Rehoboth Beach Effluent Disposal Study

Evaluation of Wastewater Discharge Alternatives

Center for the Inland Bays
STAC Meeting
January 13, 2006

Stearns & Wheler, LLC
Environmental Engineers and Scientists

Agenda

- Background
- Objectives/Goals
- Land Search
- Discharge Alternatives
- Conclusions
- Next Steps

Background

- TMDL requiring zero discharge
- JPPM Presentation – January 2002
- Kick-Off Meeting – December 13, 2002
- Workshop #1 – May 15, 2003
- Inland Bays Presentation – July 31, 2003
- Workshop #2 – February 19, 2004

Objectives

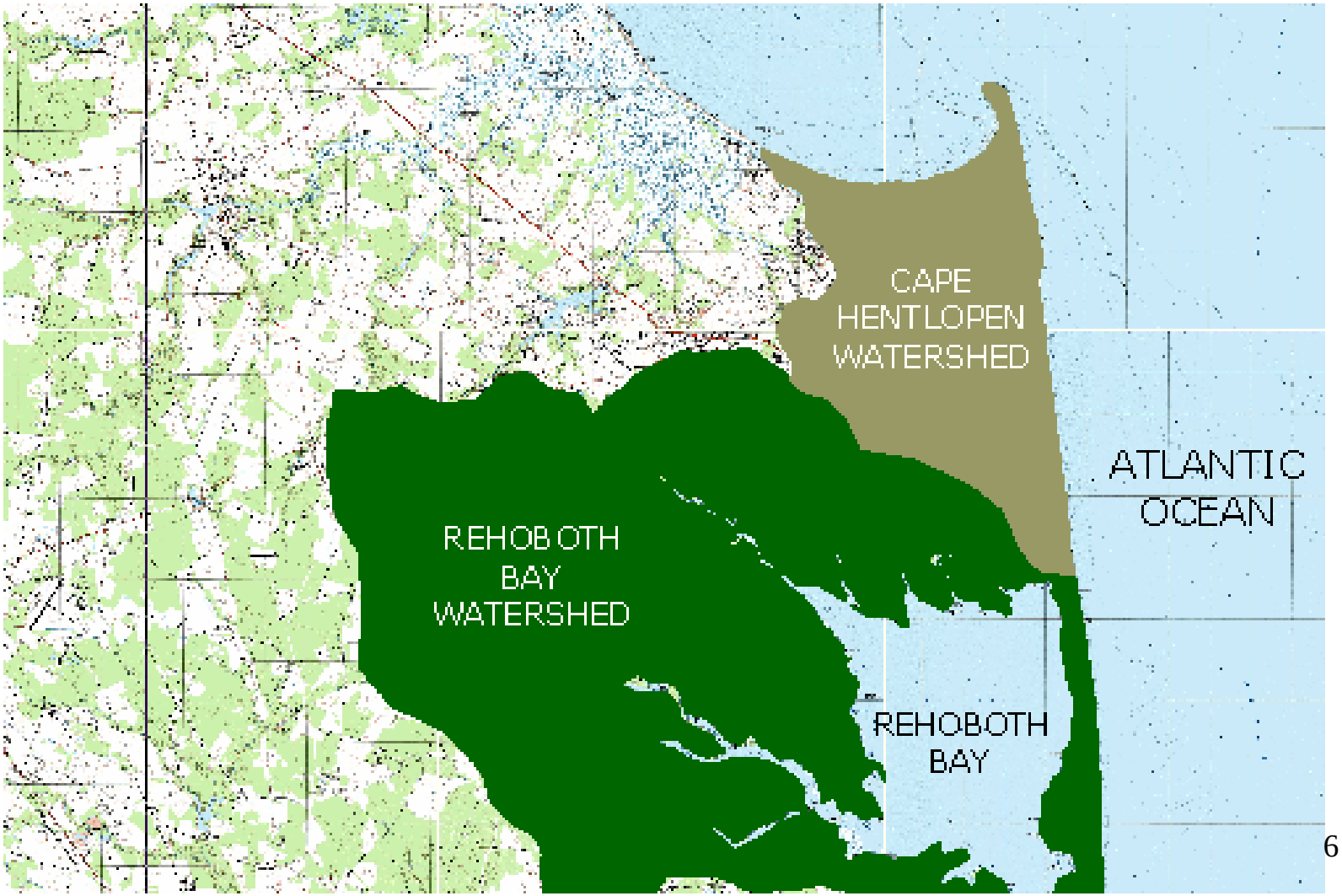
- Identify the most cost-effective and technically feasible solution for the City of Rehoboth Beach
- Identify the most cost-effective and technically feasible Regional solution

Approach

Evaluate the following discharge alternatives

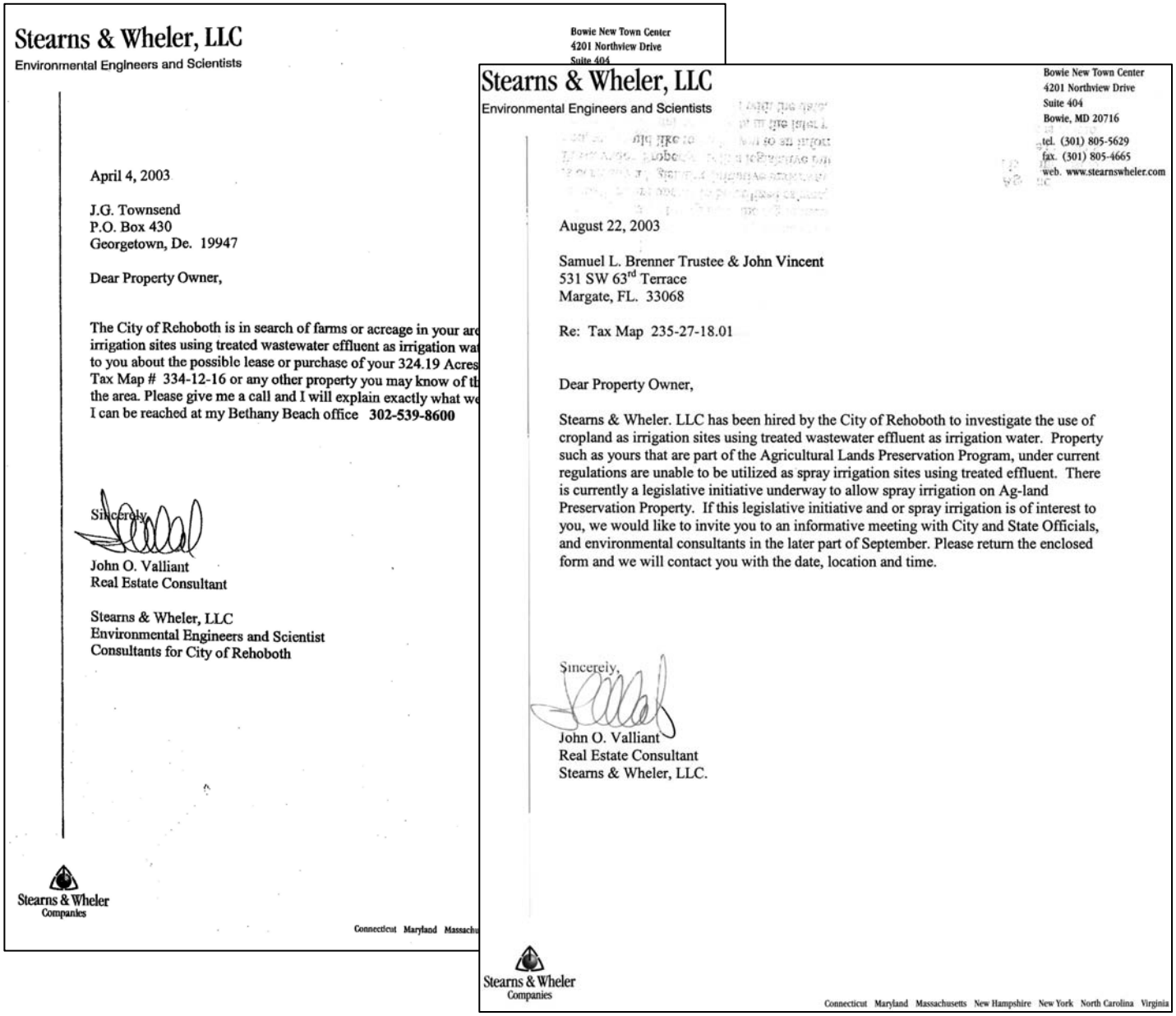
- Rehoboth Beach Solutions
  - Land Application
  - Rapid Infiltration Beds
  - Underground Injection
    - Deep Injection Wells
    - Shallow Injection Wells
  - Ocean Outfall
- Regional (Rehoboth Beach and Sussex County)
  - Ocean Outfall

Land Availability Study
Watershed



Land Availability Study

- Skip Valliant / Sea Coast Realty identified properties:
  - private property
  - located within 12 miles of the WWTP
  - greater than 100 acres
- Initial and follow-up letters were sent expressing interest in purchasing or leasing properties



Stearns & Wheler, LLC
Environmental Engineers and Scientists

Bowie New Town Center
4201 Northview Drive
Suite 404

April 4, 2003

J.G. Townsend
P.O. Box 430
Georgetown, De. 19947

Dear Property Owner,

The City of Rehoboth is in search of farms or acreage in your are
irrigation sites using treated wastewater effluent as irrigation wat
to you about the possible lease or purchase of your 324.19 Acres
Tax Map # 334-12-16 or any other property you may know of th
the area. Please give me a call and I will explain exactly what we
I can be reached at my Bethany Beach office **302-539-8600**

Sincerely,

John O. Valliant
Real Estate Consultant

Stearns & Wheler, LLC
Environmental Engineers and Scientist
Consultants for City of Rehoboth

Stearns & Wheler
Companies

Connecticut Maryland Massachu

Stearns & Wheler, LLC
Environmental Engineers and Scientists

Bowie New Town Center
4201 Northview Drive
Suite 404
Bowie, MD 20716
tel. (301) 805-5629
fax. (301) 805-4665
web. www.stearnswheler.com

August 22, 2003

Samuel L. Brenner Trustee & John Vincent
531 SW 63rd Terrace
Margate, FL. 33068

Re: Tax Map 235-27-18.01

Dear Property Owner,

Stearns & Wheler. LLC has been hired by the City of Rehoboth to investigate the use of cropland as irrigation sites using treated wastewater effluent as irrigation water. Property such as yours that are part of the Agricultural Lands Preservation Program, under current regulations are unable to be utilized as spray irrigation sites using treated effluent. There is currently a legislative initiative underway to allow spray irrigation on Ag-land Preservation Property. If this legislative initiative and or spray irrigation is of interest to you, we would like to invite you to an informative meeting with City and State Officials, and environmental consultants in the later part of September. Please return the enclosed form and we will contact you with the date, location and time.

Sincerely,

John O. Valliant
Real Estate Consultant
Stearns & Wheler, LLC.

Stearns & Wheler
Companies

Connecticut Maryland Massachusetts New Hampshire New York North Carolina Virginia

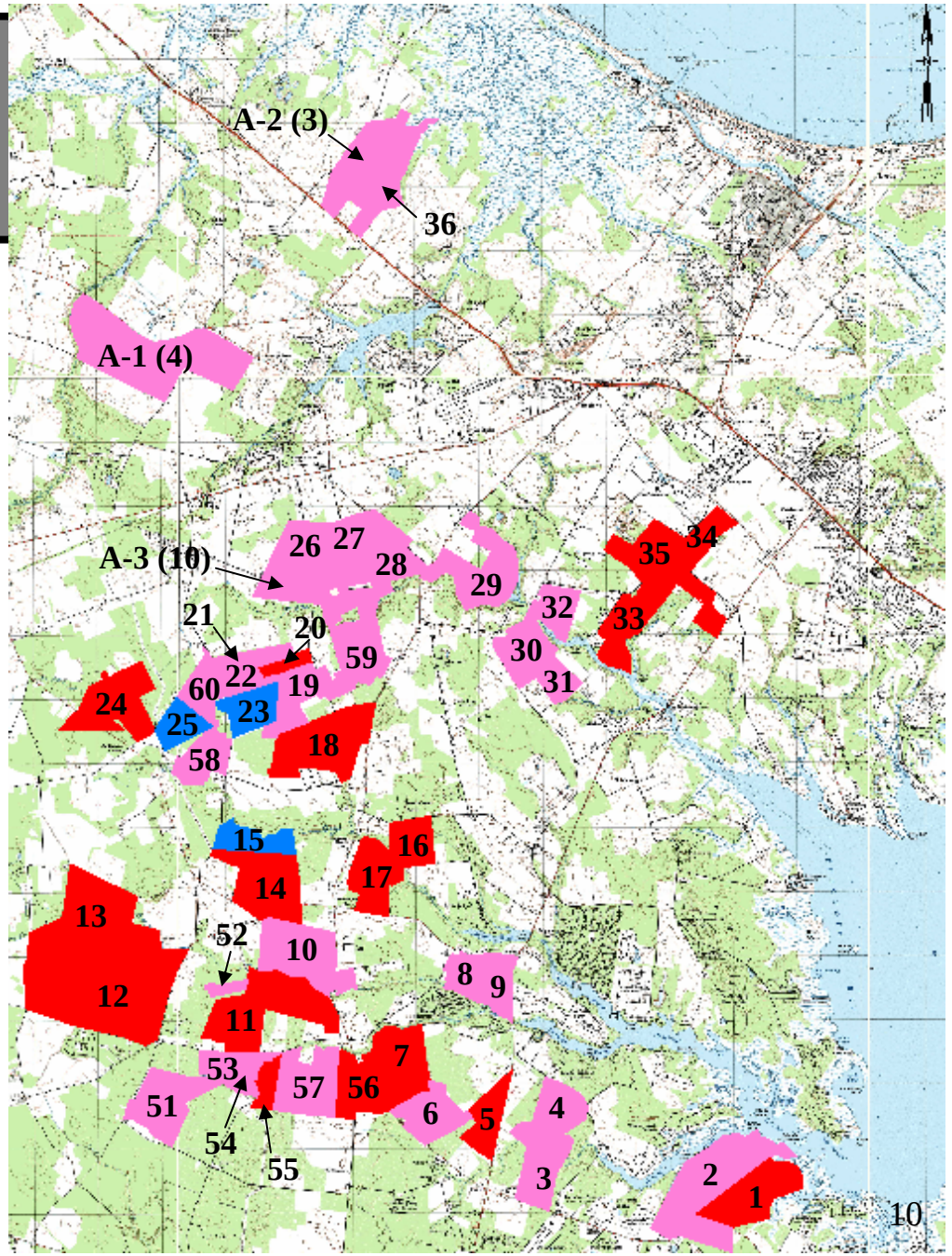
Sample Letters

Land Availability Study

- Minimal response
- Agricultural Preservation Districts
- Initial and follow-up letters were sent to District landowners
- Follow-up phone calls were made to landowners that expressed any interest

Land Availability Survey - Results

- Not interested (17)
- No response (43)
- Interested (3)

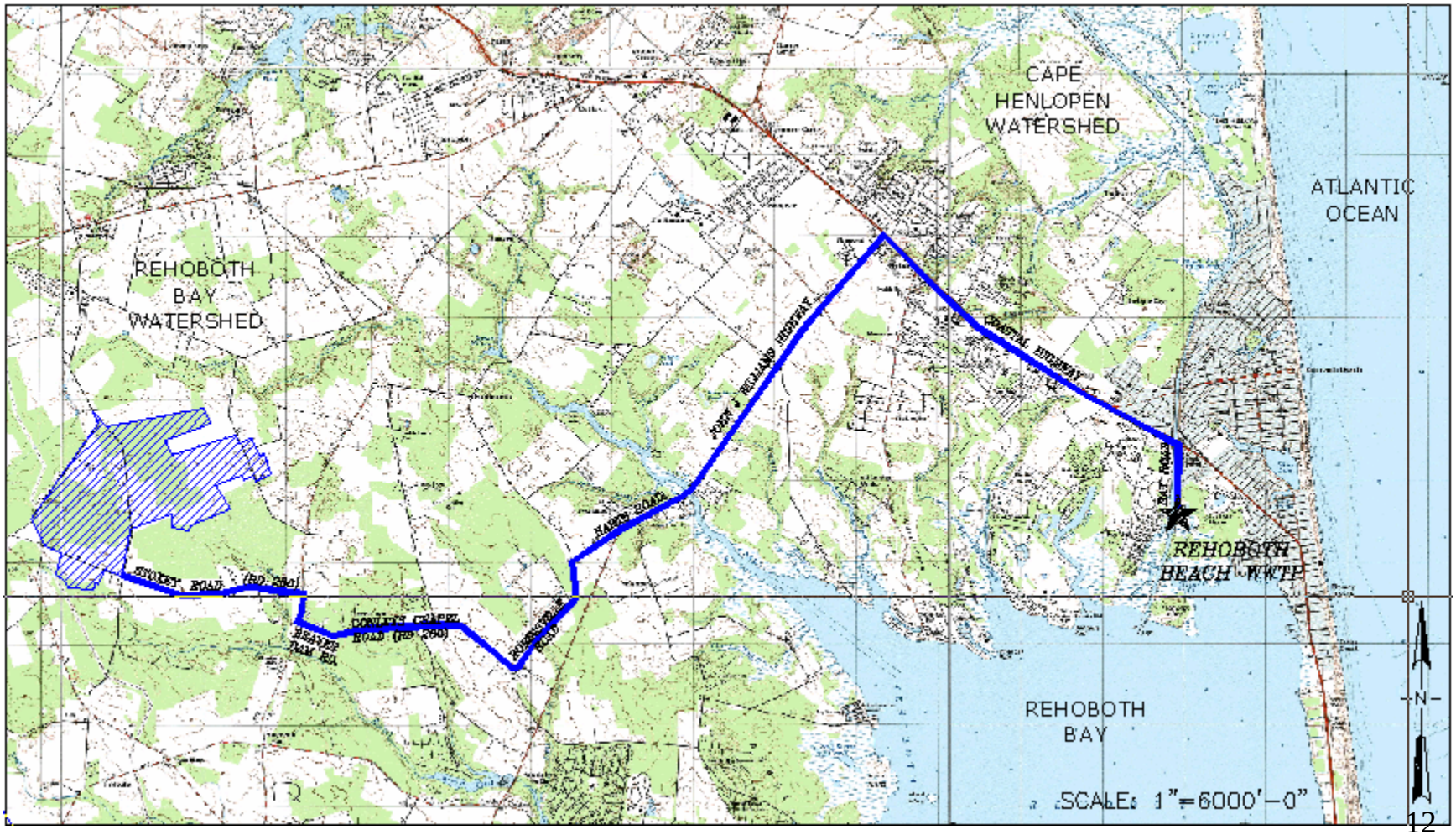


Spray Irrigation
Land Requirements

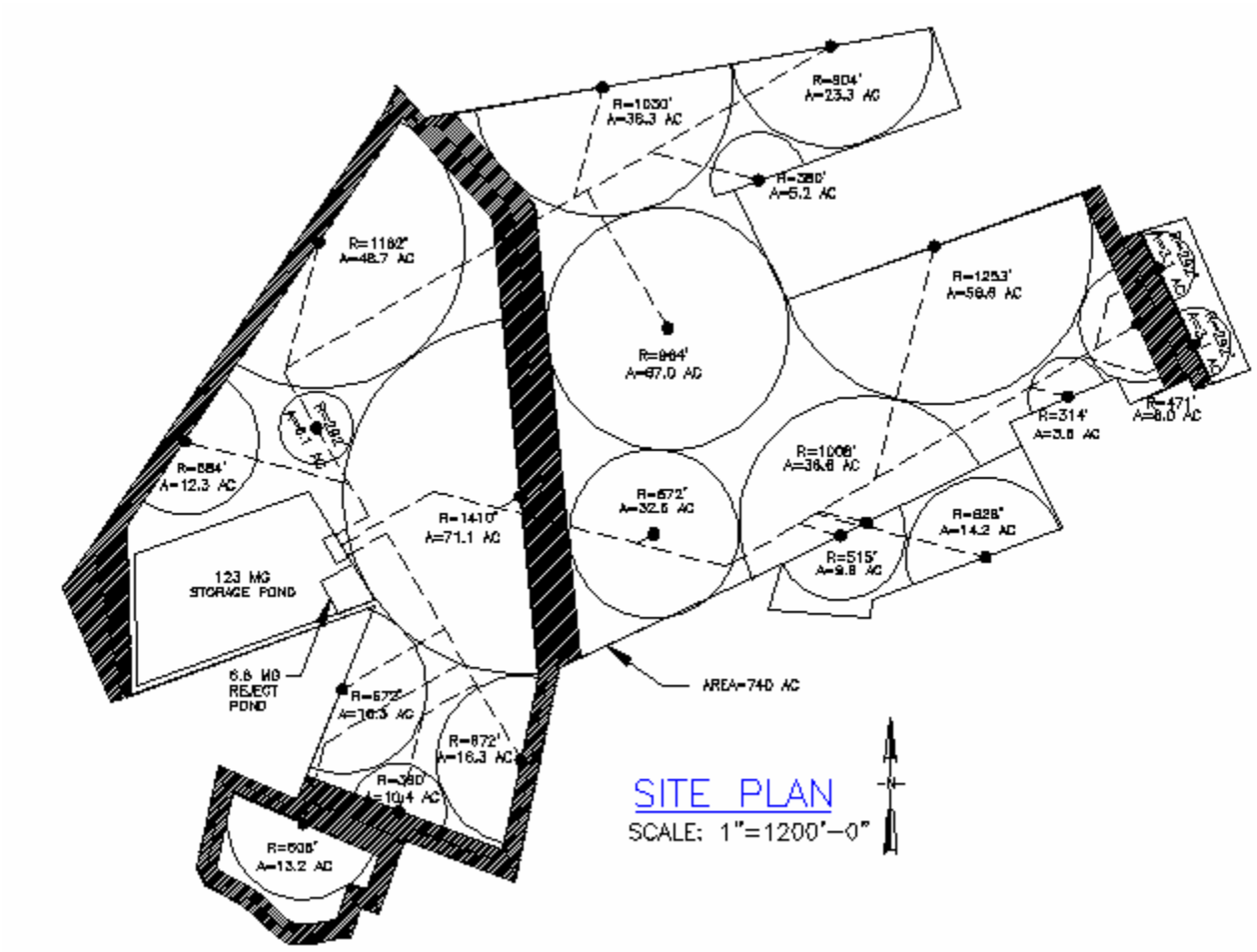
- Area required
  - Spray fields only 496 acres
  - Total (including buffers and lagoon) 740 acres

- Not enough land available for purchase or lease

Spray Irrigation
Site Location



Spray Irrigation
Spray Field Layout



Spray Irrigation
Cost Summary

Description	Cost
Rehoboth Beach WWTP Effluent Pump Station	$1,000,000
Force Main to Lagoon (Holding Pond)	$15,500,000
Spray Irrigation System	$16,400,000
Land Purchase Price(1)	$18,500,000
Construction Cost (Year 2004 Dollars)(2)	**$51,400,000**
Engineering, Construction Inspection, Administration, Legal and Financial Expenses @ 30%	**$9,900,000**
Total Project Cost	**$61,300,000**

Notes:
1. Land price estimate based on 740 acres @ $25,000 per acre.
2. Cost includes 30 % contingency

Rapid Infiltration Beds (RIB)

Falmouth, MA – 0.8 mgd facility

Rapid Infiltration Beds
Issues

Nutrient Fate

- Potential sites are in the Rehoboth Bay Watershed
- Groundwater flows directly and indirectly into the Love Creek and Herring Creek
- Ultimately the nutrients discharge to Inland Bays:
  - At 3.4 mgd and 5 mg/L TN = 142 lbs/day
  - At 3.4 mgd and 1 mg/L TP = 28.5 lbs/day

Groundwater Mounding

- Discharge into Columbia aquifer
- Groundwater depth is approximately 10 feet
- Hantaxis Model used to determine mounding based on:
- An annual average flow of 2.3 mgd over 90 acres results in the potential formation of a 9 foot mound
- Additional modeling required for more precise predictions

RIB – Advantages/Disadvantages

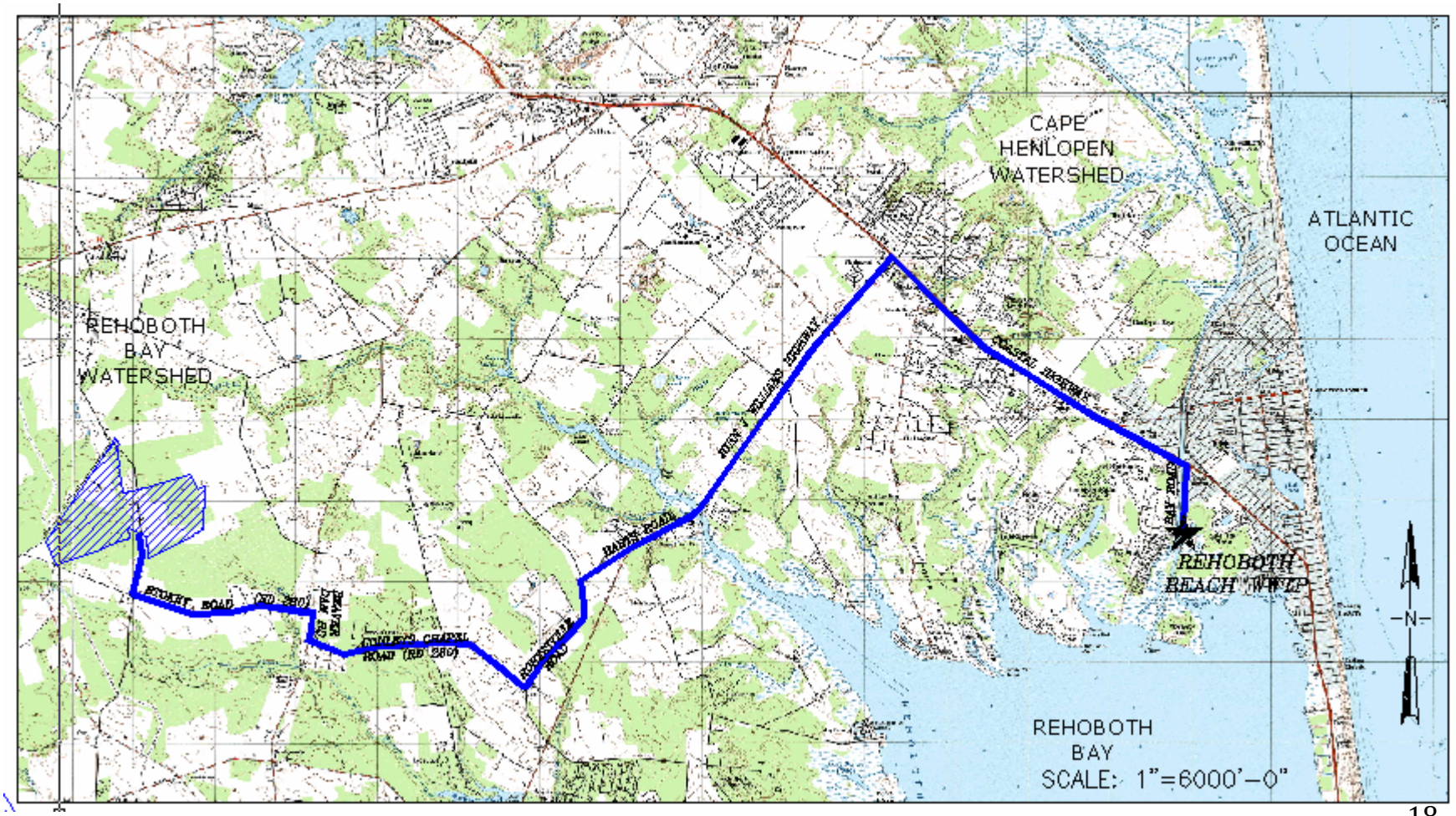
Advantages

- Easy to operate
- Relatively inexpensive

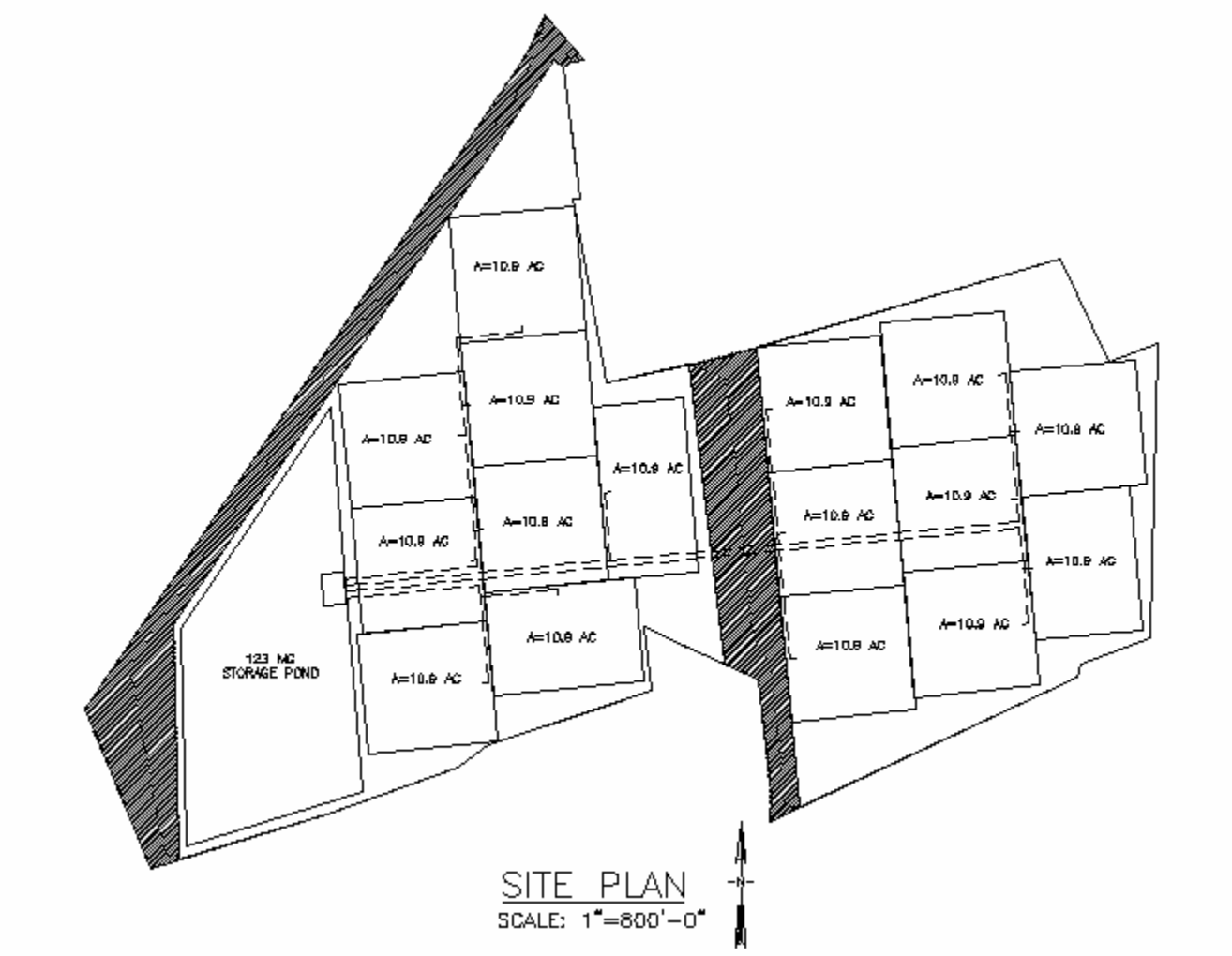
Disadvantages

- Large land requirement (cost)
- Nutrient transport into Inland Bays greater than TMDL
- Potential for 9-foot of water mounding
- Potential for increase nitrates in groundwater

Rapid Infiltration Beds
Field Location



Rapid Infiltration Beds
RIB Layout



Rapid Infiltration Beds
Summary of Costs

Description	Cost
Rehoboth Beach WWTP Effluent Pump Station	$1,000,000
Force Main to Holding Pond	$15,500,000
Rapid Infiltration Bed System	$18,900,000
Land Purchase Price(1)	$7,350,000
Construction Cost (Year 2004 Dollars)(2)	**$42,750,000**
Engineering, Construction Inspection, Administration, Legal and Financial Expenses @ 30%	**$10,600,000**
Total Project Cost	**$53,350,000**

Notes:

1. Land price estimate based on 296 acres @ $25,000 per acre.
2. Cost includes 30 % contingency. No contingency for land prices.

Underground Injection
Definitions

- Shallow Injection Wells (Class V)
  - Wells that discharge into an existing or potential drinking water aquifer defined as Underground Source of Drinking Water (USDW) which has TDS < 10,000 mg/L
  - Must meet primary drinking water standards
- Deep Injection Wells (DIW)
  - Discharge below USDW aquifers
  - Confined from aquifers above

Shallow Injection Well

- Regulated as Class V well
  - Delaware's UIC regulations define Class V as well being used to "replenish the water in an aquifer" and "not included in Class I, II, III, and IV wells."
  - Does not specifically define the injection of treated wastewater
  - Must meet primary drinking water standards or discharge in a non-USDW aquifer (>10,000 TDS, salt water intrusion)
- Injection would enter the water table

  (Columbia aquifer)

Shallow Injection Well
Issues

Nutrient Fate

- The groundwater recharges the Lewes and Rehoboth Canal
- Nutrient load will move from the Canal into the Inlands Bays

Groundwater Mounding

- Groundwater mounding can occur based on rate of recharge and hydraulic conductivity
- Discharge will recharge water table – Columbia aquifer
- Groundwater depth is approximately 5-10 feet below grade
- Significant potential for localized mounding and flooding if shallowest aquifer used
- Pilot testing necessary for well and aquifer verification

Shallow Injection Well
Advantages /Disadvantages

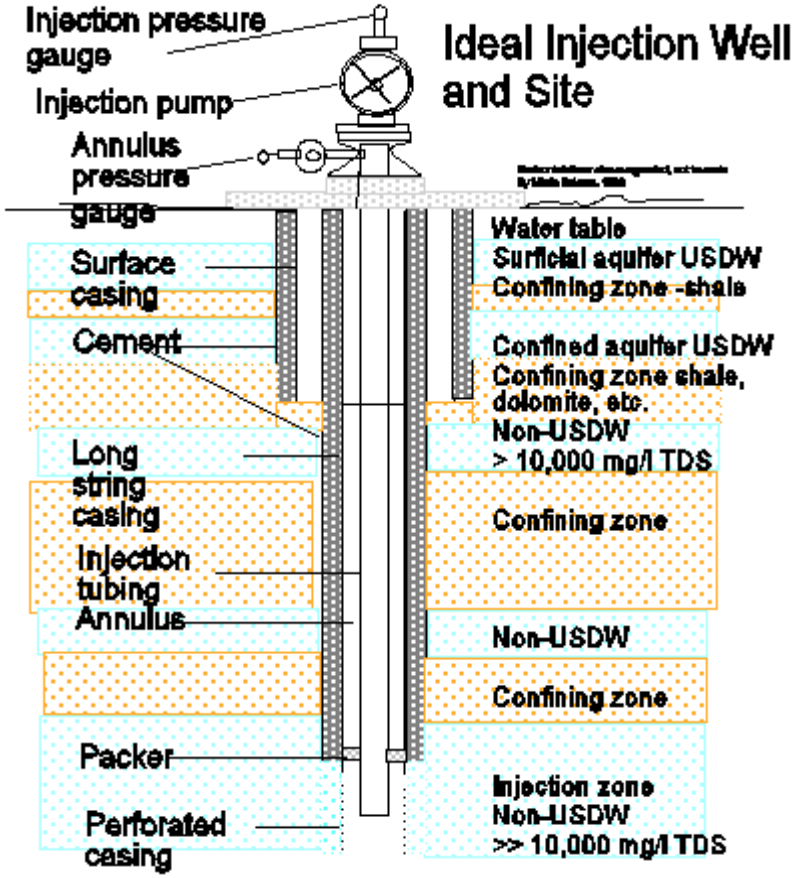
Advantages

- Significantly less land requirements
- Recharge groundwater

Disadvantages

- Nutrient transport ultimately into Inland Bays
- Complex operations
- High level of pretreatment required (drinking water standards)
- Periodic maintenance required (acid cleaning)
- Unknown aquifer hydraulic capacity
- Significant risk of mounding based on RIB data
- Potential increase of nitrates in groundwater
- No salt water intrustion aquifers available
- Pilot borings required to characterize well and aquifer

Deep Well Injection
Typical Schematic

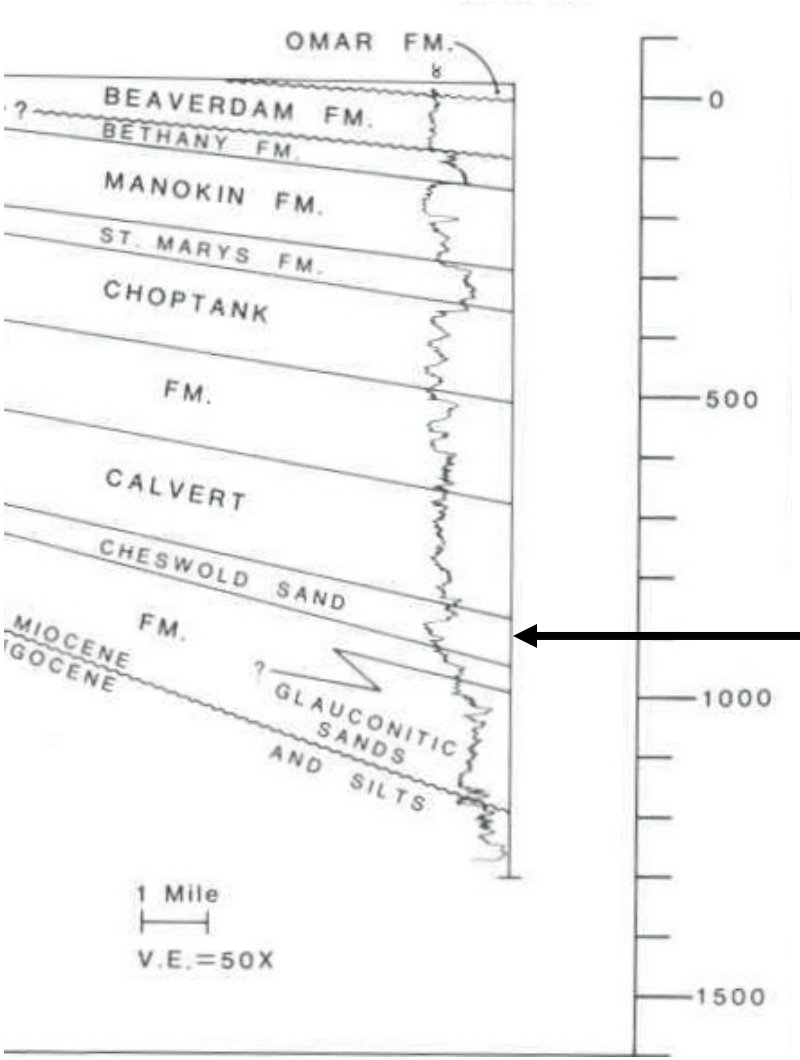


Deep Injection Well

Deep Well Injection
Site Selection Criteria

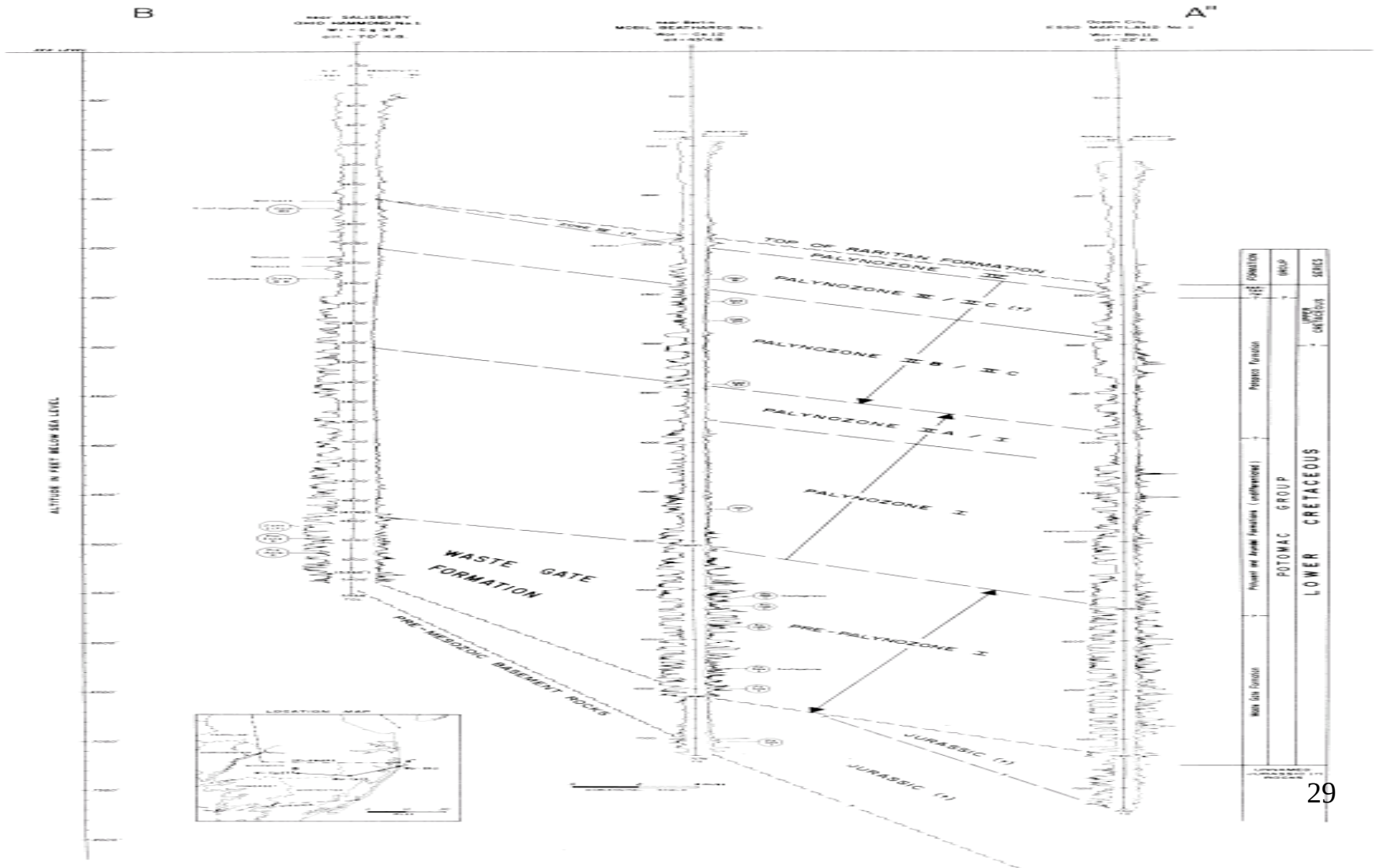
- An injection zone must:
  - not be a USDW
  - be separated from USDW by overlying confining layers
  - have adequate hydraulic capacity
  - be sufficiently far from a location where the aquifer turns into a USDW such that no effluent can migrate to the USDW

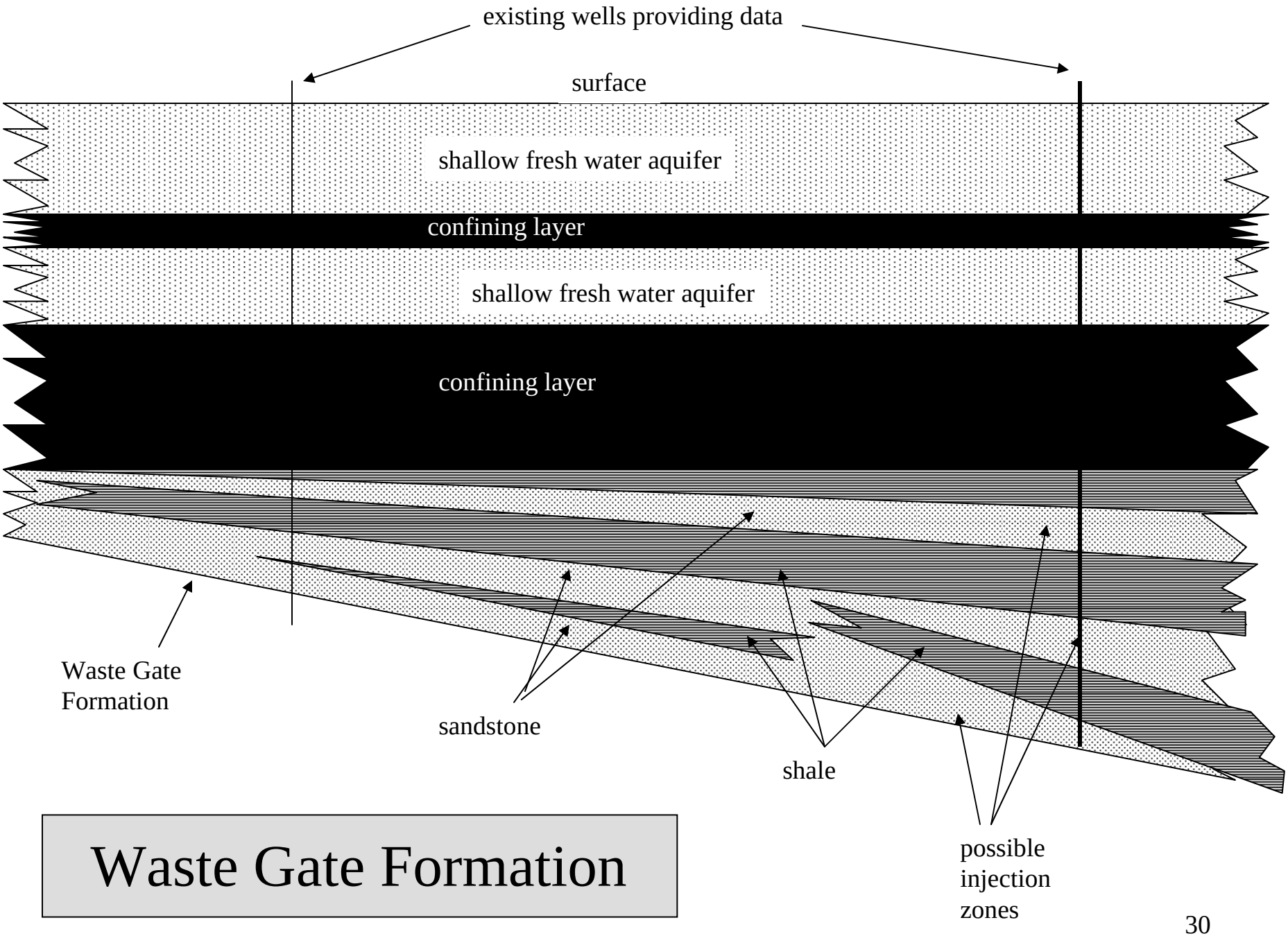
Deep Well Injection
Cheswold Formation



Potential DIW aquifer

Waste Gate Formation





Waste Gate Formation

DIW - Advantages/Disadvantages

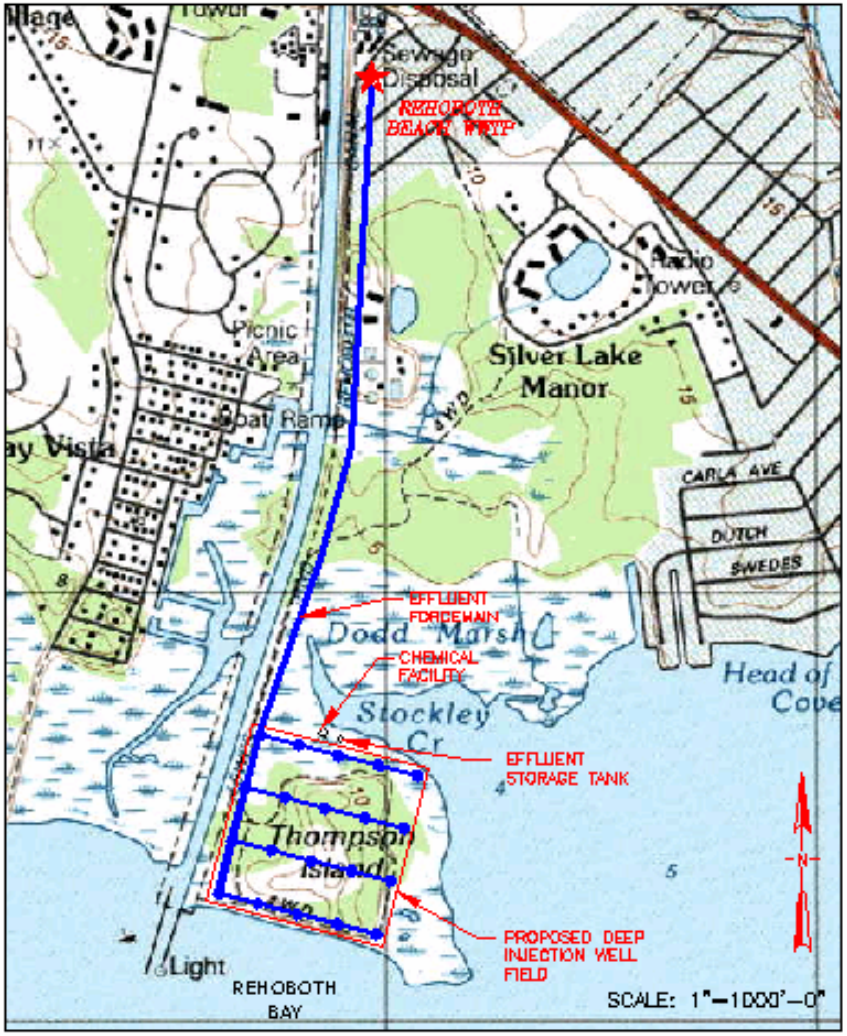
Advantages

- Significantly less land requirement
- No potential for ultimate discharge to surface water
- Primary drinking water standards not required

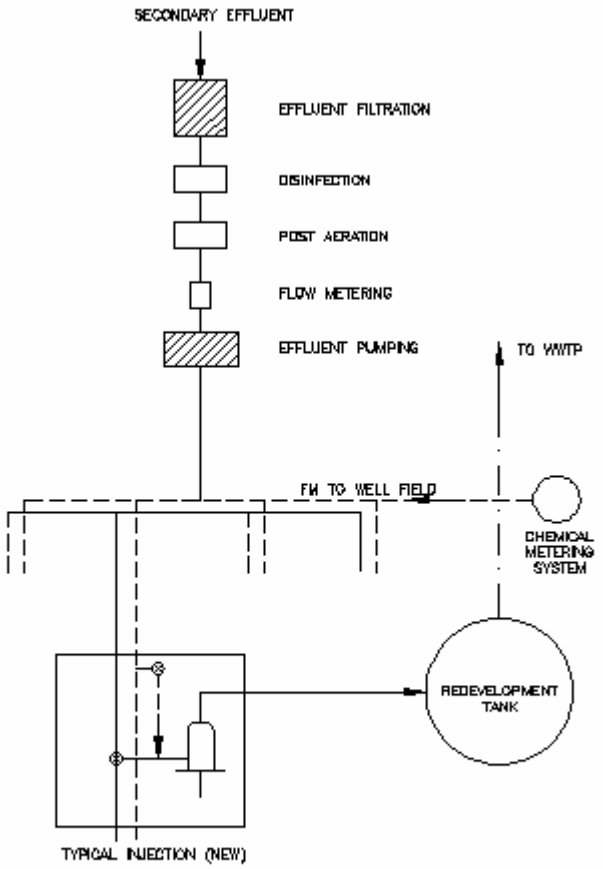
Disadvantages

- Complex operations
- High level of pretreatment required including filtration and chlorination
- Periodic maintenance required
- Unknown subsurface below 900 ft
- Unknown aquifer hydraulic capacity
- Pilot borings required to characterize well and aquifer
- No qualified local contractor
- No groundwater recharge
- High Risk

Deep Well Injection
Site Layout



Deep Well Injection
Schematic



PROPOSED DEEP WELL
INJECTION PROCESS SCHEMATIC
NOT TO SCALE

Deep Well Injection
Summary of Costs

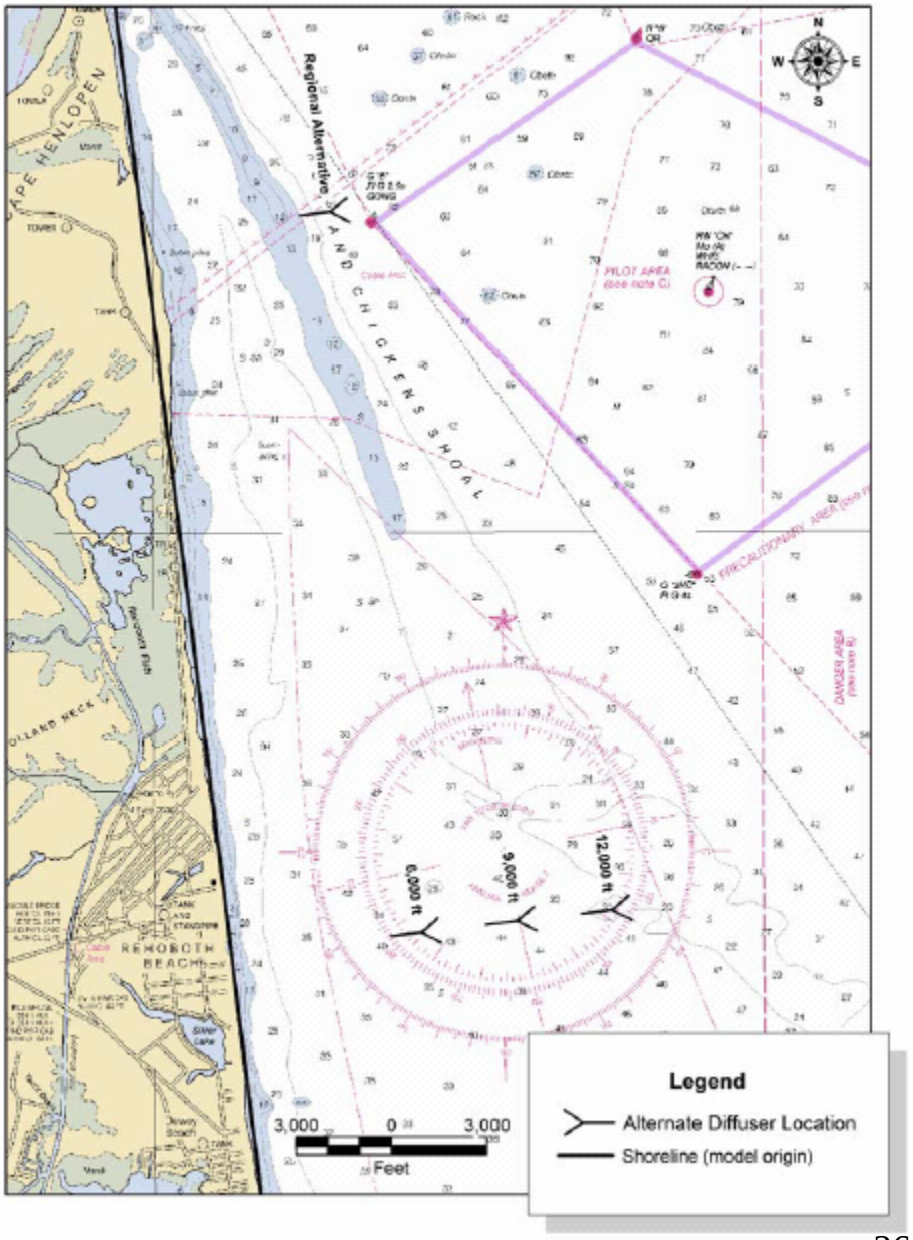
Description	Cost
Rehoboth Beach WWTP - Effluent Filters	$2,680,000
Rehoboth Beach WWTP – Effluent Pump Station	$1,000,000
Chlorination System	$30,000
Force Main to Well Field	$1,090,000
6,000 ft Deep Injection Well (20 wells @ $4,000,000)	$80,000,000
Well Field Pipe Manifold	$760,000
Well Redevelopment	$410,000
Land Purchase Price(1)	$1,050,000
Construction Cost (Year 2004 Dollars)(2)	**$87,020,000**
Engineering, Construction Inspection, Administration, Legal and Financial Expenses @ 30%	**$25,800,000**
Total Project Cost	**$112,800,000**

Notes:
1. Land price estimate based on 42 acres @ $25,000 per acre
2. Cost includes 30 % contingency. No contingency on land purchase.

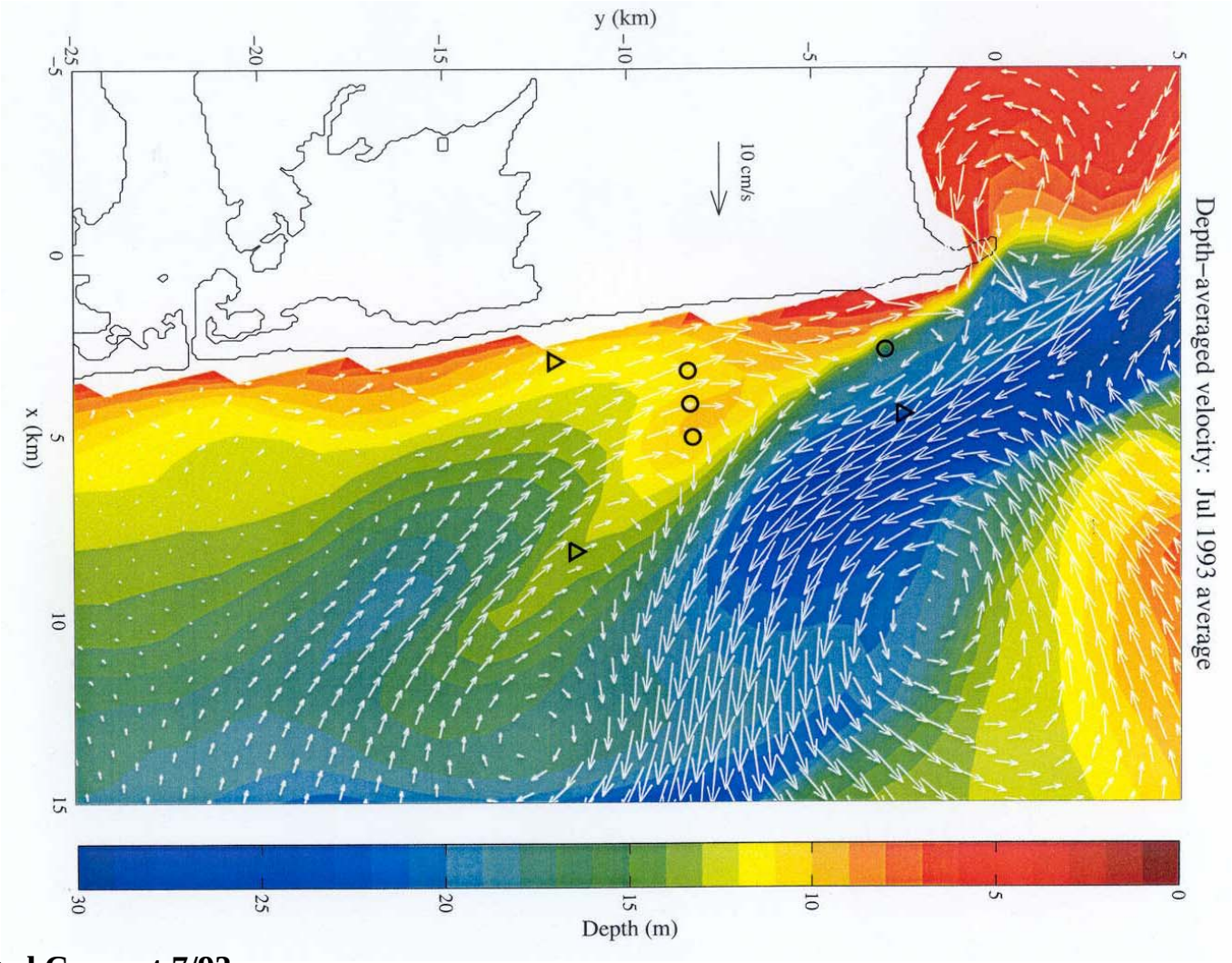
Ocean Outfall

- Location
- University of Delaware current model
- Mixing Model (CORMIX)
  - Rehoboth Beach only
  - Regional alternatives
  - Optimized diffuser design

Outfall Locations

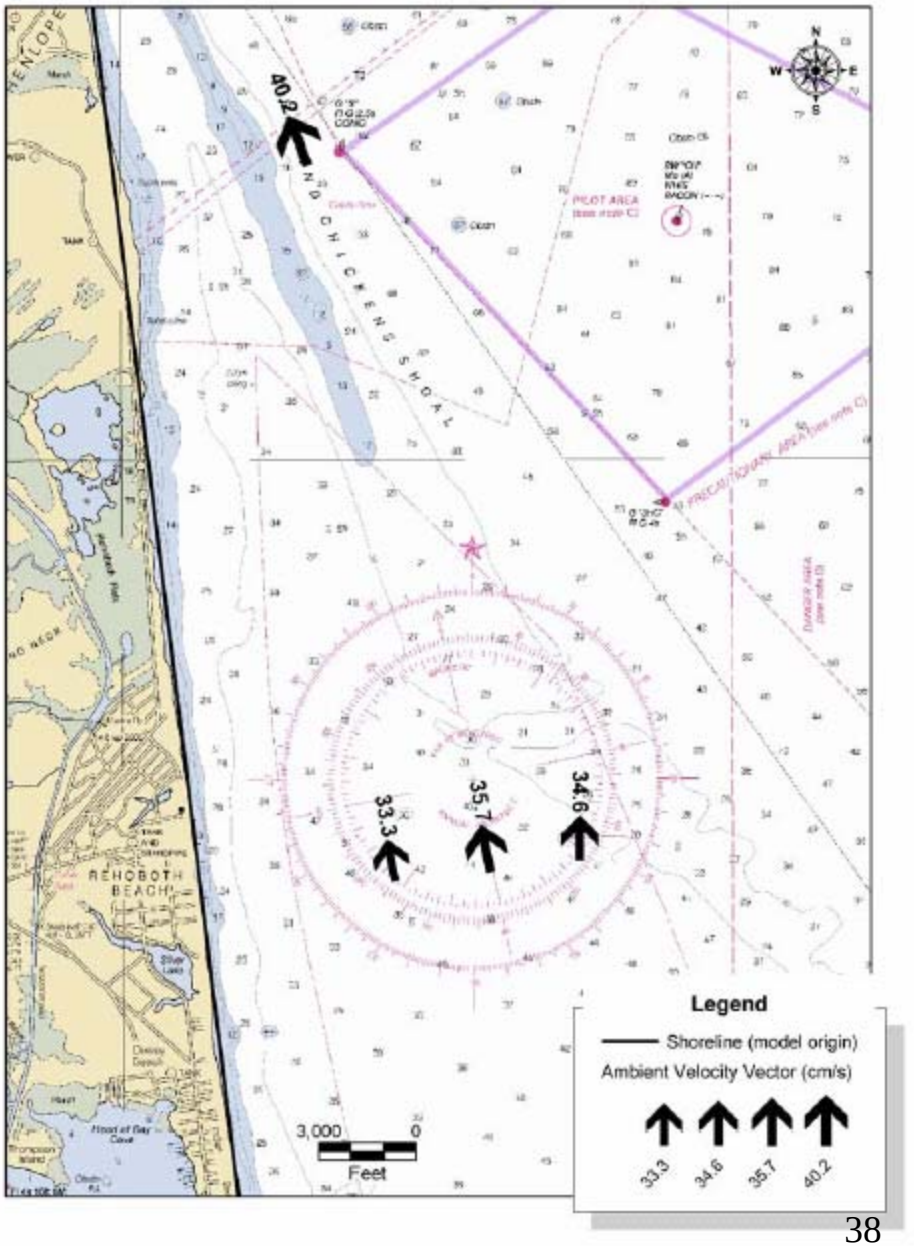


University of Delaware
Current Model



Depth Averaged Current 7/93

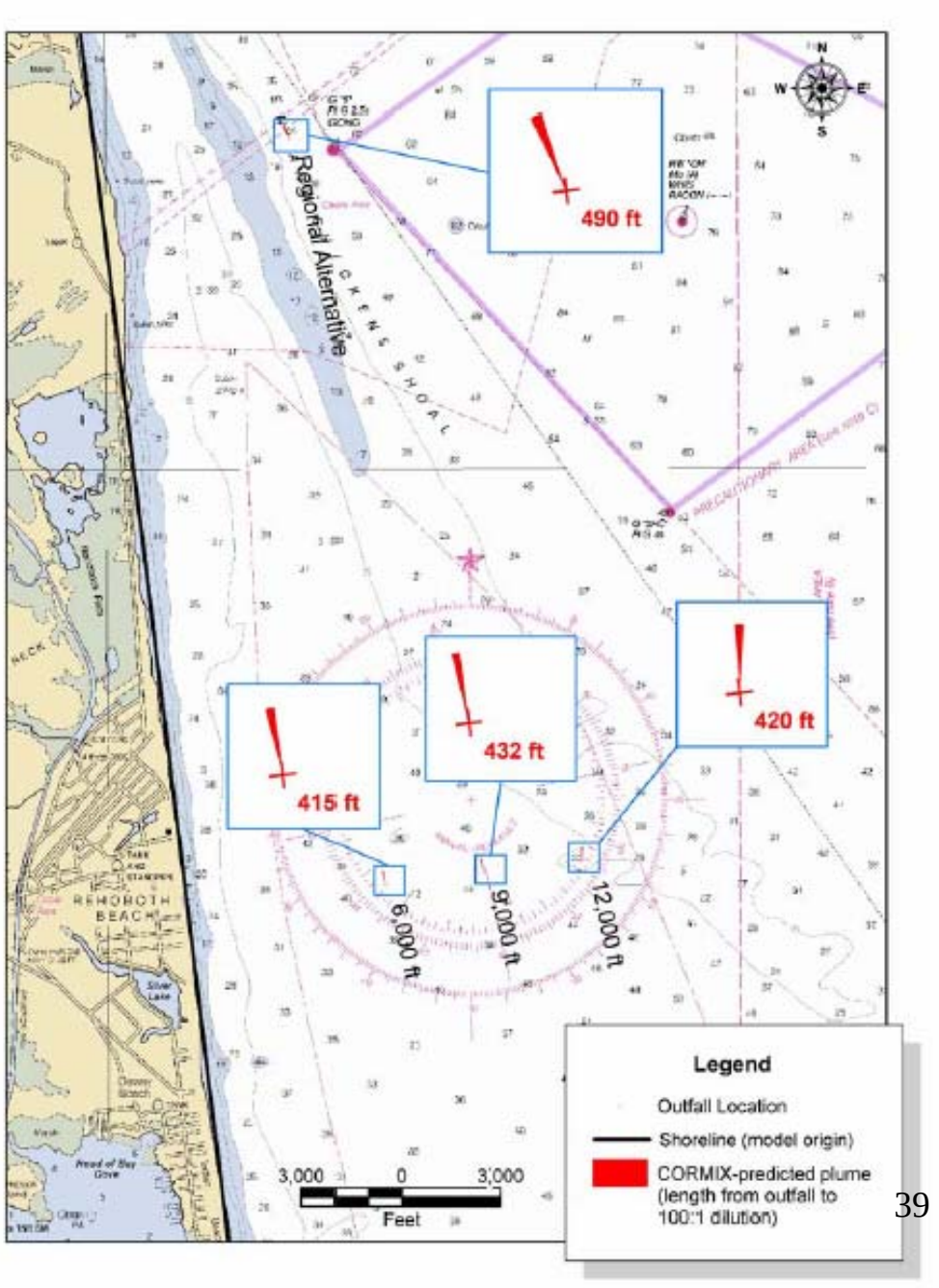
Current Velocity



Distance to 100:1 Dilution

Rehoboth Beach

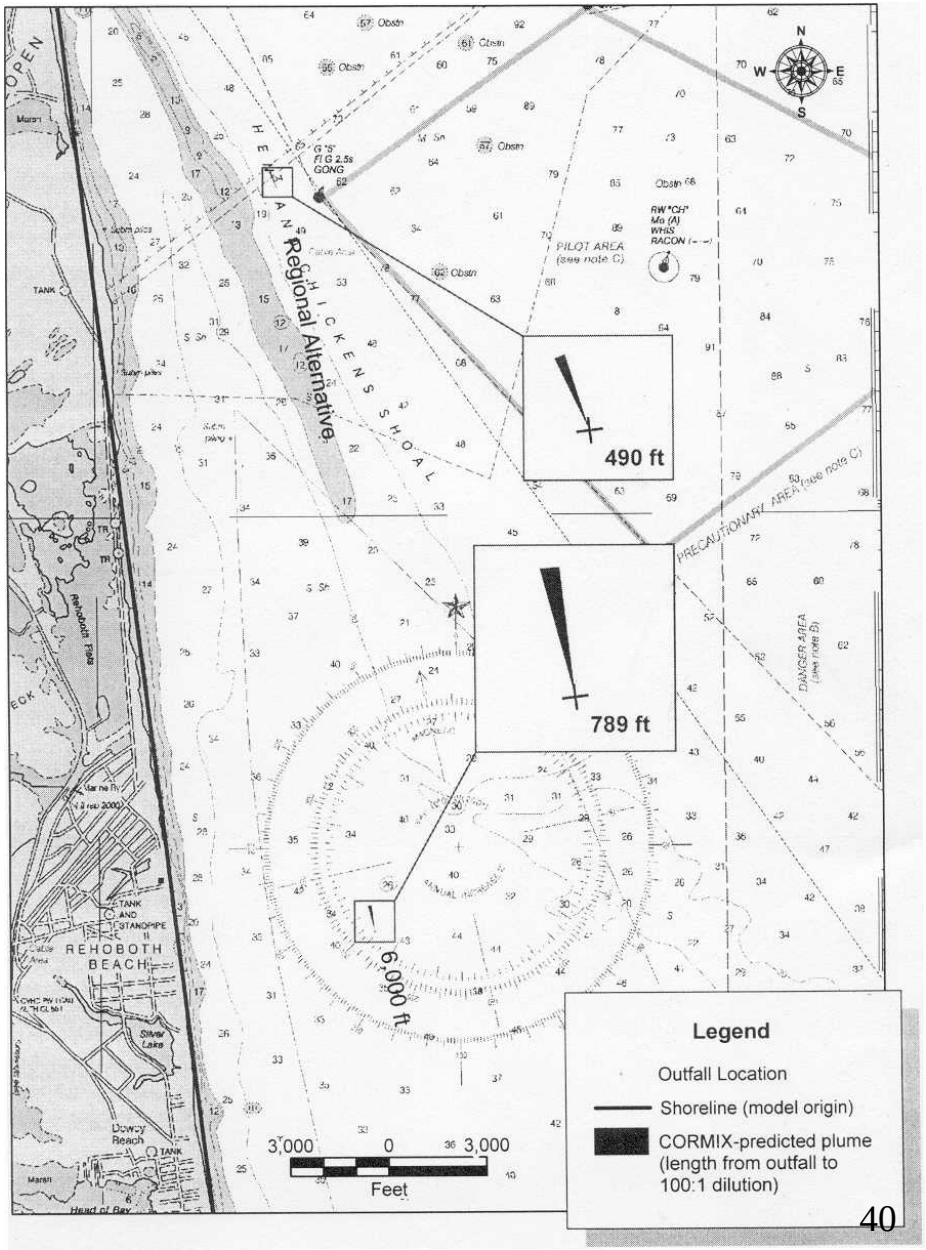
Only Flows



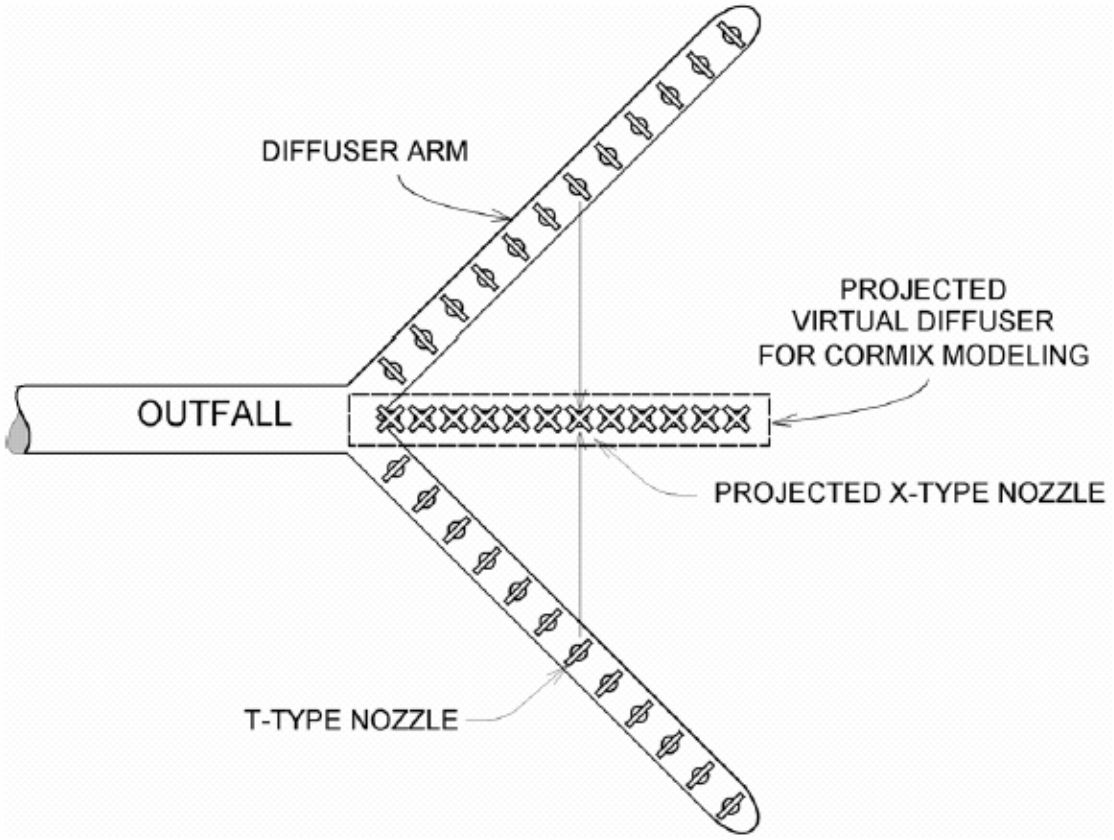
Distance to 100:1 Dilution

Regional

Flows



Schematic Design of Diffuser



Ocean Outfall – Advantages/Disadvantages

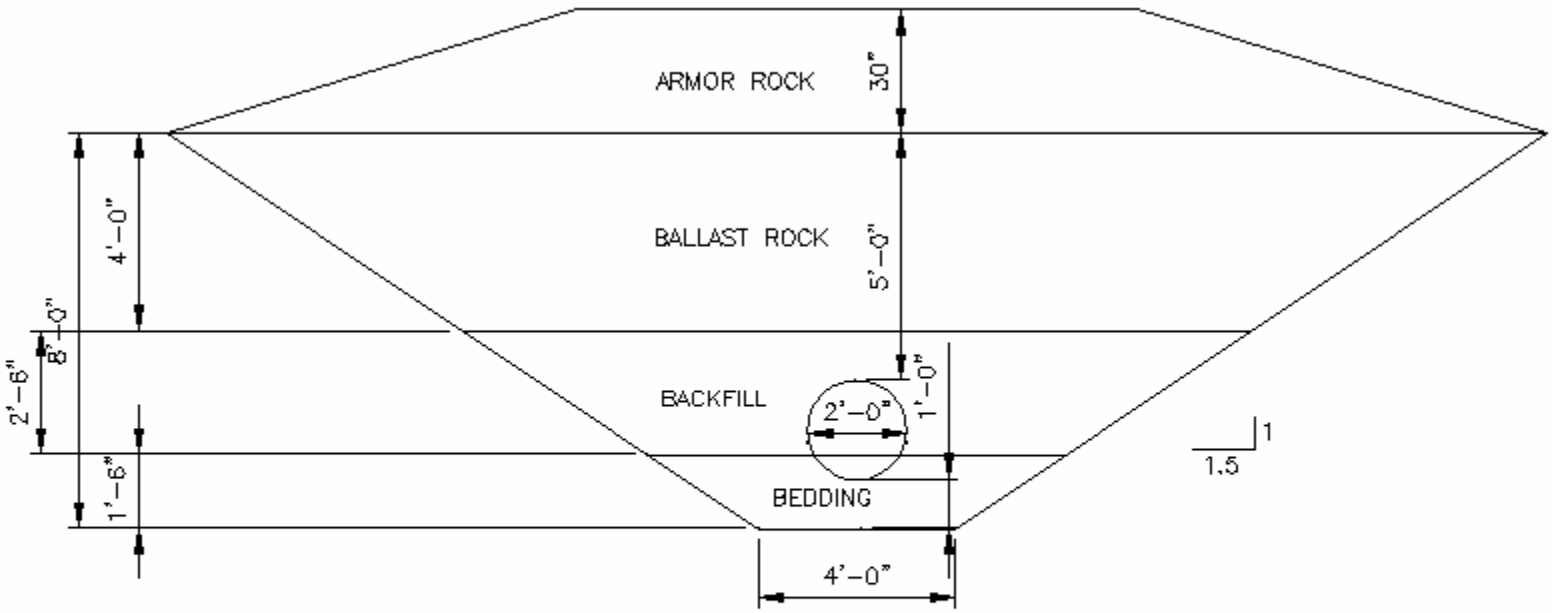
Advantages

- Minimal operation required (pumping)
- Minimal maintenance requirements (outfall inspections)
- No potential nutrient transport into Inland Bays
- Perceived as ultimate solution

Disadvantages

- Public acceptance
- Permitting
- No groundwater recharge

Ocean Outfall
Cross Section



TYPICAL OCEAN OUTFALL
CROSS SECTION
SCALE: NTS

Ocean Outfall
Force Main and Outfall

Ocean Outfall
Summary of Costs

Rehoboth Beach Only

Description	Cost
Rehoboth Beach WWTP Effluent Filters	$2,860,000
Rehoboth Beach WWTP Effluent Pump Station	$1,500,000
Effluent Force Main	$2,670,000
Ocean Outfall	$22,100,000
Construction Cost (Year 2004 Dollars)[2]	**$29,130,000**
Engineering, Construction Inspection, Administration, Legal and Financial Expenses @ 30%	**$7,500,000**
Total Project Cost	**$36,630,000**

Regional Solution

Description	Cost
Rehoboth Beach WWTP Improvements	$4,360,000
Wolfe Neck RWF Improvements	$17,700,000
Rehoboth Beach Force Main	$1,290,000
Wolfe Neck Force Main	$3,710,000
Force Main from Tie-In to Ocean Outfall	$1,950,000
Ocean Outfall	$22,400,000
Construction Cost (Year 2004 Dollars)[1]	**$51,400,000**
Engineering, Construction Inspection, Administration, Legal and Financial Expenses @ 30%	**$15,400,000**
Total Project Cost	**$66,800,000**

Alternative Comparison

Issue	Land Application	RIB	Underground Injection		Ocean Outfall
			Shallow	Deep	
Public Acceptance	+	0	-	-	-
Environmental Impacts	+	-	-	0	0
Nutrient Loading to Inland Bays	0	-	-	+	+
Permitting Issues	+	-	-	-	0
Reliability	0	0	-	-	+
Operability	0	+	-	-	+
Constructability	0	+	-	-	0
Long Term Solution	0	-	0	0	+
Groundwater Recharge	+	+	+	-	-
Land Requirement	-	-	0	0	+
Risk	+	0	-	-	+
Cost	0	0	0	-	+
Summary **+** **0** **-**	**5** **6** **1**	**3** **4** **5**	**1** **3** **8**	**1** **3** **8**	**7** **3** **2**

Conclusions

Eliminate:

- Spray Irrigation
  - Land not available
- Rapid Infiltration Beds
  - Land not available
  - Nutrient discharge to Inland Bays
- Shallow Well Injection
  - No appropriate sites or aquifers
  - Nutrient discharge to Inland Bays
- Deep Well Injection
  - Excessive risk and cost

Recommended Alternative:

- Ocean Outfall
  - Lowest PW Value
  - Regional solution

Ocean Outfall
Impact on User Fees

	Rehoboth Beach Only		Regional Solution	
	No Grant	**With Grant**	**No Grant**	**With Grant**
Rehoboth Beach				
Total Annual User Charge	$997	$455	$661	$455
Percent Increase	223%	50%	118%	50%
% MHI [1]	1.4	0.6	0.9	0.6
Grant Amount [3]	--	$32,500,000	--	$12,700,000
Sussex County				
Total Annual User Charge			$983	$882
Percent Increase			58%	42%
% MHI [2]			1.7	1.5
Grant Amount [4]			--	$29,900,000

Notes:

[1] Rehoboth Beach MHI = $72,050 (projected to 2012).

[2] Sussex County MHI = $57,600 (projected to 2012) – Estimate.

[3] Grant as required to limit user charge increase to 50%.

[4] Grant based on 50% of capital cost.

Next Steps

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- Make report available (pdf format)
- Present to various interest groups
- Consent order compliance schedule
- NP-7 Permit Application
- Baseline studies

Questions ?

Alternative Capital Costs

Effluent Disposal Alternative	Capital Cost (2004$)
Spray Irrigation	$61,300,000
Rapid Infiltration Bed	$53,350,000
Deep Well Injection	$112,800,000
Ocean Outfall	
Rehoboth Beach only	$36,630,000
Regional Solution - Rehoboth Beach	$16,800,000
Regional Solution - Sussex County	$50,100,000
Regional Solution - Total	$66,900,000

Additional Operating & Maintenance Costs

Effluent Disposal Alternative	O&M Cost (2004$)
Spray Irrigation	$140,000
Rapid Infiltration Bed	$135,000
Deep Well Injection	$156,000
Ocean Outfall	
Rehoboth Beach only	$158,000
Regional Solution – Rehoboth Beach	$158,000
Regional Solution – Sussex County	$603,000

Present Worth Cost Assumptions

Parameter	Value
Period for Present Worth Analysis	20
Annual Inflation Rate[(1)]	3.000%
Annual Interest Rate[(1)]	6.625%
Effluent Annual Interest Rate[(2)]	3.519%
Conversion Factor For Annual Cost to Present Worth[(3)]	14.19

Present Worth Alternative Cost Summary

Effluent Disposal Alternative	Capital Cost (2004$)	20-year O&M Present Worth Costs (2004$)	Present Worth Cost (2004$)
Spray Irrigation	$61,300,000	$1,990,000	$63,290,000
Rapid Infiltration Bed	$53,350,000	$1,920,000	$55,270,000
Deep Well Injection	$112,800,000	$2,210,000	$115,010,000
Ocean Outfall			
Rehoboth Beach	$36,630,000	$2,240,000	$38,870,000
Regional – Rehoboth Beach	$16,800,000	$2,240,000	$19,040,000
Regional – Sussex County	$50,100,000	$8,560,000	$58,660,000

Rehoboth Beach Annual Revenue

Source	2003 Revenue ($)
Metered Sewers – Commercial	$394,744
Metered Sewers – Residential	$641,030
North Shores	$130,379
Dewey Beach	$457,425
Henlopen Acres	$37,285
Total	**$1,660,862**

Rehoboth Beach User Charge Cost Analysis Parameters

Parameter	Value
Period for Present Worth Analysis(1)	20 years
Annual Interest Rate(1)	4%
Conversion Factor for Present Worth to Annual Cost(2)	0.0736

Notes:

1. Assumed values for Present Worth Analysis
2. Calculated conversion value: $(Rate*(1+Rate)^{20})/(1+Rate)^{20} -1)$

Rehoboth Beach Ocean Outfall
Annual O&M Cost – No Grant Funding

Source	Value
Total Cost (Year $2012)	$43,740,000

Source	Value
Existing WWTP O&M Costs	$1,530,000
Additional O&M Costs (Ocean Outfall)	$189,000
Additional WWTP O&M Costs	$418,000
Annual Interest	$1,750,000
Annual Principal	$1,470,000
Total Annual Cost	$5,360,000

Note: All costs in Year 2012 dollars

Rehoboth Beach Annual Revenue with 223% Increase in User Charges and No Grant Funding

Source	Value
Metered Sewers – Commercial	$2,070,000
Metered Sewers – Residential	$1,270,000
North Shores	$420,000
Dewey Beach	$1,480,000
Henlopen Acres	$120,000
Total	**$5,360,000**
New Rehoboth Beach User Charge	**$977.46**

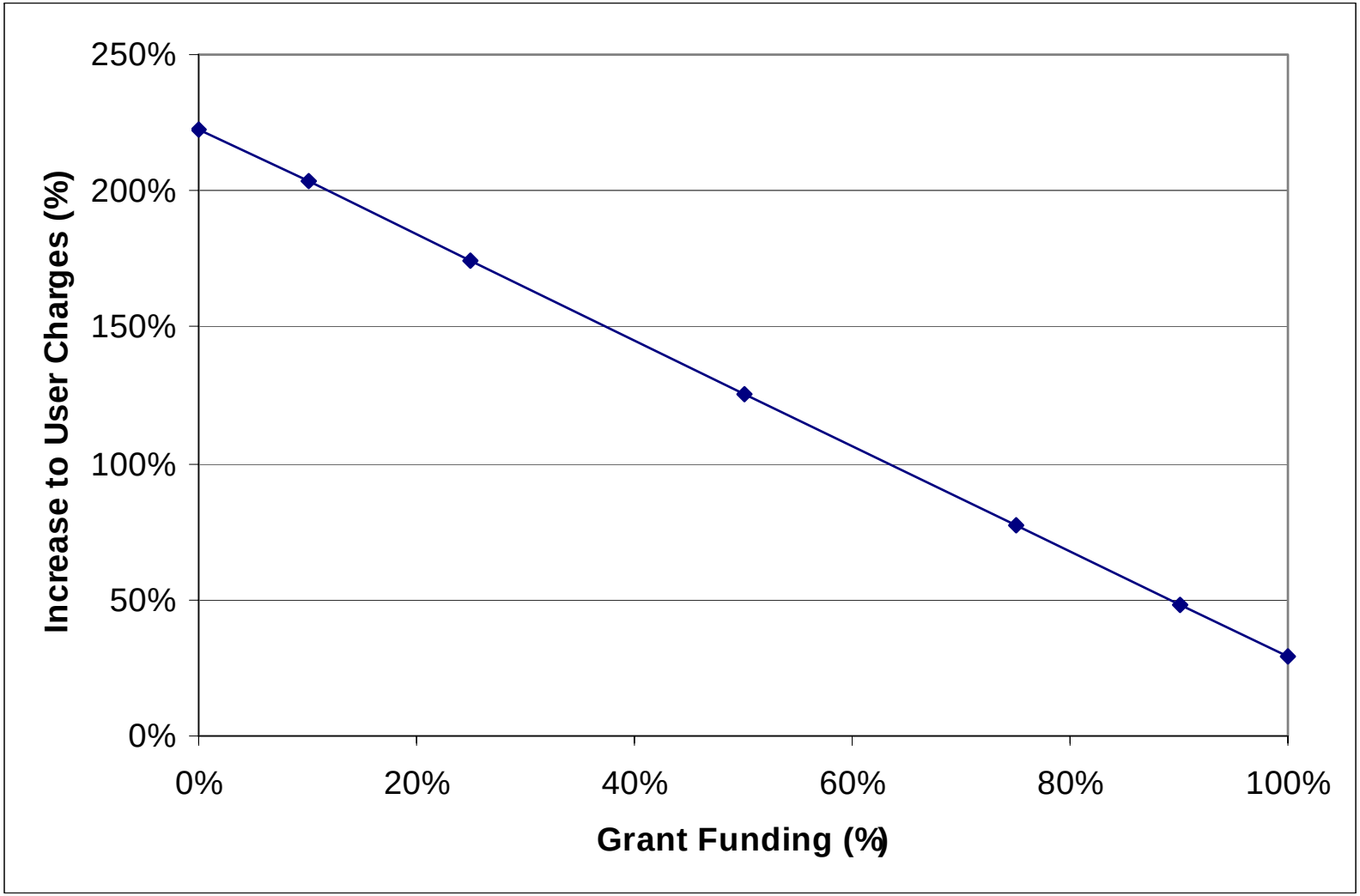
Note: All costs in Year 2012 dollars

Rehoboth Beach Annual Revenue
50% Increase in User Charges & 88.7% Grant

Source	Value
Rehoboth Beach Loan	$4,940,000
87.7% Grant Funding	$38,800,000
Total Cost (Year $2012)	$43,740,000

Source	Value
Metered Sewers – Commercial	$960,000
Metered Sewers – Residential	$590,000
North Shores	$200,000
Dewey Beach	$690,000
Henlopen Acres	$60,000
Total	**$2,500,000**
New Rehoboth Beach User Charge	**$454.63**

Rehoboth Beach Ocean Outfall
Grant Funding Sensitivity Analysis



Rehoboth Beach Annual Cost
Regional Ocean Outfall Option – No Grant Funding

Source	Value
Total Cost (Year $2012)	$20,060,000

Source	Value
Existing WWTP O&M Costs	$1,530,000
Additional O&M Costs (Ocean Outfall)	$189,000
Additional WWTP O&M Costs	$418,000
Annual Interest	$802,000
Annual Principal	$678,000
Total Annual Cost	$3,620,000

Rehoboth Beach Annual Revenue with 118% Increase in User Charges and No Grant Funding

Source	Value
Metered Sewers – Commercial	$1,400,000
Metered Sewers – Residential	$860,000
North Shores	$280,000
Dewey Beach	$1,000,000
Henlopen Acres	$80,000
Total	**$3,620,000**
New Rehoboth Beach User Charge	**$660.73**

Note: All costs in Year 2012 dollars

Rehoboth Beach Annual Revenue
50% Increase in User Charges & 75.5% Grant

Source	Value
Rehoboth Beach Loan	$4,910,000
75.5% Grant Funding	$15,150,000
Total Cost (Year $2012)	$20,060,000

Source	Value
Metered Sewers – Commercial	$960,000
Metered Sewers – Residential	$590,000
North Shores	$200,000
Dewey Beach	$690,000
Henlopen Acres	$60,000
Total	**$2,500,000**
New Rehoboth Beach User Charge	**$454.63**

Sussex County Annual Cost
Regional Ocean Outfall Option – No Grant Funding

Source	Value
Total Cost (Year $2012)	$59,820,000

Source	Value
Annual Loan Cost (Interest & Principal)	$3,714,000
Additional O&M Costs (WWTP & Ocean Outfall)	$720,000
Total Annual Cost	$4,434,000

Note:

1. Estimated 40 year bond at annual interest rate of 5.50%
2. All cost in Year 2012 dollars

Sussex County Annual Cost Regional Ocean Outfall Option with 39% Increase in User Charges

Source	Value
Annual Cost for Ocean Outfall and Plant Upgrades	$4,434,000
Number of EDUs (Year 2012)	18,326
Additional O&M Costs (WWTP & Ocean Outfall) per EDU	$242
Estimated User Charge	$621
Project 2012 User Charge – 39% Increase	$863

Sussex County Annual Cost Regional Ocean Outfall Option with 50% Grant Funding

Source	Value
Sussex County Loan	$29,910,000
50.0% Grant Funding	$29,910,000
Total Cost (Year $2012)	$59,820,000

Source	Value
Annual Loan Cost (Interest & Principal)	$1,857,000
Additional O&M Costs (WWTP & Ocean Outfall)	$720,000
Total Annual Cost	$2,577,000

Rehoboth Beach Annual Revenue with 50% Grant Funding and 23% Increase in User Charges

Source	Value
Annual Cost for Ocean Outfall and Plant Upgrades	$2,577,000
Number of EDUs (Year 2012)	18,326
Additional O&M Costs (WWTP & Ocean Outfall) per EDU	$141
Estimated User Charge	$621
Project 2012 User Charge	$762