24**	**FY 29**	**FY 34**
	Sewer Rate and Sales Information												
1	Base Sewer Charge ($/mo)	$ 120.00	$ 123.00	$ 126.08	$ 129.23	$ 132.46	$ 135.77	$ 139.16	$ 142.64	$ 146.21	$ 149.86	$ 130.00	$ 6.00
2	Service Charge ($/1000 gals)	$ 8.00	$8.20	$8.41	$8.62	$8.83	$9.05	$9.28	$9.51	$9.75	$9.99	$10.50	$9.00
3	Average Monthly Sewer Bill	$160.80	$164.82	$168.94	$173.16	$177.49	$181.93	$186.48	$191.14	$195.92	$200.82	$183.55	$51.90
4	Projected Annual Flow (1000s gals)	116,850	120,356	123,966	127,685	131,516	135,461	139,525	143,711	148,022	152,463	176,746	204,897
5	Projected Total Connections (ERC)	1,461	1,505	1,550	1,597	1,645	1,694	1,745	1,797	1,851	1,907	2,210	2,562
6	Ocean Sands New Connections (ERCs)	109	29	30	31	32	33	34	35	36	37	43	50
7	Corolla Light New Connections (ERCs)	54	15	15	15	16	16	17	17	18	18	21	25
8	Existing OS Connections (2011)	868											
9	Existing CL Connections (2011)	430											
10	New OS Tap Fee	$ 20,000	$ 20,500	$ 21,013	$ 21,538	$ 22,076	$ 22,628	$ 23,194	$ 23,774	$ 24,368	$ 24,977	$ 28,259	$ 31,973
11	New CL Tap Fee	$ 23,000	$ 23,575	$ 24,164	$ 24,768	$ 25,388	$ 26,022	$ 26,673	$ 27,340	$ 28,023	$ 28,724	$ 32,498	$ 36,769
	Annual Revenues												
12	Annual Base Charge Revenue	$ 2,104,251	$ 2,221,563	$ 2,345,415	$ 2,476,172	$ 2,614,219	$ 2,759,962	$ 2,913,830	$ 3,076,276	$ 3,247,778	$ 3,428,841	$ 3,448,108	$ 184,491
13	Annual Service Charge Revenue	$ 934,800	$ 986,915	$ 1,041,936	$ 1,100,024	$ 1,161,350	$ 1,226,095	$ 1,294,450	$ 1,366,615	$ 1,442,804	$ 1,523,241	$ 1,855,834	$ 1,844,075
14	Interest		$ 33,049	$ 31,415	$ 29,610	$ 30,713	$ 34,930	$ 42,498	$ 53,671	$ 38,944	$ 27,924	$ 19,120	$ 36,739
15	**SUBTOTAL SERVICE CHARGE REVENUES**	$3,039,051	$3,241,527	$3,418,766	$3,605,806	$3,806,281	$4,020,986	$4,250,778	$4,496,562	$4,729,526	$4,980,006	$5,323,062	$2,065,304
16	Tap Fee (Existing OS Connections)	$0	$0	$0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
17	Tap Fee (Existing CL Connections)	$0	$0	$0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
18	Tap Fee (New OS Connections)	$2,178,833	$600,819	$634,315	$669,678	$707,012	$746,428	$788,042	$831,975	$878,358	$927,326	$1,216,292	$1,595,304
19	Tap Fee (New CL Connections)	$1,241,282	$342,287	$361,369	$381,516	$402,785	$425,241	$448,948	$473,977	$500,401	$528,298	$692,922	$908,845
20	**SUBTOTAL TAP FEE REVENUES**	$3,420,115	$943,106	$995,684	$1,051,194	$1,109,798	$1,171,669	$1,236,989	$1,305,952	$1,378,758	$1,455,624	$1,909,214	$2,504,149
21	**TOTAL REVENUES**	$6,459,166	$4,184,633	$4,414,450	$4,657,000	$4,916,079	$5,192,655	$5,487,767	$5,802,513	$6,108,285	$6,435,630	$7,232,277	$4,569,453
	Annual Operation Expenses												
22	O & M New Plant and Facilities	$934,800	$972,472	$1,011,663	$1,052,433	$1,094,846	$1,138,968	$1,184,869	$1,232,619	$1,282,294	$1,333,970	$1,625,321	$1,980,305
23	Capital Reserve Fund			$202,000	$210,000	$219,000	$228,000	$237,000	$247,000	$256,000	$267,000	$325,000	$396,000
24	**SUBTOTAL OPERATION EXPENSES**	$934,800	$972,472	$1,213,663	$1,262,433	$1,313,846	$1,366,968	$1,421,869	$1,479,619	$1,538,294	$1,600,970	$1,950,321	$2,376,305
	Existing and New Debt												
25	Debt Service for Phase 1 WWTP	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$0
26	Phase 1 Construction (Impact Fees)	$0	$0	$0									
27	Debt Service for Phase 2 WWTP	$ -	$ -	$ -	$ -	$ -			$ 1,983,561	$ 1,983,561	$ 1,983,561	$ 1,983,561	$ 1,983,561
28	**SUBTOTAL EXISTING AND NEW DEBT**	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$5,304,656	$5,304,656	$5,304,656	$5,304,656	$1,983,561
29	**TOTAL EXPENSE**	$4,255,895	$4,293,567	$4,534,758	$4,583,528	$4,634,941	$4,688,063	$4,742,964	$6,784,275	$6,842,950	$6,905,626	$7,254,977	$4,359,866
30	**Net Gain/Loss**	**$2,203,271**	**($108,934)**	**($120,308)**	**$73,472**	**$281,138**	**$504,592**	**$744,803**	**($981,762)**	**($734,665)**	**($469,996)**	**($22,700)**	**$209,587**
31	**Accumulated Cash Flow Balance**	**$2,203,271**	**$2,094,338**	**$1,974,030**	**$2,047,502**	**$2,328,640**	**$2,833,232**	**$3,578,035**	**$2,596,273**	**$1,861,608**	**$1,391,613**	**$1,251,975**	**$2,658,845**
32	**Days Cash on Hand**	**860**	**786**	**594**	**592**	**647**	**757**	**918**	**640**	**442**	**317**	**234**	**408**

TABLE 2-7: ANNUAL O&M COSTS

OPTION 1 - OCEAN SANDS AND COROLLA LIGHT - LOW GROWTH

COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK OUTER BANKS

Operational Year #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**15**	**20**
Fiscal Year	**FY 15**	**FY 16**	**FY 17**	**FY 18**	**FY 19**	**FY 20**	**FY 21**	**FY 22**	**FY 23**	**FY 24**	**FY 29**	**FY 34**
Summer Monthly Demand (gpd)	779,000	790,685	802,545	814,583	826,802	839,204	851,792	864,569	877,538	890,701	959,538	1,033,695
Annual Demand (gallons)	116,850,000	118,602,750	120,381,791	122,187,518	124,020,331	125,880,636	127,768,845	129,685,378	131,630,659	133,605,119	143,930,657	155,054,195
Unit WWTP O&M Costs ($/1000 gals)	$8.00	$8.08	$8.16	$8.24	$8.32	$8.41	$8.49	$8.58	$8.66	$8.75	$9.20	$9.66
Annual WWTP O&M	$934,800	$958,310	$982,412	$1,007,119	$1,032,448	$1,058,415	$1,085,034	$1,112,322	$1,140,297	$1,168,976	$1,323,557	$1,498,579
Collection System O&M	-	-	-	-	-	-	-	-	-	-	-	-
Total O&M New Plant and Facilities	**$934,800**	**$958,310**	**$982,412**	**$1,007,119**	**$1,032,448**	**$1,058,415**	**$1,085,034**	**$1,112,322**	**$1,140,297**	**$1,168,976**	**$1,323,557**	**$1,498,579**

Table 2-8: CASH FLOW PROJECTION
OPTION 1 - OCEAN SANDS AND COROLLA LIGHT - LOW GROWTH
COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK OUTER BANKS

	Operational Year #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**15**	**20**
	Fiscal Year	**FY 15**	**FY 16**	**FY 17**	**FY 18**	**FY 19**	**FY 20**	**FY 21**	**FY 22**	**FY 23**	**FY 24**	**FY 29**	**FY 34**
	Sewer Rate and Sales Information												
1	Base Sewer Charge ($/mo)	$ 156.00	$ 159.90	$ 163.90	$ 167.99	$ 172.19	$ 170.00	$ 166.00	$ 162.00	$ 158.00	$ 155.00	$ 140.00	$ 70.00
2	Service Charge ($/1000 gals)	$ 8.00	$8.20	$8.41	$8.62	$8.83	$9.05	$9.00	$9.00	$9.00	$9.00	$9.00	$9.00
3	Average Monthly Sewer Bill	$196.80	$201.72	$206.76	$211.93	$217.23	$216.16	$211.90	$207.90	$203.90	$200.90	$185.90	$115.90
4	Projected Annual Flow (1000s gals)	116,850	118,603	120,382	122,188	124,020	125,881	127,769	129,685	131,631	133,605	143,931	155,054
5	Projected Total Connections (ERC)	1,378	1,399	1,420	1,441	1,463	1,485	1,507	1,529	1,552	1,576	1,697	1,829
6	Ocean Sands New Connections (ERCs)	53	14	14	14	14	15	15	15	15	16	17	18
7	Corolla Light New Connections (ERCs)	26	7	7	7	7	7	7	7	8	8	8	9
8	Existing OS Connections (2011)	868											
9	Existing CL Connections (2011)	430											
10	Existing OS Tap Fee	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
11	Existing CL Tap Fee	$ -	$ -	$ -	$ -	$ -							
12	New OS Tap Fee	$ 20,000	$ 20,500	$ 21,013	$ 21,538	$ 22,076	$ 22,628	$ 23,194	$ 23,774	$ 24,368	$ 24,977	$ 28,259	$ 31,973
13	New CL Tap Fee	$ 21,000	$ 21,525	$ 22,063	$ 22,615	$ 23,180	$ 23,760	$ 24,354	$ 24,962	$ 25,586	$ 26,226	$ 29,672	$ 33,572
	Annual Revenues												
14	Annual Base Charge Revenue	$ 2,579,623	$ 2,683,775	$ 2,792,133	$ 2,904,865	$ 3,022,149	$ 3,028,383	$ 3,001,484	$ 2,973,096	$ 2,943,182	$ 2,930,608	$ 2,851,571	$ 1,535,976
15	Annual Service Charge Revenue	$ 934,800	$ 972,543	$ 1,011,809	$ 1,052,661	$ 1,095,162	$ 1,139,379	$ 1,149,920	$ 1,167,168	$ 1,184,676	$ 1,202,446	$ 1,295,376	$ 1,395,488
16	Interest		$ 13,169	$ 10,480	$ 6,924	$ 5,444	$ 6,166	$ 7,470	$ 8,380	$ 8,970	$ 9,203	$ 8,749	$ 86,295
17	**SUBTOTAL SERVICE CHARGE REVENUES**	$3,514,423	$3,669,486	$3,814,421	$3,964,449	$4,122,755	$4,173,928	$4,158,874	$4,148,644	$4,136,827	$4,142,257	$4,155,696	$3,017,759
18	Tap Fee (Existing OS Connections)	$0	$0	$0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
19	Tap Fee (Existing CL Connections)	$0	$0	$0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
20	Tap Fee (New OS Connections)	$1,065,271	$283,289	$294,726	$306,626	$319,006	$331,886	$345,286	$359,227	$373,730	$388,820	$473,912	$577,627
21	Tap Fee (New CL Connections)	$554,113	$147,356	$153,305	$159,495	$165,935	$172,634	$179,604	$186,856	$194,400	$202,249	$246,511	$300,459
22	**SUBTOTAL TAP FEE REVENUES**	$1,619,384	$430,644	$448,032	$466,121	$484,940	$504,520	$524,890	$546,082	$568,130	$591,069	$720,423	$878,086
23	**TOTAL REVENUES**	$5,133,807	$4,100,131	$4,262,453	$4,430,570	$4,607,695	$4,678,448	$4,683,763	$4,694,727	$4,704,957	$4,733,326	$4,876,119	$3,895,844
	Annual Operation Expenses												
24	O & M New Plant and Facilities	$934,800	$958,310	$982,412	$1,007,119	$1,032,448	$1,058,415	$1,085,034	$1,112,322	$1,140,297	$1,168,976	$1,323,557	$1,498,579
25	Capital Reserve Fund			$196,000	$201,000	$206,000	$212,000	$217,000	$222,000	$228,000	$234,000	$265,000	$300,000
26	**SUBTOTAL OPERATION EXPENSES**	$934,800	$958,310	$1,178,412	$1,208,119	$1,238,448	$1,270,415	$1,302,034	$1,334,322	$1,368,297	$1,402,976	$1,588,557	$1,798,579
	Existing and New Debt												
27	Debt Service for Phase 1 WWTP	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$0
28	Debt Service for Phase 2 WWTP	$ -	$ -										$ 2,725,500
29	**SUBTOTAL EXISTING AND NEW DEBT**	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$3,321,095	$2,725,500
30	**TOTAL EXPENSE**	$4,255,895	$4,279,405	$4,499,507	$4,529,214	$4,559,543	$4,591,509	$4,623,129	$4,655,417	$4,689,392	$4,724,071	$4,909,652	$4,524,079
31	**Net Gain/Loss**	**$877,912**	**($179,274)**	**($237,054)**	**($98,644)**	**$48,152**	**$86,939**	**$60,635**	**$39,310**	**$15,565**	**$9,255**	**($33,533)**	**($628,235)**
32	**Accumulated Cash Flow Balance**	**$877,912**	**$698,638**	**$461,584**	**$362,940**	**$411,092**	**$498,030**	**$558,665**	**$597,975**	**$613,540**	**$622,795**	**$549,703**	**$5,124,741**
33	**Days Cash on Hand**	**343**	**266**	**143**	**110**	**121**	**143**	**157**	**164**	**164**	**162**	**126**	**1040**

TABLE 2-12: ANNUAL O&M COSTS
OPTION 2 - OCEAN SANDS, COROLLA LIGHT AND MONTERAY SHORES
COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK OUTER BANKS

Operational Year #	1	2	3	4	5	6	7	8	9	10	15	20
Fiscal Year	FY 14	FY 15	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22	FY 23	FY 28	FY 33
Summer Monthly Demand (gpd)	1,175,504	1,210,769	1,247,092	1,284,505	1,323,040	1,362,731	1,403,613	1,445,722	1,489,093	1,533,766	1,778,055	2,061,253
Annual Demand (gallons)	176,325,587	181,615,354	187,063,815	192,675,729	198,456,001	204,409,681	210,541,972	216,858,231	223,363,978	230,064,897	266,708,271	309,187,984
Unit WWTP O&M Costs ($/1000 gals)	$8.00	$8.08	$8.16	$8.24	$8.32	$8.41	$8.49	$8.58	$8.66	$8.75	$9.20	$9.66
Annual WWTP O&M	$1,410,605	$1,467,452	$1,526,590	$1,588,112	$1,652,113	$1,718,693	$1,787,956	$1,860,011	$1,934,969	$2,012,949	$2,452,594	$2,988,262
Collection System O&M	-	-	-	-	-	-	-	-	-	-	-	-
Total O&M New Plant and Facilities	**$1,410,605**	**$1,467,452**	**$1,526,590**	**$1,588,112**	**$1,652,113**	**$1,718,693**	**$1,787,956**	**$1,860,011**	**$1,934,969**	**$2,012,949**	**$2,452,594**	**$2,988,262**

TABLE 2-13: CASH FLOW PROJECTION
OPTION 2 - OCEAN SANDS, COROLLA LIGHT AND MONTERAY SHORES
COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK OUTER BANKS

	Operational Year #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**15**	**20**
	Fiscal Year	**FY 15**	**FY 16**	**FY 17**	**FY 18**	**FY 19**	**FY 20**	**FY 21**	**FY 22**	**FY 23**	**FY 24**	**FY 29**	**FY 34**
	Sewer Rate and Sales Information												
1	Base Monthly Sewer Charge	$ 138.00	$141.45	$144.99	$148.61	$152.33	$156.13	$160.04	$164.04	$145.00	$140.00	$115.00	$10.00
2	Service Charge ($/1000 gals)	$8.00	$8.20	$8.41	$8.62	$8.83	$9.05	$9.28	$9.51	$9.25	$9.25	$9.25	$9.25
3	Average Monthly Sewer Bill	$178.80	$183.27	$187.85	$192.55	$197.36	$202.30	$207.35	$212.54	$192.18	$187.18	$162.18	$57.18
4	Projected Annual Flow (1000s gals)	176,326	181,615	187,064	192,676	198,456	204,410	210,542	216,858	223,364	230,065	266,708	309,188
5	Projected Total Connections (ERC)	1,959	2,018	2,078	2,141	2,205	2,271	2,339	2,410	2,482	2,556	2,963	3,435
6	Ocean Sands New Connections (ERCs)	138	30	31	32	33	34	35	36	37	38	44	51
7	Corolla Light New Connections (ERCs)	68	15	15	16	16	17	17	18	18	19	22	25
8	Monteray Shores New Connections (ERCs)	62	14	14	14	15	15	16	16	17	17	20	23
9	Existing OS Connections (2011)	868											
10	Existing CL Connections (2011)	430											
11	Existing MS Connections (2011)	392											
12	Existing OS Tap Fee	$ -											
13	Existing CL Tap Fee	$ -											
14	New OS Tap Fee	$ 12,500	$12,812.50	$13,132.81	$13,461.13	$13,797.66	$14,142.60	$14,496.17	$14,858.57	$15,230.04	$15,610.79	$17,662.17	$19,983.13
15	New CL Tap Fee	$ 14,000	$14,350.00	$14,708.75	$15,076.47	$15,453.38	$15,839.71	$16,235.71	$16,641.60	$17,057.64	$17,484.08	$19,781.63	$22,381.10
16	Existing MS Tap Fee	$ -											
17	New MS Tap Fee	$ 21,000	$21,525.00	$22,063.13	$22,614.70	$23,180.07	$23,759.57	$24,353.56	$24,962.40	$25,586.46	$26,226.12	$29,672.45	$33,571.65
	Annual Revenues												
18	Annual Base Charge Revenue	$ 3,244,391	3425265.582	$ 3,616,224	$ 3,817,829	$ 4,030,673	$ 4,255,383	$ 4,492,620	$ 4,743,084	$ 4,318,370	$ 4,294,545	$ 4,089,527	$ 412,251
19	Annual Service Charge Revenue	$ 1,410,605	$ 1,489,246	$ 1,572,271	$ 1,659,925	$ 1,752,466	$ 1,850,166	$ 1,953,313	$ 2,062,210	$ 2,066,117	$ 2,128,100	$ 2,467,052	$ 2,859,989
20	Interest		$ 33,966	$ 24,932	$ 15,158	$ 9,249	$ 7,526	$ 10,285	$ 17,873	$ 30,655	$ 37,003	$ 41,468	$ 28,816
21	**SUBTOTAL SERVICE CHARGE REVENUES**	$4,654,995	$4,948,477	$5,213,427	$5,492,912	$5,792,388	$6,113,075	$6,456,219	$6,823,167	$6,415,142	$6,459,648	$6,598,046	$3,301,056
22	Tap Fee (Existing OS Connections)	$ -	$ -	$ -			$ -	$ -	$ -	$ -	$ -	$ -	$ -
23	Tap Fee (Existing CL Connections)	$ -	$ -	$ -									
24	Tap Fee (New OS Connections)	$ 1,728,124	$ 386,777	$ 408,340	$ 431,105	$ 455,139	$ 480,513	$ 507,302	$ 535,584	$ 565,443	$ 596,966	$ 782,988	$ 1,026,977
25	Tap Fee (New CL Connections)	$ 958,830	$ 214,599	$ 226,563	$ 239,194	$ 252,529	$ 266,607	$ 281,471	$ 297,163	$ 313,730	$ 331,220	$ 434,432	$ 569,806
26	Tap Fee Rev (Exist MS Connections)	$ -	$ -	$ -									
27	Tap Fee Rev (New MS Connections)	$ 1,311,144	$ 293,452	$ 309,812	$ 327,084	$ 345,319	$ 364,570	$ 384,895	$ 406,353	$ 429,007	$ 452,924	$ 594,061	$ 779,177
28	**SUBTOTAL TAP FEE REVENUES**	$3,998,098	$894,828	$944,715	$997,383	$1,052,987	$1,111,691	$1,173,667	$1,239,099	$1,308,179	$1,381,110	$1,811,481	$2,375,960
29	**TOTAL REVENUES**	$8,653,093	$5,843,305	$6,158,142	$6,490,295	$6,845,374	$7,224,766	$7,629,886	$8,062,266	$7,723,321	$7,840,758	$8,409,527	$5,677,016
	Annual Operation Expenses												
30	O & M New Plant and Facilities	$1,410,605	$1,467,452	$1,526,590	$1,588,112	$1,652,113	$1,718,693	$1,787,956	$1,860,011	$1,934,969	$2,012,949	$2,452,594	$2,988,262
31	Capital Reserve Fund			$305,000	$318,000	$330,000	$344,000	$358,000	$372,000	$387,000	$403,000	$491,000	$598,000
32	**SUBTOTAL OPERATION EXPENSES**	$1,410,605	$1,467,452	$1,831,590	$1,906,112	$1,982,113	$2,062,693	$2,145,956	$2,232,011	$2,321,969	$2,415,949	$2,943,594	$3,586,262
	Existing and New Debt												
33	Debt Service for Phase 1 WWTP	$4,978,120	$4,978,120	$4,978,120	$4,978,120	$4,978,120	$4,978,120	$4,978,120	$4,978,120	$4,978,120	$4,978,120	$4,978,120	$0
34	Debt Service for Phase 2 WWTP	$ -	$ -	$ -	$ -							$ 2,116,010	$ 2,116,010
35	**SUBTOTAL EXISTING AND NEW DEBT**	$4,978,120	$4,978,120	$4,978,120	$4,978,120	$4,978,120	$4,978,120	$4,978,120	$4,978,120	$4,978,120	$4,978,120	$7,094,130	$2,116,010
36	**TOTAL EXPENSE**	$6,388,725	$6,445,572	$6,809,710	$6,884,232	$6,960,233	$7,040,813	$7,124,076	$7,210,131	$7,300,089	$7,394,069	$10,037,724	$5,702,272
37	**Net Gain/Loss**	**$ 2,264,369**	**($602,267)**	**($651,569)**	**($393,937)**	**($114,858)**	**$183,953**	**$505,810**	**$852,135**	**$423,231**	**$446,690**	**($1,628,197)**	**($25,256)**
38	**Accumulated Cash Flow Balance**	**$ 2,264,369**	**$ 1,662,102**	**$1,010,533**	**$616,596**	**$501,738**	**$685,691**	**$1,191,500**	**$2,043,635**	**$2,466,867**	**$2,913,556**	**$1,136,347**	**$1,895,828**
39	**Days Cash on Hand**	**586**	**413**	**201**	**118**	**92**	**121**	**203**	**334**	**388**	**440**	**141**	**193**

TABLE 2-17: ANNUAL O&M COSTS
OPTION 3 - OCEAN SANDS, COROLLA LIGHT, MONTERAY SHORES, WHALEHEAD, COROLLA VILLAGE, OCEAN HILL
COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK OUTER BANKS

Operational Year #	1	2	3	4	5	6	7	8	9	10	15	20
Fiscal Year	FY 14	FY 15	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22	FY 23	FY 28	FY 33
Summer Monthly Demand (gpd)	1,141,266	1,175,504	1,210,769	1,247,092	1,906,033	1,951,471	1,992,537	2,034,835	2,078,402	2,123,276	2,368,666	2,652,817
Annual Demand (gallons)	171,189,890	176,325,587	181,615,354	187,063,815	285,904,929	292,720,633	298,880,552	305,225,269	311,760,327	318,491,437	355,299,904	397,922,508
Unit WWTP O&M Costs ($/1000 gals)	$8.00	$8.08	$8.16	$8.24	$8.32	$8.41	$8.49	$8.58	$8.66	$8.75	$9.20	$9.66
Annual WWTP O&M	$1,369,519	$1,424,711	$1,482,127	$1,541,856	$2,380,111	$2,461,219	$2,538,142	$2,617,942	$2,700,734	$2,786,635	$3,267,265	$3,845,870
Collection System O&M	-	-	-	-	$320,000	$323,200	$326,432	$329,696	$332,993	$336,323	$353,479	$371,510
Total O&M New Plant and Facilities	**$1,369,519**	**$1,424,711**	**$1,482,127**	**$1,541,856**	**$2,700,111**	**$2,784,419**	**$2,864,574**	**$2,947,639**	**$3,033,727**	**$3,122,958**	**$3,620,744**	**$4,217,380**

TABLE 2-18: CASH FLOW PROJECTION
OPTION 3 - OCEAN SANDS, COROLLA LIGHT, MONTERAY SHORES, WHALEHEAD, COROLLA VILLAGE, OCEAN HILL
COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK OUTER BANKS

	Operational Year #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**15**	**20**
	Fiscal Year	**FY 15**	**FY 16**	**FY 17**	**FY 18**	**FY 19**	**FY 20**	**FY 21**	**FY 22**	**FY 23**	**FY 24**	**FY 29**	**FY 34**
	Sewer Rate and Sales Information												
1	Monthly Base Charge	$ 150	$153.75	$157.59	$161.53	$165.57	$170.00	$162.00	$154.00	$146.00	$138.00	$98.00	$15.00
2	Service Charge ($/1000 gals)	$8.00	$8.20	$8.41	$8.62	$8.83	$9.00	$9.00	$9.00	$9.00	$9.00	$9.00	$9.00
3	Average Monthly Sewer Bill	$190.80	$195.57	$200.46	$205.47	$210.61	$215.90	$207.90	$199.90	$191.90	$183.90	$143.90	$60.90
4	Projected Annual Flow (1000s gals)	171,190	176,326	181,615	187,064	285,905	292,721	298,881	305,225	311,760	318,491	355,300	397,923
5	Projected Total Connections (ERC)	1,902	1,959	2,018	2,078	3,177	3,252	3,321	3,391	3,464	3,539	3,948	4,421
6	Ocean Sands New Connections (ERCs)	109	29	30	31	32	33	34	35	36	37	43	50
7	Corolla Light New Connections (ERCs)	54	15	15	15	16	16	17	17	18	18	21	25
8	Monteray Shores New Connections (ERCs)	49	13	14	14	14	15	15	16	16	17	19	23
9	CV New Connections	72	0	0	0	2	2	2	2	2	3	3	3
10	OH New Connections	111	0	0	0	2	0	0	0	0	0	0	0
11	New OS Tap Fee	$ 10,500	$10,763	$11,032	$11,307	$11,590	$11,880	$12,177	$12,481	$12,793	$13,113	$14,836	$16,786
12	New CL Tap Fee	$ 12,500	$12,813	$13,133	$13,461	$13,798	$14,143	$14,496	$14,859	$15,230	$15,611	$17,662	$19,983
13	New MS Tap Fee	$ 18,000	$18,450	$18,911	$19,384	$19,869	$20,365	$20,874	$21,396	$21,931	$22,480	$25,434	$28,776
14	CV/OH Tap Fee	$ 31,000	$31,775	$32,569	$33,384	$34,218	$35,074	$35,950	$36,849	$37,770	$38,715	$43,802	$49,558
15	WH Tap Fee	$ 26,000	$26,650	$27,316	$27,999	$28,699	$29,417	$30,152	$30,906	$31,678	$32,470	$36,737	$41,565
	Annual Revenues												
16	Monthly Base Charge Revenue	$ 3,423,798	$ 3,614,675	$ 3,816,193	$ 4,028,945	$ 6,311,711	$ 6,635,001	$ 6,455,820	$ 6,267,292	$ 6,068,934	$ 5,860,242	$ 4,642,585	$ 795,845
17	Annual Service Charge Revenue	$ 1,369,519	$ 1,445,870	$ 1,526,477	$ 1,611,578	$ 2,524,684	$ 2,634,486	$ 2,689,925	$ 2,747,027	$ 2,805,843	$ 2,866,423	$ 3,197,699	$ 3,581,303
18	Interest		$ 10,561	$ 8,368	$ 432,728	$ 13,441	$ 31,633	$ 48,298	$ 58,659	$ 66,590	$ 71,936	$ 53,542	$ 39,872
19	**SUBTOTAL SERVICE CHARGE REVENUES**	$4,793,317	$5,071,105	$5,351,038	$6,073,252	$8,849,836	$9,301,120	$9,194,043	$9,072,978	$8,941,367	$8,798,602	$7,893,826	$4,417,020
20	Tap Fee (Existing OS Connections)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
21	Tap Fee (Existing CL Connections)	$ -	$ -	$ -	$ -	$ -							
22	Tap Fee (New OS Connections)	$ 1,143,887	$ 315,430	$ 333,015	$ 351,581	$ 371,181	$ 391,875	$ 413,722	$ 436,787	$ 461,138	$ 486,846	$ 638,553	$ 837,534
23	Tap Fee (New CL Connections)	$ 674,610	$ 186,026	$ 196,396	$ 207,346	$ 218,905	$ 231,109	$ 243,993	$ 257,596	$ 271,957	$ 287,119	$ 376,588	$ 493,938
24	Tap Fee Rev (Exist MS Connections)	$ -	$ -	$ -									
25	Tap Fee Rev (New MS Connections)		$ 244,204	$ 257,818	$ 272,192	$ 287,366	$ 303,387	$ 320,301	$ 338,158	$ 357,010	$ 376,913	$ 494,364	$ 648,414
26	Tap Fee Rev (CV Connections)			$2,344,995	$ -	$ 73,911	$ 78,032	$ 82,382	$ 86,975	$ 91,824	$ 96,943	$ 127,152	$ 140,068
27	Tap Fee Rev (OH Connections)			$3,615,201	$ -	$ 68,436	$ -	$ -	$ -	$ -	$ -	$ -	$ -
28	Tap Fee Rev (WH Connections)			$22,508,590	$ -	$ 709,443	$ 272,986	$ -	$ -	$ -	$ -	$ -	$ -
29	**SUBTOTAL TAP FEE REVENUES**	$1,818,497	$745,659	$29,256,016	$831,118	$1,729,243	$1,277,389	$1,060,398	$1,119,515	$1,181,928	$1,247,821	$1,636,657	$2,119,954
30	**TOTAL REVENUES**	$6,611,814	$5,816,765	$34,607,053	$6,904,370	$10,579,079	$10,578,509	$10,254,441	$10,192,494	$10,123,295	$10,046,423	$9,530,483	$6,536,974
	Annual Operation Expenses												
31	O & M New Plant and Facilities	$1,369,519	$1,424,711	$1,482,127	$1,541,856	$2,700,111	$2,784,419	$2,864,574	$2,947,639	$3,033,727	$3,122,958	$3,620,744	$4,217,380
32	Capital Reserve Fund			$296,000	$308,000	$540,000	$557,000	$573,000	$590,000	$607,000	$625,000	$724,000	$843,000
33	**SUBTOTAL OPERATION EXPENSES**	$1,369,519	$1,424,711	$1,778,127	$1,849,856	$3,240,111	$3,341,419	$3,437,574	$3,537,639	$3,640,727	$3,747,958	$4,344,744	$5,060,380
	Existing and New Debt												
34	Debt Service for Phase 1 WWTP	$4,538,240	$4,538,240	$4,538,240	$4,538,240	$4,538,240	$4,538,240	$4,538,240	$4,538,240	$4,538,240	$4,538,240	$4,538,240	$0
35	Debt Service for Phase 2 WWTP	$ -	$ -		$28,468,786	$ 1,587,888	$ 1,587,888	$ 1,587,888	$ 1,587,888	$ 1,587,888	$ 1,587,888	$ 1,587,888	
36	Debt Service for Phase 3 WWTP	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,427,252	$ 1,427,252
37	**SUBTOTAL EXISTING AND NEW DEBT**	$4,538,240	$4,538,240	$4,538,240	$33,007,025	$6,126,127	$6,126,127	$6,126,127	$6,126,127	$6,126,127	$6,126,127	$7,553,380	$1,427,252
38	**TOTAL EXPENSE**	$5,907,759	$5,962,951	$6,316,366	$34,856,882	$9,366,238	$9,467,546	$9,563,701	$9,663,766	$9,766,855	$9,874,086	$11,898,123	$6,487,632
39	**Net Profit/Loss**	**$ 704,055**	**($146,186)**	**$28,290,687**	**($27,952,512)**	**$1,212,841**	**$1,110,963**	**$690,739**	**$528,728**	**$356,441**	**$172,337**	**($2,367,640)**	**$49,342**
40	**Accumulated Cash Flow Balance**	**$ 704,055**	**$ 557,869**	**$28,848,556**	**$896,044**	**$2,108,885**	**$3,219,848**	**$3,910,587**	**$4,439,315**	**$4,795,755**	**$4,968,092**	**$1,201,809**	**$2,707,480**
41	**Days Cash on Hand**	**188**	**143**	**5922**	**177**	**238**	**352**	**415**	**458**	**481**	**484**	**101**	**195**

TABLE 2-22: ANNUAL O&M COSTS

OPTION 4 - OCEAN SANDS, COROLLA LIGHT, WHALEHEAD, COROLLA VILLAGE, OCEAN HILL - MODERATE GROWTH

COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK OUTER BANKS

Operational Year #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**15**	**20**
Fiscal Year	**FY 14**	**FY 15**	**FY 16**	**FY 17**	**FY 18**	**FY 19**	**FY 20**	**FY 21**	**FY 22**	**FY 23**	**FY 28**	**FY 33**
Summer Monthly Demand (gpd)	876,546	902,843	929,928	957,826	1,608,089	1,644,588	1,676,448	1,709,263	1,743,063	1,777,877	1,968,254	2,188,629
Annual Demand (gallons)	131,481,939	135,426,397	139,489,189	143,673,865	241,213,281	246,688,235	251,467,182	256,389,498	261,459,483	266,681,567	295,238,066	328,294,376
Unit WWTP O&M Costs ($/1000 gals)	$8.00	$8.08	$8.16	$8.24	$8.32	$8.41	$8.49	$8.58	$8.66	$8.75	$9.20	$9.66
Annual WWTP O&M	$1,051,856	$1,094,245	$1,138,343	$1,184,219	$2,008,060	$2,074,175	$2,135,500	$2,199,074	$2,264,985	$2,333,326	$2,714,948	$3,172,923
Collection System O&M	-	-	-	-	$183,000	$187,575	$192,264	$197,071	$201,998	$207,048	$234,255	$265,039
Total O&M New Plant and Facilities	**$1,051,856**	**$1,094,245**	**$1,138,343**	**$1,184,219**	**$2,191,060**	**$2,261,750**	**$2,327,764**	**$2,396,145**	**$2,466,983**	**$2,540,373**	**$2,949,204**	**$3,437,962**

TABLE 2-23: CASH FLOW PROJECTION
OPTION 4 - OCEAN SANDS, COROLLA LIGHT, WHALEHEAD, COROLLA VILLAGE, OCEAN HILL - MODERATE GROWTH
COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK OUTER BANKS

	Operational Year #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**15**	**20**
	Fiscal Year	**FY 15**	**FY 16**	**FY 17**	**FY 18**	**FY 19**	**FY 20**	**FY 21**	**FY 22**	**FY 23**	**FY 24**	**FY 29**	**FY 34**
	Sewer Rate and Sales Information												
1	Monthly Base Charge	$ 125	$128.13	$131.33	$135.00	$130.00	$125.00	$120.00	$115.00	$110.00	$105.00	$80.00	$5.00
2	Service Charge ($/1000 gals)	$8.00	$8.20	$8.41	$8.62	$9.00	$9.00	$9.00	$9.00	$9.00	$9.00	$9.00	$9.00
3	Average Monthly Sewer Bill	$165.80	$169.95	$174.19	$178.94	$175.90	$170.90	$165.90	$160.90	$155.90	$150.90	$125.90	$50.90
4	Projected Annual Flow (1000s gals)	131,482	135,426	139,489	143,674	241,213	246,688	251,467	256,389	261,459	266,682	295,238	328,294
5	Projected Total Connections (ERC)	1,461	1,505	1,550	1,596	2,680	2,741	2,794	2,849	2,905	2,963	3,280	3,648
6	Ocean Sands New Connections (ERCs)	109	29	30	31	32	33	34	35	36	37	43	50
7	Corolla Light New Connections (ERCs)	54	15	15	15	16	16	17	17	18	18	21	25
8	CV Connections	0	0	0	0	74	2	2	2	2	3	3	0
9	OH Connections	0	0	0	0	113	0	0	0	0	0	0	0
10	Whalehead Connections	0	0	0	0	849	9	0	0	0	0	0	0
11	New OS Tap Fee	$ 17,000	$17,425	$17,861	$18,307	$18,765	$19,234	$19,715	$20,208	$20,713	$21,231	$24,021	$27,177
12	New CL Tap Fee	$ 19,000	$19,475	$19,962	$20,461	$20,972	$21,497	$22,034	$22,585	$23,150	$23,728	$26,847	$30,374
13	New CV/OH Tap Fee	$ 31,000	$31,775	$32,569	$33,384	$34,218	$35,074	$35,950	$36,849	$37,770	$38,715	$43,802	$49,558
14	New WH Tap Fee	$ 31,000	$31,775	$32,569	$33,384	$34,218	$35,074	$35,950	$36,849	$37,770	$38,715	$43,802	$49,558
	Annual Revenues												
15	Monthly Base Charge Revenue	$ 2,191,366	$ 2,313,534	$ 2,442,514	$ 2,586,130	$ 4,181,030	$ 4,111,471	$ 4,023,475	$ 3,931,306	$ 3,834,739	$ 3,733,542	$ 3,149,206	$ 218,863
16	Annual Service Charge Revenue	$ 1,051,856	$ 1,110,496	$ 1,172,407	$ 1,237,768	$ 2,170,920	$ 2,220,194	$ 2,263,205	$ 2,307,505	$ 2,353,135	$ 2,400,134	$ 2,657,143	$ 2,954,649
17	Interest		$ 25,626	$ 22,453	$ 18,678	$ 17,858	$ 9,063	$ 19,401	$ 24,026	$ 27,721	$ 30,426	$ 27,059	$ 79,060
18	**SUBTOTAL SERVICE CHARGE REVENUES**	$3,243,221	$3,449,656	$3,637,373	$3,842,575	$6,369,808	$6,340,728	$6,306,080	$6,262,837	$6,215,595	$6,164,102	$5,833,407	$3,252,572
19	Tap Fee (Existing OS Connections)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
20	Tap Fee (Existing CL Connections)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
21	Tap Fee (New OS Connections)	$1,852,008	$510,696	$539,168	$569,226	$600,961	$634,464	$669,835	$707,179	$746,604	$788,227	$1,033,848	$1,356,008
22	Tap Fee (New CL Connections)	$1,025,407	$282,759	$298,523	$315,165	$332,736	$351,286	$370,870	$391,546	$413,375	$436,420	$572,414	$750,785
23	Tap Fee Rev (CV Connections)				$0	$2,537,622	$78,032	$82,382	$86,975	$91,824	$96,943	$127,152	$0
24	Tap Fee Rev (OH Connections)				$0	$3,866,657	$0	$0	$0	$0	$0	$0	$0
25	Tap Fee Rev (WH Connections)				$0	$29,041,670	$325,484	$0	$0	$0	$0	$0	$0
26	**SUBTOTAL TAP FEE REVENUES**	$2,877,415	$793,455	$837,690	$884,391	$36,379,645	$1,389,265	$1,123,087	$1,185,700	$1,251,802	$1,321,590	$1,733,414	$2,106,793
27	**TOTAL REVENUES**	$6,120,636	$4,243,111	$4,475,063	$4,726,967	$42,749,452	$7,729,993	$7,429,168	$7,448,536	$7,467,397	$7,485,692	$7,566,821	$5,359,366
	Annual Operation Expenses												
28	O & M New Plant and Facilities	$1,051,856	$1,094,245	$1,138,343	$1,184,219	$2,191,060	$2,261,750	$2,327,764	$2,396,145	$2,466,983	$2,540,373	$2,949,204	$3,437,962
29	Capital Reserve Fund			$228,000	$237,000	$438,000	$452,000	$466,000	$479,000	$493,000	$508,000	$590,000	$688,000
30	**SUBTOTAL OPERATION EXPENSES**	$1,051,856	$1,094,245	$1,366,343	$1,421,219	$2,629,060	$2,713,750	$2,793,764	$2,875,145	$2,959,983	$3,048,373	$3,539,204	$4,125,962
	Existing and New Debt												
31	Debt Service for Phase 1 WWTP	$3,360,398	$3,360,398	$3,360,398	$3,360,398	$3,360,398	$3,360,398	$3,360,398	$3,360,398	$3,360,398	$3,360,398	$3,360,398	$0
32	Debt Service for Phase 2 WWTP	$ -	$ -	$ -	$ -	$ 37,346,313	$ 966,668	$ 966,668	$ 966,668	$ 966,668	$ 966,668	$ -	
33	Debt Service for Phase 3 WWTP	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 854,064	$ 854,064
34	**SUBTOTAL EXISTING AND NEW DEBT**	$3,360,398	$3,360,398	$3,360,398	$3,360,398	$40,706,711	$4,327,066	$4,327,066	$4,327,066	$4,327,066	$4,327,066	$4,214,462	$854,064
35	**TOTAL EXPENSE**	$4,412,254	$4,454,644	$4,726,742	$4,781,617	$43,335,771	$7,040,816	$7,120,831	$7,202,211	$7,287,049	$7,375,440	$7,753,666	$4,980,025
36	**Net Gain/Loss**	**$1,708,382**	**($211,532)**	**($251,678)**	**($54,650)**	**($586,319)**	**$689,177**	**$308,337**	**$246,325**	**$180,348**	**$110,252**	**($186,845)**	**$379,340**
37	**Accumulated Cash Flow Balance**	**$1,708,382**	**$1,496,850**	**$1,245,172**	**$1,190,522**	**$604,203**	**$1,293,379**	**$1,601,716**	**$1,848,042**	**$2,028,389**	**$2,138,642**	**$1,617,059**	**$5,650,012**
38	**Days Cash on Hand**	**593**	**499**	**333**	**306**	**84**	**174**	**209**	**235**	**250**	**256**	**167**	**500**

TABLE 2-25: ANNUAL O&M COSTS
OPTION 4 - OCEAN SANDS, COROLLA LIGHT, WHALEHEAD, COROLLA VILLAGE, OCEAN HILL - LOW GROWTH
COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK OUTER BANKS

Operational Year #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**15**	**20**
Fiscal Year	**FY 14**	**FY 15**	**FY 16**	**FY 17**	**FY 18**	**FY 19**	**FY 20**	**FY 21**	**FY 22**	**FY 23**	**FY 28**	**FY 33**
Summer Monthly Demand (gpd)	826,590	838,989	851,574	864,347	1,490,776	1,512,121	1,531,603	1,545,838	1,560,286	1,574,951	1,651,644	1,734,264
Annual Demand (gallons)	123,988,490	125,848,317	127,736,042	129,652,083	223,616,464	226,818,161	229,740,375	231,875,631	234,042,915	236,242,709	247,746,642	260,139,646
Unit WWTP O&M Costs ($/1000 gals)	$8.00	$8.08	$8.16	$8.24	$8.32	$8.41	$8.49	$8.58	$8.66	$8.75	$9.20	$9.66
Annual WWTP O&M	$991,908	$1,016,854	$1,042,428	$1,068,645	$1,861,570	$1,907,105	$1,950,992	$1,988,816	$2,027,480	$2,067,001	$2,278,227	$2,514,216
Collection System O&M	-	-	-	-	$183,000	$187,575	$192,264	$197,071	$201,998	$207,048	$234,255	$265,039
Total O&M New Plant and Facilities	**$991,908**	**$1,016,854**	**$1,042,428**	**$1,068,645**	**$2,044,570**	**$2,094,680**	**$2,143,257**	**$2,185,887**	**$2,229,477**	**$2,274,049**	**$2,512,482**	**$2,779,255**

TABLE 2-26: CASH FLOW PROJECTION
OPTION 4 - OCEAN SANDS, COROLLA LIGHT, WHALEHEAD, COROLLA VILLAGE, OCEAN HILL - LOW GROWTH
COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK OUTER BANKS

	Operational Year #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**15**	**20**
	Fiscal Year	**FY 15**	**FY 16**	**FY 17**	**FY 18**	**FY 19**	**FY 20**	**FY 21**	**FY 22**	**FY 23**	**FY 24**	**FY 29**	**FY 34**
	Sewer Rate and Sales Information												
1	Monthly Base Charge	$ 165	$169	$173	$178	$171	$163	$155	$147	$139	$131	$91	$10
2	Service Charge ($/1000 gals)	$8.00	$8.20	$8.41	$8.62	$9.00	$9.00	$9.00	$9.00	$9.00	$9.00	$9.00	$9.00
3	Average Monthly Sewer Bill	$205.80	$210.95	$216.22	$221.62	$216.59	$208.59	$200.59	$192.59	$184.59	$176.59	$136.59	$55.90
4	Projected Annual Flow (1000s gals)	123,988	125,848	127,736	129,652	223,616	226,818	229,740	231,876	234,043	236,243	247,747	260,140
5	Projected Total Connections (ERC)	1,378	1,398	1,419	1,441	2,485	2,520	2,553	2,576	2,600	2,625	2,753	2,890
6	Ocean Sands New Connections (ERCs)	53	14	14	14	14	15	15	15	15	16	17	18
7	Corolla Light New Connections (ERCs)	26	7	7	7	7	7	7	7	8	8	8	9
8	CV Connections	0	0	0	0	73	1	1	1	1	1	1	1
9	OH Connections	0	0	0	0	113	0	0	0	0	0	0	0
10	Whalehead Connections	0	0	0	0	836	13	9	0	0	0	0	0
11	New OS Tap Fee	$ 17,000	$17,425	$17,861	$18,307	$18,765	$19,234	$19,715	$20,208	$20,713	$21,231	$24,021	$27,177
12	New CL Tap Fee	$ 19,000	$19,475	$19,962	$20,461	$20,972	$21,497	$22,034	$22,585	$23,150	$23,728	$26,847	$30,374
13	New CV/OH Tap Fee	$ 31,000	$31,775	$32,569	$33,384	$34,218	$35,074	$35,950	$36,849	$37,770	$38,715	$43,802	$49,558
14	New WH Tap Fee	$ 31,000	$31,775	$32,569	$33,384	$34,218	$35,074	$35,950	$36,849	$37,770	$38,715	$43,802	$49,558
	Annual Revenues												
15	Monthly Base Charge Revenue	$ 2,727,747	$ 2,837,880	$ 2,952,459	$ 3,071,664	$ 5,089,122	$ 4,920,047	$ 4,738,378	$ 4,535,084	$ 4,327,827	$ 4,116,512	$ 2,995,652	$ 346,853
16	Annual Service Charge Revenue	$ 991,908	$ 1,031,956	$ 1,073,621	$ 1,116,969	$ 2,012,548	$ 2,041,363	$ 2,067,663	$ 2,086,881	$ 2,106,386	$ 2,126,184	$ 2,229,720	$ 2,341,257
17	Interest		$ 11,613	$ 9,787	$ 7,001	$ 6,364	$ 19,820	$ 37,905	$ 51,645	$ 57,466	$ 60,082	$ 21,204	$ 27,897
18	**SUBTOTAL SERVICE CHARGE REVENUES**	$3,719,655	$3,881,448	$4,035,868	$4,195,635	$7,108,034	$6,981,231	$6,843,947	$6,673,610	$6,491,679	$6,302,778	$5,246,576	$2,716,007
19	Tap Fee (Existing OS Connections)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
20	Tap Fee (Existing CL Connections)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
21	Tap Fee (New OS Connections)	$905,481	$240,795	$250,517	$260,632	$271,155	$282,103	$293,493	$305,343	$317,671	$330,497	$402,825	$490,983
22	Tap Fee (New CL Connections)	$501,340	$133,322	$138,705	$144,305	$150,131	$156,193	$162,499	$169,060	$175,886	$182,987	$223,034	$271,844
23	Tap Fee Rev (CV Connections)				$0	$2,500,666	$38,448	$40,000	$41,615	$43,295	$45,043	$54,901	$66,916
24	Tap Fee Rev (OH Connections)				$0	$3,866,657	$0	$0	$0	$0	$0	$0	$0
25	Tap Fee Rev (WH Connections)				$0	$28,618,733	$440,013	$326,955	$0	$0	$0	$0	$0
26	**SUBTOTAL TAP FEE REVENUES**	$1,406,821	$374,117	$389,222	$404,937	$35,407,342	$916,756	$822,947	$516,018	$536,852	$558,527	$680,760	$829,743
27	**TOTAL REVENUES**	$5,126,475	$4,255,565	$4,425,090	$4,600,571	$42,515,376	$7,897,988	$7,666,894	$7,189,627	$7,028,531	$6,861,306	$5,927,335	$3,545,749
	Annual Operation Expenses												
28	O & M New Plant and Facilities	$991,908	$1,016,854	$1,042,428	$1,068,645	$2,044,570	$2,094,680	$2,143,257	$2,185,887	$2,229,477	$2,274,049	$2,512,482	$2,779,255
29	Capital Reserve Fund			$208,000	$214,000	$409,000	$419,000	$429,000	$437,000	$446,000	$455,000	$502,000	$556,000
30	**SUBTOTAL OPERATION EXPENSES**	$991,908	$1,016,854	$1,250,428	$1,282,645	$2,453,570	$2,513,680	$2,572,257	$2,622,887	$2,675,477	$2,729,049	$3,014,482	$3,335,255
	Existing and New Debt												
31	Debt Service for Phase 1 WWTP	$3,360,398	$3,360,398	$3,360,398	$3,360,398	$3,360,398	$3,360,398	$3,360,398	$3,360,398	$3,360,398	$3,360,398	$3,360,398	$0
32	Debt Service for Phase 2 WWTP	$ -	$ -	$ -	$ -	$ 35,804,316	$ 818,260	$ 818,260	$ 818,260	$ 818,260	$ 818,260	$ -	
33	Debt Service for Phase 3 WWTP	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
34	**SUBTOTAL EXISTING AND NEW DEBT**	$3,360,398	$3,360,398	$3,360,398	$3,360,398	$39,164,714	$4,178,658	$4,178,658	$4,178,658	$4,178,658	$4,178,658	$3,360,398	$0
35	**TOTAL EXPENSE**	$4,352,306	$4,377,253	$4,610,827	$4,643,044	$41,618,284	$6,692,339	$6,750,915	$6,801,546	$6,854,136	$6,907,707	$6,374,881	$3,335,255
36	**Net Gain/Loss**	**$774,169**	**($121,687)**	**($185,737)**	**($42,472)**	**$897,092**	**$1,205,649**	**$915,979**	**$388,081**	**$174,395**	**($46,402)**	**($447,545)**	**$210,494**
37	**Accumulated Cash Flow Balance**	**$774,169**	**$652,482**	**$466,745**	**$424,273**	**$1,321,365**	**$2,527,014**	**$3,442,994**	**$3,831,075**	**$4,005,470**	**$3,959,069**	**$966,062**	**$2,070,292**
38	**Days Cash on Hand**	**285**	**234**	**136**	**121**	**197**	**367**	**489**	**533**	**546**	**530**	**117**	**227**

3. Rate Evaluations – Public/Private Partnership

3.1 Description of Public/Private Partnership

Currituck Utilities, LLC and its affiliate, Outer Banks Ventures, Inc. (OBV) have proposed a public/private partnership (PPP) with Currituck County for the Regional Outer Banks WWTP. OBV and Currituck Utilities would be responsible for all engineering, construction, and financing of the regional WWTP, including reject storage, wastewater treatment, and effluent disposal. Some limited wastewater collection infrastructure from the existing Ocean Sands WWTP to convey Ocean Sands flows to the regional WWTP would be included. OBV would provide green space, and access to several ponds in Corolla Light for groundwater disposal.

Currituck County would be responsible for operations and maintenance of the regional WWTP. Under the preliminary terms of the PPP, OBV would lease the wastewater infrastructure to Currituck County for a 20-year term. At the end of the term Currituck County would own all wastewater infrastructure for the regional utility and have deeded rights to the land used for the WWTP, reject storage, effluent disposal, and groundwater disposal.

The OBV proposal is based on the same treatment processes and effluent standards as recommended in TM 2. It is recommended that the preliminary infrastructure layouts and preliminary information developed in this Master Plan be used in planning under the PPP approach. However, there are two main differences between what OBV proposes for the PPP and what Hazen and Sawyer recommended in TM 2.

The first difference is related to payment for land used for wastewater infrastructure for currently unsewered subdivisions. Since the unsewered areas do not have available land for wastewater management, Hazen and Sawyer included land acquisition costs for effluent disposal. Land costs were based on the acreage needed to provide the required effluent disposal capacity for each unsewered subdivision and the average cost of undeveloped land on the Currituck Southern Outer Banks. OBV proposes to reduce land costs by planning for “dual use” of property for development and for effluent disposal. OBV proposes to construct facilities above the high-rate infiltration disposal basins, such as the regional WWTP, parking garage, and potentially, retail stores. Facilities would be constructed on piles that would penetrate through the high-rate infiltration basins. This approach is unprecedented in North Carolina. Additionally, there are some concerns with this dual use approach, as follows:

- Permittability by NC Division of Water Quality (DWQ).
- Ease of operation and maintenance of high-rate infiltration basins – infiltration basins will require maintenance using heavy equipment such as front end loaders or backhoes and there is a concern over clearances and ease with which heavy equipment can be operated amongst structural foundations.
- Reduced net area for disposal – use of pilings and spread footers will reduce the net area for effluent disposal, and thus require more area.

- Structural stability – overhead structures will be supported on pile foundations. If the piles were designed as friction piles, there could be a potential for washing out of soil around the friction piles and causing settlement. If the pile foundations were supported by spread footers, then the net area for disposal could be further reduced depending on how NC DWQ views the net disposal area.

OBV applied for a non-discharge permit for a 600,000 gpd WWTP based on this concept and DWQ issued a contingent permit (Permit No. WQ0035060). DWQ required that a permit modification be submitted prior to WWTP construction, which would include geotechnical report and detailed structural design for the WWTP. DWQ also referenced the 15 foot setback required between high-rate infiltration basins and building foundations. Before DWQ would approve a variance to this requirement, it would need to be demonstrated that the support pilings would not penetrate through the surficial aquifer and that the above structures could be adequately supported while treated effluent is discharged into the basins below.

The financial terms of the PPP include the following:

- OBV will acquire the Corolla Light wastewater system from Carolina Water Service at a cost of $1,850,000.

- OBV will acquire the DeGabrielle tract for reject storage and groundwater disposal.

- Currituck County will lease the wastewater system from OBV for a period of 20 years.

- Lease payment will be based on a construction cost of $23.50 per gallon capacity for any subdivision providing its own land for effluent disposal.

- Lease payment will be based on a construction cost of $30.00 per gallon capacity for any subdivision for which OBV provides land for effluent disposal.

- Lease payment covers capital costs for wastewater treatment, reject storage, effluent pumping and conveyance, effluent disposal, groundwater management system, and disposal of groundwater. Wastewater collection from the existing Ocean Sands WWTP to the Regional WWTP is included.

- Lease payment does not include wastewater collection to new areas that do not currently have collection systems such as Ocean Sands Section G and T, Corolla Village, Ocean Hill, and Whalehead.

- Lease payment will be determined based on financing the capital improvements over 20 years at 5.5 percent interest and a cost of bond issuance at 2.5 percent.

- OBV proposed that impacts initially be set at $4,000 per ERC for Corolla Light customers and $5,300 per ERC for Ocean Sands customers. The difference in impact fee accounts for the wastewater collection system to convey Ocean Sands flows to the regional WWTP.

- OBV proposes that impact fees increase annually equal to the amount of the lease payment (i.e. so that new customers pay full financing costs for their portion of capacity allocation).

- Currituck County will be responsible for setting customer rates and fees.

3.2 Assumptions Used In the Rate Evaluation

In order to project future revenue requirements, as well as revenues to be derived from sewer rates, several assumptions were made for the rate evaluation as follows:

1. Construction costs have been escalated by 2.5 percent per year to the mid-point of construction.

2. Impact fees will be paid at the time that wastewater flow allocation is made by the County to a developer or customer.

3. Capital costs for major wastewater collection infrastructure are included. Costs for wastewater collection within a development are not included and will be borne by the developer to extend collection systems to individual customers.

4. Plant expansions will be timed so that construction will be completed when the demand equals 80 percent of the current plant capacity.

5. No grants will be obtained.

6. Lease payment is based on financing at 5.5 percent for a 20-year term with a 2.5 percent cost of bond issuance.

7. Estimated average household consumption allowance was set at 600 gallons per day (gpd) per Equivalent Residential Connection (ERC) for purposes of determining capacity requirements. Cash flow projections show the average monthly sewer bill based on an average flow of 170 gpd.

8. Cash reserves – Rates and fees were set to maintain a minimum of 90 days of operating budget.

9. Capital Reserve Fund – Provides for major capital and equipment replacement and infrastructure rehabilitation. Cash flow projections include funding of capital reserve fund beginning in third year of operation at a rate of approximately 25 percent of annual O&M costs.

10. Rate of inflation used for monthly service charges (user rates) was assumed to be 2.5 percent per year.

11. Rate of inflation for operation and maintenance costs was assumed to be 1.0 percent per year.

3.3 Operating and Maintenance Costs

Operation and maintenance costs include the costs of daily operations such items as administration, billing, engineering, operations, and maintenance. The actual O&M costs of other similar facilities were used as the basis for projecting future O&M expenses. Additional costs were added when significant additions were made to the sewer utility systems, both in plant operation costs and miles of line work associated with the sewer lines. The O&M costs were estimated at $8.00 per 1,000 gallons treated in 2011 dollars and then escalated at 1.0 percent annually to keep pace with inflation and to account for changing economies of scale.

3.4 Rate Evaluation – Option 1

3.4.1 Existing and Planned Capital Costs

The capital costs for each phase of wastewater infrastructure for Option 1 to serve Ocean Sands and Corolla Light are provided in **Table 3-1**. The escalated construction costs (to the midpoint of construction) are shown for reference. The annual lease payment to OBV for Phase 1 is $1,775,000 based on the financing terms discussed above. This lease payment covers existing Ocean Sands and Corolla Light customers as of 2011. For new customers, the lease payment increases by $1,023 per customer as shown in **Table 3-4**. The lease payment for new customers increases when Phase 2 comes online and is based on 2.5 percent per year escalation from 2011.

Capital costs are shown for wastewater collection infrastructure that would not be financed by OBV but financed separately by the County.

Table 3-1: Capital Costs and Funding – Public-Private Partnership Option 1

Description	FY Scheduled for Construction	FY 10 Construction Costs	Escalated Construction Costs	Lease Payment (per ERC)
Treatment and Disposal				
Phase 1 WWTP (1.2 mgd)	FY 2014	$22,913,000	$22,913,000	$1,023
Phase 2 WWTP (0.8 mgd expansion)	FY 2021	$18,800,000	$24,140,000	$1,313
	SUBTOTAL	**$41,713,000**	**$47,053,000**	**--**
Wastewater Collection				
Ocean Sands	FY 2014	$1,976,000	$2,162,000	--
Corolla Light	FY 2014	Costs paid by OBV/Currituck Utilities		--
	SUBTOTAL	**$1,976,000**	**$2,162,000**	**--**

3.4.2 Sewer Rates and Fees

A rate evaluation was conducted to assess user rates and impact fees required to cover the lease payment to OBV, debt service for wastewater collection infrastructure, and O&M costs. A projection of O&M costs for Option 1 is shown in **Table 3-2**, and a cash flow analysis for the 20-year period is shown in **Table 3-3**. This rate evaluation assumes a base sewer charge of $110 per month and a service charge of $8.00 per 1,000 gallons. Rates are increased by 2.5 percent each year due to inflation until FY 2019 and then are held constant at a monthly base charge of $116 and a usage charge of $8.75 per 1,000 gallons. The impact fees during Phase 1 increase by $1,023 each year to compensate for the lease payments not made on the property since FY 2015. After the construction of Phase 2, the lease payment increases to account for inflation since the construction of Phase 1. From FY 2021 forward, the impact fees increase by $1,313.

The projected monthly sewer bill and impacts fees are summarized in **Table 3-4** for the 20-year period. Average monthly sewer bills were calculated based on average wastewater flow and should represent typical non-summer monthly bill for each ERC.

Table 3-4 : Yearly Rates and Fees – Public-Private Partnership Option 1 –Moderate Growth

Fiscal Year	Average Monthly Sewer Bill	Ocean Sands Customer Impact Fee	Corolla Light Customer Impact Fee
FY 2015	$151	$5,300	$4,000
FY 2016	$155	$6,323	$5,023
FY 2017	$158	$7,346	$6,046
FY 2018	$162	$8,369	$7,069
FY 2019	$161	$9,392	$8,092
FY 2020	$161	$10,415	$9,115
FY 2021	$161	$11,438	$10,138
FY 2022	$161	$12,751	$11,451
FY 2023	$161	$14,064	$12,764
FY 2024	$161	$15,377	$14,077
FY 2029	$161	$21,942	$20,642
FY 2034	$161	$28,507	$27,207

As with the Public Utility Options 1 and 4, a low-growth scenario was evaluated for the same options as part of the Public-Private Partnership. The growth rate in wastewater flows was reduced from 3 percent to 1.5 percent. A projection of O&M costs for Option 1 – Low Growth is shown in **Table 3-5**, and a cash flow analysis for the 20-year period is shown in **Table 3-6**. The resulting average monthly bill and impacts fees are summarized in **Table 3-7**, below.

Table 3-7 : Yearly Rates and Fees – Public-Private Partnership Option 1 – Low Growth

Fiscal Year	Average Monthly Sewer Bill	Ocean Sands Customer Impact Fee	Corolla Light Customer Impact Fee
FY 2015	$161	$5,300	$4,000
FY 2016	$165	$6,323	$5,023
FY 2017	$169	$7,346	$6,046
FY 2018	$171	$8,369	$7,069
FY 2019	$171	$9,392	$8,092
FY 2020	$171	$10,415	$9,115
FY 2021	$171	$11,438	$10,138
FY 2022	$171	$12,751	$11,451
FY 2023	$171	$14,064	$12,764
FY 2024	$171	$15,377	$14,077
FY 2029	$171	$21,942	$20,642
FY 2034	$171	$28,507	$27,207

3.5 Rate Evaluation – Option 4

3.5.1 Existing and Planned Capital Costs

The capital costs for each phase of wastewater infrastructure for Option 1 to serve Ocean Sands, Corolla Light, Corolla Village, Ocean Hill, and Whalehead are shown in **Table 3-8**. The escalated construction costs (to the midpoint of construction) are shown for reference. The annual lease payment to OBV for Phase 1 is $1,775,000 based on the financing terms discussed above. This lease payment covers existing Ocean Sands and Corolla Light customers as of 2011. For new customers, the lease payment increases by $1,023 per customer as shown in **Table 3-11**. The lease payment for new customers increases when subsequent phases come online based on 2.5 percent per year escalation from 2011. Capital costs are shown for wastewater collection infrastructure that would not be financed by OBV but would be financed separately by the County.

Table 3-8: Capital Costs and Funding – Public-Private Partnership Option 4

Description	FY Scheduled for Construction	FY 10 Construction Costs	Escalated Construction Costs	Lease Payment Per ERC
Treatment and Disposal				
Phase 1 WWTP (1.2 mgd)	FY 2014	$22,913,000	$22,913,000	$1,023
Phase 2 WWTP (1.0mgd expansion)	FY 2018	$27,740,000	$33,882,000	$1,249
Phase 3 WWTP (0.5 mgd expansion)	FY 2024	$10,702,000	$15,187,000	$1,451
	SUBTOTAL	**$61,355,000**	**$71,981,000**	**--**
Wastewater Collection				
Ocean Sands	FY 2013	$1,976,000	$2,162,000	--
Corolla Light	FY 2013	Costs paid by OBV/Currituck Utilities		--
Corolla Village and Ocean Hill	FY 2013	$3,352,000	$3,667,000	--
Whalehead	FY 2013	$8,168,000	$8,937,000	--
	SUBTOTAL	**$13,496,000**	**$14,766,000**	**--**

3.5.2 Sewer Rates and Fees

A rate evaluation was conducted to assess user rates and impact fees required to cover the lease payment to OBV, debt service for wastewater collection infrastructure, and O&M costs. A

projection of O&M costs for Option 4 is provided in **Table 3-9**, and a cash flow analysis for the 20-year period is provided in **Table 3-10**.

This rate evaluation assumes a monthly base charge of $122 and a service charge of $8.00 per 1,000 gallons. These values will increase with inflation. The impact fees for new customers during Phase 1 increase by $1,023 each year to account for financing costs of the wastewater capacity. During Phase 2, the lease payment increases to $1,249 per ERC for new customers. The impact fee therefore increases $1,249 every year from FY 2018 to FY 2023. During Phase 3, the lease payment is $1,451 per ERC and the impact fee therefore increases $1,451 every year from FY 2023 forward. The Phase 2 and 3 lease payments were escalated from the original lease payment of $1,023 based on a 2.5 percent inflation rate from FY 2015 until the end of construction for each phase.

The projected monthly sewer bill and impacts fees are summarized in **Table 3-11** for the 20-year period. Monthly sewer bills were calculated based on average wastewater flow and should represent typical non-summer monthly bill for each ERC.

Table 3-11: Yearly Rates and Fees – Public-Private Partnership Option 4 – Moderate Growth

Fiscal Year	Average Monthly Sewer Bill	Ocean Sands Customer Impact Fee	Corolla Light Customer Impact Fee	Corolla Village/Ocean Hill Customer Impact Fee	Whalehead Customer Impact Fee
FY 2015	$166	$5,300	$4,000	$18,700	$13,100
FY 2016	$170	$6,323	$5,023	$19,723	$14,123
FY 2017	$174	$7,346	$6,046	$20,746	$15,146
FY 2018	$179	$8,369	$7,069	$21,769	$16,169
FY 2019	$183	$9,619	$8,319	$23,019	$17,419
FY 2020	$160	$10,869	$9,569	$24,269	$18,669
FY 2021	$160	$12,119	$10,819	$25,519	$19,919
FY 2022	$160	$13,369	$12,069	$26,769	$21,169
FY 2023	$160	$14,619	$13,319	$28,019	$22,419
FY 2024	$160	$15,869	$14,569	$29,269	$23,669
FY 2029	$160	$23,119	$21,819	$36,519	$30,919
FY 2034	$160	$30,369	$29,069	$43,769	$38,169

A low-growth scenario was also evaluated to assess impact of 1.5 percent per annum growth rate. With fewer new connections each year, the monthly base charge must be increased to cover the rent payments to OBV. A projection of O&M costs for Option 4 – Low Growth is shown in **Table 3-12**, and a cash flow analysis for the 20-year period is shown in **Table 3-13**. The resulting monthly sewer bills and impact fees are summarized below in **Table 3-14**.

Table 3-14: Yearly Rates and Fees – Public-Private Partnership Option 4 – Low Growth

Fiscal Year	Average Monthly Sewer Bill	Ocean Sands Customer Impact Fee	Corolla Light Customer Impact Fee	Corolla Village/Ocean Hill Customer Impact Fee	Whalehead Customer Impact Fee
FY 2015	$189	$5,300	$4,000	$18,700	$13,100
FY 2016	$194	$6,323	$5,023	$19,723	$14,123
FY 2017	$198	$7,346	$6,046	$20,746	$15,146
FY 2018	$203	$8,369	$7,069	$21,769	$16,169
FY 2019	$208	$9,619	$8,319	$23,019	$17,419
FY 2020	$168	$10,869	$9,569	$24,269	$18,669
FY 2021	$168	$12,119	$10,819	$25,519	$19,919
FY 2022	$168	$13,369	$12,069	$26,769	$21,169
FY 2023	$168	$14,619	$13,319	$28,019	$22,419
FY 2024	$168	$15,869	$14,569	$29,269	$23,669
FY 2029	$168	$23,119	$21,819	$36,519	$30,919
FY 2034	$168	$30,369	$29,069	$43,769	$38,169

TABLE 3-2: ANNUAL O&M COSTS
PUBLIC PRIVATE PARTNERSHIP OPTION 1 - OCEAN SANDS AND COROLLA LIGHT - MODERATE GROWTH
COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK OUTER BANKS

Operational Year #	1	2	3	4	5	6	7	8	9	10	15	20
Fiscal Year	FY 15	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 29	FY 34
Summer Monthly Demand (gpd)	779,000	802,370	826,441	851,234	876,771	903,075	930,167	958,072	986,814	1,016,418	1,178,307	1,365,981
Annual Demand (gallons)	116,850,000	120,355,500	123,966,165	127,685,150	131,515,704	135,461,176	139,525,011	143,710,761	148,022,084	152,462,747	176,746,109	204,897,182
Unit WWTP O&M Costs ($/1000 gals)	$8.00	$8.08	$8.16	$8.24	$8.32	$8.41	$8.49	$8.58	$8.66	$8.75	$9.20	$9.66
Annual WWTP O&M	$934,800	$972,472	$1,011,663	$1,052,433	$1,094,846	$1,138,968	$1,184,869	$1,232,619	$1,282,294	$1,333,970	$1,625,321	$1,980,305
Collection System O&M	-	-	-	-	-	-	-	-	-	-	-	-
Total O&M New Plant and Facilities	**$934,800**	**$972,472**	**$1,011,663**	**$1,052,433**	**$1,094,846**	**$1,138,968**	**$1,184,869**	**$1,232,619**	**$1,282,294**	**$1,333,970**	**$1,625,321**	**$1,980,305**

TABLE 3-3: CASH FLOW PROJECTION
PUBLIC PRIVATE PARTNERSHIP OPTION 1 - OCEAN SANDS AND COROLLA LIGHT - MODERATE GROWTH
COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK OUTER BANKS

	Operational Year #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**15**	**20**
		FY 15	**FY 16**	**FY 17**	**FY 18**	**FY 19**	**FY 20**	**FY 21**	**FY 22**	**FY 23**	**FY 24**	**FY 29**	**FY 34**
	Sewer Rate and Sales Information												
1	Base Sewer Charge ($/mo)	$ 110.00	$ 112.75	$ 115.57	$ 118.46	$ 116.00	$ 116.00	$ 116.00	$ 116.00	$ 116.00	$ 116.00	$ 116.00	$ 116.00
2	Service Charge ($/1000 gals)	$ 8.00	$8.20	$8.41	$8.62	$8.75	$8.75	$8.75	$8.75	$8.75	$8.75	$8.75	$8.75
3	Average Monthly Sewer Bill	$151	$155	$158	$162	$161	$161	$161	$161	$161	$161	$161	$161
4	Projected Annual Flow (1000s gals)	116,850	120,356	123,966	127,685	131,516	135,461	139,525	143,711	148,022	152,463	176,746	204,897
5	Projected Total Connections (ERC)	1,461	1,505	1,550	1,597	1,645	1,694	1,745	1,797	1,851	1,907	2,210	2,562
6	Ocean Sands New Connections (ERCs)	109	29	30	31	32	33	34	35	36	37	43	50
7	Corolla Light New Connections (ERCs)	54	15	15	15	16	16	17	17	18	18	21	25
8	Existing OS Connections (2011)	868											
9	Existing CL Connections (2011)	430											
10	New OS Tap Fee	$ 5,300	$ 6,323	$ 7,346	$ 8,369	$ 9,392	$ 10,415	$ 11,438	$ 12,751	$ 14,064	$ 15,377	$ 21,942	$ 28,507
11	New CL Tap Fee	$ 4,000	$ 5,023	$ 6,046	$ 7,069	$ 8,092	$ 9,115	$ 10,138	$ 11,451	$ 12,764	$ 14,077	$ 20,642	$ 27,207
	Annual Revenues												
12	Annual Base Charge Revenue	$ 1,928,897	$ 2,036,433	$ 2,149,964	$ 2,269,825	$ 2,289,408	$ 2,358,090	$ 2,428,833	$ 2,501,698	$ 2,576,749	$ 2,654,052	$ 3,076,773	$ 3,566,823
13	Annual Service Charge Revenue	$ 934,800	$ 986,915	$ 1,041,936	$ 1,100,024	$ 1,150,762	$ 1,185,285	$ 1,220,844	$ 1,257,469	$ 1,295,193	$ 1,334,049	$ 1,546,528	$ 1,792,850
14	Interest		$ 6,782	$ 7,958	$ 7,445	$ 8,226	$ 8,648	$ 9,153	$ 9,741	$ 10,399	$ 11,141	$ 15,625	$ 1,519,586
15	**SUBTOTAL SERVICE CHARGE REVENUES**	$2,863,697	$3,030,130	$3,199,858	$3,377,293	$3,448,397	$3,552,024	$3,658,830	$3,768,909	$3,882,342	$3,999,242	$4,638,927	$6,879,260
16	Tap Fee (Existing OS Connections)	$0	$0	$0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
17	Tap Fee (Existing CL Connections)	$0	$0	$0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
18	Tap Fee (New OS Connections)	$577,391	$185,316	$221,757	$260,218	$300,787	$343,556	$388,621	$446,229	$506,943	$570,899	$944,387	$1,422,366
19	Tap Fee (New CL Connections)	$215,875	$72,929	$90,416	$108,886	$128,383	$148,951	$170,638	$198,521	$227,922	$258,909	$440,123	$672,495
20	**SUBTOTAL TAP FEE REVENUES**	$793,266	$258,245	$312,173	$369,104	$429,170	$492,508	$559,259	$644,749	$734,865	$829,808	$1,384,510	$2,094,862
21	**TOTAL REVENUES**	$3,656,963	$3,288,376	$3,512,031	$3,746,397	$3,877,567	$4,044,531	$4,218,089	$4,413,658	$4,617,207	$4,829,050	$6,023,437	$8,974,121
	Annual Operation Expenses												
22	O&M New Plant and Facilities **[from Annual O&M tab]**	$934,800	$972,472	$1,011,663	$1,052,433	$1,094,846	$1,138,968	$1,184,869	$1,232,619	$1,282,294	$1,333,970	$1,625,321	$1,980,305
23	Capital Reserve Fund			$202,000	$210,000	$219,000	$228,000	$237,000	$247,000	$256,000	$267,000	$325,000	$396,000
24	**SUBTOTAL OPERATION EXPENSES**	$934,800	$972,472	$1,213,663	$1,262,433	$1,313,846	$1,366,968	$1,421,869	$1,479,619	$1,538,294	$1,600,970	$1,950,321	$2,376,305
	Debt and Lease Payments												
25	20-yr Lease Existing Customers ***[from Blueprint]***	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000
26	20-yr Lease Ph 1 New Customers **[(Line 4 - 1298)*LEASE AMT**	$167,041	$211,888	$258,080	$305,658	$354,664	$405,139	$457,129	$510,679	$565,834	$622,645	$933,309	$1,293,454
27		$1,023	$2,046	$3,069	$4,092	$5,115	$6,138	$7,161	$8,474	$9,787	$11,100	$17,665	$24,230
28	Phase 1 WWTP Impact Fees Paid to OBV	$167,041	$89,694	$138,577	$190,312	$245,027	$302,853	$363,929	$443,576	$527,675	$616,421	$1,137,245	$1,808,339
29	OS Collection System	$180,922	$180,922	$180,922	$180,922	$180,922	$180,922	$180,922	$180,922	$180,922	$180,922	$180,922	$180,922
30	**SUBTOTAL EXISTING AND NEW DEBT**	$2,270,004	$2,237,504	$2,332,579	$2,431,893	$2,535,613	$2,643,915	$2,756,980	$2,890,177	$3,029,432	$3,174,988	$4,006,476	$5,037,715
31	**TOTAL EXPENSE**	$3,204,804	$3,209,976	$3,546,242	$3,694,326	$3,849,459	$4,010,883	$4,178,849	$4,369,796	$4,567,725	$4,775,958	$5,956,797	$7,414,020
32	**Net Gain/Loss**	**$452,158**	**$78,400**	**($34,211)**	**$52,072**	**$28,108**	**$33,648**	**$39,240**	**$43,862**	**$49,481**	**$53,092**	**$66,640**	**$1,560,101**
33	**Accumulated Cash Flow Balance**	**$452,158**	**$530,558**	**$496,347**	**$548,419**	**$576,527**	**$610,175**	**$649,416**	**$693,278**	**$742,759**	**$795,851**	**$1,108,308**	**$2,932,485**
34	**Days Cash on Hand**	**177**	**199**	**179**	**190**	**192**	**196**	**200**	**205**	**211**	**218**	**249**	**541**

TABLE 3-5: ANNUAL O&M COSTS
PUBLIC PRIVATE PARTNERSHIP OPTION 1 - OCEAN SANDS AND COROLLA LIGHT - LOW GROWTH
COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK OUTER BANKS

Operational Year #	1	2	3	4	5	6	7	8	9	10	15	20
Fiscal Year	FY 15	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 29	FY 34
Summer Monthly Demand (gpd)	779,000	790,685	802,545	814,583	826,802	839,204	851,792	864,569	877,538	890,701	959,538	1,033,695
Annual Demand (gallons)	116,850,000	118,602,750	120,381,791	122,187,518	124,020,331	125,880,636	127,768,845	129,685,378	131,630,659	133,605,119	143,930,657	155,054,195
Unit WWTP O&M Costs ($/1000 gals)	$8.00	$8.08	$8.16	$8.24	$8.32	$8.41	$8.49	$8.58	$8.66	$8.75	$9.20	$9.66
Annual WWTP O&M	$934,800	$958,310	$982,412	$1,007,119	$1,032,448	$1,058,415	$1,085,034	$1,112,322	$1,140,297	$1,168,976	$1,323,557	$1,498,579
Collection System O&M	-	-	-	-	-	-	-	-	-	-	-	-
Total O&M New Plant and Facilities	**$934,800**	**$958,310**	**$982,412**	**$1,007,119**	**$1,032,448**	**$1,058,415**	**$1,085,034**	**$1,112,322**	**$1,140,297**	**$1,168,976**	**$1,323,557**	**$1,498,579**

TABLE 3-6: CASH FLOW PROJECTION
PUBLIC PRIVATE PARTNERSHIP OPTION 1 - OCEAN SANDS AND COROLLA LIGHT - LOW GROWTH
COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK OUTER BANKS

	Operational Year #	**1** **FY 15**	**2** **FY 16**	**3** **FY 17**	**4** **FY 18**	**5** **FY 19**	**6** **FY 20**	**7** **FY 21**	**8** **FY 22**	**9** **FY 23**	**10** **FY 24**	**15** **FY 29**	**20** **FY 34**
	Sewer Rate and Sales Information												
	Base Sewer Charge ($/mo)	$ 120.00	$ 123.00	$ 126.08	$ 128.00	$ 128.00	$ 128.00	$ 128.00	$ 128.00	$ 128.00	$ 128.00	$ 128.00	$ 128.00
1	Service Charge ($/1000 gals)	$ 8.00	$8.20	$8.41	$8.50	$8.50	$8.50	$8.50	$8.50	$8.50	$8.50	$8.50	$8.50
2	Average Monthly Sewer Bill	$161	$165	$169	$171	$171	$171	$171	$171	$171	$171	$171	$171
3	Projected Annual Flow (1000s gals)	116,850	118,603	120,382	122,188	124,020	125,881	127,769	129,685	131,631	133,605	143,931	155,054
4	Projected Total Connections (ERC)	1,378	1,399	1,420	1,441	1,463	1,485	1,507	1,529	1,552	1,576	1,697	1,829
5	Ocean Sands New Connections (ERCs)	53	14	14	14	14	15	15	15	15	16	17	18
6	Corolla Light New Connections (ERCs)	26	7	7	7	7	7	7	7	8	8	8	9
7	New OS Tap Fee	$ 5,300	$ 6,323	$ 7,346	$ 8,369	$ 9,392	$ 10,415	$ 11,438	$ 12,751	$ 14,064	$ 15,377	$ 21,942	$ 28,507
8	New CL Tap Fee	$ 4,000	$ 5,023	$ 6,046	$ 7,069	$ 8,092	$ 9,115	$ 10,138	$ 11,451	$ 12,764	$ 14,077	$ 20,642	$ 27,207
	Annual Revenues												
9	Annual Base Charge Revenue	$ 1,984,325	$ 2,064,442	$ 2,147,794	$ 2,213,297	$ 2,246,497	$ 2,280,194	$ 2,314,397	$ 2,349,113	$ 2,384,350	$ 2,420,115	$ 2,607,151	$ 2,808,642
10	Annual Service Charge Revenue	$ 934,800	$ 972,543	$ 1,011,809	$ 1,038,594	$ 1,054,173	$ 1,069,985	$ 1,086,035	$ 1,102,326	$ 1,118,861	$ 1,135,644	$ 1,223,411	$ 1,317,961
11	Interest		$ 4,088	$ 5,938	$ 6,049	$ 6,792	$ 7,510	$ 8,183	$ 8,823	$ 9,426	$ 9,972	$ 11,680	$ 1,509,985
12	**SUBTOTAL SERVICE CHARGE REVENUES**	$2,919,125	$3,041,073	$3,165,541	$3,257,940	$3,307,462	$3,357,689	$3,408,615	$3,460,262	$3,512,636	$3,565,731	$3,842,241	$5,636,587
13	Tap Fee (Existing OS Connections)	$0	$0	$0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
14	Tap Fee (Existing CL Connections)	$0	$0	$0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
15	Tap Fee (New OS Connections)	$282,297	$87,377	$103,037	$119,146	$135,716	$152,756	$170,277	$192,671	$215,698	$239,373	$367,968	$515,010
16	Tap Fee (New CL Connections)	$105,545	$34,386	$42,011	$49,856	$57,927	$66,228	$74,766	$85,716	$96,978	$108,558	$171,488	$243,497
17	**SUBTOTAL TAP FEE REVENUES**	$387,842	$121,764	$145,047	$169,002	$193,643	$218,985	$245,043	$278,387	$312,676	$347,931	$539,456	$758,507
18	**TOTAL REVENUES**	$3,306,967	$3,162,837	$3,310,589	$3,426,942	$3,501,104	$3,576,674	$3,653,658	$3,738,649	$3,825,312	$3,913,662	$4,381,697	$6,395,094
	Annual Operation Expenses												
19	O&M New Plant and Facilities **[from Annual O&M tab]**	$934,800	$958,310	$982,412	$1,007,119	$1,032,448	$1,058,415	$1,085,034	$1,112,322	$1,140,297	$1,168,976	$1,323,557	$1,498,579
20	Capital Reserve Fund			$196,000	$201,000	$206,000	$212,000	$217,000	$222,000	$228,000	$234,000	$265,000	$300,000
21	**SUBTOTAL OPERATION EXPENSES**	$934,800	$958,310	$1,178,412	$1,208,119	$1,238,448	$1,270,415	$1,302,034	$1,334,322	$1,368,297	$1,402,976	$1,588,557	$1,798,579
	Debt and Lease Payments												
22	20-yr Lease Existing Customers ***[from Blueprint]***	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000
23	20-yr Lease Ph 1 New Customers **[(Line 4 - 1298)*LEASE AMT**	$81,844	$102,989	$124,452	$146,236	$168,348	$190,791	$213,571	$236,692	$260,160	$283,980	$408,549	$542,745
24		$1,023	$2,046	$3,069	$4,092	$5,115	$6,138	$7,161	$8,474	$9,787	$11,100	$17,665	$24,230
25	Phase 1 WWTP Impact Fees Paid to OBV	$81,844	$42,291	$64,388	$87,138	$110,557	$134,658	$159,458	$191,525	$224,519	$258,460	$443,112	$654,763
26	OS Collection System	$180,922	$180,922	$180,922	$180,922	$180,922	$180,922	$180,922	$180,922	$180,922	$180,922	$180,922	$180,922
27	**SUBTOTAL EXISTING AND NEW DEBT**	$2,099,610	$2,081,202	$2,124,762	$2,169,297	$2,214,827	$2,261,371	$2,308,950	$2,364,139	$2,420,601	$2,478,362	$2,787,584	$3,133,430
28	**TOTAL EXPENSE**	$3,034,410	$3,039,512	$3,303,174	$3,377,416	$3,453,275	$3,531,786	$3,610,984	$3,698,462	$3,788,899	$3,881,338	$4,376,140	$4,932,009
29	**Net Gain/Loss**	**$272,558**	**$123,325**	**$7,415**	**$49,526**	**$47,829**	**$44,888**	**$42,674**	**$40,187**	**$36,414**	**$32,324**	**$5,557**	**$1,463,085**
30	**Accumulated Cash Flow Balance**	**$272,558**	**$395,882**	**$403,297**	**$452,824**	**$500,653**	**$545,541**	**$588,216**	**$628,403**	**$664,816**	**$697,140**	**$784,204**	**$2,195,404**
31	**Days Cash on Hand**	**106**	**151**	**150**	**164**	**177**	**188**	**198**	**206**	**213**	**218**	**216**	**535**

TABLE 3-9: ANNUAL O&M COSTS
PUBLIC PRIVATE PARTNERSHIP OPTION 4 - OCEAN SANDS AND COROLLA LIGHT
COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK OUTER BANKS

Operational Year #	1	2	3	4	5	6	7	8	9	10	15	20
Fiscal Year	FY 14	FY 15	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22	FY 23	FY 28	FY 33
Summer Monthly Demand (gpd)	876,546	902,843	929,928	957,826	1,608,089	1,644,588	1,676,448	1,709,263	1,743,063	1,777,877	1,968,254	2,188,629
Annual Demand (gallons)	131,481,939	135,426,397	139,489,189	143,673,865	241,213,281	246,688,235	251,467,182	256,389,498	261,459,483	266,681,567	295,238,066	328,294,376
Unit WWTP O&M Costs ($/1000 gals)	$8.00	$8.08	$8.16	$8.24	$8.32	$8.41	$8.49	$8.58	$8.66	$8.75	$9.20	$9.66
Annual WWTP O&M	$1,051,856	$1,094,245	$1,138,343	$1,184,219	$2,008,060	$2,074,175	$2,135,500	$2,199,074	$2,264,985	$2,333,326	$2,714,948	$3,172,923
Collection System O&M	-	-	-	-	183,000	184,830	186,678	188,545	190,431	192,335	202,146	212,457
Total O&M New Plant and Facilities	**$1,051,856**	**$1,094,245**	**$1,138,343**	**$1,184,219**	**$2,191,060**	**$2,259,005**	**$2,322,178**	**$2,387,619**	**$2,455,416**	**$2,525,660**	**$2,917,094**	**$3,385,380**

TABLE 3-10: CASH FLOW PROJECTION
PUBLIC PRIVATE PARTNERSHIP OPTION 4 - OCEAN SANDS, COROLLA LIGHT, WHALEHEAD, COROLLA VILLAGE, OCEAN HILL
COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK OUTER BANKS

	Operational Year #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**15**	**20**
	Fiscal Year	**FY 14**	**FY 15**	**FY 16**	**FY 17**	**FY 18**	**FY 19**	**FY 20**	**FY 21**	**FY 22**	**FY 23**	**FY 28**	**FY 33**
	Sewer Rate and Sales Information												
1	Monthly Base Charge	$ 125	$128.13	$131.33	$134.61	$137.98	$114.00	$114.00	$114.00	$114.00	$114.00	$114.00	$114.00
2	Service Charge ($/1000 gals)	$8.00	$8.20	$8.41	$8.62	$8.83	$9.00	$9.00	$9.00	$9.00	$9.00	$9.00	$9.00
3	Average Monthly Sewer Bill	$166	$170	$174	$179	$183	$160	$160	$160	$160	$160	$160	$160
4	Projected Annual Flow (1000s gals)	131,482	135,426	139,489	143,674	241,213	246,688	251,467	256,389	261,459	266,682	295,238	328,294
5	Projected Total Connections (ERC)	1,461	1,505	1,550	1,596	2,680	2,741	2,794	2,849	2,905	2,963	3,280	3,648
6	Ocean Sands New Connections (ERCs)	109	29	30	31	32	33	34	35	36	37	43	50
7	Corolla Light New Connections (ERCs)	54	15	15	15	16	16	17	17	18	18	21	25
8	CV Connections	0	0	0	0	74	2	2	2	2	3	3	0
9	OH Connections	0	0	0	0	113	0	0	0	0	0	0	0
10	Whalehead Connections	0	0	0	0	849	9	0	0	0	0	0	0
11	New OS Tap Fee	$ 5,300	$ 6,323	$ 7,346	$ 8,369	$ 9,619	$ 10,869	$ 12,119	$ 13,369	$ 14,619	$ 15,869	$ 23,119	$ 30,369
12	New CL Tap Fee	$ 4,000	$ 5,023	$ 6,046	$ 7,069	$ 8,319	$ 9,569	$ 10,819	$ 12,069	$ 13,319	$ 14,569	$ 21,819	$ 29,069
13	New CV/OH Tap Fee	$ 18,700	$ 19,723	$ 20,746	$ 21,769	$ 23,019	$ 24,269	$ 25,519	$ 26,769	$ 28,019	$ 29,269	$ 36,519	$ 43,769
14	New WH Tap Fee	$ 13,100	$ 14,123	$ 15,146	$ 16,169	$ 17,419	$ 18,669	$ 19,919	$ 21,169	$ 22,419	$ 23,669	$ 30,919	$ 38,169
	Annual Revenues												
15	Monthly Base Charge Revenue	$ 2,191,366	$ 2,313,534	$ 2,442,514	$ 2,578,684	$ 4,437,572	$ 3,749,661	$ 3,822,301	$ 3,897,120	$ 3,974,184	$ 4,053,560	$ 4,487,619	$ 4,990,075
16	Annual Service Charge Revenue	$ 1,051,856	$ 1,110,496	$ 1,172,407	$ 1,237,768	$ 2,130,035	$ 2,220,194	$ 2,263,205	$ 2,307,505	$ 2,353,135	$ 2,400,134	$ 2,657,143	$ 2,954,649
17	Interest		$ 10,731	$ 16,157	$ 19,829	$ 25,120	$ 9,514	$ 12,010	$ 13,130	$ 14,127	$ 15,009	$ 17,060	$ 1,463,381
18	**SUBTOTAL SERVICE CHARGE REVENUES**	$3,243,221	$3,434,762	$3,631,077	$3,836,281	$6,592,727	$5,979,369	$6,097,516	$6,217,756	$6,341,446	$6,468,703	$7,161,821	$9,408,105
19	Tap Fee (New OS Connections)	$577,391	$185,316	$221,757	$260,218	$308,057	$358,532	$411,759	$467,856	$526,948	$589,165	$995,045	$1,515,271
20	Tap Fee (New CL Connections)	$215,875	$72,929	$90,416	$108,886	$131,984	$156,370	$182,101	$209,234	$237,832	$267,958	$465,219	$718,520
21	Tap Fee Rev (CV Connections)				$0	$1,707,089	$53,994	$58,478	$63,183	$68,117	$73,291	$106,010	$0
22	Tap Fee Rev (OH Connections)				$0	$2,601,147	$0	$0	$0	$0	$0	$0	$0
23	Tap Fee Rev (WH Connections)				$0	$14,783,854	$173,248	$0	$0	$0	$0	$0	$0
24	**SUBTOTAL TAP FEE REVENUES**	$793,266	$258,245	$312,173	$369,104	$19,532,131	$742,145	$652,337	$740,273	$832,898	$930,414	$1,566,274	$2,233,791
25	**TOTAL REVENUES**	$4,036,487	$3,693,007	$3,943,250	$4,205,385	$26,124,858	$6,721,514	$6,749,853	$6,958,029	$7,174,344	$7,399,116	$8,728,095	$11,641,896
	Annual Operation Expenses												
26	O & M New Plant and Facilities	$1,051,856	$1,094,245	$1,138,343	$1,184,219	$2,191,060	$2,259,005	$2,322,178	$2,387,619	$2,455,416	$2,525,660	$2,917,094	$3,385,380
27	Capital Reserve Fund			$228,000	$237,000	$438,000	$452,000	$464,000	$478,000	$491,000	$505,000	$583,000	$677,000
28	**SUBTOTAL OPERATION EXPENSES**	$1,051,856	$1,094,245	$1,366,343	$1,421,219	$2,629,060	$2,711,005	$2,786,178	$2,865,619	$2,946,416	$3,030,660	$3,500,094	$4,062,380
	Debt and Lease Payments												
29	20-yr Lease Existing Customers ***[from Blueprint]***	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000
30	20-yr Lease Ph 1 New Customers **[(Line 4 - 1298)*LEASE AMT**	$166,657	$211,493	$257,673	$305,239	$1,413,937	$1,476,169	$1,530,490	$1,586,440	$1,644,069	$1,703,426	$2,028,019	$2,403,759
31	WWTP Impact Fees Paid to OBV - OS/CL	$ 1,023	$ 2,046	$ 3,069	$ 4,092	$ 5,342	$ 6,592	$ 7,842	$ 9,092	$ 10,342	$ 11,592	$ 18,842	$ 26,092
32	WWTP Impact Fees Paid to OBV - unsewered	$ 3,723	$ 4,746	$ 5,769	$ 6,792	$ 8,042	$ 9,292	$ 10,542	$ 11,792	$ 13,042	$ 14,292	$ 21,542	$ 28,792
33	Impact Fees Paid to OBV	$166,657	$89,671	$138,541	$190,263	$8,586,382	$432,073	$422,593	$503,636	$589,162	$679,365	$1,275,240	$1,946,804
34	OS Collection System	$180,895	$180,895	$180,895	$180,895	$180,895	$180,895	$180,895	$180,895	$180,895	$180,895	$180,895	$180,895
35	Collection System for Unsewered Areas	$0	$0	$0	$0	$12,600,000	$0	$0	$0	$0	$0	$0	$0
36	**SUBTOTAL EXISTING AND NEW DEBT**	$2,269,209	$2,237,058	$2,332,109	$2,431,397	$24,536,214	$3,844,137	$3,888,977	$4,025,971	$4,169,125	$4,318,686	$5,239,153	$6,286,458
37	**TOTAL EXPENSE**	$3,321,065	$3,331,303	$3,698,452	$3,852,615	$27,165,274	$6,555,141	$6,675,155	$6,891,590	$7,115,541	$7,349,347	$8,739,248	$10,348,838
38	**Net Gain/Loss**	**$715,422**	**$361,704**	**$244,798**	**$352,770**	**($1,040,416)**	**$166,373**	**$74,698**	**$66,439**	**$58,803**	**$49,769**	**($11,152)**	**$1,293,058**
39	**Accumulated Cash Flow Balance**	**$715,422**	**$1,077,126**	**$1,321,924**	**$1,674,694**	**$634,278**	**$800,651**	**$875,349**	**$941,789**	**$1,000,592**	**$1,050,361**	**$1,126,201**	**$2,251,773**
40	**Days Cash on Hand**	**248**	**359**	**353**	**430**	**88**	**108**	**115**	**120**	**124**	**127**	**117**	**202**

TABLE 3-12: ANNUAL O&M COSTS
PUBLIC PRIVATE PARTNERSHIP OPTION 4 - OCEAN SANDS AND COROLLA LIGHT - LOW GROWTH
COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK OUTER BANKS

Operational Year #	1	2	3	4	5	6	7	8	9	10	15	20
Fiscal Year	FY 14	FY 15	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22	FY 23	FY 28	FY 33
Summer Monthly Demand (gpd)	826,590	838,989	851,574	864,347	1,490,575	1,512,121	1,531,603	1,545,838	1,560,286	1,574,951	1,651,644	1,734,264
Annual Demand (gallons)	123,988,490	125,848,317	127,736,042	129,652,083	223,586,314	226,818,161	229,740,375	231,875,631	234,042,915	236,242,709	247,746,642	260,139,646
Unit WWTP O&M Costs ($/1000 gals)	$8.00	$8.08	$8.16	$8.24	$8.32	$8.41	$8.49	$8.58	$8.66	$8.75	$9.20	$9.66
Annual WWTP O&M	$991,908	$1,016,854	$1,042,428	$1,068,645	$1,861,319	$1,907,105	$1,950,992	$1,988,816	$2,027,480	$2,067,001	$2,278,227	$2,514,216
Collection System O&M	-	-	-	-	$183,000	$184,830	$186,678	$188,545	$190,431	$192,335	$202,146	$212,457
Total O&M New Plant and Facilities	**$991,908**	**$1,016,854**	**$1,042,428**	**$1,068,645**	**$2,044,319**	**$2,091,935**	**$2,137,671**	**$2,177,362**	**$2,217,910**	**$2,259,336**	**$2,480,373**	**$2,726,674**

TABLE 3-13: CASH FLOW PROJECTION

PUBLIC PRIVATE PARTNERSHIP OPTION 4 - OCEAN SANDS, COROLLA LIGHT, WHALEHEAD, COROLLA VILLAGE, OCEAN HILL - LOW GROWTH

COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK OUTER BANKS

	Operational Year #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**15**	**20**
	Fiscal Year	**FY 14**	**FY 15**	**FY 16**	**FY 17**	**FY 18**	**FY 19**	**FY 20**	**FY 21**	**FY 22**	**FY 23**	**FY 28**	**FY 33**
	Sewer Rate and Sales Information												
1	Monthly Base Charge	$148	$152	$155	$159	$163	$122	$122	$122	$122	$122	$122	$122
2	Service Charge ($/1000 gals)	$8.00	$8.20	$8.41	$8.62	$8.75	$9.00	$9.00	$9.00	$9.00	$9.00	$9.00	$9.00
3	Average Monthly Sewer Bill	$189	$194	$198	$203	$208	$168	$168	$168	$168	$168	$168	$168
4	Projected Annual Flow (1000s gals)	123,988	125,848	127,736	129,652	223,586	226,818	229,740	231,876	234,043	236,243	247,747	260,140
5	Projected Total Connections (ERC)	1,378	1,398	1,419	1,441	2,484	2,520	2,553	2,576	2,600	2,625	2,753	2,890
6	Ocean Sands New Connections (ERCs)	53	14	14	14	14	15	15	15	15	16	17	18
7	Corolla Light New Connections (ERCs)	26	7	7	7	7	7	7	7	8	8	8	9
8	CV Connections	0	0	0	0	73	1	1	1	1	1	1	1
9	OH Connections	0	0	0	0	113	0	0	0	0	0	0	0
10	Whalehead Connections	0	0	0	0	836	13	9	0	0	0	0	0
11	New OS Tap Fee	$ 5,300	$ 6,323	$ 7,346	$ 8,369	$ 9,619	$ 10,869	$ 12,119	$ 13,369	$ 14,619	$ 15,869	$ 23,119	$ 30,369
12	New CL Tap Fee	$ 4,000	$ 5,023	$ 6,046	$ 7,069	$ 8,319	$ 9,569	$ 10,819	$ 12,069	$ 13,319	$ 14,569	$ 21,819	$ 29,069
13	New CV/OH Tap Fee	$ 18,700	$ 19,723	$ 20,746	$ 21,769	$ 23,019	$ 24,269	$ 25,519	$ 26,769	$ 28,019	$ 29,269	$ 36,519	$ 43,769
14	New WH Tap Fee	$ 13,100	$ 14,123	$ 15,146	$ 16,169	$ 17,419	$ 18,669	$ 19,919	$ 21,169	$ 22,419	$ 23,669	$ 30,919	$ 38,169
	Annual Revenues												
15	Monthly Base Charge Revenue	$ 2,446,706	$ 2,545,492	$ 2,648,266	$ 2,755,190	$ 4,870,136	$ 3,689,575	$ 3,737,110	$ 3,771,844	$ 3,807,098	$ 3,842,881	$ 4,030,012	$ 4,231,605
16	Annual Service Charge Revenue	$ 991,908	$ 1,031,956	$ 1,073,621	$ 1,116,969	$ 1,956,380	$ 2,041,363	$ 2,067,663	$ 2,086,881	$ 2,106,386	$ 2,126,184	$ 2,229,720	$ 2,341,257
17	Interest		$ 11,035	$ 20,224	$ 27,910	$ 37,173	$ 9,839	$ 13,860	$ 17,177	$ 19,032	$ 20,647	$ 24,908	$ 1,470,483
18	**SUBTOTAL SERVICE CHARGE REVENUES**	$3,438,614	$3,588,484	$3,742,112	$3,900,069	$6,863,690	$5,740,778	$5,818,634	$5,875,901	$5,932,516	$5,989,713	$6,284,640	$8,043,344
19	Tap Fee (New OS Connections)	$282,297	$87,377	$103,037	$119,146	$138,996	$159,415	$180,415	$202,009	$224,210	$247,032	$387,706	$548,649
20	Tap Fee (New CL Connections)	$105,545	$34,386	$42,011	$49,856	$59,552	$69,527	$79,789	$90,342	$101,195	$112,352	$181,266	$260,161
21	Tap Fee Rev (CV Connections)				$0	$1,682,229	$26,604	$28,394	$30,231	$32,117	$34,054	$45,772	$59,099
22	Tap Fee Rev (OH Connections)				$0	$2,593,436	$8,130	$0	$0	$0	$0	$0	$0
23	Tap Fee Rev (WH Connections)				$0	$14,568,555	$234,210	$181,155	$0	$0	$0	$0	$0
24	**SUBTOTAL TAP FEE REVENUES**	$387,842	$121,764	$145,047	$169,002	$19,042,767	$497,886	$469,752	$322,582	$357,522	$393,438	$614,745	$867,909
25	**TOTAL REVENUES**	$3,826,456	$3,710,247	$3,887,159	$4,069,071	$25,906,457	$6,238,664	$6,288,386	$6,198,483	$6,290,038	$6,383,150	$6,899,385	$8,911,254
	Annual Operation Expenses												
26	O & M New Plant and Facilities	$991,908	$1,016,854	$1,042,428	$1,068,645	$2,044,319	$2,091,935	$2,137,671	$2,177,362	$2,217,910	$2,259,336	$2,480,373	$2,726,674
27	Capital Reserve Fund			$208,000	$214,000	$409,000	$418,000	$428,000	$435,000	$444,000	$452,000	$496,000	$545,000
28	**SUBTOTAL OPERATION EXPENSES**	$991,908	$1,016,854	$1,250,428	$1,282,645	$2,453,319	$2,509,935	$2,565,671	$2,612,362	$2,661,910	$2,711,336	$2,976,373	$3,271,674
	Debt and Lease Payments												
29	20-yr Lease Existing Customers ***[from Blueprint]***	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000	$1,755,000
30	20-yr Lease Ph 1 New Customers **[(Line 4 - 1298)*LEASE AMT**	$81,482	$102,622	$124,079	$145,858	$1,213,577	$1,250,312	$1,283,528	$1,307,799	$1,332,434	$1,357,438	$1,488,199	$1,629,067
31	WWTP Impact Fees Paid to OBV - OS/CL	$ 1,023	$ 2,046	$ 3,069	$ 4,092	$ 5,342	$ 6,592	$ 7,842	$ 9,092	$ 10,342	$ 11,592	$ 18,842	$ 26,092
32	WWTP Impact Fees Paid to OBV - unsewered	$ 3,723	$ 4,746	$ 5,769	$ 6,792	$ 8,042	$ 9,292	$ 10,542	$ 11,792	$ 13,042	$ 14,292	$ 21,542	$ 28,792
33	Impact Fees Paid to OBV	$81,482	$42,280	$64,371	$87,116	$8,335,202	$274,452	$282,182	$218,757	$252,140	$286,475	$499,515	$743,774
34	OS Collection System	$180,895	$180,895	$180,895	$180,895	$180,895	$180,895	$180,895	$180,895	$180,895	$180,895	$180,895	$180,895
35	Collection System for Unsewered Areas	$0	$0	$0	$0	$13,790,747	$0	$0	$0	$0	$0	$0	$0
36	**SUBTOTAL EXISTING AND NEW DEBT**	$2,098,858	$2,080,797	$2,124,345	$2,168,869	$25,275,421	$3,460,659	$3,501,605	$3,462,451	$3,520,468	$3,579,808	$3,923,610	$4,308,736
37	**TOTAL EXPENSE**	$3,090,766	$3,097,651	$3,374,773	$3,451,514	$27,728,739	$5,970,594	$6,067,275	$6,074,813	$6,182,378	$6,291,144	$6,899,982	$7,580,409
38	**Net Gain/Loss**	**$735,690**	**$612,596**	**$512,386**	**$617,557**	**($1,822,282)**	**$268,070**	**$221,111**	**$123,671**	**$107,660**	**$92,007**	**($598)**	**$1,330,844**
39	**Accumulated Cash Flow Balance**	**$735,690**	**$1,348,286**	**$1,860,672**	**$2,478,229**	**$655,947**	**$924,017**	**$1,145,128**	**$1,268,798**	**$1,376,458**	**$1,468,465**	**$1,659,924**	**$2,763,017**
40	**Days Cash on Hand**	**271**	**484**	**543**	**705**	**98**	**134**	**163**	**177**	**189**	**198**	**204**	**308**

4. Summary and Recommendations

4.1 Rate Evaluation Summary

This Comprehensive Wastewater Master Plan evaluated two options that included Monteray Shores (Options 2 and 3). These options were included to evaluate costs if the County desired to serve the Monteray Shores customers by constructing new capacity in the regional wastewater utility. However, the evaluations included herein do not account for the acquisition cost of the Monteray Shores wastewater system from Carolina Water Services Inc. The rate evaluations lead to a conclusion that serving Monteray Shores area from a regional utility is not economically viable even without consideration of acquisition costs for the private utility. Currituck County and Carolina Water Services have not negotiated transfer of the private utility to the County so the economic feasibility of the County acquiring the private utility and operating the existing wastewater infrastructure is not known at this time.

The remaining options are Option 1 (Ocean Sands and Corolla Light) and Option 4 (Ocean Sands, Corolla Light, and the unsewered areas). For these two service area options, a comparison of the rate evaluation for the public approach and the public/private partnership are shown in **Tables 4-1** (Moderate Growth) **and 4-2** (Low Growth).

Under the PPP approach, impact fees would generally be lower. Initially, impact fees under the PPP approach would be considerably lower (about 70 to 80 percent) than under the Public Utility Approach. Impact fees would increase more rapidly under the PPP approach and at the end of the 20-year planning horizon, would be 12 percent higher for Ocean Sands and 4 to 23 percent lower for the other service areas.

For Option 1, monthly sewer bills would be higher initially under the Public Utility Approach, but could be reduced considerably once the debt for the Phase 1 project is retired. For Option 4, monthly sewer bills would be lower under the Public Utility Approach throughout the 20-year planning horizon. Monthly sewer bills were escalated at 2.5 percent per year until the 20-year cash flow analyses showed it was no longer necessary to inflate rates to cover expenses and maintain cash reserves. The actual timing and magnitude of required rate increases will be subject to current costs (i.e. inflationary pressures), the rate of growth, and timing of impact fee revenue collection.

Rates and fees were also evaluated with a 1.5 percent annual growth rate. Rates would be higher under this scenario to cover the lower rate of impact fee collection. For the Public Utility Approach, monthly sewer bills would be approximately 22 percent higher. For the Public Utility Approach, monthly sewer bills would need to be approximately 3 percent higher, which demonstrates that OBV assumes much of the risk related to growth rates and impact fee collection under the PPP approach.

Table 4-1: COMPARISON OF RATE EVALUATIONS FOR PUBLIC AND PUBLIC-PRIVATE OPTIONS - MODERATE GROWTH

COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK COUNTY SOUTHERN OUTER BANKS

Currituck County and Currituck Utilities

	Option 1 - Public Utility			Option 4 - Public Utility					Option 1 - Pubic-Private Partnership			Option 4 - Pubic-Private Partnership				
Fiscal Year	Average Monthly Sewer Bill	OS Customer Impact Fee	CL Customer Impact Fee	Average Monthly Sewer Bill	OS Customer Impact Fee	CL Customer Impact Fee	CV/OH Customer Impact Fee	WH Customer Impact Fee	Average Monthly Sewer Bill	OS Customer Impact Fee	CL Customer Impact Fee	Average Monthly Sewer Bill	OS Customer Impact Fee	CL Customer Impact Fee	CV/OH Customer Impact Fee	WH Customer Impact Fee
FY 2015	$161	$20,000	$23,000	$166	$17,000	$19,000	$31,000	$31,000	$151	$5,300	$4,000	$166	$5,300	$4,000	$18,700	$13,100
FY 2016	$165	$20,500	$23,575	$170	$17,425	$19,475	$31,775	$31,775	$155	$6,323	$5,023	$170	$6,323	$5,023	$19,723	$14,123
FY 2017	$169	$21,013	$24,164	$174	$17,861	$19,962	$32,569	$32,569	$158	$7,346	$6,046	$174	$7,346	$6,046	$20,746	$15,146
FY 2018	$173	$21,538	$24,768	$179	$18,307	$20,461	$33,384	$33,384	$162	$8,369	$7,069	$179	$8,369	$7,069	$21,769	$16,169
FY 2019	$177	$22,076	$25,388	$176	$18,765	$20,972	$34,218	$34,218	$161	$9,392	$8,092	$183	$9,619	$8,319	$23,019	$17,419
FY 2020	$182	$22,628	$26,022	$171	$19,234	$21,497	$35,074	$35,074	$161	$10,415	$9,115	$160	$10,869	$9,569	$24,269	$18,669
FY 2021	$186	$23,194	$26,673	$166	$19,715	$22,034	$35,950	$35,950	$161	$11,438	$10,138	$160	$12,119	$10,819	$25,519	$19,919
FY 2022	$191	$23,774	$27,340	$161	$20,208	$22,585	$36,849	$36,849	$161	$12,751	$11,451	$160	$13,369	$12,069	$26,769	$21,169
FY 2023	$196	$24,368	$28,023	$156	$20,713	$23,150	$37,770	$37,770	$161	$14,064	$12,764	$160	$14,619	$13,319	$28,019	$22,419
FY 2024	$201	$24,977	$28,724	$151	$21,231	$23,728	$38,715	$38,715	$161	$15,377	$14,077	$160	$15,869	$14,569	$29,269	$23,669
FY 2025	$206	$25,602	$29,442	$146	$21,761	$24,322	$39,683	$39,683	$161	$16,690	$15,390	$160	$17,319	$16,019	$30,719	$25,119
FY 2026	$208	$26,242	$30,178	$141	$22,305	$24,930	$40,675	$40,675	$161	$18,003	$16,703	$160	$18,769	$17,469	$32,169	$26,569
FY 2027	$200	$26,898	$30,932	$136	$22,863	$25,553	$41,692	$41,692	$161	$19,316	$18,016	$160	$20,219	$18,919	$33,619	$28,019
FY 2028	$192	$27,570	$31,706	$131	$23,435	$26,192	$42,734	$42,734	$161	$20,629	$19,329	$160	$21,669	$20,369	$35,069	$29,469
FY 2029	$184	$28,259	$32,498	$126	$24,021	$26,847	$43,802	$43,802	$161	$21,942	$20,642	$160	$23,119	$21,819	$36,519	$30,919
FY 2030	$76	$28,966	$33,311	$71	$24,621	$27,518	$44,897	$44,897	$161	$23,255	$21,955	$160	$24,569	$23,269	$37,969	$32,369
FY 2031	$68	$29,690	$34,144	$66	$25,237	$28,206	$46,020	$46,020	$161	$24,568	$23,268	$160	$26,019	$24,719	$39,419	$33,819
FY 2032	$60	$30,432	$34,997	$61	$25,868	$28,911	$47,170	$47,170	$161	$25,881	$24,581	$160	$27,469	$26,169	$40,869	$35,269
FY 2033	$52	$31,193	$35,872	$56	$26,514	$29,634	$48,349	$48,349	$161	$27,194	$25,894	$160	$28,919	$27,619	$42,319	$36,719
FY 2034	$52	$31,973	$36,769	$51	$27,177	$30,374	$49,558	$49,558	$161	$28,507	$27,207	$160	$30,369	$29,069	$43,769	$38,169

Notes:

OS = Ocean Sands

CL = Corolla Light

CV = Corolla Village

OH = Ocean Hill

WH = Whalehead

Table 4-2: COMPARISON OF RATE EVALUATIONS FOR PUBLIC AND PUBLIC-PRIVATE OPTIONS - LOW GROWTH

COMPREHENSIVE WASTEWATER MASTER PLAN FOR THE CURRITUCK COUNTY SOUTHERN OUTER BANKS

Currituck County and Currituck Utilities

	Option 1 - Public Utility			Option 4 - Public Utility					Option 1 - Pubic-Private Partnership			Option 4 - Pubic-Private Partnership				
Fiscal Year	Average Monthly Sewer Bill	OS Customer Impact Fee	CL Customer Impact Fee	Average Monthly Sewer Bill	OS Customer Impact Fee	CL Customer Impact Fee	CV/OH Customer Impact Fee	WH Customer Impact Fee	Average Monthly Sewer Bill	OS Customer Impact Fee	CL Customer Impact Fee	Average Monthly Sewer Bill	OS Customer Impact Fee	CL Customer Impact Fee	CV/OH Customer Impact Fee	WH Customer Impact Fee
FY 2015	$197	$20,000	$21,000	$206	$17,000	$19,000	$31,000	$31,000	$161	$5,300	$4,000	$189	$5,300	$4,000	$18,700	$13,100
FY 2016	$202	$20,500	$21,525	$211	$17,425	$19,475	$31,775	$31,775	$165	$6,323	$5,023	$194	$6,323	$5,023	$19,723	$14,123
FY 2017	$207	$21,013	$22,063	$216	$17,861	$19,962	$32,569	$32,569	$169	$7,346	$6,046	$198	$7,346	$6,046	$20,746	$15,146
FY 2018	$212	$21,538	$22,615	$222	$18,307	$20,461	$33,384	$33,384	$171	$8,369	$7,069	$203	$8,369	$7,069	$21,769	$16,169
FY 2019	$217	$22,076	$23,180	$217	$18,765	$20,972	$34,218	$34,218	$171	$9,392	$8,092	$208	$9,619	$8,319	$23,019	$17,419
FY 2020	$216	$22,628	$23,760	$209	$19,234	$21,497	$35,074	$35,074	$171	$10,415	$9,115	$168	$10,869	$9,569	$24,269	$18,669
FY 2021	$212	$23,194	$24,354	$201	$19,715	$22,034	$35,950	$35,950	$171	$11,438	$10,138	$168	$12,119	$10,819	$25,519	$19,919
FY 2022	$208	$23,774	$24,962	$193	$20,208	$22,585	$36,849	$36,849	$171	$12,751	$11,451	$168	$13,369	$12,069	$26,769	$21,169
FY 2023	$204	$24,368	$25,586	$185	$20,713	$23,150	$37,770	$37,770	$171	$14,064	$12,764	$168	$14,619	$13,319	$28,019	$22,419
FY 2024	$201	$24,977	$26,226	$177	$21,231	$23,728	$38,715	$38,715	$171	$15,377	$14,077	$168	$15,869	$14,569	$29,269	$23,669
FY 2025	$198	$25,602	$26,882	$169	$21,761	$24,322	$39,683	$39,683	$171	$16,690	$15,390	$168	$17,319	$16,019	$30,719	$25,119
FY 2026	$195	$26,242	$27,554	$161	$22,305	$24,930	$40,675	$40,675	$171	$18,003	$16,703	$168	$18,769	$17,469	$32,169	$26,569
FY 2027	$192	$26,898	$28,243	$153	$22,863	$25,553	$41,692	$41,692	$171	$19,316	$18,016	$168	$20,219	$18,919	$33,619	$28,019
FY 2028	$189	$27,570	$28,949	$145	$23,435	$26,192	$42,734	$42,734	$171	$20,629	$19,329	$168	$21,669	$20,369	$35,069	$29,469
FY 2029	$186	$28,259	$29,672	$137	$24,021	$26,847	$43,802	$43,802	$171	$21,942	$20,642	$168	$23,119	$21,819	$36,519	$30,919
FY 2030	$116	$28,966	$30,414	$56	$24,621	$27,518	$44,897	$44,897	$171	$23,255	$21,955	$168	$24,569	$23,269	$37,969	$32,369
FY 2031	$116	$29,690	$31,175	$56	$25,237	$28,206	$46,020	$46,020	$171	$24,568	$23,268	$168	$26,019	$24,719	$39,419	$33,819
FY 2032	$116	$30,432	$31,954	$56	$25,868	$28,911	$47,170	$47,170	$171	$25,881	$24,581	$168	$27,469	$26,169	$40,869	$35,269
FY 2033	$116	$31,193	$32,753	$56	$26,514	$29,634	$48,349	$48,349	$171	$27,194	$25,894	$168	$28,919	$27,619	$42,319	$36,719
FY 2034	$116	$31,973	$33,572	$56	$27,177	$30,374	$49,558	$49,558	$171	$28,507	$27,207	$168	$30,369	$29,069	$43,769	$38,169

Notes:

OS = Ocean Sands

CL = Corolla Light

CV = Corolla Village

OH = Ocean Hill

WH = Whalehead

The advantages of the PPP Approach are as follows:

- OBV is responsible for financing capital improvements, such that the debt is not considered part of the County's overall debt ratio.
- The terms of the PPP place more of the financial risk on OBV. If growth occurs at rates less than the 3 percent projected in this Master Plan, then existing customers would be more protected from rate increases than under the Public Utility approach.
- Lower impact fees.
- Lower monthly sewer bills initially under each Service Area Option.

The advantages of the Public Utility Approach are as follows:

- County would directly control the design and scope of capital improvements.
- County would be responsible and have direct control over the allocation of wastewater capacity to customers.
- Lower monthly sewer bills by FY 2030 (16th year of operation).

Under all scenarios, projected rates and fees for a regional utility represent a significant increase over current sewer rates. This is due to higher costs related to advanced treatment to meet new effluent standards required by the 2T rules. Also, the existing WWTP infrastructure is in poor condition, so the proposed project includes construction of new capacity and demolition of all existing infrastructure. More detail regarding the cost implications of constructing new wastewater capacity can be found in TM No. 2.

Based on the current rate and fee schedule for the Ocean Sands Water and Sewer District, a comparable customer with an average wastewater flow of 170 gpd would have a monthly sewer bill of $20.11. However, the OSWSD sewer rates and fees do not cover current sewer expenses. Revenues generated from water rates cover part of the costs to operate the sewer system. Therefore, a direct comparison between existing rates and proposed rates and fees for the regional system is difficult. As presented in **Table 2-1**, O&M costs for the Ocean Sands WWTP and sewer collection system have averaged $8.84 per 1,000 gallons treated over the last three years. The projected sewer usage rate for the regional system is initially $8.00 per 1,000 gallons treated in FY 2015.

Carolina Water Services has obtained approval from the NC Utilities Commission to increase sewer rates for Monteray Shores and Corolla Light to cover the costs of the recent WWTP

expansion. For a customer generating 170 gpd of wastewater, the monthly sewer bill would be approximately $91.55 (assuming a 5/8-inch water meter). Of course, this rate increase will be applied to Corolla Light customers, who are not served by the upgraded Monteray Shores WWTP.

It is worth noting that the ERC used for this Master Plan was 600 gpd based on State design guidelines for wastewaster flow and an average residence of five bedrooms. A typical 3-bedroom residence located in the Piedmont may have an average wastewater flow of 200 to 275 gpd. Typical wastewater flows for residences on the Outer Banks are higher than in typical communities due to the number of bedrooms, number of people residing in vacation homes, and the resort nature of the Outer Banks. Water and wastewater use may be higher since typical customers are not inclined to practice the same water conservation behaviors while on vacation that they would at home.

4.2 Recommendations

Rates and fees for an Outer Banks Regional Wastewater Utility that is either County owned and operated or implemented as a Public/Private Partnership between Currituck County and Currituck Utilities were evaluated. The technical aspects and capital costs for both ownership alternatives are similar. The major difference is whether 1) land is acquired from OBV and dedicated solely for effluent disposal for unsewered areas as proposed for a County-owned system, or 2) the “dual use” approach is utilized where structures are constructed over the high-rate infiltration basins.

The dual use approach is a new idea that does not have a precedent in North Carolina. This approach could represent a more efficient use of land; however, there are several concerns. The dual use approach may hinder effective operation and maintenance of the high-rate infiltration basins. Additionally, DWQ has not issued a formal permit for this approach even though OBV was granted a conditional permit contingent on geotechnical investigation and structural design. The Remaining land suitable for high-rate infiltration is limited on the Outer Banks. Strong growth and development is expected to return to the Outer Banks in the near future, so relying on the dual use approach is not recommended until proven feasible. If there is a failure in this approach and other available disposal sites are allowed to develop, then wastewater management on the Outer Banks could be compromised.

The results of the financial evaluation are similar for implementing the Outer Banks Regional WWTP as either a publically owned utility or as a PPP. The rate evaluation demonstrated comparable monthly sewer bills, lower impacts fees, and higher fund balances with a Public Utility approach as compared to the PPP approach. The results of the rate evaluation are directly affected by the assumptions made in the analyses.

The decision to pursue any of the Service Area Options will be based on many factors, including capital costs, rates and fees, water quality and environmental protection, wastewater treatment availability, and consultation with the residents in those areas, particularly for unsewered areas. Regardless of the service area option selected, it is recommended that the County pursue at least

Phase 1 of Service Area Option 1, which includes Ocean Sands and Corolla Light. The recommended Phase 1 project includes construction of a 1.2 mgd regional wastewater system to serve the existing Ocean Sands and Corolla Light customers while providing 225,000 gpd excess capacity for future customers. The implementation schedule for Phase 1 is critical since Currituck County must meet a strict compliance schedule for the Special Order of Consent (SOC) negotiated with DWQ for the Ocean Sands WWTP. If Currituck County decides to proceed with a regional wastewater system, then it must be online by October 2015.

For Option 4, service to the unsewered areas would begin in Phase 2, which is planned for completion in FY 2019. This would allow time for the County to confirm the level of interest by property owners for centralized sewer. This will require several public meetings or discussions with homeowner's associations to present the Comprehensive Wastewater Master Plan. Service to the unsewered areas will require construction of new wastewater collection systems in Corolla Village, Ocean Hill, and Whalehead. The time to complete collection system construction may be lengthy, particularly if substantial road-side construction is limited to the offseason to reduce impacts on traffic and vacation rentals during the summer. Currituck County cannot proceed with Service Area Option 4 until these discussions have taken place. It is recommended that the County proceed with Phase 1 of Option 1 in order to meet its required obligations as outlined in the SOC. Planning and design for Phase 1 can be accomplished to allow for future service to the unsewered areas if it is later decided to proceed with Option 4.

If it is decided to utilize the Public-Private Partnership Approach, then the following actions are recommended:

- The initial planning and dedication of land for the regional utility should be based on the layouts presented in this Master Plan. The infrastructure planning in this Master Plan includes some conservatism and should be the basis for any legal or financial arrangements. There are some potential options to reduce land and/or capital requirements, but these options are contingent upon additional engineering design, technical investigations, and/or negotiations with State and federal regulatory agencies.

- The County should have a mechanism to allocate wastewater capacity to new customers rather than this function being the sole responsibility of OBV.

- Land required for the Phase 1 project for the WWTP, reject storage, effluent disposal, groundwater management, other infrastructure should be deeded to the County. The County could acquire easements for disposal of groundwater into irrigation ponds.

- The County should be directly involved in the planning and design for the regional system. The County should consider retaining an engineering firm to assist in technical reviews, and serve as a program manager throughout the design, permitting, and construction of the wastewater infrastructure.

- Project schedule should be based on the recommended schedule in this Master Plan and accounts for environmental review. OBV has indicated that the SEPA process would not be required under the PPP approach. However, if the County operates, maintains, and leases the regional system from OBV, this would be considered by the State as an "expenditure of public monies" and SEPA review would be required.

ATTACHMENT A:

Blueprint for the Development of a Regional Wastewater System in Currituck County's Southern Outer Banks, Outer Banks Ventures, March 2011

3/4/2011

CURRITUCK UTILITIES, LLC'S BLUEPRINT FOR THE DEVELOPMENT OF A REGIONAL WASTEWATER SYSTEM ON CURRITUCK COUNTY'S SOUTHERN OUTER BANKS

The Southern Outer Banks region of Currituck County is confronting stormwater and wastewater challenges resulting from residential and commercial development in this ecologically sensitive coastal zone. In order for the County to preserve and enhance its tax base, it must solve these challenges. When the Mid-Currituck Bridge opens for traffic in 2016, the County will experience a great deal of additional residential and commercial growth. After the new bridge is constructed, it will take about the same amount of time to drive from downtown Norfolk to Corolla as it currently takes to drive from downtown Norfolk to the Northern beach neighborhoods of Virginia Beach.

Current wastewater systems in the area are privately owned and consist of septic tanks and packaged sewer plants that are decades old. Many of these septic tanks and sewer systems are now operating outside of design and state standards. The septic tanks and old sewer systems are causing environmental problems and elevating health risks. High water tables create situations where septic tanks fail to treat sewage during heavy rains. Consequently, a "break-out" of sewage can occur above ground causing untreated sewage to find its way into street puddles, ponds and, ultimately, the Currituck Sound.

Currituck County can solve these problems through the implementation of a Regional Wastewater System with a central wastewater plant to serve all of the customers in the Currituck Southern Outer Banks area. The construction of a state of the art wastewater plant using green technology and producing reuse quality water will ensure that the tax base of the County is protected and continues to grow. In addition, troubling legal and operational issues caused by the present fractured ownership of wastewater treatment systems in this critical area of the County will be resolved once and for all.

Currituck Utilities, LLC is in the unique position to offer a solution to resolve these issues. As outlined in this Blueprint, Currituck Utilities and its affiliate, Outer Banks Ventures, Inc. ("OBV"), have the land resources, engineers, technology and experience to create a permanent wastewater solution for the Currituck County Southern Outer Banks area. Currituck Utilities has contracted to purchase the Corolla Light Wastewater System owned by Carolina Water Service of North Carolina ("CWS"), and use it as the nucleus of a Regional Wastewater System. We propose that Currituck County will own the collection systems and customers, and will ultimately own the Central Wastewater Plant at the end of lease term as discussed below.

The County's Ocean Sands Wastewater Plant is at the end of its useful life. Currituck Utilities proposes that this plant be replaced with capacity from a new Regional Plant to be located either on Currituck Utilities' land in Monteray Shores (formerly the Bob DeGabrielle Tract), or on the Corolla Light Phase 11 and 12 parcels that it owns. Currituck Utilities' construction of a

sophisticated advanced treatment system will produce reuse quality effluent that will replace the hodge podge of current treatment systems. The Currituck Sound and other Outer Banks ecosystems will benefit and be restored from this level of treatment.

Once the new capacity at the Regional Plant site comes online in late 2012 or early 2013, the current Ocean Sands wastewater treatment plant will be removed from service.

By combining their respective resources, Currituck County and Currituck Utilities will provide a wastewater solution that otherwise could not exist. The overall cost to mainland taxpayers will be zero, as they will not be served by the Regional Wastewater System. The cost to the customers that are on these current systems will be less than what the private public utilities will charge if they replace the existing wastewater plants, and less than what the County will have to charge it simply replaces the plant in Ocean Sands without participating in the proposed Regional System. A Regional Wastewater System will remain a goal, and never become a reality, unless action is taken now.

This Blueprint describes how the relationship between the County and Currituck Utilities will be structured and the steps required to create and operate the Regional Wastewater System serving the Outer Banks. To accomplish the goals stated herein, Currituck Utilities has assembled a group of some of the best experts in wastewater technology, hydrology, finance and business to implement a comprehensive plan to create the System. Final details will be memorialized in contracts prepared by the parties, and approved by Currituck County staff and the Board of Commissioners.

In short, we envision the County ordering sufficient wastewater capacity in a new plant to be constructed by Currituck Utilities on land owned by Currituck Utilities and its affiliate, Outer Banks Ventures, Inc., in order to accommodate the residential and commercial needs of the Ocean Sands and Corolla Light communities. The disposal of Ocean Sands wastewater flow will still be on land in Ocean Sands. Ocean Sands will also continue to provide the green area for the wastewater flow applicable to Ocean Sands.

The County will set and charge rates and collect fees from those served by the new plant. Over time, the plant and collection lines will be expanded to accommodate unserved areas and new users. The new plant and collection lines, as expanded over time, will comprise the Regional Wastewater System.

OUTLINE OF PROPOSAL

A. **DEDICATION OF CURRITUCK UTILITIES RESOURCES.** Currituck Utilities has contracted to purchase CWS's wastewater system in Corolla Light. This system will be combined with the County's Oceans Sands System. Additional lands owned by Outer Banks Ventures and these two systems will comprise the nucleus of the Regional Wastewater System. In addition, Currituck Utilities has assembled a team of engineers and professionals that will finalize the Master Plan for the Regional Wastewater System. Currituck County and Currituck Utilities have jointly hired Hazen and Sawyer to review and ensure that the resources are adequate and that the Regional Plan is viable.

To minimize the effect of land cost on rates for wastewater, OBV will subject its land holdings to a dual use (development and disposal to co-exist). This economic benefit to OBV allows OBV to dedicate the land required for the Regional System at a much lower cost than would otherwise be possible on the Currituck Southern Outer Banks.

B. **CENTRAL WASTEWATER PLANT LEASE FOR OPERATIONS.** The contract between Currituck County and Currituck Utilities will provide for the conveyance of the Corolla Light collection system to the County. Currituck Utilities will provide or cause its affiliate, OBV, to provide open space, infiltration basins, means of disposal of groundwater, required plant expansion, and all improvements and construction required to create a complete Regional Wastewater Plant which will be leased to the County.

The County will lease the Regional Plant for a term of 20 years. This term will provide Currituck Utilities and OBV with the time and flexibility required to incorporate the Regional System's wastewater disposal areas, groundwater disposal areas, green areas and wastewater plant site on their land. Currituck County will lease, operate, and at the end of 20 years, own the Regional Wastewater Plant. At the end of the 20 year lease term, the plant will be transferred to the County.

During the term of the lease, the County will pay rent to Currituck Utilities equal to the amount necessary to fully amortize over 20 years a bond to construct the first phase of the Regional Wastewater Plant for Ocean Sands and Corolla Light's existing customers. This bond will be obtained by Currituck Utilities. The lease will be triple net, with the County being responsible for the payment of all expenses relating to the Regional Wastewater Plant (i.e. taxes, insurance, repairs, wages and so forth). The County's initial sewer plant lease payment to Currituck Utilities will be spread across and paid for by the existing customers in Corolla Light and Ocean Sands. The County, by virtue of this lease, will control, operate, and maintain the central plant.

The County will set rates and fees as it deems necessary to recover the costs of operating and maintaining the wastewater systems and to make the lease payments to Currituck Utilities. It is anticipated that the County will hire employees to operate these plants, or employ the operator currently used in Ocean Sands, Envirotech. Currituck Utilities will

provide additional expertise from its engineering and management teams during the lease term to further assist as needed.

C. **WASTEWATER PLANT EXPANSIONS.** The Regional Wastewater Plant will be designed to be expanded in multiple phases to serve the future needs of all of the Southern Currituck County communities on the Outer Banks. The first phase will accommodate the capacity required by the *existing* customers in Ocean Sands and Corolla Light. In addition, excess capacity will be constructed and paid for by Currituck Utilities to be held as inventory and offered for sale to future customers.

This first construction phase of the Regional Plant will consist of a 1.2 MGD plant. The expansion of the Regional Wastewater System over time will also serve the communities currently using septic tanks and old technology packaged plants. The capacity of the Central Plant will be designed so it can be expanded from its initial 1.2 MGD capacity to as much as 3.6 MGD using green, state of the art water reuse technology. Currituck Utilities' engineering team is comprised of Ed Andrews, Carlos Gomez, Rob Burgin, Linwood Stroud, and Rick Willis (the "Engineering Team") who will design the system to meet or exceed design parameters (flow capabilities, equalization size, construction quality, etc.) as stated herein and will work closely with County staff and Hazen and Sawyer to ensure that the improved and enlarged system meets, or exceeds, the County's wastewater needs and design requirements. The Regional Wastewater System will also be designed to mitigate wherever possible the stormwater problems and associated health risks confronting several of the Currituck beach communities.

During the 20 year expansion period, Currituck Utilities will provide access to additional open space and pond easements located in Corolla Light which may be necessary for the infiltration and disposal systems for each expansion of the Regional Wastewater System. These dedications will be recorded to benefit Currituck County. At the end of the lease term and upon Currituck Utilities' receipt of payment for all constructed capacity, ownership of the leased wastewater system shall be conveyed to Currituck County.

Existing open space in Ocean Sands will be made available by the County to Currituck Utilities, at no additional expense to Currituck Utilities, for infiltration ponds or other wastewater needs for Ocean Sands existing and new customers. The land in Ocean Sands will only be utilized for Ocean Sands' portion of the total flow.

D. **CALCULATION OF REGIONAL PLANT LEASE PAYMENT FOR EXISTING CUSTOMERS.** The County's lease payment to Currituck Utilities is estimated to be $1,554,000 per year, payable in monthly installments. This lease payment provides the capacity required to serve all *existing* customers in Ocean Sands and Corolla Light, as projected in the Hazen and Sawyer TM2. This price includes upgrades to the disposal system in Ocean Sands, which for the immediate future shall remain on the same land in Ocean Sands. It pays for ALL PLANT CONSTRUCTION COSTS to create a complete Central Wastewater Plant for existing customers.

The lease payment for the plant capacity required for the flow from existing customers can be summarized as follows:

$ 23.50	Construction Cost per Gallon of Capacity for existing customers in Ocean Sands and Corolla Light
779,000	GPD required for existing flow (Hazen & Sawyer study)
155,000	GPD required by NC (20% of existing flow as excess capacity)
935,000	GPD of flow initially needed by County from CU for existing customers in Ocean Sands and Corolla Light (Rounded)
$ 21,970,000	Cost for Plant Construction for existing customers ($23.50 x 935,000)
$ 5,000,000	Impact Fee from Existing customers
$ 16,970,000	Required Bond
$ 1,400,000	Required Interest Reserve Account for Bond
$ 450,000	Bond fees @ 2.5% plus closing costs
$ 18,820,000	Total Bond
$ 1,554,000	Total Annual Payment on Bond (bond amortized over 20 years at 5.5% interest rate) (This Equals the County's Annual Lease Payment)

This Lease Payment may be adjusted up or down by the interest rate of the bond. Once set, it will not change.

The Lease Payment for the first phase of the Regional Plant proposed by Currituck Utilities can be broken down into a cost per customer equivalent, (as per the Hazen and Sawyer report - 600 GPD per customer) in the following way:

$ 1,554,000	Lease Payment for existing customers
1,298	Assumed Customer Equivalents (Per Hazen & Sawyer study)
$ 1,197	Annual Cost of lease per Customer Equivalent
$ 5,000,000	Impact Fee for existing customers
$ 3,852	Impact Fee per customer equivalent

The Lease Payment for the first phase of the Regional Plant can also be broken down into a cost per GPD:

$ 1,554,000	Lease Payment for existing customers
779,000	Dedicated Gallons for Ocean Sands and Corolla Light existing Customers Equivalents (Per Hazen & Sawyer study)
$ 1.99	Lease Payment per GPD for required plant capacity for existing customers in Corolla Light and Ocean Sands ($1,554,000 divided by 779,000)

E. <u>CALCULATION OF REGIONAL PLANT LEASE PAYMENT AND IMPACT FEE FOR NEW CUSTOMERS.</u> With this number of $1.99 per GPD of capacity in mind, the Lease payment and impact fees that CU proposes for the new connections in Corolla Light and Ocean Sands are:

LEASE PAYMENT FOR NEW CUSTOMERS IN OCEAN SANDS AND COROLLA LIGHT

$ 1.99	Annual Lease Payment per GPD of Plant Capacity

(For each new 600 GPD customer equivalent, rent for the central plant will increase by $1.99 times 600 GPD, or $1,194 per year)

IMPACT FEE FOR NEW CUSTOMERS IN OCEAN SANDS AND COROLLA LIGHT

To adjust for the fact that the new connections will not be paying for capacity from day one, an impact fee will be required for new customers. These impact fees will likely need to be modified when the second plant expansion occurs to account for the change in the ENR cost index and the cost of bond financing.

$ 1.99	Adjusted Annual cost per GPD from above
$ 1.99	Increase in Impact Fee per GPD payable to Currituck Utilities each Year for new customers in Corolla Light and Ocean Sands starting in year 2 (Year 2 equals $1.99 plus $1.99= $3.98, Year 5 equals $1.99 times 5= $9.95, etc.)

ADDITIONAL IMPACT FEE FOR NEW CUSTOMERS NOT IN OCEAN SANDS AND COROLLA LIGHT

For new customers that are not in Corolla Light or Ocean Sands there will be an additional cost per GPD for new capacity of:

$ 4.50	Additional Impact Fee per State required GPD for any Customer outside of Corolla Light and Ocean Sands

NOTE: THESE RATES WILL BE ADJUSTED WHEN NEW PLANT CAPACITY IS CONSTRUCTED AND WILL BE BASED ON THE CUMULATIVE CHANGE IN THE ENR COST OF CONSTRUCTION INDEX SINCE THE LAST EXPANSION.

EXAMPLES – EXAMPLES ARE BASED ON 2011 BOND ISSUE AND 2012 PLANT IN SERVICE

EXAMPLE ONE

600	GPD New House by State Requirements in Corolla Light or Ocean Sands in 2014
$ 3,582	Impact Fee paid to Currituck Utilities at Building Permit Issuance (600 times $5.97 ($1.99 times 3 years))
$ 1,194	Increase in annual rent paid by Currituck County to Currituck Utilities at Building Permit Issuance ($1.99 times 600)

EXAMPLE TWO

600	GPD New House by State Requirements in Corolla Light or Ocean Sands in 2019
$ 9,552	Impact Fee paid to Currituck Utilities at Building Permit Issuance (600 times $15.92($1.99 times 8))
$ 1,194	Increase in annual rent paid by Currituck County to Currituck Utilities at Building Permit Issuance

EXAMPLE THREE

600	GPD New House by State Requirements in Village of Corolla in 2014
$ 7,380	Impact Fee paid to Currituck Utilities at Building Permit Issuance for Capacity ($7.80 times 600) + ($4.50 times 600)
$ 1,194	Increase in annual rent paid by Currituck County to Currituck Utilities at Building Permit Issuance

EXAMPLE FOUR

600	GPD New House by State Requirements in Village of Corolla in 2019
$ 12,252	Impact Fee paid to Currituck Utilities at Building Permit Issuance for Capacity ($15.92 times 600) + ($4.50 times 600)
$ 1,194	Increase in annual rent paid by Currituck County to Currituck Utilities at Building Permit Issuance

THIS DOES NOT INCLUDE THE COST FOR CONSTRUCTION OF THE COLLECTION SYSTEM IN THE VILLAGE OF COROLLA, JUST PLANT COST.

F. **PROPOSED SYSTEM RATES.** As the owner of the leasehold interest in the central plant, and owner of the collection systems and customers, and as the operator of these systems, the County will establish the utility rates it deems appropriate. Currituck Utilities and Currituck County will jointly notify the North Carolina Utilities Commission of the contract for the purchase of the system from Currituck Utilities and the lease arrangement for the Regional Plant. Currituck Utilities and the County will also jointly seek the Utility Commission's expedited approval of (1) Currituck Utilities' purchase of the wastewater system from CWS, (2) Currituck Utilities' lease of the Regional Wastewater Plant and sale of the wastewater systems to the County and (3) the County's plan to set wastewater utility rates.

G. **COLLECTION SYSTEMS.** Collection systems will be installed in areas which are not currently served with central sewer. It is anticipated that collection system connection fees will be charged to customers hooking up to the system by the County and remitted to Currituck Utilities. These costs can be accounted for and paid by users on a GPD basis in each community (similar to how the plant costs are paid by users), or in the alternative, frontage fees could be charged by new users to pay these expenses. The Village of Corolla will be the first area for this collection system expansion. The collection system connection fee for the newly built collection system will be based upon the cost of construction. .(See Section F – Required Ordinance) Currituck Utilities will propose the timing and scope of each collection system expansion to the County. The County may either accept that proposal or the County may undertake to install the collection system in each unserved area. We believe that Currituck Utilities can do this work as a public private entity cheaper than the County can, and provide the financing

H. **REQUIRED ACTION AND ORDINANCE.** It is suggested that the County create an appropriate political subdivision, with an appropriate management group, to supervise and coordinate the responsibilities arising from its operation of the Regional Wastewater System. The County must also pass an ordinance that requires all Southern Outer Banks property owners currently on septic tanks to hook up to the Regional System during the 20 year lease period and/or once it is available to serve their property. All new construction in areas with collection will be required to hook up and not be allowed to use septic tanks.

I. **THE RATIONALE FOR CURRITUCK COUNTY TO PARTNER WITH CURRITUCK UTILITIES TO DEVELOP A REGIONAL WASTEWATER SYSTEM.** Currituck Utilities has the land, technical expertise and resources to immediately assist with the implementation of this plan to design, permit, and build a wastewater plant, and to assist the County with creating this Regional Wastewater System. Upon its implementation, the County will operate a first class system to serve Ocean Sands and other communities in an environmentally sensitive fashion. Moreover, the economic vitality and tourism industry on the Outer Banks (and the tax dollars associated therewith) will be preserved and will grow. Currituck Utilities has taken or is ready to take the following actions:

1. In October of 2008, the County requested that Rick Willis send a letter to the County regarding his desire to assist the County with the County's obligation to provide wastewater services to the Ocean Sands community. This letter was forwarded by the County to State officials.
2. Currituck Utilities has a contract to purchase the CWS Corolla Light Wastewater system as discussed herein.
3. Currituck Utilities has met with the North Carolina Utility Commission and received guidance for transitioning the ownership and operation of CWS's wastewater systems to Currituck Utilities and Currituck County.
4. Currituck Utilities has assembled and retained a group of experienced and highly respected professionals (the Engineering Team) to study and agree on the feasibility of the implementation of a Regional Wastewater System.
5. Currituck Utilities' costs and fees described herein are less than those identified by Hazen and Sawyer if Currituck County were to attempt to build the Regional System without Currituck Utilities.
6. Ed Andrews has prepared a Hydrogeologic Evaluation dated 10/7/2009, which demonstrates that Currituck Utilities can dispose of all effluent generated by the regional wastewater system.
7. The Engineering Team has determined that, for environmental reasons, and to assist with current stormwater disposal problems, a regional wastewater system should include plans to eliminate all septic tanks which discharge marginally treated effluent.
8. The Engineering Team has determined that the required Regional Wastewater Plant should incorporate "green" technology, and apply the highest level of treatment reasonably possible to achieve "reuse" quality effluent.
9. Currituck Utilities intends to form a 501c3 non-profit entity to assist with environmental stewardship during the Regional System's design, construction and operation. This entity is expected to draw on all the resources available in North Carolina to assist Currituck Utilities in achieving the most environmentally sustainable plant design possible.
10. The Engineering Team, and Hazen and Sawyer, have determined that such a regional system is feasible. The Engineers are now prepared to finalize a master plan and design the first phase of plant capacity expansion and the related collection and disposal systems to serve the Ocean Sands community and Corolla Light. It is anticipated that Currituck County will retain Hazen and Sawyer as a consultant to review Regional Wastewater Plant design and assure the County that the plant design will meet their needs.
11. The Engineering Team preliminarily determined that a maximum 3,600,000 GPD plant would accomplish the goal of eliminating septic tanks and be sufficient for the foreseeable residential and commercial growth on the Outer Banks over the next 20 years.
12. Pursuant to the Agreement for Water and Sewer Service – Corolla Light PUD dated 3/6/86 between CWS and Currituck Utilities' affiliate, Outer Banks Ventures, Inc. ("OBV"), CWS must obtain OBV's written consent prior to selling the water and wastewater systems located in Corolla Light. Currituck Utilities

will obtain OBV's required approval of CWS's sale of its Corolla Light systems to Currituck Utilities.

13. Currituck Utilities will provide or cause its affiliate, OBV, to provide open space, infiltration basins, and means of disposal if needed for the required wastewater system expansions, which may be critical to create a Regional Wastewater System.
14. Currituck Utilities' owners have the local knowledge and the business experience to efficiently and diligently implement this Regional Wastewater System plan.
15. As an accommodation to the County, Currituck Utilities will provide access to land owned by its affiliate, OBV, for Deep Water wells for the SOBWS.

The relationship between Currituck Utilities and the County described in this Blueprint provides the County with the means to permanently control, in an environmentally sensitive manner, the delivery and quality of critical wastewater services on the Southern Outer Banks. Currituck County, through this undertaking with Currituck Utilities, will ensure that adequate wastewater services are available for future residential and commercial growth, thereby directly protecting and increasing the County's tax base.

NEXT STEP. It is requested that the Currituck County Board of Commissioners authorize the County Manager, County Attorney and County Engineer to finalize an agreement with Currituck Utilities to memorialize the relationship and obligations of the parties. Currituck Utilities and Currituck County will then prepare and circulate draft documents for review, modification, and final approval by County staff and the Board of Commissioners. The transactions and rates will be contingent upon the approval of the North Carolina Utilities Commission, or the agreement by the Commission that the County can set the rates. While the Utilities Commission considers the request for approval, the design of the Regional Wastewater System will proceed with the goal of bringing the first plant capacity expansion online for the 2013 season, or sooner.

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