BASIS OF DESIGN REPORT

Water Treatment and Distribution Facilities
Rodanthe-Waves-Salvo
Dare County, North Carolina

Black & Veatch
B&V Project 24420
Revised April 1994

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BASIS OF DESIGN REPORT

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Water Treatment and Distribution Facilities
Rodanthe-Waves-Salvo

A. General

1. Project Description

This project involves the design, bidding, and construction management of a new water treatment and distribution system for Dare County, North Carolina. The system will serve three villages on Hatteras Island: Rodanthe, Waves, and Salvo (RWS). This report will outline the design parameters, schedule, and cost for this project.

This project will include design of a 1 mgd reverse osmosis water treatment plant, two brackish wells, a 1 million gallon (MG) ground storage tank, 0.2 MG elevated storage tank, approximately 115,000 linear feet of water distribution main from 2-inch to 12-inch diameter, and all required appurtenances.

2. Background Data

Feasibility studies for serving the RWS area of Dare County were initially begun in 1982. The reports listed below contain background information for this project.

Water Supply and Treatment Alternatives for the Villages of Rodanthe-Waves-Salvo, August 1982 by Moore, Gardner & Associates

Potable Water Feasibility Report for Rodanthe-Waves-Salvo, August 1987 by Black & Veatch

Report on Reverse Osmosis Pilot Test, May 1990 by Ian C. Watson, P.E.

Hatteras Island Water System Feasibility Analysis, August 1990, by Malcolm Pirnie

Potable Water Feasibility Report for Rodanthe-Waves-Salvo, Revised June 1993 by Black & Veatch

3. *Governing Standards*

The following codes and standards apply to the design of this project.

- N.C. State Building Code - 1991 edition with 1994 revisions.
  - Volume I - General Construction
  - Volume IC - Accessibility
  - Volume II - Plumbing
  - Volume III - Mechanical
  - Volume IV - Electrical
  - Volume V - Fire Prevention
- N.C. Occupational and Health Standards for General Industry, 1991
- United States American and Disabilities Act
- National Fire Prevention Code
- North Carolina Administrative Code
  - Rules Governing Public Water Systems, January 1991
  - Sedimentation Control
  - Stormwater
- Policies and Procedures for Accommodating Utilities on Highway Rights-of-Way - N.C. Department of Transportation.
- Dare County Zoning Standards.

4. *Drafting Standards and Procedures*

a. Drawings. Drawings will be on 24 inch x 36 inch mylar and shall conform to the policies outlined in the Technical Data and Drafting Procedures Manual.

The plant and associated drawings will be AutoCAD Release 10 with the following general title block:

Water Treatment Facilities
Dare County, North Carolina
Rodanthe-Waves-Salvo

The distribution and raw water lines will be manual drafting on aerial photography at 1" = 100 feet scale with the following general title block:

Water Distribution System

Dare County, NC
Rodanthe-Waves-Salvo

b. Specifications. Standard Black & Veatch front-end documents and specifications format will be used.

5. Regulatory Permits/Approvals

The following permits and approvals are required for this project.

CAMA	Permit
NCDEHNR (EA)	FONSI
Corps of Engineers	Section 404 (Canal Crossings)
NCDEHNR - DHS	Permit to Construct
NCDEHNR - DLQ	Erosion Control Permit
NCDEHNR - DEM	Stormwater General Permit
NCDEHNR - DEM	NPDES Permit to Discharge to Sound
NCDOT	Highway Encroachment
Dare County Planning Board	Site Plan Approval
Dare County Health Department	Septic Tank Approval
NC Department of Insurance	Building Code Compliance
Dare County Inspection Department	Building Code Compliance

6. Construction Contracts

The work will be divided into the following individual bidder contract sections:

Contract No.	Description
1	RO Equipment Procurement
2	Generator Procurement
3	Site Grading and Erosion Control
4	Prestressed Storage Tank
5	General Contract
6	HVAC
7	Plumbing
8.	Electrical
9.	PLC SCADA Hardware Procurement
10.	Distributed Control/SCADA Software
11.	Elevated Storage Tank
12.	Distribution System (includes raw water lines)

The wells will be handled as a change order to an ongoing contract with the County. *Contract 12 will be subdivided into three sections to allow more participation from local contractors with limited licenses.*

7. Elevations

All elevations shown on the project drawings will be based on USGS datum.

8. Flood Elevation

The base flood elevation at the plant site is 8.0 according to Dare County building code officials. Due to recent flooding this is expected to increase to 10.0 at the next code revision. All facilities will be designed for a base flood elevation of 10.0.

9. Utilities

The following utilities exist in the project area:

Telephone: Carolina Telephone and Telegraph Co.
P.O. Box 430
Manteo, North Carolina 27954
Telephone: (919) 473-5373

Power: Cape Hatteras EMC
P.O. Box 9
Buxton, North Carolina 27920
Telephone: (919) 995-5616
Contact: Rich Bauer

There is no natural gas.

10. Land and Rights-of-Way

Dare County purchased the site for the water treatment facility shown as Area "A" on Figure 1. The following property remains to be purchased:

- Property within 100 feet of well No. 1 located in Area A above (shown as Area B on Figure 1).

- Easement for the concentrate discharge to Pamlico Sound. *Two potential routes were evaluated indicated as Areas C and D on Figure 1.* Area C follows the route of an existing 10 feet wide easement for a portion of the distance. Area D follows the access road to the marina. *Area D is the chosen route.*
- *A temporary easement to the south of the plant site indicated as Area E for staging by contractors.*
- Property for the well No. 2 site which will be located approximately 2,000 feet south of the plant site (approximately 1 acre). *This will also be the site of the elevated tank.*
- *The County may opt to purchase a site for location of future well No. 3 if funds are available. This will be located approximately 2,000 feet south of well No. 2 site.*

Dare County officials are currently negotiating with property owners to purchase this property.

11. Surveys

A topographic survey of the plant site (Area A) was performed shortly after the property was purchased. This survey will be used for site grading. The following additional surveying is required.

- Topographic survey of Area B (see Figure 1) and confirmation that this survey will tie to Area A topography (see Figure 2).
- A property boundary survey of Areas A and B to accurately locate and define all property corners on the ground. These property corners will be used by contractors for site staking.
- *An easement survey and a topographic survey of Area D.*
- Property and topographic surveys of the well No. 2 site.
- *Establishment of a USGS bench mark on the plant site and well No. 2 site.*

12. Work by Owner

Dare County will perform the following:

- Negotiations with property owners for all easements and property to be obtained.
- Acquisition of all property.

- Property and topographic surveys of all property including maps and legal descriptions.

13. Geotechnical Investigation

Geo Technologies has entered into a subcontract with Black & Veatch to perform all geotechnical investigations for this work. A geotechnical report has been issued for the plant site and is included as Appendix A. Investigation of the elevated tank site and a subsequent report will be completed after the site is identified.

14. Wetlands Delineation

As a part of the permitting process, wetlands within the project area potentially impacted by construction will be delineated. Black & Veatch *has contracted* with a local delineater to perform this service.

B. Water Quality

1. Raw Water

Groundwater quality records from existing production well No. 1 at the plant site were analyzed to develop raw water quality assumptions. Based upon data currently available to Black & Veatch, the water quality to be used for design is presented in Table 1. *This data will be verified when the well is repumped, sampled, and again analyzed early in the project.*

TABLE 1
Groundwater
Anticipated Raw Water Quality

Constituent	Design Basis	Constituent	Design Basis
Aluminum, mg/L	0.26	Chloride, mg/L	515
Calcium, mg/L	13	Fluoride, mg/L	2
Copper, mg/L	0.02	Nitrate, mg/L	0.11
Magnesium, mg/L	25.6	Sulfate, mg/L	6.6
Manganese, mg/L	0.01	Total Anions, mEq/L	29.0
Potassium, mg/L	32.1	TDS	2095
Strontium, mg/L	0.93	Silica	32.5
Sodium, mg/L	599	Hardness ($CaCO_3$), mg/L	138
Barium, mg/L	0.15	Alkalinity ($CaCO_3$), mg/L	710
Iron, mg/L	0.12	pH, units	7.91
Total Cations, mEq/L	29.7	Boron, mg/L	1.59
Bicarbonate, mg/L	866	TOC	80
Carbonate, mg/L (as CO_3)	<0.01		

2. Product Water

The final product water quality from the RO treatment plant will depend upon the membranes used (i.e., those manufactured by Hydranautics, Fluid systems, etc.), the quality of the feedwater, process recovery, and the age of the membranes in service. Projections were made at two operating conditions as follows:

a. Initial Operation

b. Operation at 3 years

Projections were made for the following membrane types:

a. Hydranautics Model 8040-LSY-CPA2, 8" size

b. Fluid Systems Model TFCL 8821LP, 8" size

c. Filmtec Model BW 30-8040, 8" size

The results are given in Tables 2 and 3.

TABLE 2
Water Quality Projections (Permeate)

Initial Operation

Constituent	Raw Water	Hydranautics	Fluid Systems	Filmtec
	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Calcium	13	0.0	0.20	0.20
Magnesium	25.6	0.10	0.40	0.30
Potassium	32.1	0.8	1.8	1.0
Sodium	599	12.8	28.8	14.7
Strontium	0.93	0.0	0.01	0.0
Barium	0.15	0.0	0.0	0.0
Iron	0.12	--	--	--
Bicarbonate	866	20.8	48.5	21.6
Chloride	515	8.2	19.0	12.1
Fluoride	2.0	0.10	0.0	0.0
Nitrate	0.11	0.0	--	0.0
Sulfate	6.6	0.50	0.40	0.0
Phosphate	0.26	--	--	--
TDS	2094	43.4	100.1	50.9
Silica	32.5	0.30	0.90	1.0
pH	7.91	--	6.3	--
Alkalinity	710	17.06	39.77	17.71
Hardness ($CaCO_3$)	138	0.41	2.1	1.7
Color	30.0	2.0	2.0	2.0
TOC	80.0	3.0	3.0	3.0

TABLE 3
Water Quality Projections (Permeate)

3 Year Operation

Constituent	Raw Water	Product Water		
		Hydranautics	Fluid System	Filmtec
	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Calcium	13.0	0.10	0.30	0.20
Magnesium	25.6	0.10	0.50	0.30
Potassium	32.1	1.0	2.2	1.0
Sodium	599	17.5	35.5	14.5
Strontium	0.93	0.0	0.01	0.0
Barium	0.15	0.0	0.0	0.0
Iron	0.12	0.01	0.01	0.01
Bicarbonate	866	31.0	59.7	21.4
Chloride	515	10.3	23.4	12.0
Fluoride	2.0	0.10	0.0	0.0
Nitrate	0.11	0.0	--	0.0
Sulfate	6.6	0.0	0.5	0.0
Phosphate	0.26	--	--	--
TDS	2,094	60.4	123.3	49.4
Silica	32.5	0.3	1.1	1.0
pH	7.91	--	6.4	--
Alkalinity	710	25.4	48.95	17.55
Hardness	138	0.66	2.80	1.73
Color	30.0	2.0	2.0	2.0
TOC	80.0	3.0	3.0	3.0

3. Concentrate

Brine concentrate quality from the RO process will also be a function of the type of membrane used, the service life, process recovery, and the quality of the feedwater. Projections are presented for the two operating conditions assuming design feedwater quality in Tables 4 and 5.

TABLE 4
Water Quality Projections (Brine)

Initial Operation

Constituent	Raw Water	Concentrate		
		Hydranautics	Fluid System	Filmtec
	(mg/L)	(mg/L)	(mg/L)	(mg/L)
'Calcium	13.0	43.1	36.5	42.5
Magnesium	25.6	88.9	75.6	88.0
Potassium	32.1	112.1	93.8	111.3
Sodium	599	2,356.1	1,982.7	2,343.6
Strontium	0.93	1.6	1.5	1.7
Barium	0.15	0.50	0.44	0.5
Iron	0.12	--	--	
Bicarbonate	866	2,855.0	2,724.4	3,390.0
Chloride	515	2,033.8	1,719.1	2,059.4
Fluoride	2.0	7.8	6.6	7.7
Nitrate	0.11	0.40	0.50	0.50
Sulfate	6.6	453.5	101.0	5.5
Phosphate	0.26	--	--	--
TDS	2,094	8,087.3	6,855.0	8,050.7
Silica	32.5	129.2	109.2	126.6
pH	7.91	7.60	8.1	--
Alkalinity	710	2,341.1	2,234.0	2,779.8
Hardness	138	472.2	401.2	467.1
Color	30.0	115	115	115
TOC	80.0	312	312	312

TABLE 5
Water Quality Projections (Brine)

3 Year Operation

Constituent	Raw Water	Concentrate		
		Hydranautics	Fluid System	Filmtec
	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Calcium	13.0	43.0	42.5	42.5
Magnesium	25.6	88.8	88.1	88.0
Potassium	32.1	111.3	108.4	111.3
Sodium	599	2,341.9	2,298.0	2,345.2
Strontium	0.93	1.6	1.74	1.7
Barium	0.15	0.5	0.51	0.5
Iron	0.12	--	--	--
Bicarbonate	866	3,371.9	3,151.2	3,392.3
Chloride	515	2,027.5	1,996.6	2,060.8
Fluoride	2.0	7.8	7.7	7.7
Nitrate	0.11	0.4	0.5	0.30
Sulfate	6.6	5.6	117.7	5.5
Phosphate	0.26	--	--	--
TDS	2,094	8,160.2	7,944.4	8,055.8
Silica	32.5	129.0	127.1	126.7
pH	7.91	8.3	8.1	--
Alkalinity	710	2,765.0	2,584.0	2,781.7
Hardness	138	471.6	467.5	467.1
Color	30.0	115.0	115.0	115.0
TOC	80.0	312	312	312

4. *Finished Water*

The finished water quality must meet the following project goals:

Item	Project Goal
Total Dissolved Solids	< 500 mg/L
Total Alkalinity	> 40 mg/L as $CaCO_3$
Total Hardness	> 40 mg/L as $CaCO_3$
Langelier Index	-0.2 to +0.2
pH	> 8.0

These goals are established in order to ensure the finished water is non-corrosive. A review of the permeate (product) water quality for the 3 year operating scenario shows that for any membrane used, some form of chemical

post treatment (addition) is required in order to meet the project goals. Blending (only) of raw water with the permeate will assist in lowering chemical treatment requirements. For example, assuming the use of the Fluid System membranes and blending at the 10 percent rate results in the following water quality:

Item	Blended Water
Total Dissolved Solids	315.8
Total Alkalinity	109.0 as $CaCO_3$
Total Hardness	18.3 as $CaCO_3$
Langelier Index	-2.32
pH	6.79

Review of this shows that some form of chemical treatment will be required. The chemicals normally used and their purpose is given below:

Chemical	Purpose
Sodium Hydroxide	Increase Alkalinity and pH, increase Langelier Index.
Lime	Increase Hardness, Alkalinity, increase Langelier Index, increase pH.

Review of the above information indicates that the use of lime would be more effective than sodium hydroxide for meeting the project goals in that its use increases hardness. However, the use of lime addition adds to the complexity of operation, and the requirement for lime silos to store the chemical detract from the aesthetics of the facility. Also, the lime treatment process results in the production of a lime sludge which must be disposed. Because of this, sodium hydroxide is the preferred post-treatment chemical. Using the Fluid Systems membranes and injecting sodium hydroxide results in the following finished water characteristics:

Item	Blended and Post-Treatment Water Quality
Total Dissolved Solids	395.5
Total Alkalinity	148.4 as $CaCO_3$
Total Hardness	18.3 as $CaCO_3$
Langelier Index	+0.11
pH	*8.0*

A sodium hydroxide feedwater dose rate of approximately 31 mg/L would be required to give the above finished water quality. Review of this shows that, with the exception of total hardness the finished water quality goals have been met. Although achieving 40 mg/L hardness goal would reduce corrosion potential, the water quality is acceptable with addition of a corrosion inhibitor. Because it is not possible to accurately predict a water's corrosivity, a corrosion inhibitor will be added.

C. Process Design Criteria

The technical criteria to be used for the design of the facility is given in Table 6. Using this information, a preliminary design has been proposed. This design is then used to size the various plant components, and assumes the use of Fluid Systems membranes. Operating conditions at the expected initial feedwater quality of 1,778 mg/L are presented in the process flow diagram of Figure 5. But, since the water quality is expected to deteriorate over time and because membrane performance changes with time, a prediction of operating conditions at the design water quality after 3 years of operation is presented in the process flow diagram of Figure 6. Proposed design values are presented in Table 7.

TABLE 6
Design Criteria

1. Initial Plant Capacity - 1 MGD
2. Future plant capacity - 2 mgd. For this initial construction, the raw water, finished water, and concentrate disposal lines are to be sized for the 2 mgd capacity. Likewise, the incoming electrical supply is also to be sized to accommodate the 2.0 mgd facility load. Also, all chemical day tanks and metering pumps will be sized for the 2.0 mgd capacity.
3. Raw Water
   a. Source. Brackish water wells drawing from the Yorktown Aquifer. Total of 2 wells each rated at 450 gpm for a total available raw water capacity of 900 gpm or 1.3 MGD.
4. RO Units
   a. Number of trains - 2
   b. Design flux rate - 14 gfd
   c. Recovery - 75%
   d. Raw Water Blend - 10%
   e. Membrane Configuration - Spiral wound, thin film composite type as manufactured by Hydranautics (CPA2), Filmtec (BW 30), or Fluid Systems (TFCL)
   f. Maximum and minimum brine flowrate in accordance with membrane manufacturers recommendations.
   g. Concentration limits - SiO_2 - 130 mg/L, LI - 1.5
5. Pretreatment
   a. 5 micron cartridge filters, one *vessel* per train
   b. Sulfuric acid addition
   c. Scale inhibitor addition
6. High Pressure Pump
   a. Number per train - 1
   b. Type - Horizontal Centrifugal type with adjustable speed drives.
   c. Product water design pressure 15 psig approximate (controlled by finished water storage overflow elevation).
   d. Protection - Provide low flow and low pressure protection for H. P. Pump.
7. Cleaning System
   a. Skid mounted.
   b. Sized to clean one stage at a time.
   c. Equipped with *one* centrifugal end suction pump.
8. Post Treatment
   a. Sodium hydroxide
   b. Corrosion inhibitor
   c. Fluoride
   d. Chlorine gas

TABLE 6 (Continued)
Design Criteria

9. Chemical Feed

   a. Sulfuric acid and sodium hydroxide
      1. Bulk storage outside sized for one month chemical supply.
      2. Transfer to day tank by gravity.
      3. Day tank and diaphragm metering pumps (2 each) inside.

   b. Scale and Corrosion Inhibitors
      1. Storage in 55 gallon drums inside - hydraulic load cell type scales.
      2. *Day tanks and diaphragm metering pumps (2 each) inside.*
      3. *Drum transfer pump to day tank.*
      4. *Motorized mixer (corrosion inhibitor only) for dilution.*

   c. Chlorine Gas
      1. Ton containers with vacuum regulator at container.
      2. Hydraulic load cell scales.
      3. Vacuum feeders with automatic switchover.

   d. Fluoride
      1. Fluosilicic acid in 55 gallon drums inside.
      2. *Day tank.*
      3. Diaphragm metering pumps (2 each).

10. Finished Water Quality Goals

Maximum TDS	-	500 mg/L
Total Hardness as $CaCO_3$	-	>40 mg/L
Alkalinity as $CaCO_3$	-	>40 mg/L
Langelier Index	-	-0.2 to +0.2
pH	-	>8.0

11. Concentrate
    a. Discharge to Sound

12. Instrumentation and Control
    a. Provide independent and fully automatic control of each train.
    b. PLC based control system.
    c. RO supplier will provide ladder logic for programming by B&V
    d. Tie controls to SCADA system for monitoring from KDH Plant.

TABLE 6 (Continued)
Design Criteria

13. RO Equipment Package

    a Items included:
    1. Membranes with pressure vessels (pressure vessel design to ASME Section X).
    2. High pressure pumps and drivers.
    3. Membrane support racks.
    4. Interconnecting piping and valves.
    5. Chemical treatment equipment (pre and post treatment) piping, valves, metering pumps, and day tanks.
    6. Cartridge filters.
    7. Permanently piped cleaning skid (including tank, circ pumps, cartridge filters).
    8. Process electrical distribution
    9. I&C logic for programming. (Computer hardware and programming by others).
    10. Locally mounted instruments.
    11. Blend station including control valve, controls, and piping as applicable.

    b. Termination points (for OEM Supply):
    1. Feedwater *entering building.*
    2. Product water *exiting building.*
    3. Electrical supply at each pump cable box and at the I&C terminal board.
    4. Concentrate discharge *exiting building.*
    5. Chemical supplies at day tank inlets.
    6. Pump seal water at pump inlet and outlet.

14. Plant Staffing/Operation
    a. Plant will be staffed while in operation.
    b. Plant will operate on a part-time basis during non-peak times but will operate daily.

TABLE 7
Proposed Design Values

Parameter	Value
Overall Recovery	76.9
Finish Water Capacity, mgd	
- Initial	1.0
- Final	2.0
Feedwater Flowrate, mgd	
- Initial	1.3
- Final	2.6
Bypass Flowrate, mgd	
- Initial	0.10
- Final	0.20
Reverse Osmosis:	
- Recovery, %	75
- Feed Flowrate, mgd	1.2
- High Pressure Pumps	
• Duty	2
• Stand-by	0
• Capacity, gpm	417
• Design Discharge Head, feet	530
• Horsepower, (assumes 70% efficiency)	*100*
• Pump, rpm	3500
• Control	variable speed
- Number of Trains	2
- Product Flowrate per Train, mgd	0.45
- Total Product Flowrate, mgd	0.90
- Total Design Power Requirement, kW	140
- Waste Brine, mgd	0.30
- Cleaning System	
• Number of tanks	1
• Tank Capacity, gallon	*750*

D. Raw Water Supply Wells

The first phase of this project will be designed to produce one million gallons of finished water per day (1 mgd). This will require a raw water supply of approximately 900 gallons per minute (gpm) with a 10 percent blend and 75 percent recovery. Two wells, each producing 450 gpm, are necessary to satisfy this requirement. *The County may purchase a site now for developing a third well in the future.*

All well sites must be approved by the N.C. Department of Environment, Health and Natural Resources, Groundwater Division.

The existing well site (Well No. 1) has been approved contingent upon acquisition of additional property to provide a 100 feet radius around the well owned and/*or* controlled by the County.

The two sites will require onsite inspection *by the Department of Health* after the County obtains options to purchase *and prior to purchasing*.

1. Existing Well

There is an existing well on the plant site (Well No. 1) that was drilled and tested in 1986. The well was drilled to a depth of 1,487 feet and terminated. Exhibit A of Appendix B is a copy of the driller's log which lists and identifies materials encountered in the down hole. A fully developed production well has been constructed at this site. The production well design, including the stainless steel screen location, was determined by examination of the drillings as well as geophysical logging of the down hole. Exhibit B of Appendix B shows a cross section of the well as installed.

On November 25, 1986, a 24-hour pump test was conducted. The well was pumped at a constant rate of 450 gpm with a maximum drawdown of minus 12.89 feet. A recovery test was observed for 12 hours following the pump test. The well immediately recovered to minus 4.81 feet and fully recovered in four hours. Pumping and recovery tests are inserted as Exhibit C of Appendix B.

Five four-inch monitoring wells (MW) were drilled to varying depths. Water level observations were taken in each MW during the pumping tests. That information is available but not included in this report.

This is a high producing well. The top of the 12-inch shutter screen is set at minus 305 feet and extends to minus 395 feet. During the 10 day extended pumping test the maximum drawdown was just over minus 15 feet. There is no information available predicting the ultimate safe yield of this well.

A 72-hour pump test will be conducted as a part of well contractor's work scope to determine if the well hydraulics have changed with time. This will also enable the County to obtain water samples for an updated series of water quality testing and to predict the safe yield.

This well will require housing in the form of a pump and piping chamber below grade. This chamber, constructed of steel, will be approximately 10 feet in diameter. An entrance tube, 4 feet in diameter, will extend above grade to El. 12. An earthen mound will surround and slope away from the entrance tube as indicated in Figure 2. The mound will be sodded to protect against erosion.

The production well is protected by a wooden structure. This structure will be demolished prior to the grading contractor mobilizing. The production and monitoring well *casings* will be *extended above finished grade* to allow *grading* of the site.

2. New Well Sites

The County *has identified two additional well sites, designated well No. 2 and well No. 3 sites. Well No. 2 is approximately 2,000 feet south of the plant site and well No. 3 is approximately 2,000 feet south of well No. 2. The County is in the process of acquiring these* sites to the south of the WTP. *Well No. 2* will be developed at this time and *well No. 3* at such time as required.

3. Test Well Construction

The first phase in developing this well *No. 2* will involve construction of a test well and several observation wells. The test well will be developed into a production well if testing results prove satisfactory.

The following steps would be taken in constructing and obtaining information from the test well.

A. Drill a nominal 30-inch diameter borehole to a depth of approximately 40 feet using the mud rotary method.

B. Install approximately 40 feet of 24-inch steel casing and grout the annular space from casing bottom to land surface.

C. Drill a nominal 6-inch diameter pilot hole using the mud rotary method to a depth of 500 feet or to *a depth satisfactory to* the Engineer. Recover formation samples and prepare borehole for geophysical logging.

D. Perform natural gamma, single point resistance, and spontaneous potential geophysical logs on the pilot hole.

E. Ream the pilot hole to a nominal 14-inch diameter using the mud rotary method to a depth determined by the Engineer.

F. Install 100 feet of 8-inch diameter continuous slot Schedule 40 PVC well screen with an end cap followed by Schedule 40 PVC casing to land surface. The screen shall be set at the depth determined by the Engineer. Screen slot size shall be based on sieve analysis of producing formation samples.

G. Place an artificial gravel filter around the screen using a tremie pipe to a height of 20 feet above the screen. Gravel filter size and grading shall be selected based on sieve analysis of producing formation samples.

H. Grout the annular space between the casing and borehole with Bentonite to a height of 25 feet above the screen.

I. Develop the well. This shall include air development and horizontal jetting. Development shall continue until the produced water is relatively clear and free of sediments or to the satisfaction of the Engineer.

J. Install a test pump and temporary discharge line to conduct a 24-hour four-stage step-drawdown test. The wellhead shall be equipped with a minimum 3/4 inch diameter inspection port so that water levels can be measured during the test. The pump should be capable of pumping from 100 to 750 gpm.

K. Install a temporary discharge line to direct water to the nearest drainage course during the pumping test.

L. Drill two four inch observation wells to depths of 60 feet and 500 feet respectfully and install Schedule 80 PVC screen and casing.

M. Obtain water samples at the conclusion of the pumping test and submit to a certified laboratory for the following tests:

Aluminum
Alkalinity, Total ($CaCO_3$)
Arsenic
Acidity - $CaCO_3$
Barium
Bicarbonate (HCO_3)
Boron
Cadmium
Calcium (Ca)
Carbonate (CO_3)
Carbon, Total Organic
Chloride (Cl)
Chromium
Color
Conductivity
Copper
Fluoride (F)
Hardness, Total
Hardness, Non Carbonate
Iron
Lead
Magnesium (Mg)
Manganese (Mn)
Mercury
Mold
Nickel
Nitrate (as N)
pH
Phosphate
Phosphorus
Potassium
Silica (as SiO_2)
Silver
Selenium
Sodium
Strontium
Sulfate
Sulfide
Sulfate
Total Dissolved Solids
Turbidity
Yeast
Zinc
Pseadomonaus

County will perform the following analyses:
Bacteriological
Sulfur reducing bacteria
SDI
LI
Hydrogen sulfide
HPC

An analysis of the drillings, geophysical logs, pump test, *and water samples* will determine the viability of developing this site and should provide a reasonable indication of expected safe yield.

4. Production Well Construction

If it is determined that conversion of the test well into a production well is feasible then the following procedure would be followed.

A. Remove the 8-inch PVC screen and casing from the bore hole.

B. Drill a nominal 24-inch diameter borehole to a depth of approximately *320* feet or as determined by the Engineer.

C. Install approximately 320 feet of 18-inch diameter steel well casing. Actual depth to be determined by the Engineer.

D. Grout the annular space between the casing and borehole with neat portland cement.

E. Drill a nominal 16-inch diameter borehole to a depth of approximately 410 feet or as determined by the Engineer. Under ream the borehole to approximately 30 inch diameter from 300 feet to 400 feet.

F. Install approximately 100 feet of 8-inch diameter stainless steel well screen. A 10-foot section of 8-inch diameter stainless steel well casing with an end cap will be placed at the bottom of the screen as sump. The screen shall be set at the depth determined by the Engineer.

G. Install approximately 150 feet of 8-inch diameter Schedule *80* PVC well casing followed by approximately 150 feet of 12-inch diameter Schedule *80* PVC well casing.

H. Place an artificial gravel filter around the screen using a tremie pipe to a height of 20 feet above the screen.

I. Grout the annular space between the casing and borehole with neat portland cement.

J. Develop the well. This shall include air development and horizontal jetting. Development shall continue until the produced water is relatively clear and free of sediments or to the satisfaction of the Engineer.

K. Install a test pump and temporary discharge line to conduct an extended pump test. The wellhead shall be equipped with a minimum 3/4 inch diameter inspection port for water level measurements. The pump should be capable of pumping from 100 to 750 gpm.

L. Conduct a continuous rate pumping test for a period of 72 hours or as determined by the Engineer. Water level measurements shall be taken in the production and observation wells.

After development and testing, the pump chamber entrance tube and site work construction would be identical to that described for the existing well.

5. Well Pump

The well pump will be submersible turbine type with all stainless steel construction. Motor will be submersible also. Pump will be sized to deliver 450 gpm at a residual pressure ahead of the cartridge filters *at the water treatment plant* of 50 psig. The approximate horsepower will be 25. In the future when a third and fourth well is added the well pump and motor must be replaced with a 30 hp pump.

If the need for the third well *is anticipated* in less than five years, consideration should be given to oversizing the motors and pump casings now. Since this is not currently anticipated and the motor efficiency will be decreased, Black & Veatch does not recommend oversizing the motor at this time.

A hydraulic actuated backpressure sustaining valve will be located on the pump discharge *as well as a check valve and isolators valve. A turbine meter with indicating and transmitting capabilities (based upon a 4-20 mA signal) shall also be provided.*

Electrical and standby generator requirements will be determined by the pump horsepower required. Well No. 2 *will* be wired for connection to a portable generator. Telemetry requirements are discussed in the electrical portion of this report. The raw water line requirements will be discussed in the water line section of the report.

6. Materials

Materials of construction shall be as follows:

8- and 12-inch casing	Schedule 40 PVC
Screen	Stainless steel
Piping	
Pump to exterior of enclosure	Schedule 10 stainless steel
Buried	SDR 21 PVC
Buried fittings	Epoxy coated ductile iron
Valves	Epoxy coated cast iron
Enclosure	Steel w/sacrificial anodes

E. Treatment Facilities

1. RO Pretreatment

a. Cartridge Filters.

Cartridge filters shall be fabricated from polypropylene continuously wound which has a nominal 5 micron rating. The cartridge filter vessels shall be *vertical* arrangement, cylindrical in shape, and constructed of stainless steel type 316 or reinforced thermosetting resin (RTR) material. The cartridge filters shall be connected to the common influent and effluent headers.

Each filter vessel shall have a capacity sufficient to hold the required number and size of cartridge elements to filter a minimum of 450 gpm each. Two cartridge filter vessels shall be provided, one for each train. Normal operation will be both cartridge filter vessels in operation with no standby.

Pertinent design parameters shall be as follows:

No. of units	2
Max flow per unit, gpm	500
Design pressure, psi	100
Removal efficiency, percent by weight	90
Pressure drop, psi	
Clean filter	*2.5*
Max w/dirty filter	*25*

b. Static Mixers.

In-Line static (motionless) mixers shall be provided at each chemical injection point. They shall be fabricated from all non-metallic materials such as polyvinyl-chloride (PVC) or RTR material. Static mixers shall be designed for pressure drops not to exceed 0.6 psi. Each mixer shall include a minimum of three fixed mixing elements, each of opposite rotation, capable of dividing and rotating the flow, resulting in equal dispersion of the chemical solutions in the process flow stream.

c. Sulfuric Acid.

Sulfuric acid at 66° baume (93.2%) will be fed to control calcium carbonate scaling and provide carbon dioxide for post-treatment purposes. This will be delivered in bulk.

Type	Sulfuric acid, 93.2%, 15.3 lb/gal		
Application Point	High pressure pump suction ahead of static mixer		
	Minimum (0.5 mgd)	Average (1.0 mgd)	Maximum (2.0 mgd)
Design dosage, mg/L (93.2%) High pressure pump suction	10	15	20
Feed Requirements, gph (93.2%) High pressure pump suction	0.16	0.49	1.16
Bulk Storage Tank			
Location	Outside Building		
Capacity, gallons	1,000		
Material	Carbon Steel, unlined *fiberglass coated*		
Day Tank			
Location	Acid/Antiscalant		
Capacity	75 gallons		
Material	Carpenter 20 stainless steel *w/pyrex site glass*		
Metering Pumps			
Number	2		
Location	Acid/Antiscalant		
Capacity, gph	0.12 - 1.20		
Discharge Pressure, psig	*100*		
Control	Flow paced based on raw water *pH*		
Diffuser	Teflon construction with quill extending to center of pipe (Hydranautics)		

Calibration chamber must be pyrex. Piping from bulk storage to day tank shall be double walled and buried.

d. Antiscalant.

A chemical sequestering agent (antiscalant) will be used to inhibit scale formation on the RO membranes. For the RO process, antiscalant is fed ahead of the high pressure feed pumps. Final design criteria for the antiscalant feed system will be developed following receipt of bid information from qualified desalination equipment manufacturers. A typical antiscalant feed system would be as follows:

Type	Aqua Feed 600, *Flocon 100, Hypersperce*		
Application Point	High pressure pump suction ahead of static mixer		
	Minimum *(0.5 mgd)*	Average *(1.0 mgd)*	Maximum *(2.0 mgd)*
Design dosage, mg/L*	3	6	10
Feed Requirements, gph (90 % solution)	0.08	0.31	1.03
Storage			
Location	*Antiscalant feed area*		
Capacity	*3-55 gallon drums*		
Day Tank			
Location	Scale inhibitor feed area		
Capacity, gallons	75		
Material	FRP *w/pyrex site glass*		
Metering Pumps			
Number	2		
Location	Scale inhibitor feed area		
Capacity, gph	0.1 - 1.0		
Discharge Pressure, psig	*100*		
Control	Flow paced based on raw water flow		
Diffuser	Corp stop type with injector quill extending to center of pipe		

**Based on Aqua Feed 600*

e. *Raw Water Flow.*

Raw water flow will be measured at each well, electronically summed and recorded by PLC control system to provide the total raw water flow to plant.

2. *RO Feed Pumps*

The high pressure RO feed pumps shall be the horizontal split case type. They shall be of multi-stage with double volute type casings having double suction and closed impellers. One pump shall be furnished per each train. They shall be sized to handle full flow (417 gpm) at a pressure rating of 230 psig on the discharge side. Pressure on the discharge side of these pumps shall be maintained by varying the speed of the pump. Flow rate shall be maintained by the control valve on the brine line exiting the second stage of each train. The pumps shall be capable of meeting the required design flowrate at pressures as low as 150 psig. Motor horsepower shall be 100. An adjustable frequency drive shall be supplied with each pump for manual speed adjustment.

3. RO Treatment Units

The RO Treatment Plant is composed of two independent trains. Each train will be composed of two stages of treatment. That is, the brine from the first stage is treated in a second stage as shown in the figures herein. Two stages are required to meet the recovery of 75 percent.

The array of each train will be approximately 2:1, depending upon which membranes are used. The array is defined as the number of pressure vessels in the first stage divided by the number in the second. The number of pressure vessels in each stage would be *approximately 12 in first stage and 5 in second stage.*

Assuming six membrane elements per each pressure vessel, the number of membrane elements would be *approximately 72 in first stage and 30 in second stage.*

The pressure vessels will be specified to be designed to meet (and be stamped by) the American Society of Mechanical Engineers (ASME), Pressure Vessel Code, Section X. Pressure vessel *feed* and *concentrate* connections will be the side entry type, in order to minimize piping requirements to and from the pressure vessels and inlet and outlet headers.

For performing the monthly membrane profiles (i.e., determining production and water quality from each pressure vessel), permanently piped and valved sample lines will be run from each pressure vessel (product side) to a sample stand located at each train. This will facilitate collection of performance data. As membranes operate, fouling of sparingly soluble salts will deposit on the membrane surfaces. As these deposits accumulate, the pressure difference across the membrane increases, normalized water production decreases, or the salt content (TDS) of the product water increases. When the output rate (normalized) drops by 10 percent, the pressure differential increases by 15 percent, or the salt content in the product water increases noticeably, the membranes must be cleaned.

Cleaning is carried out by recirculating a dilute solution of acid or alkaline cleaners (dependent upon what type of scale is to be removed from the membranes). The membranes are cleaned by stage at low recirculating pressure (20-60 psig) and relatively high flowrate (30-40 gpm per pressure vessel). Recycle periods are sometimes alternated with soak periods where the cleaning chemicals are not recirculated. Once the membranes have been cleaned, they are flushed using fresh water or permeate. The cleaning system is described in greater detail later.

4. Post-Treatment

Post treating of the permeate from the RO treatment trains is required to passivate the water and reduce it's corrosiveness, as discussed previously. Chlorine will be used as the disinfectant, sodium hydroxide (caustic soda) will be used for pH adjustment, a corrosion inhibitor shall be used to reduce water corrosivity, and fluoride will be used for dental hygiene.

a. Chlorine. Chlorine will be used as a finished water disinfectant. Separate chlorine feed and chlorine storage rooms will be provided. Solution type chlorine feeders will be provided in the chlorine feed room. A distribution panel will be used to divide the solution to the points of application.

Space will be provided for one ton containers, including two on scales, in the chlorine storage room. Dial indicating scales will be provided for weighing the two containers. Chlorine will be fed from one of the two containers on the scale with a switchover device provided to automatically change to the second container when the first container is empty. A two ton capacity electric monorail hoist will be installed in the storage room for handling ton containers. The monorail will extend to a roll up door accessing the delivery area for direct truck unloading.

Chlorine solution will normally be injected ahead of the finished water storage reservoir. A second point of application after the reservoir will be provided to boost the chlorine residual to the system if needed. Control of second feed will be manual.

Application points	Finished water ahead of static mixer and high service pump suction		
	Minimum	Average	Maximum
Design dosage, mg/L			
Finished Water to Ground Storage Tank	1.0	5.0	10.0
Feeders			
Number	2		
Location	Chlorine feed room		
Type	Wall-mounted, vacuum feed		
Capacity, ppd	20	100	200
Injector water supply			
Rate, gpm	15-20	15-20	15-20
Pressure, psi	40	40	40
Control	*Paced on finished water flow rate*		

Distribution panel	
Location	Chlorine feed room wall
Type	1 in - 2 out
Diffuser	
Number	2
Type	Corp stop with injection quill extending to center of pipe
Storage	
Location	Chlorine storage room
Ton containers	3 (including 1 empty)
Hoist	
Capacity, ton	2
Motor	2-1/2 hp hoist, 1/4 hp trolley
Scales	2
Type	Hydraulic load cell with 12 inch dial
Manifold	
Function	Connect vacuum chlorine gas lines from container mounted vacuum regulator with automatic switchover
Accessories	
Gas detectors	
Number	2
Location	Chlorine feed and storage rooms
Function	Alarm *light and horn* on exterior walls of chlorine feed and chlorine storage rooms and at plant control panel
Gas mask	
Number	1
Location	Interior walls near chlorine feed and storage rooms
Residual analyzer	1
Sample	Finished water pump station discharge
Measurement range, mg/L	0-10
Type	*Membrane (EIT)*

b. Sodium Hydroxide. Sodium hydroxide (caustic) *will* be used to adjust the pH of the RO product water. Caustic would be received at the plant in a 25 percent solution strength and stored in the bulk storage tank. Caustic would be fed to the finished water from a day tank and metering pump in the caustic feed room.

Type	Sodium hydroxide, 25% NaOH, 10.6 lb/gal		
Application point	Finished Water to ground storage tank		
Design dosage, mg/L			
Minimum	15		
Average	30		
Maximum	40		
Feed requirements (25% NaOH)	lb/day	gph	
Minimum (0.5 mgd)	250		1.0
Average (1 mgd)	1,000	3.9	
Maximum (2 mgd)	2,670	10.5	
Bulk Storage Tank			
Location	Outside		
Capacity, gallons	2,500		
Material	FRP		
Day tank			
Location	Caustic feed room		
Capacity, gal	300		
Material	FRP		
Metering pump			
Number	2		
Location	Caustic feed room		
Capacity, gph	1-10		
Discharge pressure, psi	15		
Control	Flow paced based on finished water *pH*		
Diffuser	Corp stop type with teflon injection quill extending to center of pipe		

c. Fluosilicic Acid. Fluosilicic acid will be used to reintroduce fluoride into the finished water. This would be received in 55 gallon drums at approximately 30 percent concentration. Storage for four 55 gallon drums is to be provided.

Type	Fluosilicic acid, 25%, H_2SiF_6, 11.7 lb/gal		
Dosage, mg/L			
Minimum	0.7		
Average	0.8		
Maximum	1.0		
Feed Requirements (25% strength)	lb/day	gph	
Minimum (0.5 mgd)	14.8	0.06	
Average (1.0 mgd)	33.8	0.14	
Maximum (2.0 mgd)	85		0.35

Storage	
Location	In fluosilicic Acid Room
Capacity	*2 - 55 gallon drums*
Day Tank	*75*
Capacity, gal	*FRP*
Material	
Metering Pumps	2
Number	Fluoride feed room
Location	0.05 to 0.5
Capacity, gph	15
Discharge pressure, psi	
Diffuser	1
Number	Corp stop type with injection quill extending to
Type	center of pipe

d. Corrosion Inhibitor. A corrosion inhibitor shall be mixed with water in a 10 percent solution and added to the product water as follows:

Type	Calgon C-9	
Dosage, mg/L		
Minimum	3	
Average	5	
Maximum	8	
Feed Requirements	lb/day	gph (10% solution)
Minimum (0.5 mgd)	12.5	0.62
Average (1.0 mgd)	41.7	2.0
Maximum (2 mgd)	13.3	6.64
Storage		
Location	*Corrosion inhibitor area*	
Capacity	*3 - 55 gallon drums*	
Day Tank		
Capacity, gal	75	
Material	FRP	
Metering Pumps		
Number	2	
Capacity, gph	0.6 - 6.0	
Discharge pressure, psig	15	
Control	Flow paced based on finished water flow rate	

Diffuser	
Number	1
Location	Product water line to storage
Type	Corp stop type with teflon injection quill to center of pipe

5. RO Cleaning System

The membrane cleaning system shall be skid mounted consisting of a cleaning solution mixing tank, centrifugal pump, cartridge filter, pH and temperature monitors, flow meter, valves, and piping as required, and a control panel. The pumps and mixing tank shall be sized by the membrane manufacturer. Typical parameters for the fluid system are as follows:

Mixing Tank	
Capacity, gals	*750*
Material	FRP
Pumps	
Number	1
Capacity, gpm	*As required by supplier (around 500 gpm)*
TDH, ft	*As required by supplier (around 140 ft)*
hp	*30 maximum*
Cartridge Filter	
Number of units	1
Max flow, gpm	*As required by supplier (around 500 gpm)*
Pressure drop, psi	
Clean	*2.5*
Max	*25*
Orientation	*Vertical*

6. Concentrate Outfall

The quality of the concentrate will depend upon the membrane employed in the RO treatment system. Table 4 gives the projected concentrations for each case. For the three cases studied, the maximum concentration of brine is not expected to exceed 8,160 mg/L. This concentration is lower than that of the sound (approximately 16,000 mg/L) where it will be disposed.

An outfall pipeline will be installed from the plant to the Pamlico Sound that will perform the following functions:

- Conduct the concentrated brine (concentrate) that does not pass through the membranes to waste.
- Conduct the raw water bypass flow during initial plant startups.
- *Conduct the membrane cleaning solution.*

See Figure 1, Area D for routing. The design parameters for this pipeline are as follows:

Capacity, gpm	700
Diameter, inches	8
Min pressure at plant, psig	30

An NPDES permit application has been submitted for this discharge.

F. Finished Water Storage and High Lift Pumping

1. Low Level Storage

A 1 MG low level storage tank will be constructed on the plant site as indicated *on Figure 2.* This tank shall be designed as follows:

Type	Prestressed concrete
Dimensions, ft	
Diameter	80
Wall height	26 ft
Overflow elevation, ft	*36*
Bottom slab El, ft	
Top El, ft	*10.0*
Min thickness, inches	*6*
Floor slope	*1/8 in per ft*
Allowable differential settlement, inches	*2*
Piping diameter, inches	
Fill	12
Suction	12
Overflow	12
Drain	*8*

Accessories

Aluminum exterior ladder with safety cage

Fiberglass roof access hatch

Interior *fiberglass* ladder with *aluminum* safety cage

Fiberglass vent

Tattletale gauge

2. High Lift Pumping

a. Pumping Units

High lift pumps shall be located in the building process area and shall draw suction from the low lift storage tank and discharge into the distribution system. Pertinent design criteria are as follows:

Number	3
Designation	HLP-1, 2, 3
Type	Horizontal split case
Capacity, gpm	350
TDH, ft	150
Max speed, rpm	1800
Drive	Constant speed
Motor, hp	20

b. Controls. A hand-off-auto control switch shall be provided for each pump. Pump control will be based upon elevated tank water level. The pumps will be activated and deactivated based upon the following elevated tank levels:

Pumps Off - 6 inches below overflow elevation
Pump 1 On - 60 percent volume below full
Pump 2 On - 65 percent volume below full

Control will be through PLC and SCADA system. A low ground storage tank water level will also deactivate pumps.

3. Finished Water Flowmeter

A flowmeter shall be installed on the high level pump discharge line as follows:

Type	Propeller meter w/local and remote indication	
Pipe diameter, inches	12	
Flow range, gpm	Initial	Future
Max	800	1500
Min	350	700

The propeller meter shall be equipped with a 4-20 mA signal that will provide flow data to PLC.

G. Water Lines - Raw and Finished

The project will require approximately 115,000 linear feet of 2-inch to 12-inch water main for the finished water distribution system and 2,000 linear feet of 12-inch for the raw water main.

The 12-inch finished water main and the 12-inch raw water main will be installed in parallel along west shoulder of N.C. Highway 12. The distribution system will connect to the 12-inch finished water main at various locations in order to serve the residential and commercial connections.

Individuals who sign a water service agreement and pay the tap-on fee before a predetermined time will have a service connection and meter installed at their property line.

1. Finished Water System Design

The distribution system was designed to serve all developed and platted property in the Villages of Rodanthe, Waves and Salvo. BV NET computer analyses was used during the 1987 feasibility study to determine flow, pressure and main size.

Each residence will be located within 500 to 700 feet of a fire hydrant. Isolation valves will be provided in order to take line segments out of service for repair or maintenance. Generally, two valves will be installed with tee and three with a cross. Valves 6-inch and smaller shall be double disk gate valves. Valves 8-inch and larger shall be butterfly type. Valve boxes will be protected by precast or poured-in-place concrete pads.

2. *Raw Water System Design*

The raw water main along N.C. Highway 12 will be designed to serve as a transmission line bringing water from three well sites to the WTP.

Well No. 1 is located at the WTP site. Well No. 2, which will be a part of this project, will be located approximately 1,500 - 2,000 feet south of the WTP. The transmission main from Well No. 2 to the WTP will be designed to carry 1,500 gpm. That represents the flow from Well No. 2, and future Well Nos. 3 and 4.

Twelve inch PVC pipe flowing at 1,500 gpm produces a headloss of 0.4 ft per 100 feet and a velocity of 4.3 ft per second. Both headloss and velocity are acceptable therefore 12-inch PVC will be specified.

Valves shall be liquid epoxy coated butterfly type.

3. *Materials*

All materials furnished for this project shall meet AWWA standards. Pipe line materials for both the distribution system and raw water main will be SDR 21 PVC. The North Carolina Department of Transportation (NCDOT) requires SDR 21 as a minimum standard in their rights-of-ways. PVC, being a non-corrosive material, will be ideal for the highly saline raw water. Distribution and raw water system fittings will be ductile iron. The lining for fittings used on the distribution system will be cement mortar and for the raw water epoxy coated 10 mils thickness. All fittings will be wrapped in polyethylene. Fire hydrants will be specified to meet present County standards with threads compatible with local volunteer fire department equipment.

Valves, valve boxes, meters, meter boxes, service tubing and other miscellaneous material will be specified to meet present County standards.

Pipe restraint will be accomplished by use of both a mechanical system and concrete blocking. JCM Sur Grip or Uni-Flange mechanical restraint systems are examples of systems specifically developed for PVC pipe. These systems provide uniform loading around the pipe circumference as compared to systems which provide set screw type point loading. The mechanical restraint system should receive a field coating of coal tar epoxy and be poly wrapped.

Concrete blocking will also be installed. Blocking will be designed to take 40 percent of the calculated thrust.

4. Installation

Pipeline installation will include excavation to the required depth with bedding in native material. Excavated areas requiring improved bedding will be stabilized with marl or coquena which is a native limestone material.

In NCDOT rights-of-ways 36 inches of cover will be required on all pipe. In private easements on rights-of-ways 30 inches of pipe cover will be acceptable.

Crossings of all NCDOT maintained roadways will require boring and jacking an encasement pipe for all lines four inches in diameter or greater. PVC carrier pipe can be placed in the casing. Service lines can be installed using a vibratory method. In all cases requirements of NCDOT's Polices and Procedures Manual must be followed. All other crossings may be open cut with PVC pipe installed in the cut.

Blocking concrete can be ready mix or Sakrete. In either case mix strength must be 3,000 psi minimum.

Service connection will require use of a tapping saddle on the PVC pipe. Corporation cock connections should be 45 degree to the vertical. Service tubing will be extruded polyethylene, copper, or Dare County standard if that is different. Service lines should be extended to the right-of-way and terminated with a lockable yoke/curb stop combination in the meter box. Meters will be purchased under this contract and installed by County personnel. *A backflow preventer will be supplied at each service.*

H. Elevated Tank

One elevated tank will be constructed as a part of this project. A 200,000 gallon pedestal spheroid tank will be located approximately 4,000 feet south of the WTP on Well Site No. 3.

This tank along with the 1,000,000 gallon ground storage tank will provide a little more than one day's WTP production in storage.

The choice of a pedestal spheroid included several considerations. The primary consideration involves maintenance. The proposed tank consists of a single tubular support column with a low head range spheroidal structure on top. This structure will be subjected to a very harsh environment and will be much easier to maintain than a double ellipsoidal tank. There are no elaborate exposed structural members, such as tension rods, struts, channels, riser rods, etc. exposed to rust and corrosion. Also, there is no external balcony, handrails or ladders to give similar problems.

Painting frequency would be about the same for all tanks; however, future repair costs on the spheroid tank should be very minimal.

Other considerations include the pleasing appearance of the spheroid. The tank will be located in a highly developed area and appearance will greatly influence public acceptance.

Overflow elevation shall be 140.0.

1. Accessories and Painting

The access door to the support pedestal will be south facing and constructed entirely of fiberglass or marine grade aluminum. Corrosion resistant materials shall be specified for all exposed accessories such as roof vent, roof hatch and obstruction light fixtures because of corrosive environment.

Specifications will address in detail requirements for surface preparation and particularly grinding of the welds. All welds should be inspected and approved prior to primer application. This step is critical to extended paint system life since virtually all paint systems first fail at the weld seams.

After erection, the tank will be power washed to remove any salt coating prior to any other cleaning operation. The tank interior and exterior will then be completely cleaned to the equivalent of SSPC-10 Near White Blast.

The tank exterior will receive a three coat 7 mil zinc primed epoxy polyurethane paint system. The specifications will identify a procedure for protection of surrounding property because this system has poor dry-fall characteristics.

The tank interior, after a SSPC-10 cleaning, will receive a three coat high build epoxy paint system. Minimum paint dry film thickness shall be 11 mils.

All weld seams will receive an additional roller or brush applied coating of primer or compatible seam sealer. After seam sealer or primer application to the welds, a Tinker-Razor low voltage holiday detector test will be conducted. Any weld *areas* failing this test will require power grinding and recoating.

2. Piping

All electrical or SCADA equipment should be above El. 10 located *inside tank. Conduit for the warning light shall be supplied by the tank contractor.*

A discharge/overflow line will be installed and routed to the nearest water course or point of free discharge. This line will require a *flap valve* to prevent rodent access to the tank.

3. Site Plan

The site plan must allow for installation of a future well at the center of the property. The well head must be 100 feet from any property line. An all-weather access drive and chain link fence will be included in the site development plan.

I. Instrumentation, Control, and SCADA

1. Instrumentation and Control

The new desalting plant will be controlled by a PCS (Plant Control System) consisting of a pair of redundant PLCs (Programmable Logic Controllers) serving as both the plant controlling device and as a SCADA (Supervisory Control and Data Acquisition) host for an additional PLC. The additional PLC will be configured to act as an RTU (Remote Terminal Unit) for the remote well and the elevated tower. An Intel 80486DX based personal computer, running a control software package, will serve as the operator interface to the new plant PCS.

An operator will use the interface, located in the control room, to operate the plant. The system will be capable of controlling subsystems of the plant or the entire plant in either a manual or automatic mode.

The PCS hardware, control software and configuration will be furnished under a separate contract.

The RO System Supplier will furnish Black & Veatch with the program for controlling the RO system, in ladder logic format. Black & Veatch will enter this program into the PCS hardware and configure the displays necessary to operate the plant.

The RO System Supplier will also furnish all field instruments, except as noted. These instruments will be as specified by Black & Veatch.

The attached sheets 4 through 8 from Contract 1 are piping and instrumentation diagrams for the water treatment process.

The following describes the various instruments and controls to be provided for this project:

Raw Water Wells

Initially the plant will be supplied by two raw water wells, one local and one remote from the plant. Communications with the local well will be hard wired while spread spectrum radio and an RTU will be used to communicate with the remote well.

Each well will be furnished with a locally mounted On-Off-Remote switch. In the remote position the well will be controlled from the PCS. Status and failure lights will be provided locally and repeated on the PCS.

Each well will be furnished with a transmitting flowmeter.

Raw Water Flow Measurement

Raw water *flow will be derived by summing the outputs of the well flowmeters in the PCS.*

RO Feedwater

The raw water enters a common line where antiscalant and acid are added based upon the raw water flow rate. The water passes through a static mixer and its pH, *conductivity*, and turbidity levels are monitored. These values are transmitted to the PCS. When *all* are within acceptable limits, the Raw Waste Valve will close and the Raw Feed Valve will open to supply water to the two RO trains. The Waste Valve and Feed Valve are two position, motor actuated valves with their position monitored by the PCS.

Cartridge Filters

Raw water flow is split between two cartridge filters. The pressure drop across each filter is measured by a DP *switch* and sent to the PCS for alarming on high pressure drop. The alarm will alert the operator that the filter cartridge requires changing. The temperature of the water entering the filters will be indicated locally.

RO High Pressure Feed Pumps

Each RO Feed Pump will have a locally mounted On-Off-Remote switch. The switch status, run status, alarms, speed, low suction pressure and discharge pressure will be monitored by the PCS which shall have full control of the pump when the switch is in the Remote position. Low suction pressure will generate an alarm and shutdown the pump.

RO Feed Valves

Each RO Feed valve will have a locally mounted Local-Remote switch. The switch status and valve position will be monitored by the PCS which will have full control over the valve when the switch is in the Remote position.

RO Units

The High Pressure Feed Pump VFD will be controlled, by the PCS, to provide a constant permeate flow. The inlet pressure to each RO unit will be monitored by the PCS and used to limit changes by the VFD. The pressure signal will also be used to stop the Feed Pump on high alarm. The differential pressure across each RO stage will be monitored by the PCS and a high differential will alert the operator that the RO Unit requires cleaning.

RO Product

RO product flow rate and conductivity will be monitored by the PCS. Flow will be indicated and totalized while conductivity will be indicated and monitored for a high alarm. A high conductivity alarm will initiate a shutdown sequence.

RO Reject

RO reject conductivity will be monitored and displayed by the PCS. RO Reject flow rate will be monitored, displayed, totalized and controlled by the PCS. The flow rate control setpoint will be 75 percent of the permeate flow divided by the sum of the permeate flow and the reject flow. (CB 5 Setpoint = .75(FIT-395-1)/ ((FIT-395-1)+(FIT-390-1)))

RO Bypass

RO bypass flow will be calculated as the plant influent flow minus the sum of both permeate flows and both reject flows. (Bypass flow = (FIT-302)-((FIT-955-1)+(FIT-395-2)+(FIT-390-1)+(FIT-390-2))) The bypass flow will be monitored by the PCS and controlled as a percentage of the plant effluent flow. The conductivity of the combined effluent will be monitored by the PCS and used to adjust the bypass ratio to insure the desired conductivity value.

Finished Water

Finished water flow will be calculated by summing both RO product flows and the bypass flow. This value will be indicated, totalized and used to pace some of the chemical feed systems.

Chemical Feed

The Antiscalant System will be automatically controlled by the PCS based on the Raw Water flow rate.

The Acid Feed System will be automatically controlled by the PCS based on both the Finished Water flow rate and pH.

The Fluoride and Corrosion Inhibitor Feed Systems will be automatically controlled by the PCS based on the Finished Water flow rate.

The Caustic Feed System will be automatically controlled by the PCS based on the Finished Water flow rate and pH.

The Chlorine Feed System will be automatically controlled by the PCS based on Finished Water flow rate.

Clean-In-Place System

The RO Clean-In-Place System will be a manual system and will not be monitored by the PCS.

Finished Water Reservoir

The PCS will monitor a level transmitter located on the Finished Water Reservoir. The level signal will be displayed, alarmed and *also used* to provide a low water cut off for the High Service Pumps.

High Service Pumps

The three high service pumps will be furnished with a locally mounted On-Off-Remote switch. When the switch is in Remote, the PCS will have control of the pumps, based on elevated tank level.

Distribution System Flowmeter

The discharge of the High Service Pumps will be monitored by a Distribution System Flowmeter. The flowmeter will *be the propeller type with* transmitter *option*. The flowmeter will initially be calibrated to 0-1500 GPM *with the* signal totalized and displayed by the PCS.

Elevated Tank Level

The remotely located elevated tank will be equipped with a level transmitter that will be monitored through a RTU and a spread spectrum radio, by the PCS. The PCS will control the High Service Pumps to maintain the proper level in the tower.

2. SCADA

Rodanthe Plant

The PCS, installed as a part of the Rodanthe, Salvo and Waves Desalter, will act as a small SCADA system host for monitoring and controlling the remote well and the remote elevated tank. The remote well status and alarm condition will be displayed and the operator will have control of the well from the PCS. The remote tank level will be displayed, alarmed and used to control the operation of the High Service Pumps.

The relative closeness of the remote sites allows comunications for this system to be handled by Spread Spectrum radio. This is a low power system, operating in the 900 MHz band, that does not require FCC licensing.

Existing Plant

A new "*smart*" RTU and radio, acting as a part of the Turbitrol SCADA system at the existing desalination plant, will be installed at the Rodanthe, Salvo and Waves Desalter. This RTU will be connected to the PCS by a data link and will have access to all of the variables in the PCS. This will allow the new desalination facility to act

as a remote node of the existing SCADA system. The SCADA host at the existing plant will be modified to add this new RTU to the polling sequence of the existing SCADA system. The configuration of the existing SCADA will be modified to include new screens, alarm summaries and reports to allow the display of all new plant operations at the existing plant.

J. Plant Building

A plant building shall be constructed as indicated in Figures 3 and 4. The building shall house administrative, process, chemical feed, and electrical MCC area.

1. Structural

The plant building structural system shall consist of the following:

Structural System

Roof	Wood trusses and wood rafters as beams. Steel W shapes as girders. Plywood roof sheeting as lateral diaphragm.
Walls	Reinforced 8-inch concrete masonry block for both load bearing and non-load bearing walls.
Floor	Reinforced concrete - slab on grade design.
Perimeter Walls	Reinforced concrete cantilever retaining walls with granular backfill.

Loadings:

Roof loads	20 psf
Wind load	120 mph
Administration Area	100 psf
Operation Area	150 psf
Dock Area	200 psf
Earthquake	Zone O

Approximate Equipment Weights:

Metering Pump	40 lbs
55-Gallon Drum, full	1,000 lbs
Day Tank, full	2,000 lbs
High Service Pump	1,185 lbs
High Pressure Pump	810 lbs
Cartridge Filter, full	1,600 lbs
R.O. Unit, full (excludes support frame)	18,000 lbs

Caustic (NaOH) Bulk Storage Tank, full	33,000 lbs
Acid (Sulfuric) Bulk Storage Tank, full	16,000 lbs
Fuel Tank, full	10,000 lbs

Material

Concrete	$f'c$ = 3,000 psi
Steel	A36
Reinforcement	Fy = 60,000 psi

2. *Architectural*

The new Dare County Reverse Osmosis Plant will be located in Rodanthe, North Carolina near the existing restored Chicamacomico Lifesaving Station built in 1928. The facility will respect its historical neighbor by use of similar forms, materials, multiple roof lines, dormers and look-out tower. Figure 4 provides building elevation views. Materials of construction shall be as follows.

Exterior Materials

Walls:	Cedar Siding or Cedar Shakes Stained Grey
Foundation Walls:	Brick - Red
Windows:	Wood Vinyl or Aluminum Clad, Six Double Hung
Doors:	6 Panel Wood or FRP
Columns:	FRP

Interior Materials

Exterior Walls:	CMV Exterior Walls furred in some areas for Drywall
Interior Walls:	Stud and Drywall in office area. CMV in service and chemical areas
Interior Doors:	Wood, Aluminum or steel depending on location and fire code requirements
Floors:	Ceramic Tile in Entry and toilet locker rooms
	Vinyl Composition Tile in Lab
	Carpet or Vinyl Composition Tile in other office areas
	Sealed Concrete in Electrical/Mechanical Service and Chemical areas

3. HVAC

A separate memorandum addressing HVAC is attached as Appendix C.

4. Plumbing

a. Potable Water. Potable water will be supplied from a tap on the high service pipeline and will be piped to the following fixtures:

Lavatory, water closet, and shower in the Lockers/Showers Room.
Service sink and water heater in Janitor's Closet.
Laboratory sink in Laboratory.
Lavatories and water closets in Men and Women's Restrooms.
Drinking fountain in the Corridor.
Chlorine injectors in the Chlorine Feed Room.
Emergency shower and eye wash in the Chemical Feed Room and the Laboratory.
Potable water piping 3 inches and smaller shall be copper. Isolation valves on the potable water piping shall be bronze ball valves.

b. Nonpotable water. A reduced pressure type backflow preventer shall be installed in a branch from the potable water line to provide a nonpotable water supply. This line shall be piped to the following fixtures:

3/4 Inch hose faucets for general washdown use in the Electrical/Mechanical Room, the Process Room, and the Chemical Room.
1-1/2 Inch post hydrant for washdown of the Bulk Chemical Storage Area.
Nonpotable water piping 2 inches and smaller shall be copper.
Isolation valves on the nonpotable water system shall be bronze ball valves.

c. Potable Hot Water Piping and Water Heater. An electric water heater shall be located in the Janitor's Closet and hot water piped to the service sink, the lavatories, the shower, and the laboratory sink.

The potable hot water piping shall be copper.
Isolation valves on the hot water piping shall be bronze ball valves.
All hot water piping shall be insulated.

d. Drain, Waste, and Vent Piping. There will be three separate drainage systems installed:

Fixture	Drain Destination
Floor drains, restroom fixtures, service sink, laboratory sink and cup sinks through a neutralization tank, drinking fountain, all in the Administration area.	Septic tank and lat. field
Floor drainage in the Process area	Stormwater drainage
Floor drainage in the Chemical Feed area and sump pump for process pipe trench	Chemical Containment area

Drain, waste, and vent piping shall be CISP, CIP, or galvanized steel pipe except laboratory drainage shall be PP or tempered glass and chemical feed area drainage and process area sump pump discharge shall be PVC.

e. Fixtures. The following fixtures will be furnished under the plumbing contract:

Neutralization tank
Lavatories
Water closets
Showers
Drinking fountain
Service sink
Water heater
Emergency shower and eye wash
Backflow preventer

K. Electrical

The electrical design memorandum is included as Appendix D of this report.

L. Engine-Generator

1. Generator. The project consists of the design of a single diesel engine-generator of about 450 kW size to be used as a power unit for the plant when the utility supplied power is not available. The engine-generator package will consist of an engine-generator, control panel, cooling system, *and accessory items* mounted inside a steel or aluminum weatherproof enclosure on a concrete slab. A critical type exhaust silencer will be included mounted on the top of the enclosure. The enclosure will include access panels and doors for servicing.

2. Fuel Storage Tank. *A 2,000 gallon steel storage tank will be located in the bulk chemical storage area and piped to the generator via double-lined buried piping.*

M. Schedule

Our goal is to place the water facilities into operation in *November* 1995. The bar chart schedule attached *is included as* Appendix E *and* addresses when work should be completed by contract.

N. Cost Opinion

The engineering agreement requires that the anticipated maximum project cost be established as a part of this Basis of Design Report. This is included in Table 8. The costs were obtained through Black & Veatch's experience on similar projects, consultation with material suppliers and contractors, and input from Dare County.

Appendix A
Geotechnical Report

GeoTechnologies, Inc.

3200 Wellington Court, Suite G
Raleigh, North Carolina 27615
919-954-1514
Fax 919-954-1428

December 20, 1993

Black & Veatch
110 West Walker Avenue
Asheboro, NC 27204-0728

Attention: Mr. Ron Duranek

Reference: Report of Subsurface Investigation
Proposed Dare County Water Improvements
Dare County, North Carolina
GeoTechnologies Project No. 1-93-715-EA

Gentlemen:

GeoTechnologies, Inc. has completed the authorized subsurface investigation to evaluate site grading and foundation support considerations for water plant improvements planned for a site in Rodantha, North Carolina. Subsurface conditions on the site were investigated by drilling five soil test borings at the approximate locations shown on the attached Figure 1. These locations were established in the field by taping distances and estimating right angles from existing site features such as the existing well house and the indicated locations should therefore be considered approximate. Elevations shown on the attached test boring records and generalized subsurface profiles were then interpolated from a provided one foot contour interval topographic plan and those elevations should also be considered approximate. All of the borings were advanced to termination depths ranging from 20 to 55 feet beneath existing site grade utilizing standard penetration test procedures at selected intervals to evaluate the consistency and density of the subsurface soils. This report presents the findings of the investigation and our recommendations for site grading and foundation support based upon these findings.

SITE AND PROJECT DESCRIPTION

It is our understanding that a parcel of land located near the life saving station in Rodantha will be developed as a new treatment plant supplying water to portions of the Outer Banks. A production well has already been installed on the central portions of the site and the site was accessible from a road cut into that well location. Topographically, the site is relatively level with a few minor dune structures within the area where construction is planned. We understand that coastal management requirements will necessitate placing fill material to raise site grades to at least elevation $^{+}10$. As such, fills on the order of 5 to 6 feet will be required in most areas in order to achieve a finished floor elevation above the design 100 year flood level.

It is our understanding that the operations building will be a relatively light structure having individual column loads of not more than 50 kips and wall loadings of no more than 3 kips per linear foot. The ground storage tank will have a height of approximately 26 feet and therefore will be designed for an assumed contact stress of approximately 2,000 psf. The water distribution main which will be extended into the site from the adjacent main highway will have a base elevation of 0 to $^{+}2$ and will necessitate cuts of approximately 4 to 6 feet in most areas.

Although subsurface conditions appear to be excellent for shallow spread footing support, we understand that new building code requirements may necessitate supporting all structures on pile foundations. As such, site grades will have to be raised by excavating the materials on-site or by importing materials and the piles will then have to be extended through the new fill to bear on the underlying virgin soils at some minimum depth below finished subgrade.

SITE GEOLOGY AND TOPOGRAPHY

Dare County is located on the Outer Banks of North Carolina in the Coastal Plain Physiographic and Geologic Province of North Carolina. The soils along the Outer Banks generally consist of sands, silts, and clays which were eroded from the Piedmont Uplands and deposited during past migrations of the seas as they moved inland and out over geologic time. The surficial deposits in Dare County are classified as being quaternary deposits which were formed in fluvial, eolian, and lacustrine environments. These quaternary deposits are inturn underlain by Yorktown Formation soil deposited during the Pliocene Epic of the Tertiary Period. Migration of the shoreline over the last two million years has redistributed the sedimentary soils originally deposited in the area and accounts for the fairly flat topography of the Coastal Plain.

The topography on the proposed site is relatively flat with a typical mean elevation of about $^{+}5$ to $^{+}6$. As indicated by the attached Figure 1, there are several areas which have mounds characteristic of a small dune with surface elevations as high as $^{+}10$. Additionally, a pit appears to have been dug adjacent to the existing well house in order to provide water for the drilling operations at that location and the water elevation measured within the pit was at elevation 3.5. This corresponds relatively closely with the measured groundwater depth of about 2 feet relative to an approximate elevation $^{+}5$ to elevation $^{+}5.5$ ground surface at the actual test boring locations.

SUBSURFACE CONDITIONS

A generalized subsurface profile prepared from the test boring data is attached to this report as Figure 2 to graphically illustrate subsurface conditions encountered at this site. More detailed descriptions of the conditions encountered at the individual test boring locations are then presented on the attached test boring records.

The subsurface profile at this site was found to consist of a surface veneer of loose to firm slightly silty to silty sand exhibiting penetration resistances ranging from 6 to 9 blows per foot extending from the ground surface to a depth of 3 to 8 feet below existing grade. With increasing depth, the sands appear to become slightly coarser, classifying as medium to fine, and they also became significantly denser. Penetration resistances below depths of 3 to 8 feet were generally in excess of 25 blows per foot and increased to in excess of 100 blows per foot in deeper zones encountered between a depth of 25 and 38 to 43 feet in the deeper borings.

Groundwater levels at the time of the investigation were very shallow existing at a depth of no more than 2 feet below existing grade. However, groundwater levels can vary significantly with variations in climatic conditions which occur over the course of the year. As such, water levels could potentially be at existing ground surface during major storm events.

RECOMMENDATIONS

The following recommendations are made based upon a review of the attached test boring data, our understanding of the proposed construction, and past experience with similar projects and subsurface conditions. Should site grading or structural plans change significantly from those now under consideration, we would appreciate being provided with that information so that these recommendations may be confirmed, extended, or modified as necessary. Additionally, should subsurface conditions adverse to those indicated by this report be encountered during construction, those differences should be reported to us for review and comment.

Site Grading Considerations. We understand that Building Code requirements will necessitate that fill soils be placed to a depth of 4 to 6 feet beneath the new structures which will be built on this property. Based on the results of the test borings, the soils on this site consist predominately of silty and slightly silty sands which should make excellent fill material. However, the groundwater table is relatively shallow existing at a depth of no more than 2 feet beneath existing grade and we therefore anticipate that excavations deeper than about 2 feet will have to be accomplished either with a track hoe or drag line, or that well points will have to be installed if it is desired to utilize a dozer or front end loader. Assuming there are no restrictions regarding excavations below the water table, we suggest that primary consideration be given to excavating in a section of the site which

will not otherwise be utilized and then using that sand to raise grade. Alternatively, sand fill can be imported to achieve the desired finished subgrade elevations.

Site grading should begin with the removal of any scrub growth in those areas designated for the new construction. Following stripping, those areas at grade or designated to receive fill should be densified in place by a minimum of three passes with a vibratory roller prior to the start of filling. The site may then be brought to grade utilizing either the on-site soils or an imported sand fill material to achieve the required finished floor elevations. The new fill should be compacted to not less than 95% of the standard Proctor maximum dry density except in the final foot beneath pavements and floor slabs where this requirement should be increased to 98% of the standard Proctor maximum.

Foundation Support Considerations. Subsurface conditions on this site are excellent for support of foundations on shallow spread footings if shallow spread footings can be utilized rather than piles. Based on the FHA Settlement Estimation Procedure using soil type and standard penetration resistance, we estimate that support of the Crom tank on a conventional slab-on-grade ring wall type footing will result in a total center settlement estimated to be on the order of approximately 1.5 inches. Similarly, settlement of the anticipated 50 kip column loads and 3 kip per linear foot wall loads within the operations building will be on the order of a half inch or less. These settlements should occur approximately concurrent with application of load and be virtually complete by the time construction is finished and the structures have been filled for the first prooffilling. These calculations assume that foundations will be sized for a net contact stress of not more than 3,000 psf and that footings will have minimum widths of not less than 24 and 16 inches for column and wall footing respectively. If shallow spread footings may be used, they should be embedded a minimum of 18 inches below finished exterior grade in order to provide an adequate safety factor for bearing capacity.

Since it is our understanding that piles will be required due to the proximity of the site to the ocean, we recommend that the structures be supported on a 20 ton design working load timber piles. Our experience has been that timber piles will not penetrate sands having standard penetration resistances in excess of 20 blows per foot. As such, unless the pile driver is prepared to preauger or jet, we anticipate that the piles will take up at a depth of 3 to 8 feet below existing site grade and that they probably cannot be driven any deeper. Since a slightly greater embedment depth may be required in order to meet code restrictions, we recommend that the contractor be prepared to preauger or jet the piles in order to obtain the minimum required tip elevation. For a 20 ton design working load, we suggest having a minimum pile length of not less than 12 to 15 feet.

The piles should be installed by driving using a hammer having a rated energy of not less than 15,000 foot pounds. The driving criteria should be established based on either the State Building Code Formula or another suitable dynamic driving formula such as the Hiley Equation. In view of the fact that the piles will take up abruptly on the firm to dense sands which exist at shallow depth, we suggest utilizing the State Building Code

Equation to establish a required set for acceptability of a design 20 ton working load. A pile load test is not recommended for this site due to the relatively light capacity of the pile and the excellent subsurface conditions which exist.

If piles are used, we suggest that the pile driving contractor initially install 6 to 8 piles around the site in order to develop a general feel for driving characteristics and to confirm that the anticipated tip elevations will result in the desired design capacity. Following driving of the 6 to 8 piles around the site, the contractor can then place a production pile order for the remaining piles. Based on the results of the test borings and past experience with similar projects, we anticipate that pile supported foundations will experience total settlements on the order of no more than 1/4 of an inch. Any settlement which does occur likely will occur concurrent with the load application and be complete once the construction is complete.

Vibration Monitoring Considerations. Although we do not anticipate that pile driving operations will affect any adjacent nearby structures, we suggest that the contractor be required to perform a preconstruction survey on any structures located within 250 feet of pile locations. Any cracks which exist in structures located within 250 feet of a driven pile should be photographed and noted prior to the start of pile driving operations. Additionally, should any structures exist within 250 feet of the tank, we recommend that a vibration monitor be utilized during the initial pile installation to confirm that vibrations associated with pile driving are well below those normally considered to be potentially damaging to sensitive structures. Ideally, vibrations should be maintained at a level of 0.5 inches per second or less. Based on our past experience with similar sites, we anticipate that vibration levels will be below this value provided piles are not driven closer than 30 to 40 feet from an existing structure.

Seismic Considerations. The Standard Building Code seismic risk map which is included in the 1988 Standard Building Code was developed by the Applied Technology Council in cooperation with the U.S. Geologic Survey to estimate zones of seismic potential throughout the United States. Based on historical data and an understanding of geology, the Applied Technology Council initially developed an approximate map of earthquake activity throughout the United States and then divided that information into four zones which were intended to provide an indication of the maximum acceleration which could be expected due to an earthquake with 90 percent confidence in a reoccurrence interval of 50 years. That initial map was then used by the Building Code committee to develop the map which is attached to this report as Figure 6. Based on the 1988 Standard Building Code Seismic Risk Map, the Rodantha site is located in a Zone 0 seismic zone. Therefore, under the 1988 Building Code, no provisions need to be made for seismic design.

A more detailed study which was conducted during the development of the seismic risk map for the United States was a 1982 report entitled "Probabilistic Estimates of Maximum Acceleration in Velocity and Rock in the Contiguous United States" prepared

by S.T. Algermissen, at el.. That report provided more detailed mappings of seismic risk zones and maximum accelerations which could be expected based on different reoccurrence intervals. We understand that research in that area is still continuing and that a more refined seismic risk map will likely be implemented within the next few years. Figures 7 and 8 include the anticipated maximum horizontal acceleration anticipated in reoccurrence periods of 50 and 250 years for the North Carolina area. Based on those mappings, the anticipated maximum acceleration in a 50 year reoccurrence period will be 0.04 g or less whereas the maximum acceleration anticipated in a 250 year period will be no more than 0.08 g. As such, the anticipated maximum acceleration levels even for very long reoccurrence intervals is small. Additionally, the soils which underlie this site consist principally of firm to dense sands which will not be subject to liquefaction or significant densification in a seismic event of the magnitudes indicated as being possible even in a 250 year reoccurrence period.

Septic Field Considerations. The sands which exist on this site consist predominately of clean fine and fine to medium sands which will have a very high rate of percolation. As such, loading rate is not a significant consideration relative to limitation of the site for development of a septic field. However, groundwater was present at a depth of 2 feet beneath existing site grade in all of the soil test borings at the time of the investigation and is indicated as existing at El $^{+}$3.5 feet in a water make up pit excavated adjacent to the existing well. As such, separation between lines and groundwater will be a significant consideration on this site and it appears possible that a fill system, previously referred to as a mound system, may be needed. We recommend that a soil consultant specializing in the area of septic field design or that a county health official be asked to survey the area of the proposed septic field and to make a recommendation regarding actual design. The design and permitting of the septic field should be accomplished before grading is begun on the site since site grading can have a significant detrimental effect on use of the site for septic field applications.

Miscellaneous Considerations. Below grade structures should be designed to resist a triangular lateral earth pressure distribution computed based on the assumption that soils below the water table behave as an equivalent fluid weighing 85 pounds per cubic foot and that soils above the groundwater table have an equivalent fluid weight of 45 pounds per cubic foot. These design values assume at rest conditions which will occur when the structure is sufficiently rigid such that it does not move sufficiently after construction to relieve earth pressures caused by fill placed against it. If cantilever structures which can tolerate movement are to be installed, they can be designed for an active earth pressure assuming an equivalent fluid weight of 80 pounds per cubic foot below the water table and 34 pounds per cubic foot above the water table. In order for the preceding design values to be applicable, all material placed within 4 feet of basement walls should be compacted with light hand held equipment rather than with heavy compaction equipment. It should also be noted that groundwater is very shallow on this site. If a heavy vibratory roller is utilized immediately adjacent to a shallow supported

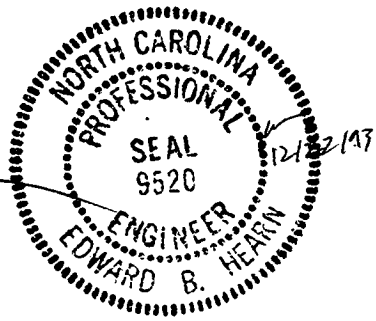
structure, there is a potential that very shallow supported structures could be adversely affected.

The sands which exist below this site are relatively permeable and will necessitate use of dewatering where excavations must extend more than 1 to 2 feet below the groundwater table. This implies that some well pointing may be needed in order to allow installation of the proposed finished water lines which will connect the new site to the local distribution system. Based on the composite grain size data attached as Figure 5, the average D_{10} particle size is about 0.15 mm which implies a permeability of about $5x10^{-2}$ cm/sec based on data developed by the U.S. Waterways Experiment Station. Design of the dewatering system should be left to the discretion of the contractor if dewatering is infact required.

GeoTechnologies, Inc. appreciates the opportunity to have provided you with our services on this project. Please contact us if you should have questions regarding this report or if we may be of any further assistance.

Very truly yours,

GeoTechnologies, Inc.



Edward B. Hearn, P.E.
NC Registration No. 9520

David L. Israel, P.E.
NC Registration No. 14319

EBH/fgo
Attachments

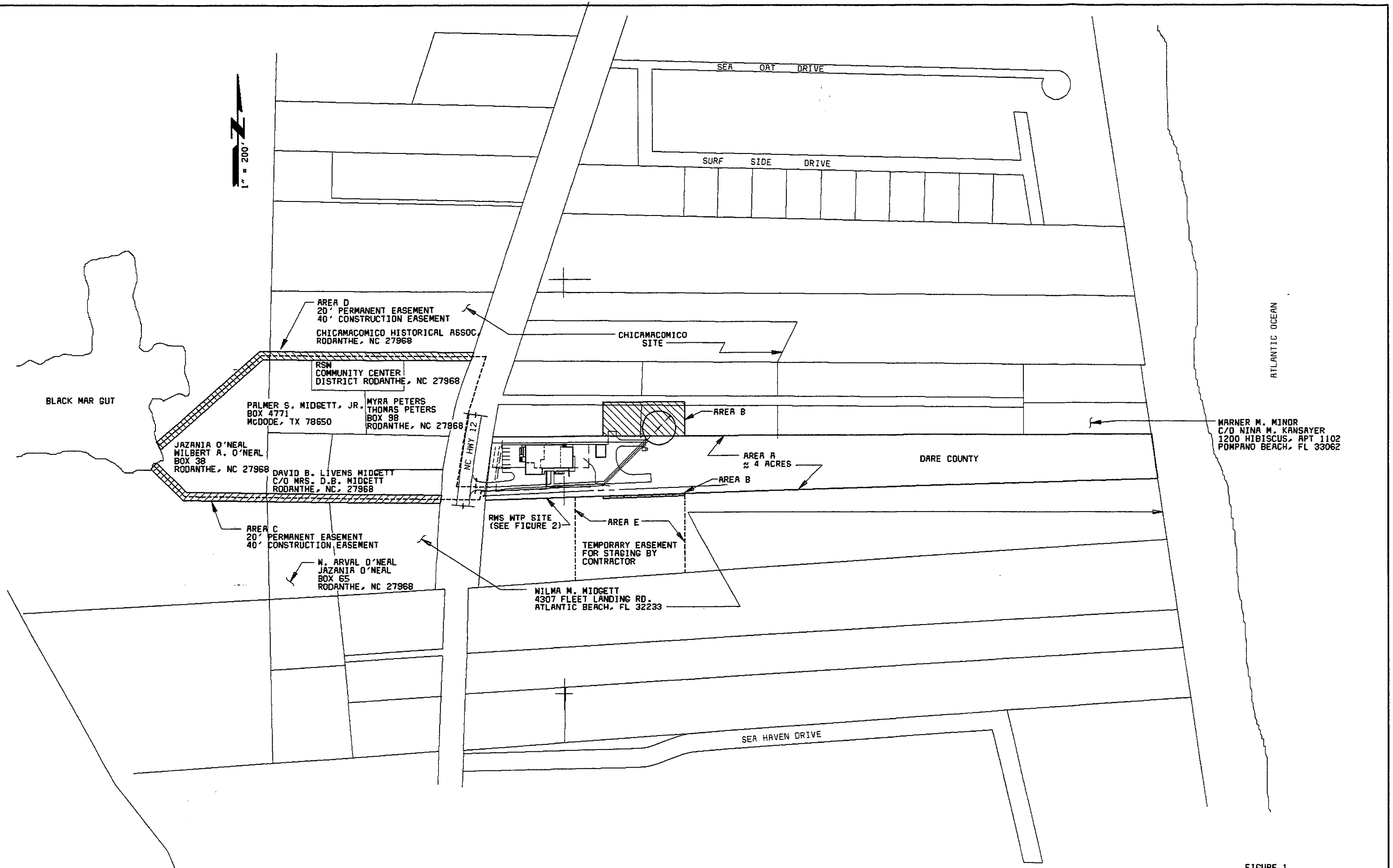


FIGURE 1

WATER TREATMENT FACILITIES
DARE COUNTY, NORTH CAROLINA
RODANTHE - WAVES - SALVO

PROPERTY AND EASEMENTS
PLANT VICINITY

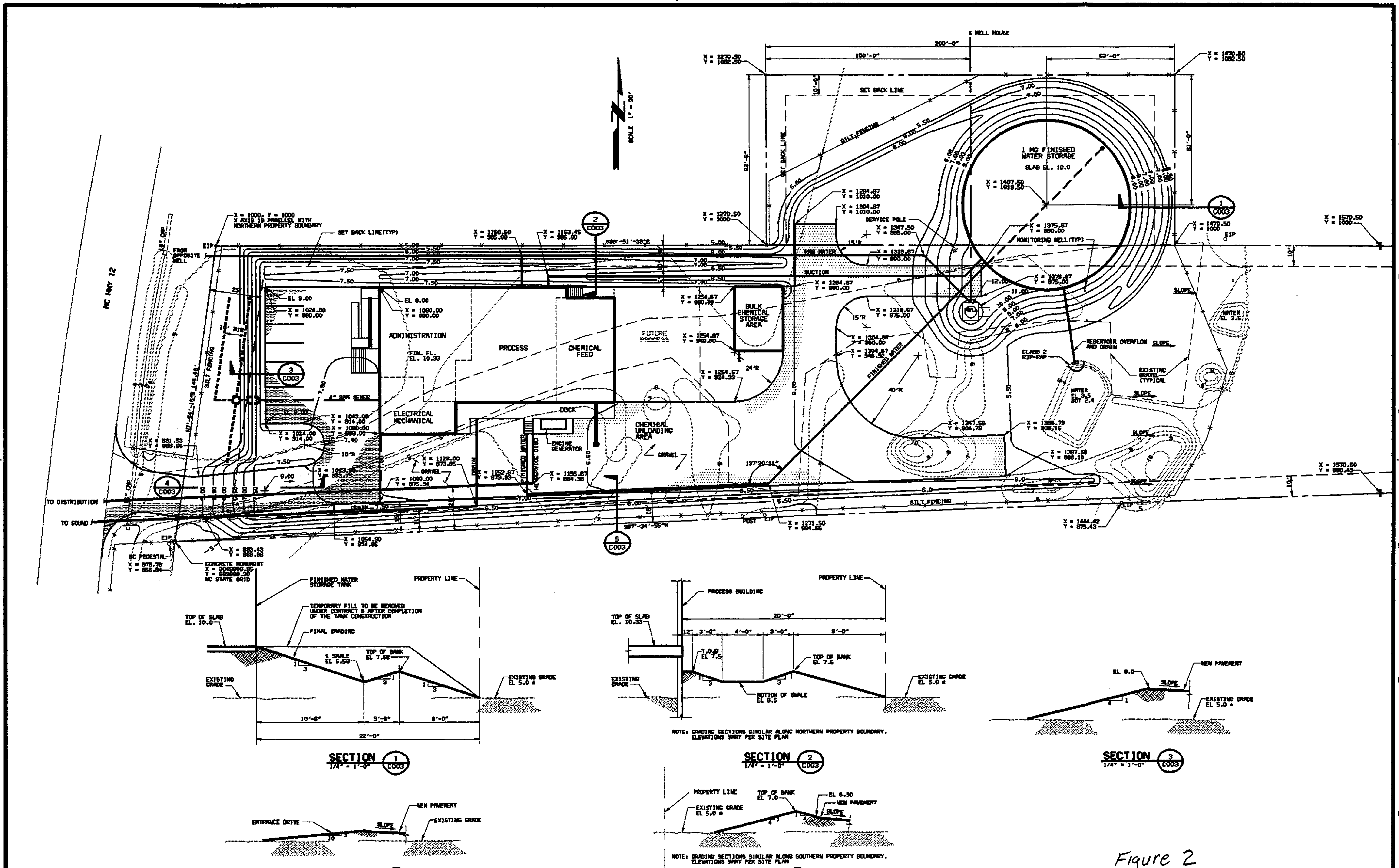


Figure 2

DESIGNED: WKP DETAILED: BLS CHECKED: APPROVED: DATE:	Black & Veatch Asheboro, North Carolina	PROJECT NO. 24420

WATER TREATMENT FACILITIES
DARE COUNTY, NORTH CAROLINA
RODANTHE - WAVES - SALVO

SITE PLAN

SHEET OF

DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP

12/16/93 11:47:43 ACD-10

24420-320-222-C003

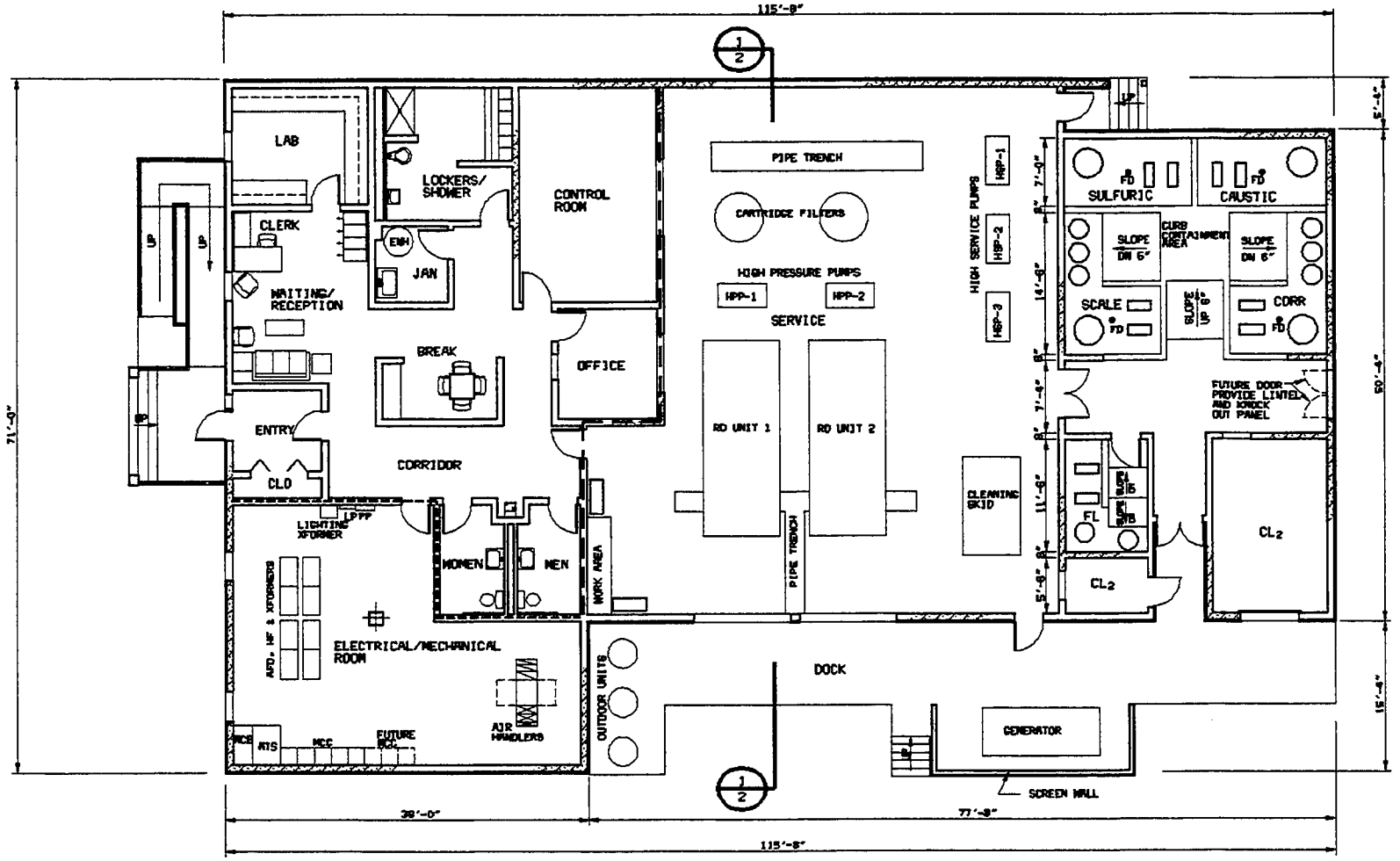
01/06/94 10:53:55 ACD-10

FINISH SCHEDULE

ROOM NO.	NAME	FLOOR FINISH	FLOOR BASE	WALLS SUBSTRATE	WALLS NORTH	WALLS SOUTH	WALLS EAST	WALLS WEST	CEILINGS HEIGHT	CEILINGS MATERIAL	CEILINGS FINISH	REMARKS
101	ENTRY	CT	CT	DW	PT	PT	PT	PT	8'-0"	DW	PT	
102	CLOSET	CT	CT	DW	PT	PT	PT	PT	8'-0"	DW	PT	
103	CORRIDOR	VCT	VINYL	DW	PT	PT	PT	PT	8'-0"	DW	PT	
104	ELEC/MECHANICAL ROOM	SCONC	NONE	CMU/DW	PT	PT	PT	PT	8'-0"	DW	PT	
105	WOMEN	CT	CT	DW	PT	PT	PT	PT	8'-0"	DW	PT	
106	MEN	CT	CT	CMU/DW	PT	PT	PT	PT	8'-0"	DW	PT	
107	OFFICE	VCT	VINYL	CMU/DW	PT	PT	PT	PT	8'-0"	DW	PT	
108	CONTROL ROOM	VCT	VINYL	CMU/DW	PT	PT	PT	PT	8'-0"	DW	PT	
109	LOCKERS/SHOWER	CT	CT	CMU-DW	SC	SC	SC	SC	8'-0"	DW	PT	
110	JANITOR	CT	CT	DW	EPX	EPX	EPX	EPX	8'-0"	DW	PT	
111	BREAK ROOM	VCT	VINYL	DW	PT	PT	PT	PT	8'-0"	DW	PT	
112	WAITING/RECEPTION	VCT	VINYL	CMU/DW	PT	PT	PT	PT	8'-0"	DW	PT	
113	LABORATORY	VCT	VINYL	CMU/DW	EPX	EPX	EPX	EPX	8'-0"	DW	PT	
114	SERVICE AREA	SCONC	NONE	CMU	SC	SC	SC	SC	16'-8"	DW	PT	
115	CONTAINMENT AREA	SC	CONC	CMU	SC	SC	SC	SC	16'-8"	DW	PT	
116	FL	SCONC	CONC	CMU	SC	SC	SC	SC	38'-8"	CONC	EXP	
117	CL2	SCONC	CONC	CMU	SC	SC	SC	SC	16'-8"	CONC	EXP	
118	CL2	SCONC	CONC	CMU	SC	SC	SC	SC	16'-8"	CONC	EXP	

LEGEND

SCONC	— SEALED CONCRETE	EPX	— EPOXY	EXP	— EXPOSED
CMU	— CONCRETE MASONRY UNIT	ACT	— ACOUSTICAL CEILING TILE	VCT	— VINYL COMPOSITION TILE
CONC	— CONCRETE	F.FIN	— FACTORY FINISH	DW	— DRYWALL
PT	— PAINT	CT	— CERAMIC TILE	SC	— SPECIAL COATING

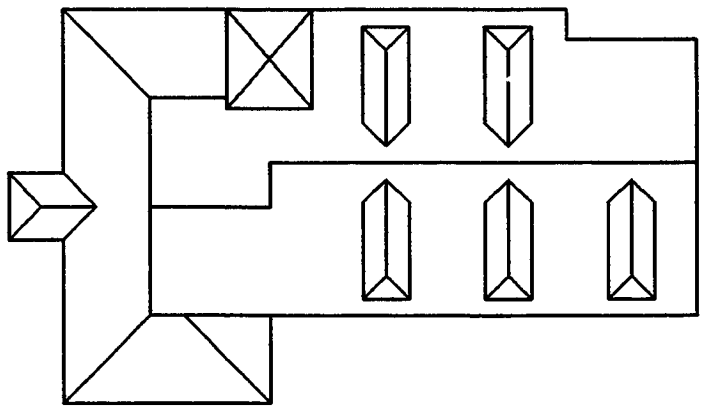


REF. N

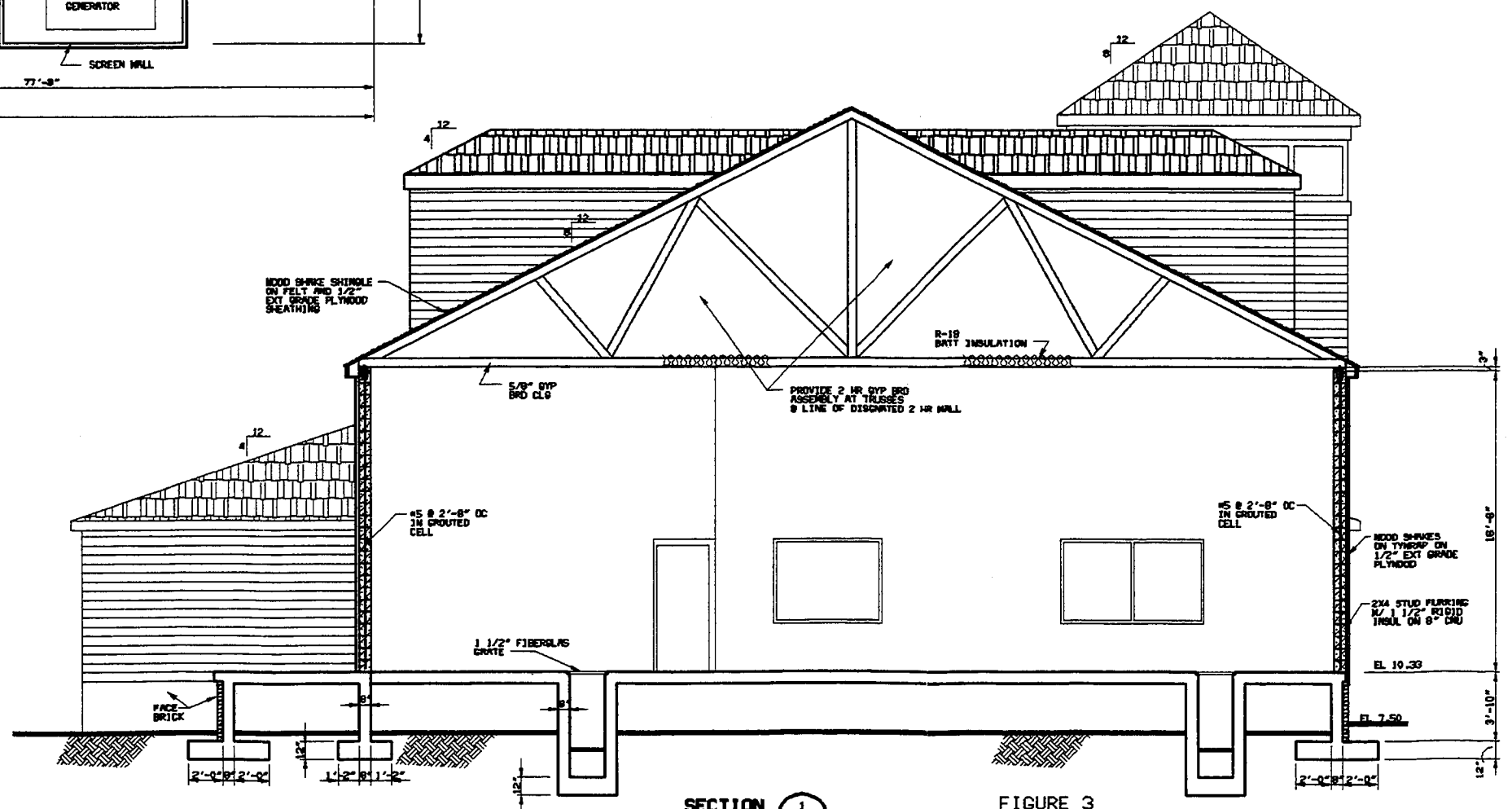
FLOOR PLAN 1/8" = 1'-0" — 6870 SQ. FT

— — — — — DENOTES 2 HR WALL

---------- DENOTES 1 HR WALL



ROOF PLAN 1/16" = 1'-0"



SECTION 1/2 — 1/4" = 1'-0"

FIGURE 3

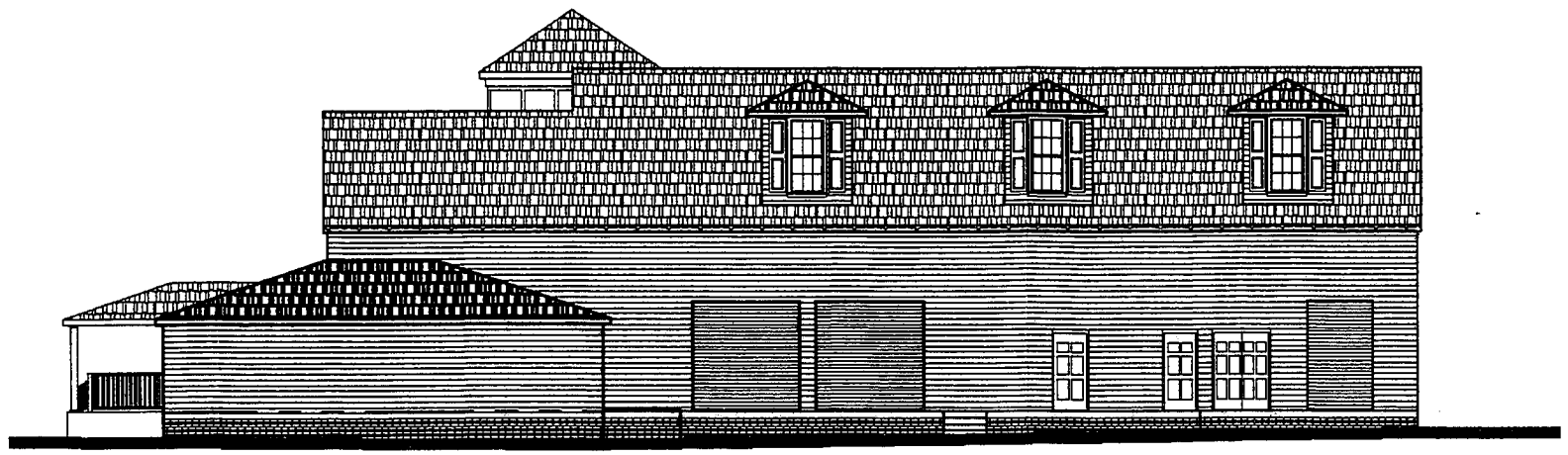
				DESIGNED RLS DETAILED TNJ CHECKED APPROVED DATE	Black & Veatch Asheboro, North Carolina	PROJECT NO. 24420	WATER TREATMENT FACILITIES DARE COUNTY, NORTH CAROLINA RODANTHE - WAVES - SALVO FLOOR PLAN, CROSS SECTION SCHEDULE AND ROOF PLAN

DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP

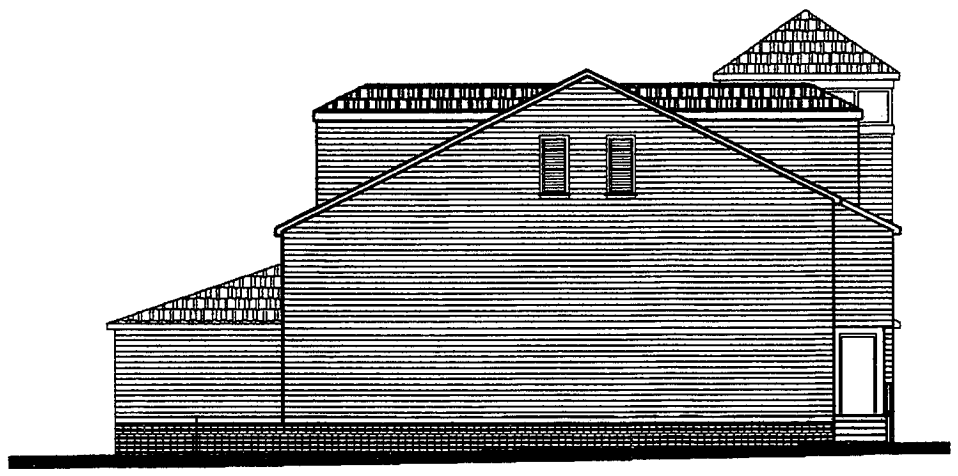
SHEET OF

PLAN-F 010295 F000000

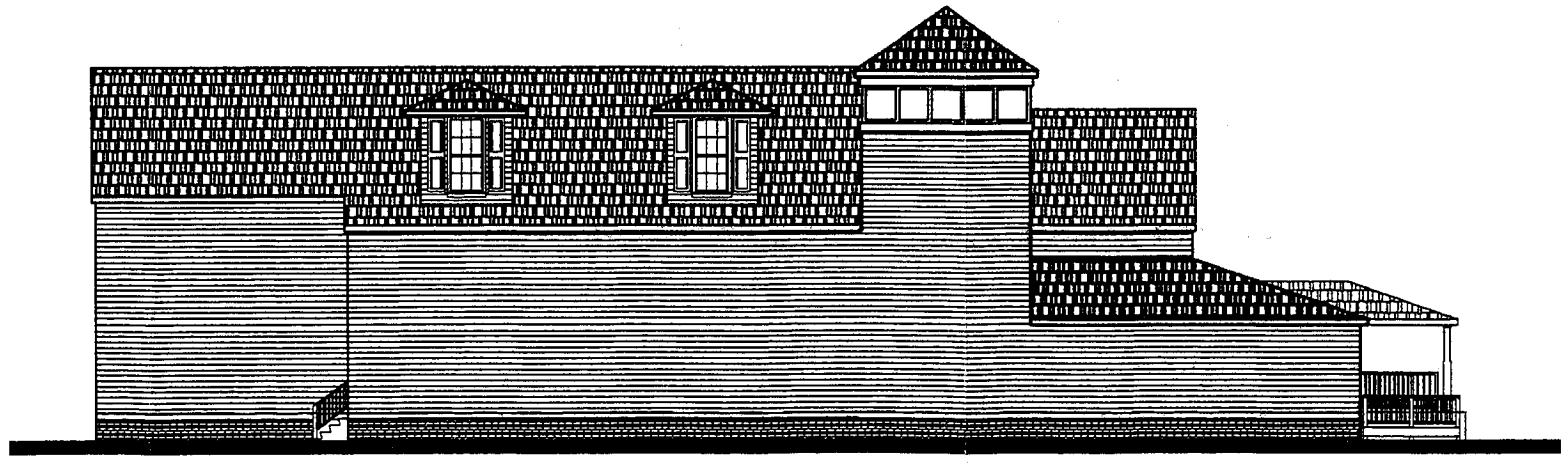
WEST ELEVATION
1/8" = 1'-0"



SOUTH ELEVATION
1/8" = 1'-0"



EAST ELEVATION
1/8" = 1'-0"



NORTH ELEVATION
1/8" = 1'-0"

FIGURE 4

DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP	DESIGNED RLS DETAILED TMJ CHECKED APPROVED DATE	Black & Veatch Asheboro, North Carolina

PROJECT NO. 24420

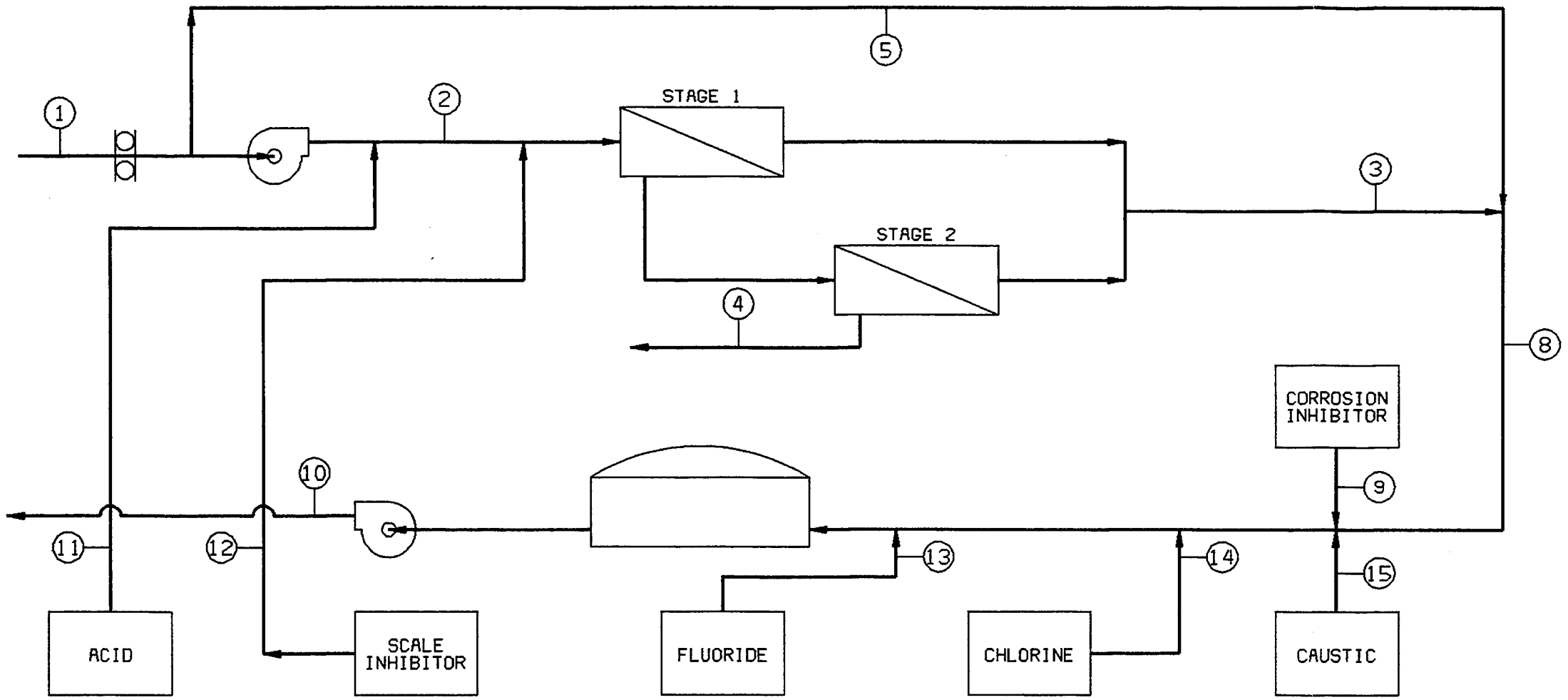
WATER TREATMENT FACILITIES
DARE COUNTY, NORTH CAROLINA
RODANTHE - WAVES - SALVO

ELEVATIONS

SHEET
OF

C004
010355
P000000

AGBLANK



* DOSE RATE (MG/L)

PROCESS STREAM ID / PROCESS STREAM PARAMETER	① FEEDWATER	② RO FEED	③ PERMIATE	④ BRINE	⑤ RO BYPASS	⑥	⑦	⑧ TO GST	⑨* CORROSION INHIBITOR	⑩ PRODUCTION TO DISTRIBUTION	⑪* ACID DOSE	⑫* SCALE INHIBITOR	⑬* FLUORIDE DOSE	⑭* CHLORINE DOSE	⑮* CAUSTIC DOSE
FLOWRATE (MGD)	1.3	1.2	0.90	0.30	0.10			1.0	5.0	1.0	13	6	2.9	3.0	26
PRESSURE (PS/G)	40	173	15	153	40			15	15	75	173	173	15	15	15
CONC (MG/L)	1,778	1,778	84	6,855	1,778			347	--	347	--	--	--	--	--

DATE	REVISION OR ISSUE	NO.	BY	CK	APP	DATE	REVISION OR ISSUE	NO.	BY	CK	APP

Black & Veatch
Engineers - Architects

PROJECT
24420

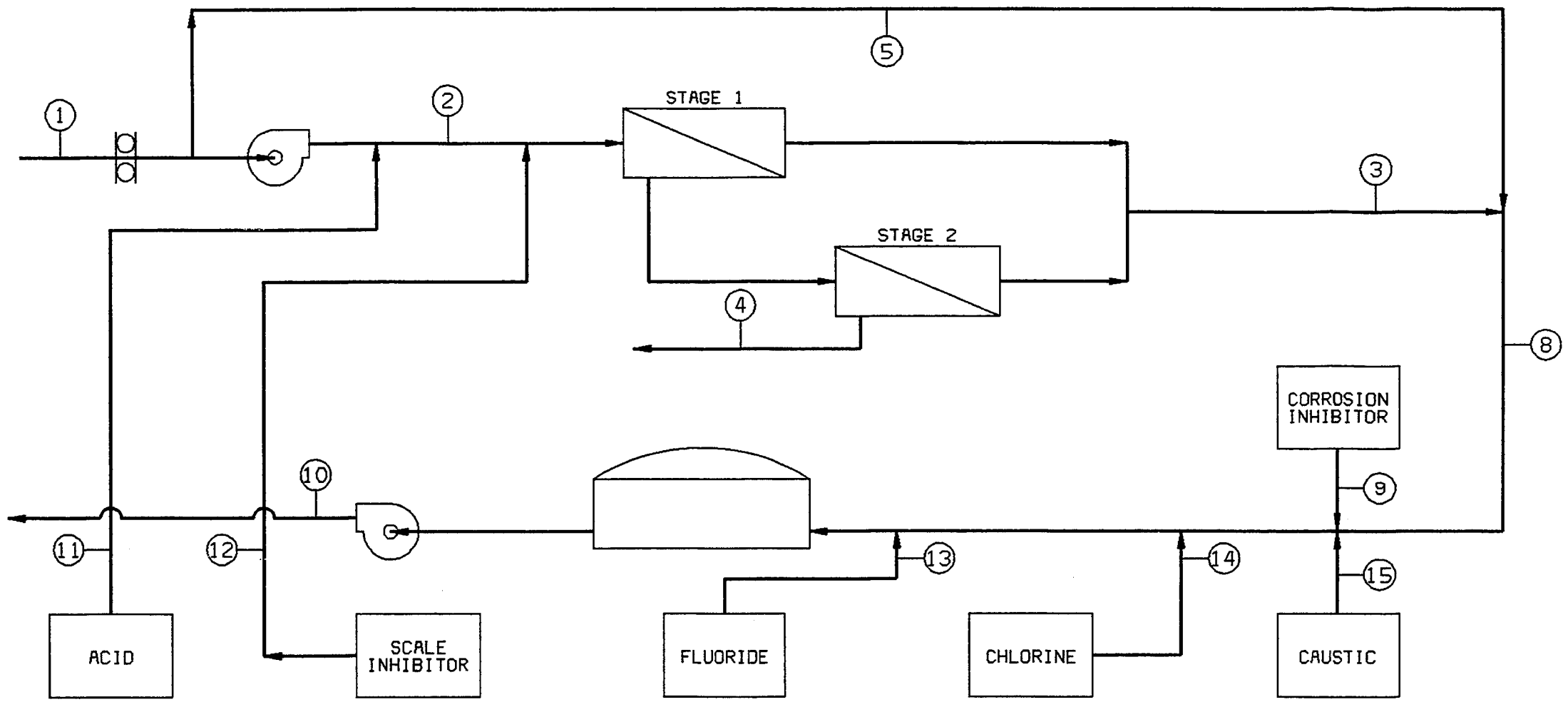
WATER TREATMENT FACILITIES
DARE COUNTY, NORTH CAROLINA
RODANTHE - WAVES - SALVO

PROCESS FLOW DIAGRAM
INITIAL OPERATING CONDITIONS

FIGURE
5

CBB000000
FCBB00000

AGBLANK



* DOSE RATE (MG/L)

PROCESS STREAM ID / PROCESS STREAM PARAMETER	① FEEDWATER	② RO FEED	③ PERMIATE	④ BRINE	⑤ RO BYPASS	⑥	⑦	⑧ TO GST	⑨* CORROSION INHIBITOR	⑩ PRODUCTION TO DISTRIBUTION	⑪* ACID DOSE	⑫* SCALE INHIBITOR	⑬* FLUORIDE DOSE	⑭* CHLORINE DOSE	⑮* CAUSTIC DOSE
FLOWRATE (MGD)	1.3	1.2	0.90	0.30	0.10			1.0	5.0	1.0	15	6	2.9	3.0	31
PRESSURE (PS/G)	40	197	15	176	40			15	15	75	197	197	15	15	15
CONC (MG/L)	2,045	2,045	123	7,944	2,045			393	--	393	--	--	--	--	--

DATE	REVISION OR ISSUE	NO.	BY	CK	APP

DATE	REVISION OR ISSUE	NO.	BY	CK	APP

Black & Veatch
Engineers - Architects

PROJECT
24420

WATER TREATMENT FACILITIES
DARE COUNTY, NORTH CAROLINA
RODANTHE - WAVES - SALVO

PROCESS FLOW DIAGRAM
FINAL OPERATING CONDITIONS (AT 3 YEARS)

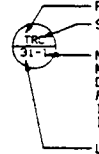
FIGURE
6

CBB00000
FCBB00000

GENERAL INSTRUMENT SYMBOLS

- FIELD MOUNTED INSTRUMENT
- INSTRUMENT MOUNTED ON FACE OF PANEL
- INSTRUMENT MOUNTED BEHIND OR INSIDE OF PANEL
- INSTRUMENT MOUNTED ON FACE OF LOCAL PANEL
- INSTRUMENT MOUNTED BEHIND OR INSIDE OF LOCAL PANEL
- SINGLE INSTRUMENT HOUSING CONTAINING TWO (OR MORE) INSTRUMENTATION FUNCTIONS
- CONTROL INTERLOCK FUNCTION. SEE SCHEMATICS AND SYSTEM SPECIFICATIONS FOR SPECIFIC FUNCTION

TAG NUMBERS AND ADDITIONAL DESIGNATIONS



PH — SEE INSTRUMENT FUNCTIONAL DESIGNATIONS AND ABBREVIATIONS.

TAG NUMBERS
MEANINGS OF IDENTIFICATION LETTERS

LETTER	FIRST LETTER: MEASURED OR INITIATING VARIABLE	FIRST LETTER: MODIFIER	SUCCEEDING LETTERS: READOUT OR PASSIVE FUNCTION	SUCCEEDING LETTERS: OUTPUT FUNCTION	SUCCEEDING LETTERS: MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C	CONDUCTIVITY (ELECTRICAL)			CONTROL	
D	DENSITY (MASS) OR SPECIFIC GRAVITY	DIFFERENTIAL			
E	VOLTAGE (EMF)		PRIMARY ELEMENT		
F	FLOW RATE	RATIO (FRACTION)			
G	USER'S CHOICE		GLASS		
H	HAND (MANUALLY INITIATED)				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME OR TIME-SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT (PILOT)		LOW
M	MOISTURE OR HUMIDITY	MOMENTARY			MIDDLE OR INTERMEDIATE
N	USER'S CHOICE		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O	USER'S CHOICE		ORIFICE (RESTRICTION)		
P	PRESSURE OR VACUUM		POINT (TEST CONNECTION)		
Q	QUANTITY	INTEGRATE OR TOTALIZE	INTEGRATE OR TOTALIZE		
R	RADIATION		RECORD OR PRINT		
S	SPEED OR FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION			VALVE, DAMPER, OR LOUVER	
W	WEIGHT OR FORCE		WELL		
X	UNCLASSIFIED		UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE, OR PRESENCE			RELAY OR COMPUTE	
Z	POSITION, DIMENSION			DRIVE, ACTUATOR OR UNCLASSIFIED FINAL CONTROL ELEMENT	

DIGITAL SYSTEMS INTERFACE SYMBOLS

NOTE: REFER TO DETAILED SYSTEM SPECIFICATIONS FOR FUNCTIONAL DESCRIPTION. ALSO SEE I/O SCHEDULES FOR COMPLETE INPUT AND OUTPUT LISTINGS.

- COMPUTER OR DISTRIBUTED CONTROL SYSTEM FUNCTION BLOCK
- PROGRAMMABLE LOGIC CONTROLLER SYSTEM FUNCTION BLOCK
  - CONTROL ALGORITHM IN SPECIFICATIONS
- DIGITAL SYSTEM I/O INTERFACE DIRECTION OF ARROW DENOTES WHETHER INPUT OR OUTPUT. HOLLOW ARROW INDICATES DISCRETE SIGNAL, FILLED ARROW INDICATES ANALOG SIGNAL.
- LETTERS, TAG NUMBERS, ABBREVIATIONS AND OTHER ANNOTATIONS ARE SIMILAR TO THE GENERAL INSTRUMENT LEGEND. DASHED LINE THRU SYMBOL REPRESENTS FUNCTIONS WHICH ARE NOT NORMALLY ACCESSIBLE TO THE OPERATOR. SOLID LINE REPRESENTS SHARED DISPLAY OR OPERATOR ACCESSIBLE FUNCTION.
- (n) — DENOTES MULTIPLE I/O POINTS W/ (n) AS THE NUMBER OF POINTS

FUNCTION DESIGNATIONS AND ABBREVIATIONS

INSTRUMENT DESIGNATIONS

K	GAIN OR ATTENUATE (INPUT:OUTPUT)
-K	GAIN AND REVERSE
Σ	ADD OR SUM (ADD AND SUBTRACT)
Δ	SUBTRACT (DIFFERENCE)
√	EXTRACT SQUARE ROOT
÷	DIVIDE
F(X)	CHARACTERIZE SIGNAL
>	HIGH-SELECT
<	LOW-SELECT
×	MULTIPLY
∫	INTEGRATE (TIME INTEGRAL)
CH_4	METHANE
Cl_2	CHLORINE
CO_2	CARBON DIOXIDE
COND	CONDUCTIVITY
DO	DISSOLVED OXYGEN
LEL	LOWER EXPLOSIVE LIMIT
MCC	MOTOR CONTROL CENTER
MLSS	MIXED LIQUOR SUSPENDED SOLIDS
O_2	OXYGEN (PURITY)
pH	pH
TURB	TURBIDITY

HAND SWITCH DESIGNATIONS

L-R	LOCAL REMOTE
O-C	OPEN-CLOSE
O-O	ON-OFF
O-O-R	ON-OFF-REMOTE
O-S-C	OPEN-STOP-CLOSE
T-B-R	TOP-BOTTOM-REMOTE

TRANSDUCER & CONVERTER DESIGNATION

E	VOLTAGE
FSK	FREQUENCY SHIFT KEYING
H	HYDRAULIC
I	CURRENT
P	PNEUMATIC
PD	PULSE DURATION
PF	PULSE FREQUENCY
R	RESISTANCE (ELECTRICAL)

EXAMPLE: I/P = CURRENT TO PNEUMATIC TRANSDUCER

POWER SUPPLY ABBREVIATIONS

AS	AIR SUPPLY
ES	ELECTRIC SUPPLY
GS	GAS SUPPLY
HS	HYDRAULIC SUPPLY
NS	NITROGEN SUPPLY
SS	STEAM SUPPLY
WS	WATER SUPPLY

LINE SYMBOLS

- MAJOR PROCESS PIPING OR FLOW CHANNEL
- SECONDARY PROCESS PIPING
- MISCELLANEOUS PIPING
- EXISTING OR FUTURE PIPING AND EQUIPMENT
- ELECTRIC SIGNAL
- HYDRAULIC SIGNAL
- PNEUMATIC SIGNAL
- ELECTRICAL DIRECTION ARROW
- SIGNAL CONNECTION POINT
- FLOW ARROW FOR PROCESS PIPING
- A — PROCESS OR SIGNAL LINE GOING TO ANOTHER SHEET
- A — PROCESS OR SIGNAL LINE FROM ANOTHER SHEET (MATCH LETTERS)
- PROCESS LINES CROSSING (NOT CONNECTED)
- INTERNAL SYSTEM SIGNAL LINK (SOFTWARE OR DATA LINK)
- AS — POWER SUPPLY SOURCE LABEL. USED ONLY WHERE NECESSARY TO HELP CLARIFY AN INSTRUMENT OR SYSTEM FUNCTION.
- FILLED SIDE INDICATES EQUIPMENT OR PROCESS NOT COVERED UNDER THIS CONTRACT.

PROCESS DEVICE SYMBOLS

- DIAPHRAGM SEAL
- DIAPHRAGM SEAL MOUNTED ON PROCESS LINE
- P — PURGE OR FLUSHING DEVICE
- REDUCER
- PRIMARY FLOW ELEMENT: ORIFICE PLATE
- PRIMARY FLOW ELEMENT: VENTURI TUBE
- PRIMARY FLOW ELEMENT: FLUME
- PRIMARY FLOW ELEMENT: WEIR
- PRIMARY FLOW ELEMENT: TURBINE OR PROPELLER-TYPE
- PRIMARY FLOW ELEMENT: PITOT TUBE
- PRIMARY FLOW ELEMENT: ELECTROMAGNETIC
- DOPPLER TYPE ULTRASONIC FLOW SENSOR
- PRIMARY ELEMENT: ROTAMETER
- Y — DRAIN
- THERMAL DISPERSION TYPE FLOW ELEMENT
- "Y" STRAINER
- VALVE: GLOBE, GATE, OR OTHER IN-LINE TYPE NOT OTHERWISE IDENTIFIED
- VALVE: THREE WAY
- SURGE CHAMBER
- VALVE: BUTTERFLY, DAMPER OR LOUVER
- VALVE: ROTARY BALL TYPE
- VALVE: CHECK
- VALVE: PLUG TYPE
- VENT TO ATMOSPHERE
- AIR/VACUUM VALVE RELEASE
- AIR RELEASE VALVE

THE FOLLOWING ADDITIONAL DESIGNATIONS MAY BE UTILIZED ADJACENT TO SOME VALVE OR GATE SYMBOLS.

NC	NORMALLY CLOSED
FC	FAILS CLOSED
FO	FAILS OPEN
FIP	FAILS IN LAST POSITION

- VS — PUMP; VS DENOTES: VARIABLE SPEED
- PUMP (EXISTING OR FUTURE)
- MIXING CHAMBER
- COMPRESSOR OR BLOWER
- MIXER
- PROPORTIONING OR METERING PUMP
- M — MOTOR

GENERAL NOTES

1. IN GENERAL, THE P &ID SYMBOLS AND DEVICE IDENTIFICATIONS ARE BASED ON INSTRUMENT SOCIETY OF AMERICA, STANDARD PRACTICE ISA-S5.1 (1988). SOME MODIFICATIONS, ADDITIONS, AND ALTERATIONS HAVE BEEN MADE AS NEEDED TO ACCOMMODATE THE PROJECT REQUIREMENTS.
2. ADDITIONAL CONTROL AND INTERLOCK REQUIREMENTS WHICH CAN BE MORE CLEARLY ILLUSTRATED ON SCHEMATIC DRAWINGS HAVE BEEN OMITTED FROM THE P & ID DRAWINGS. SOME PROCESS ITEMS, SUCH AS EQUIPMENT ISOLATION VALVES, BYPASS LINES, ETC., WHICH ARE NOT CRITICAL FOR AN UNDERSTANDING OF THE INSTRUMENTATION FUNCTIONS HAVE ALSO BEEN OMITTED.
3. THIS IS A GENERAL LEGEND SHEET. SOME SYMBOLS AND ABBREVIATIONS MAY NOT BE UTILIZED ON THIS SPECIFIC PROJECT.
4. PIPING AND EQUIPMENT LEGEND APPLIES TO P & ID SHEETS ONLY AND MAY DIFFER FROM LEGENDS FOR OTHER SHEETS.

VALVE AND GATE ACTUATOR SYMBOLS

- DIAPHRAGM
- DIAPHRAGM WITH POSITIONER
- PRESSURE-REDUCING VALVE, SELF-CONTAINED
- PRESSURE-SUSTAINING VALVE, SELF-CONTAINED
- DIAPHRAGM VALVE
- P — AIR CYLINDER
- S — SOLENOID
- E/H — ELECTRO-HYDRAULIC OPERATOR
- E — ELECTRIC MOTOR
- H — HYDRAULIC CYLINDER
- NO SYMBOL — MANUALLY (HAND) OPERATED

CONTRACT 1

DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP

DESIGNED DJH
DETAILED AJK
CHECKED
APPROVED
DATE

Black & Veatch, Orlando, Florida

PROJECT NO. 24420

WATER TREATMENT FACILITIES
DARE COUNTY, NORTH CAROLINA
RODANTHE - WAVES - SALVO

P & ID
LEGEND AND ABBREVIATIONS

I-1

SHEET 4 OF 8

CCG. DWG. NO: 24420-190-000-E012

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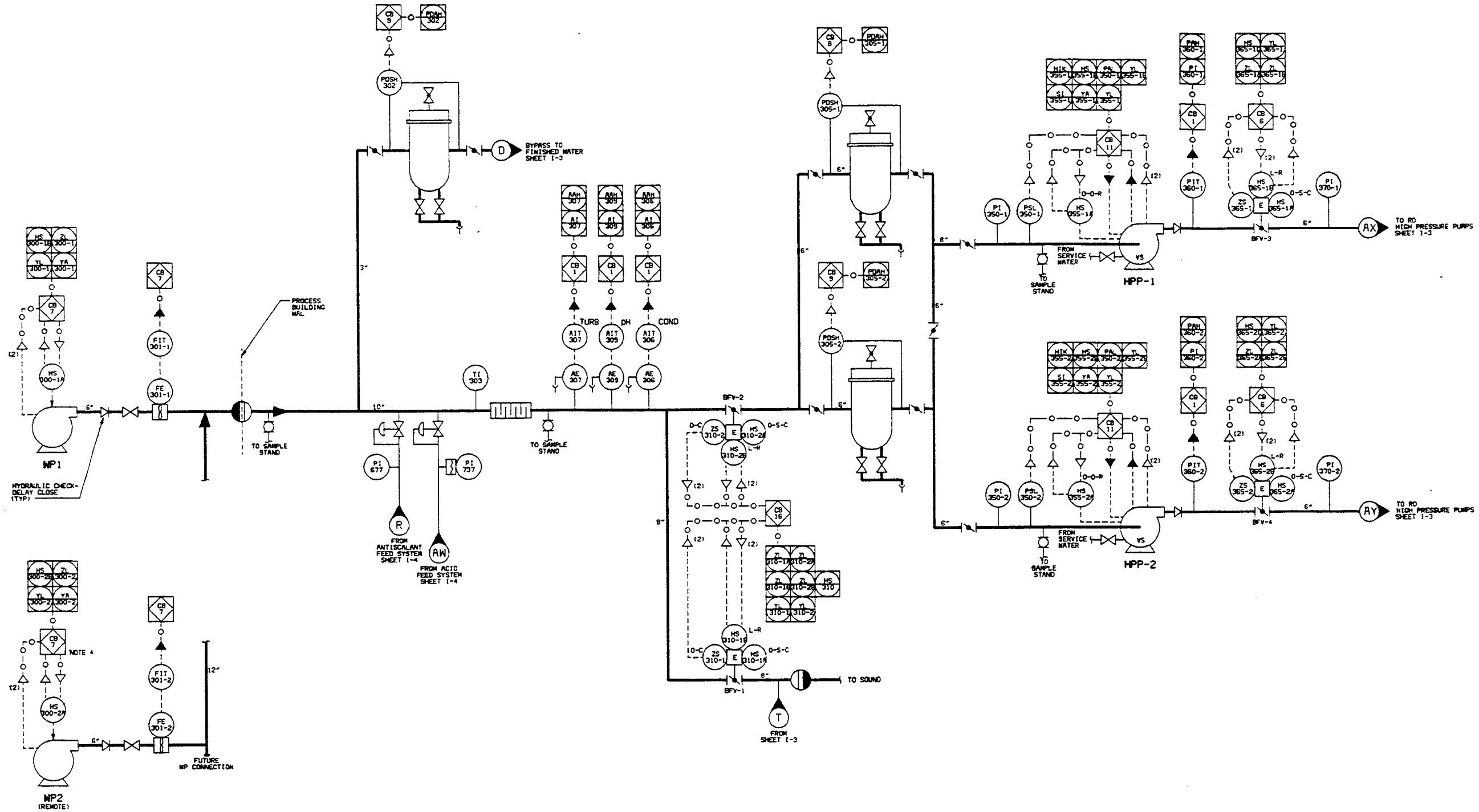
04/19/94 15:19:36 ATSS



NOTES:

1. PROVIDE SIGNAL BOOSTERS AND ISOLATORS AS REQUIRED.
2. SEE SPECIFICATIONS FOR ADDITIONAL EQUIPMENT REQUIREMENTS NOT SHOWN ON THIS DIAGRAM.
3. SEE P & ID LEGEND ON SHEET I-1.
4. LINKED BY RADIO TO PLANT CONTROL SYSTEM (PCS:

CONTRACT 1

	WATER TREATMENT FACILITIES DARE COUNTY, NORTH CAROLINA ROANTHE - WAVES - SALVO		I-2
	P & ID FEEDWATER TREATMENT SYSTEM		SHEET 5 OF 8

DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP

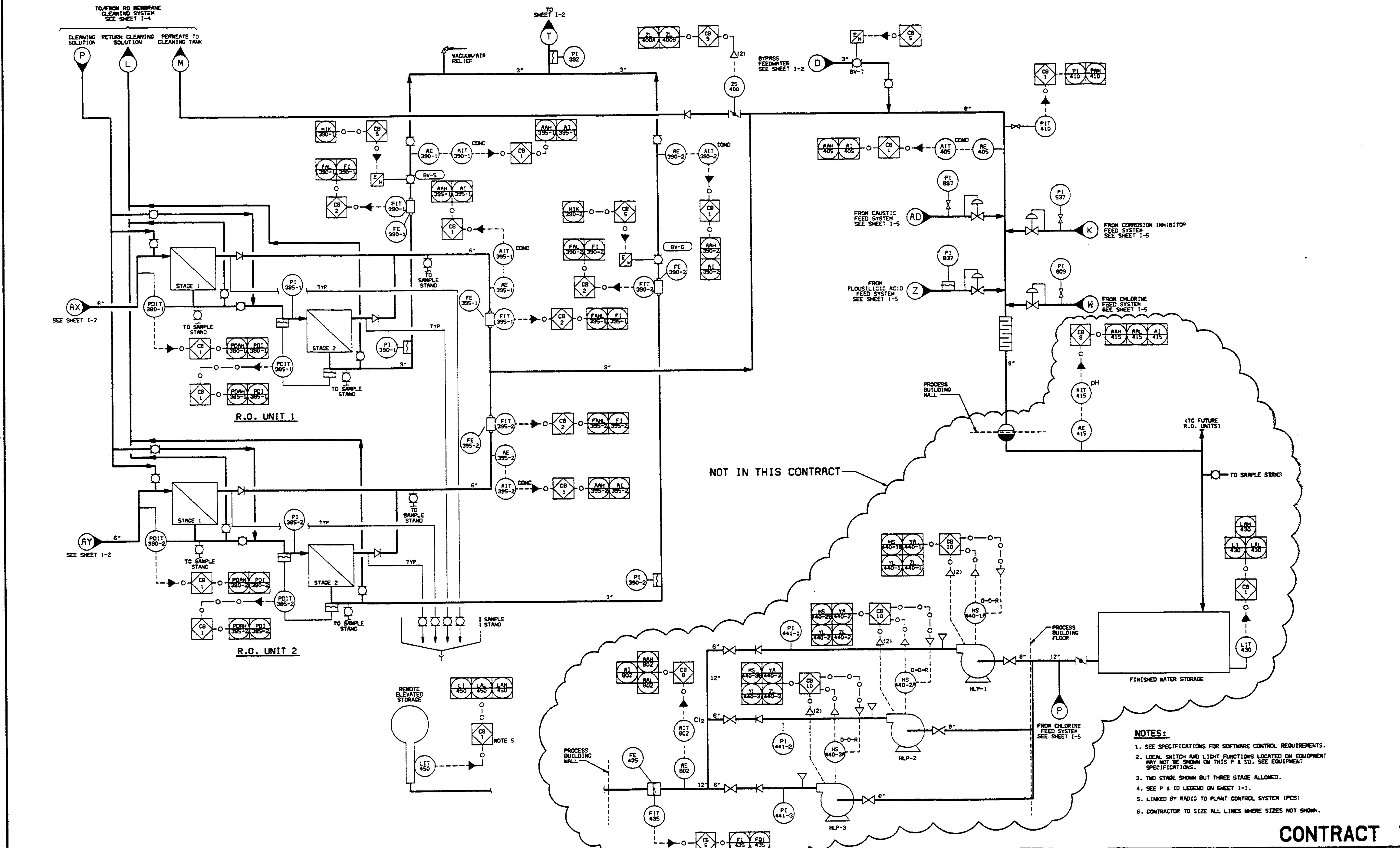
DESIGNED QUM/CMC
DETAILED AJM
CHECKED
APPROVED
DATE

Black & Veatch
Orlando, Florida

PROJECT NO. 24420

CCG. DWG. NO: 24420-190-000-E003

CBG1032.WPL
FCB024420_XXX.ATB.WPL



NOTES:

1. SEE SPECIFICATIONS FOR SOFTWARE CONTROL REQUIREMENTS.
2. LOCAL SWITCH AND LIGHT FUNCTIONS LOCATED ON EQUIPMENT MAY NOT BE SHOWN ON THIS P & ID. SEE EQUIPMENT SPECIFICATIONS.
3. TWO STAGE SHOWN BUT THREE STAGE ALLOWED.
4. SEE P & ID LEGEND ON SHEET I-1.
5. LINKED BY RADIO TO PLANT CONTROL SYSTEM (PCS)
6. CONTRACTOR TO SIZE ALL LINES WHERE SIZES NOT SHOWN.

CONTRACT 1

WATER TREATMENT FACILITIES
DARE COUNTY, NORTH CAROLINA
RODANTHE - WAVES - SALVO

P & ID
REVERSE OSMOSIS SYSTEM

PROJECT NO. 24420

I-3

SHEET 6 OF 8

Black & Veatch
Orlando, Florida

DESIGNED DRM
DETAILED AJH
CHECKED
APPROVED
DATE

DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP

CCG. DWG. NO: 24420-190-000-E002

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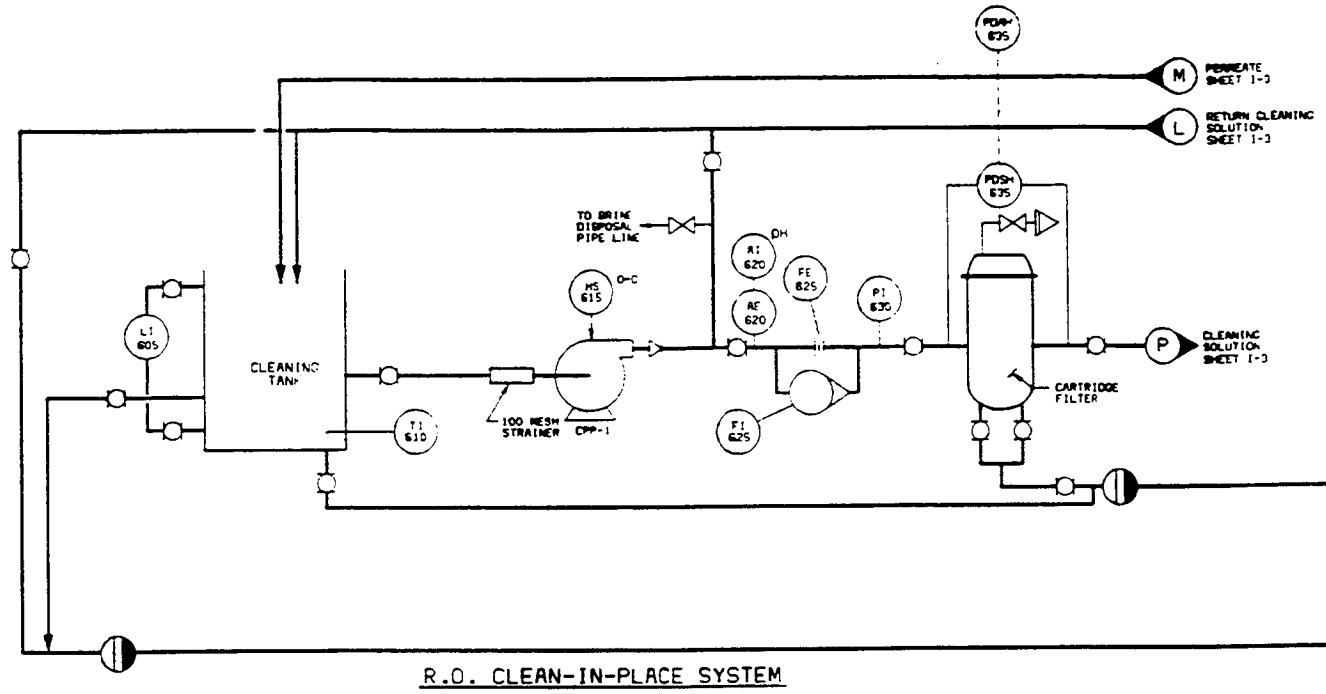
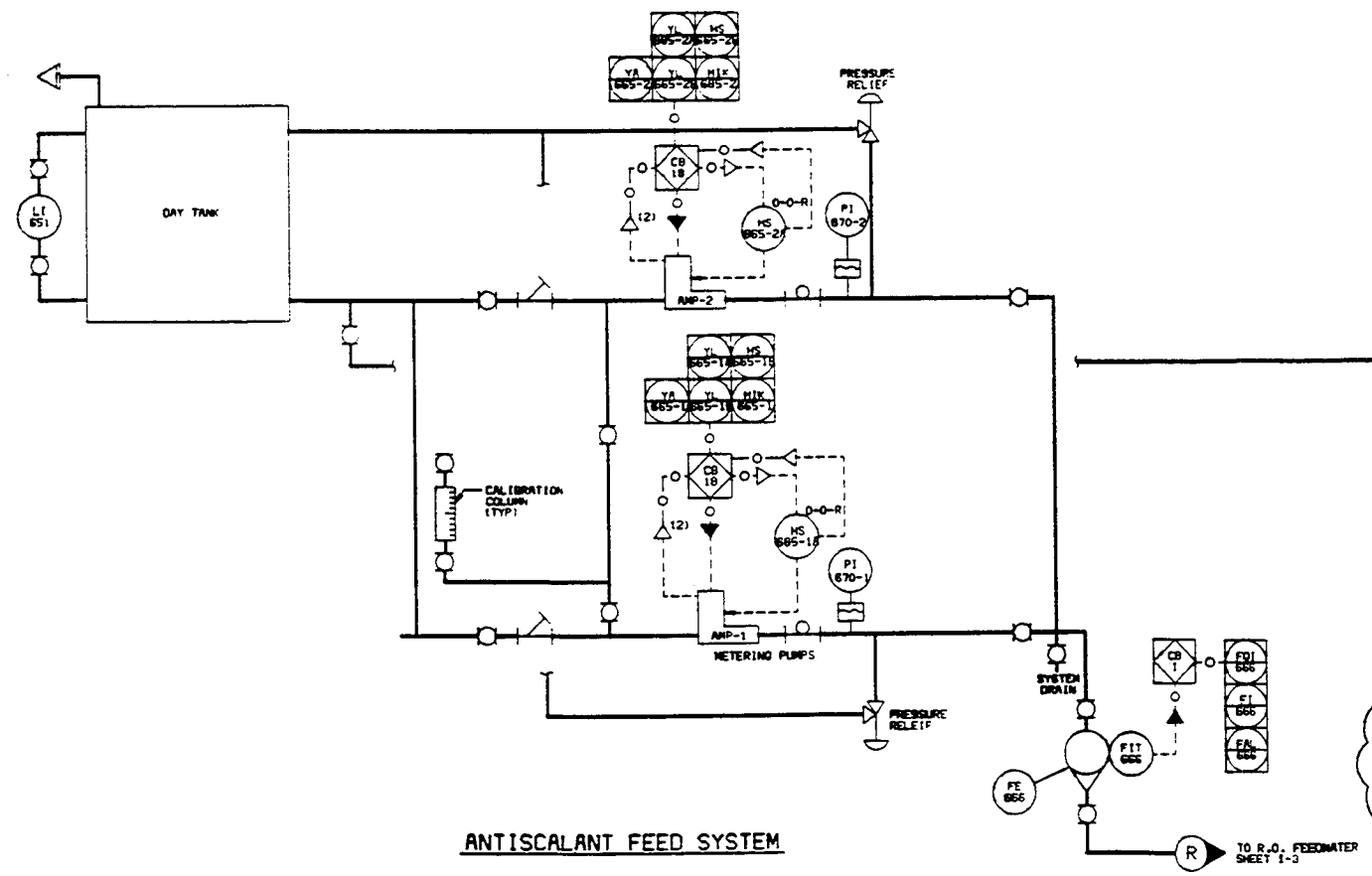
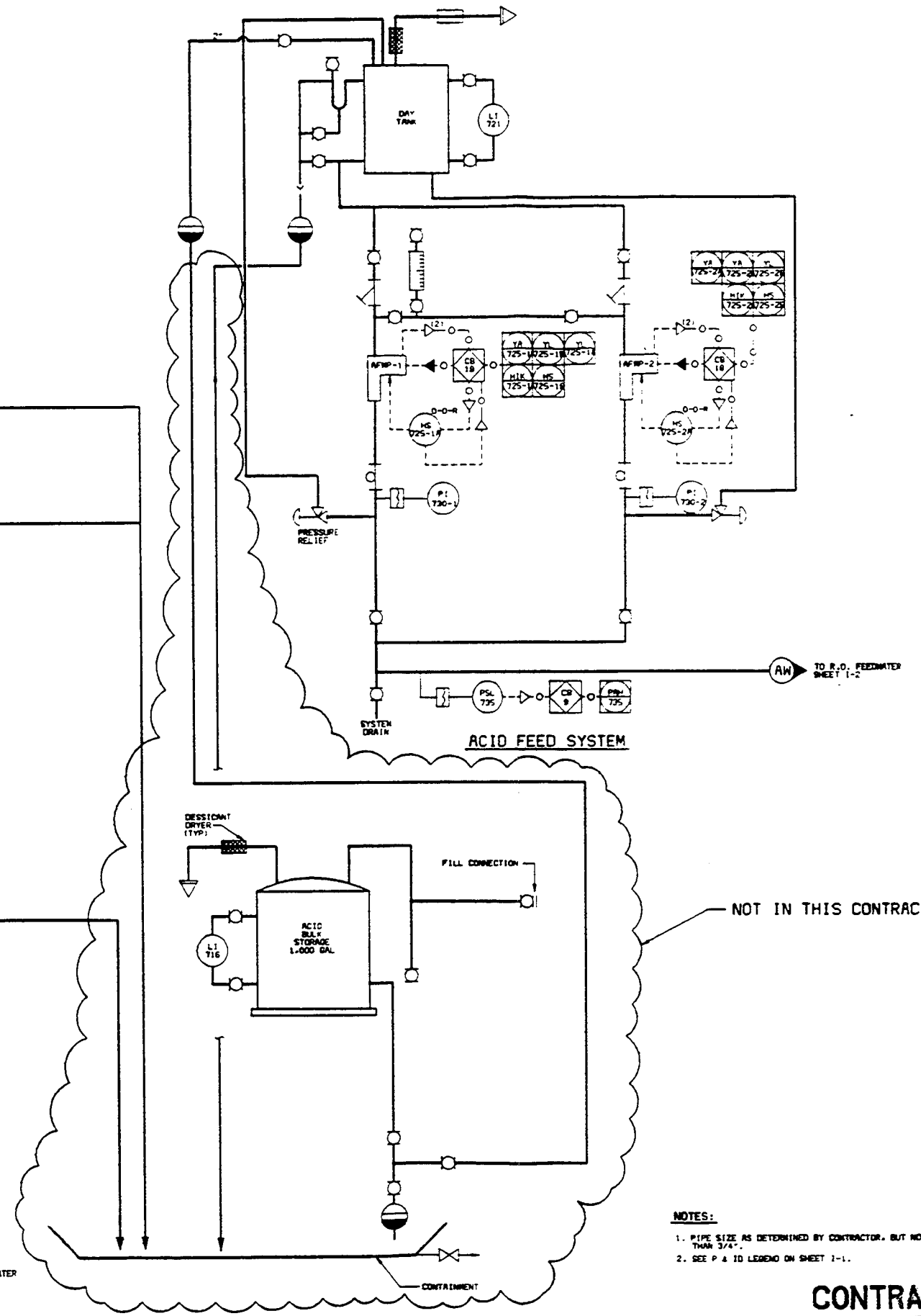
04/19/94 16:03:01 ATSSK



R.O. CLEAN-IN-PLACE SYSTEM



ANTISCALANT FEED SYSTEM



NOTES:

1. PIPE SIZE AS DETERMINED BY CONTRACTOR. BUT NOT LESS THAN 3/4".
2. SEE P & ID LEGEND ON SHEET I-1.

CONTRACT 1

DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP

DESIGNED DRW
DETAILED AJK
CHECKED
APPROVED
DATE

Black & Veatch
Orlando, Florida

PROJECT NO. 24420

WATER TREATMENT FACILITIES
DARE COUNTY, NORTH CAROLINA
RODANTHE - WAVES - SALVO

P & ID
PROCESS CHEMICAL FEED SYSTEMS

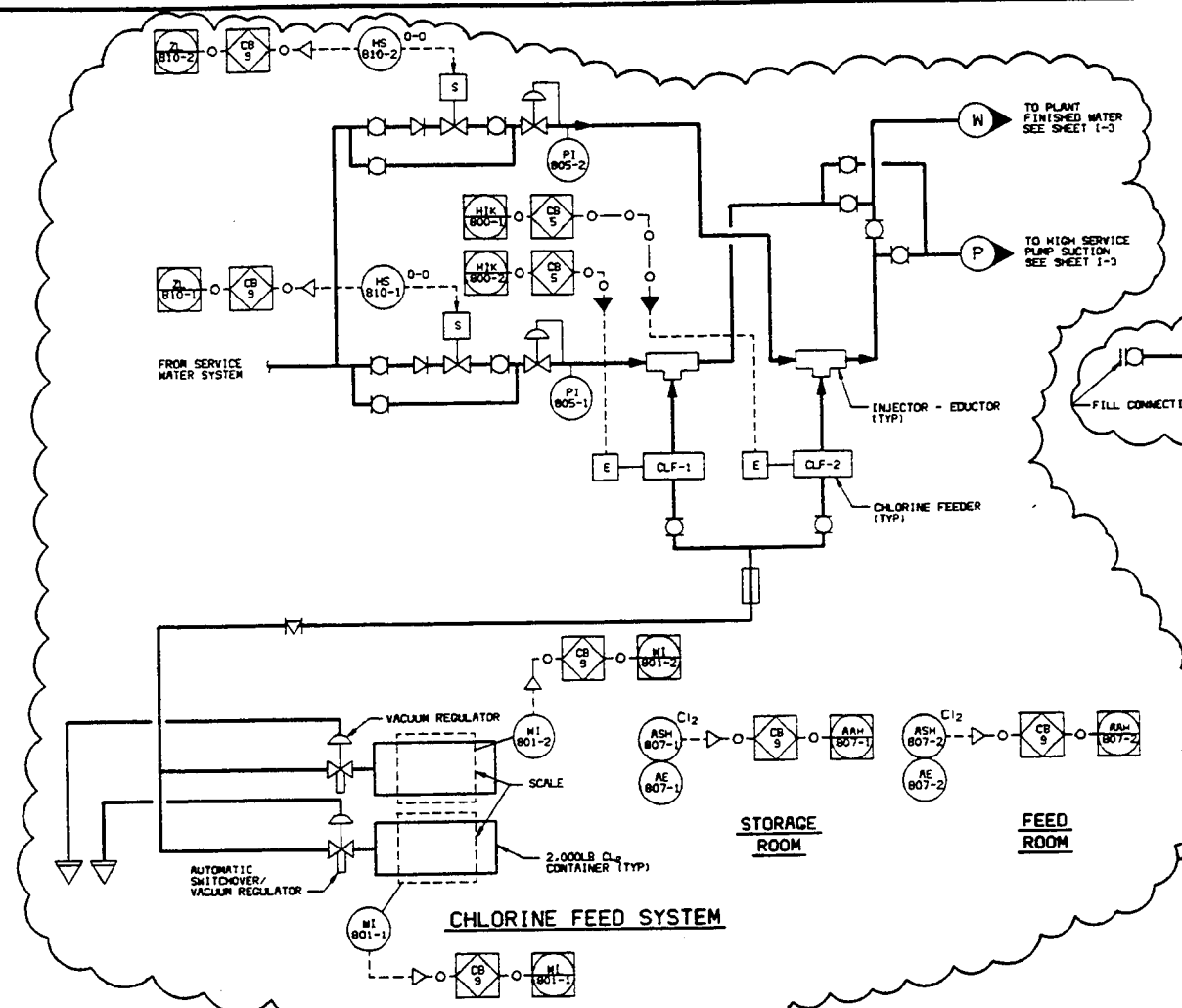
I-4

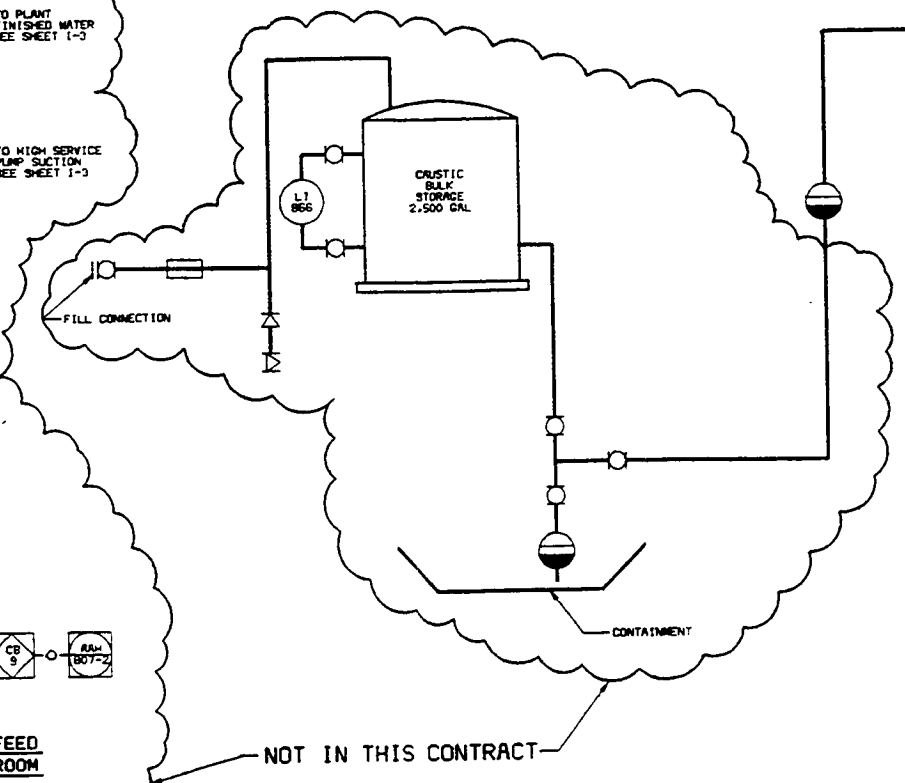
SHEET 7 OF 8

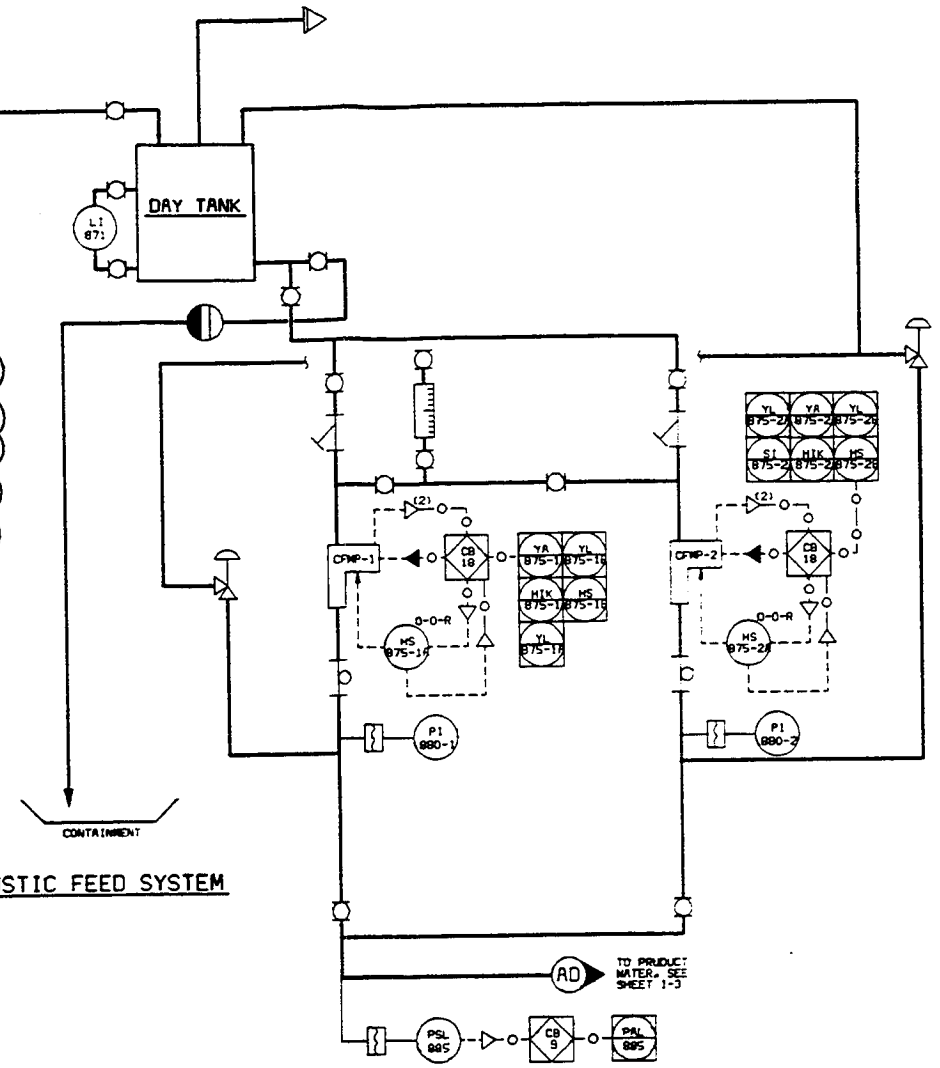
CONT. DWG. NO: 24420-130-000-EDY

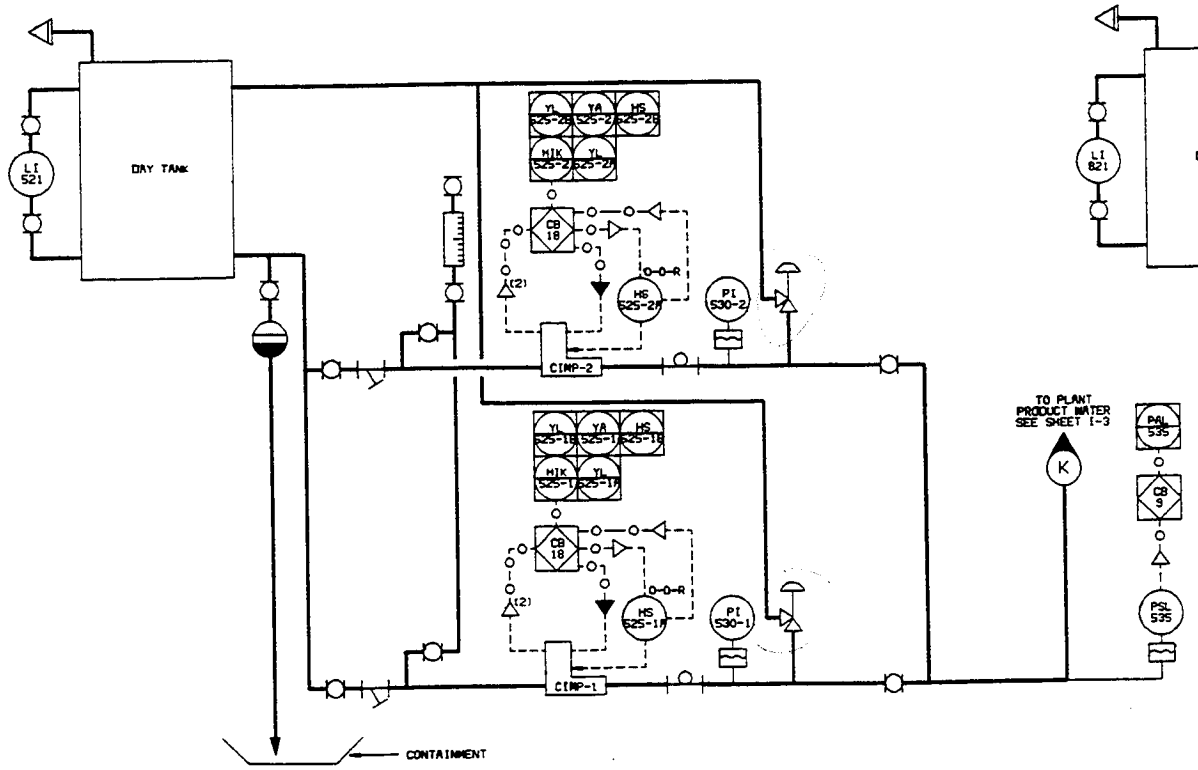
CB01072.VPL
FCB024420.XXX.ATB.VPL

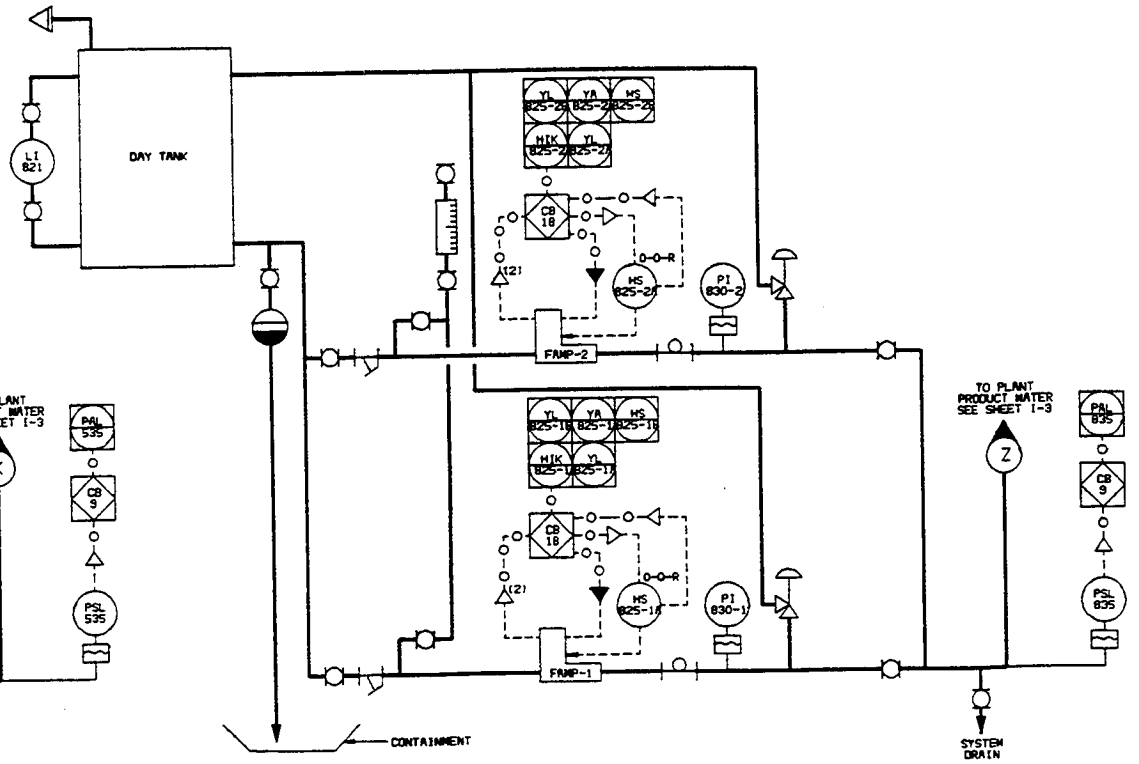
04/20/94 07:34:00 VPL
04/19/94 16:19:27 ATSSK











NOTES:

1. PIPE SIZE AS DETERMINED BY CONTRACTOR, BUT NOT LESS THAN 3/4".
2. SEE P & ID LEGEND ON SHEET I-1.

CONTRACT 1

DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP

DESIGNED DJM
DETAILED AJM
CHECKED
APPROVED
DATE

Black & Veatch
Orlando, Florida

PROJECT NO. 24420

WATER TREATMENT FACILITIES
DARE COUNTY, NORTH CAROLINA
RODANTHE - WAVES - SALVO

P & ID
PRE- AND POST TREATMENT
CHEMICAL FEED SYSTEM

I-5

SHEET 8 OF 8

CCG. DWG. NO: 24420-190-000-E005

CB01032.VPL
FCB024420.XXX.A1B.VPL

SUMMARY OF RECOMMENDATIONS

Operations Building:

Representative Borings - B-1 through B-3
Recommended Design Bearing Pressure - 3,000 psf (net- i.e. contact stress less overburden)
Minimum Embedment - 18"
Minimum Column Width - 24"
Minimum Wall Footing Width - 16"
Estimated Settlement of 50 kip Column - 0.57"
Estimated Settlement of 3k/ft Wall Footing - 0.42"
Recommended Pile Type (if required) - 20 T timber pile
Recommended Minimum Length - 15 feet
Precautions - preconstruction survey on structures within 250 feet
Preaugering & Jetting - required to penetrate below El $^{+}1$ to El $^{-}3$
Groundwater - assume at El $^{+}3.5$

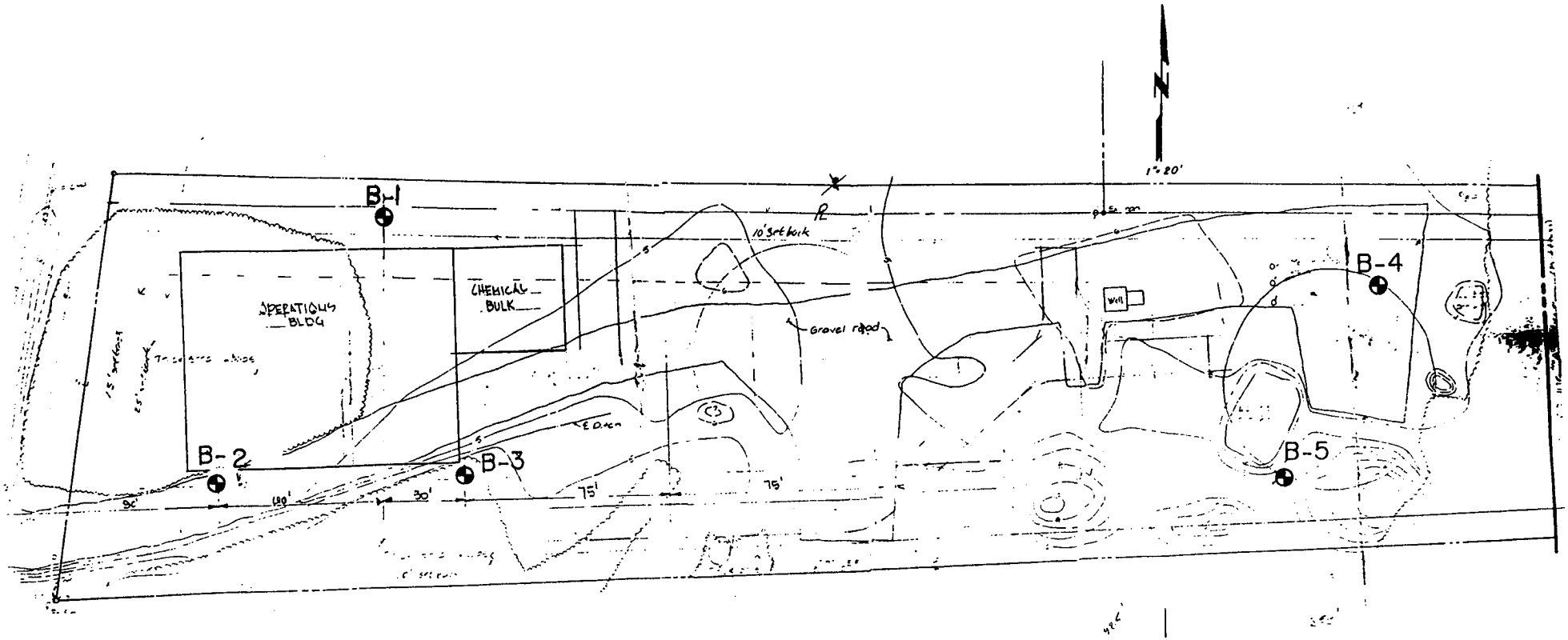
Crom Tank:

Representative Borings - B-4 through B-5
Recommended Design Bearing Pressure - 3,000 psf net
Minimum Embedment - 18"
Minimum Width - 16"
Estimated Center Settlement Assuming 2 ksf Contact Stress - 1.48"
Estimated Edge Settlement - 0.75"
Recommended Pile Type (if required) - 20 T timber pile
Recommended Minimum Length - 15 feet
Precautions - preconstruction survey on structures within 250 feet
Preaugering and Jetting - required to penetrate below El $^{-}3$
Groundwater - assume at El $^{+}3.5$

Miscellaneous Design Recommendations:

On-site soils suitable for reuse as structural fill.
Compact structural fill to 95% of the Standard Proctor (ASTM D-698)
Seismic Zone - 0; therefore, no allowance for seismic loads required
Design Lateral Pressure Values:
Assumed Unit Weight = 110 pcf moist
Assumed Unit Weight = 120 pcf saturated

Kq = 0.31	γa Equiv. = 34 pcf above; 80 pcf below
Ko = 0.41	γo Equiv. = 45 pcf above; 86 pcf below
Kp = 3.26	γp Equiv. = 355 pcf above; 250 pcf below



PROJECT:

Rodanthe WTP
Rodanthe, North Carolina

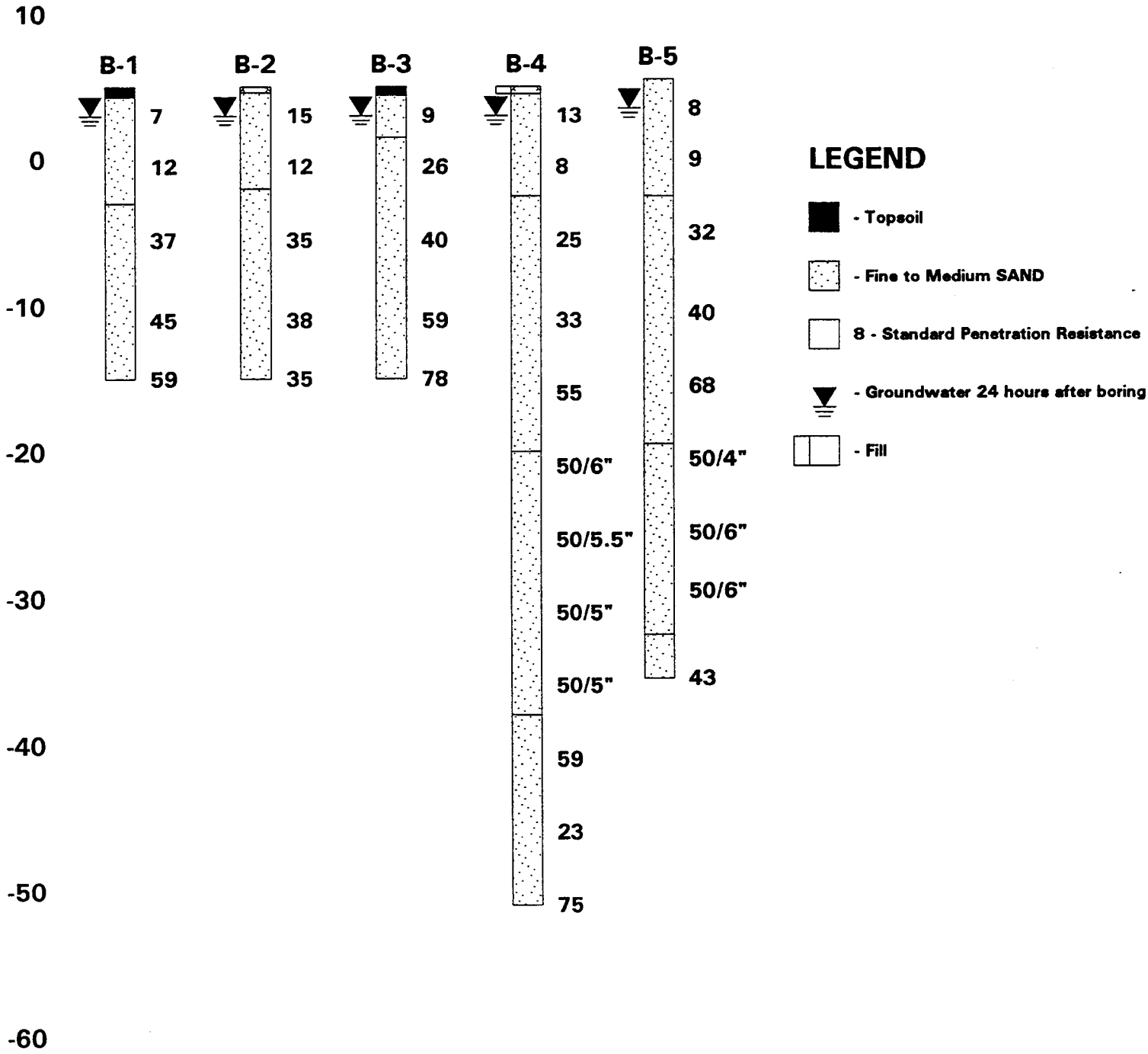
GeoTechnologies, Inc.

SCALE: Not to Scale

JOB No: 1-93-715-EA

FIGURE No: 1

GENERALIZED SUBSURFACE PROFILE



PROJECT:

Rodanthe WWTP
Rodanthe, North Carolina

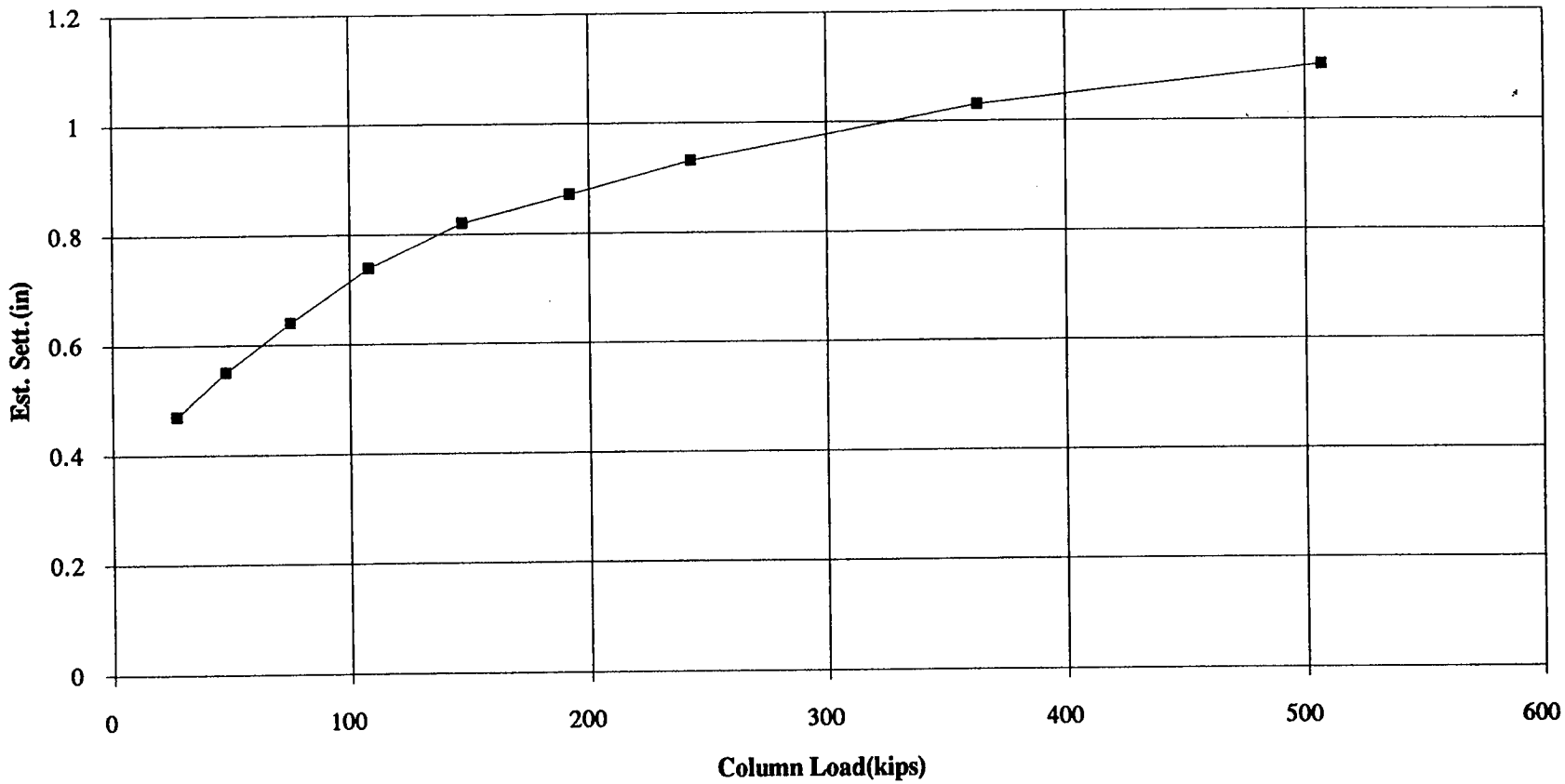
GeoTechnologies, Inc.

SCALE:As Shown

JOB NO:1-93-715-EA

FIG NO:2

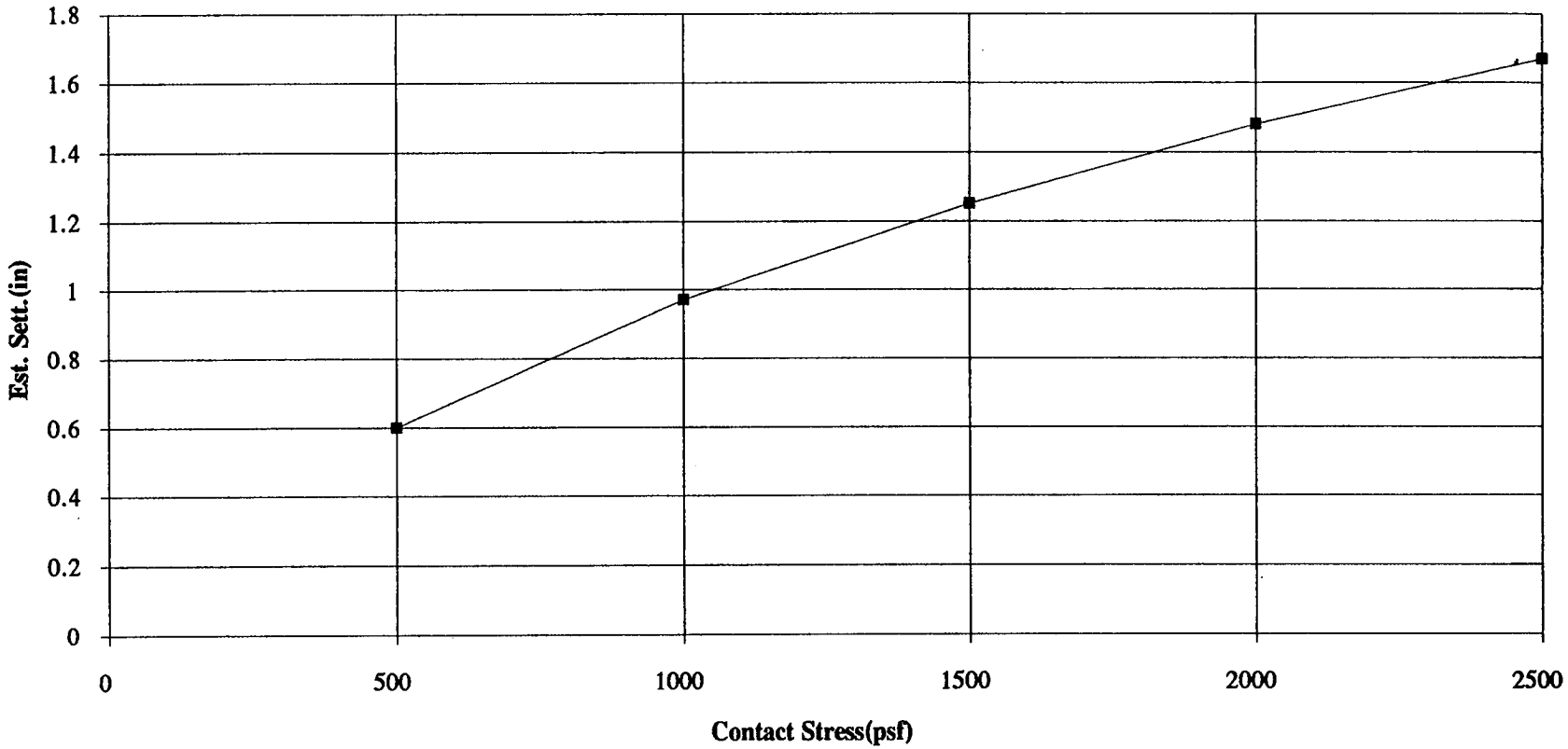
ESTIMATED SETTLEMENT OF COLUMNS WITH INDICATED LOADS



Assumes 3ksf bearing pressure and 1.5ft of embedment.

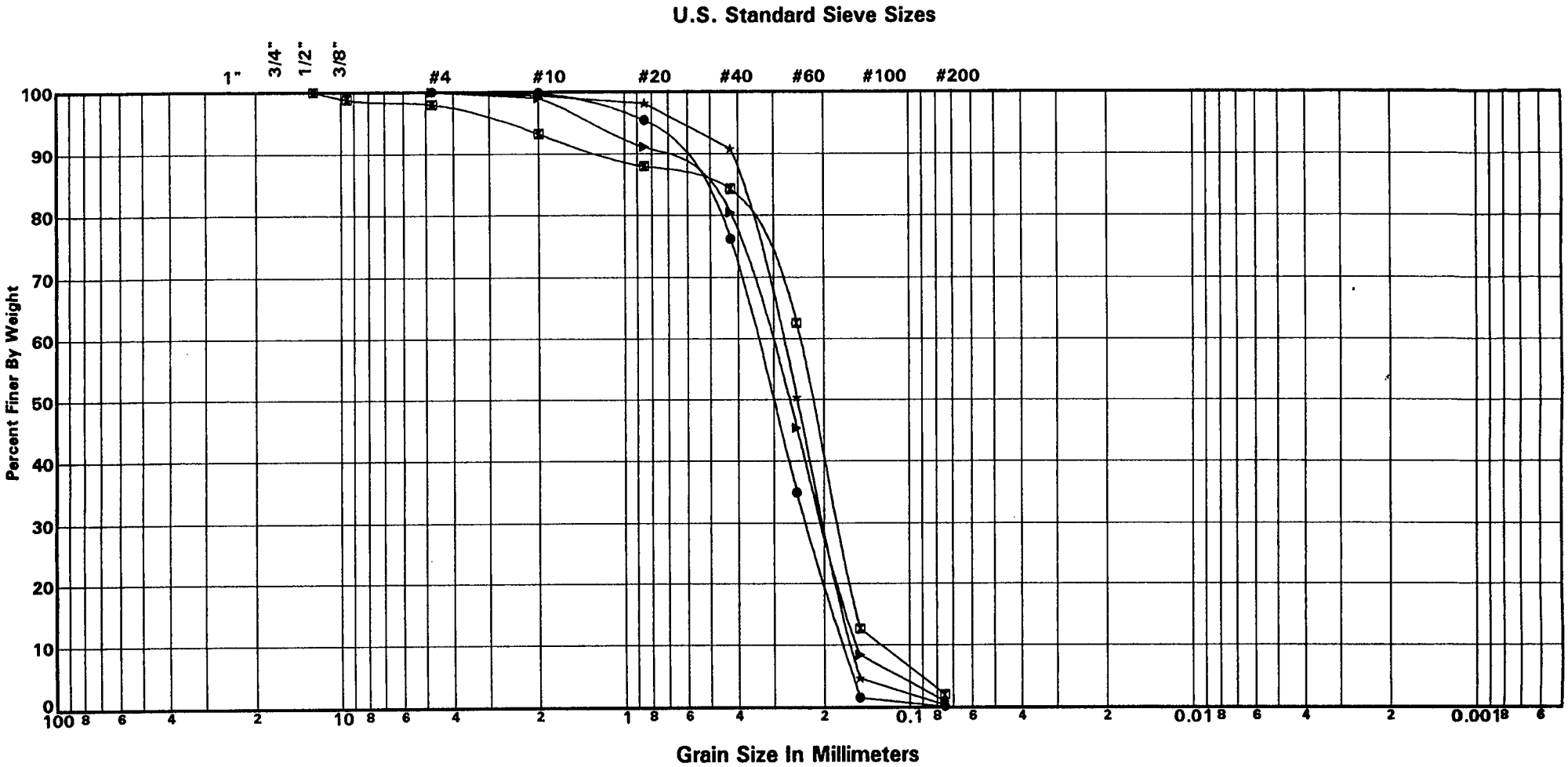
FIGURE 3

ESTIMATED SETTLEMENT AT CENTER OF A 80' DIAMETER TANK FOR VARIOUS CONTACT STRESSES



Assumes 1.5ft of embedment from existing grade.

FIGURE 4



GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
						COMPOSITE PLOT OF GRAIN SIZE DISTRIBUTION

Project:

Rodanthe WWTP
Rodanthe, North Carolina

Job No.: 1-93-715-EA

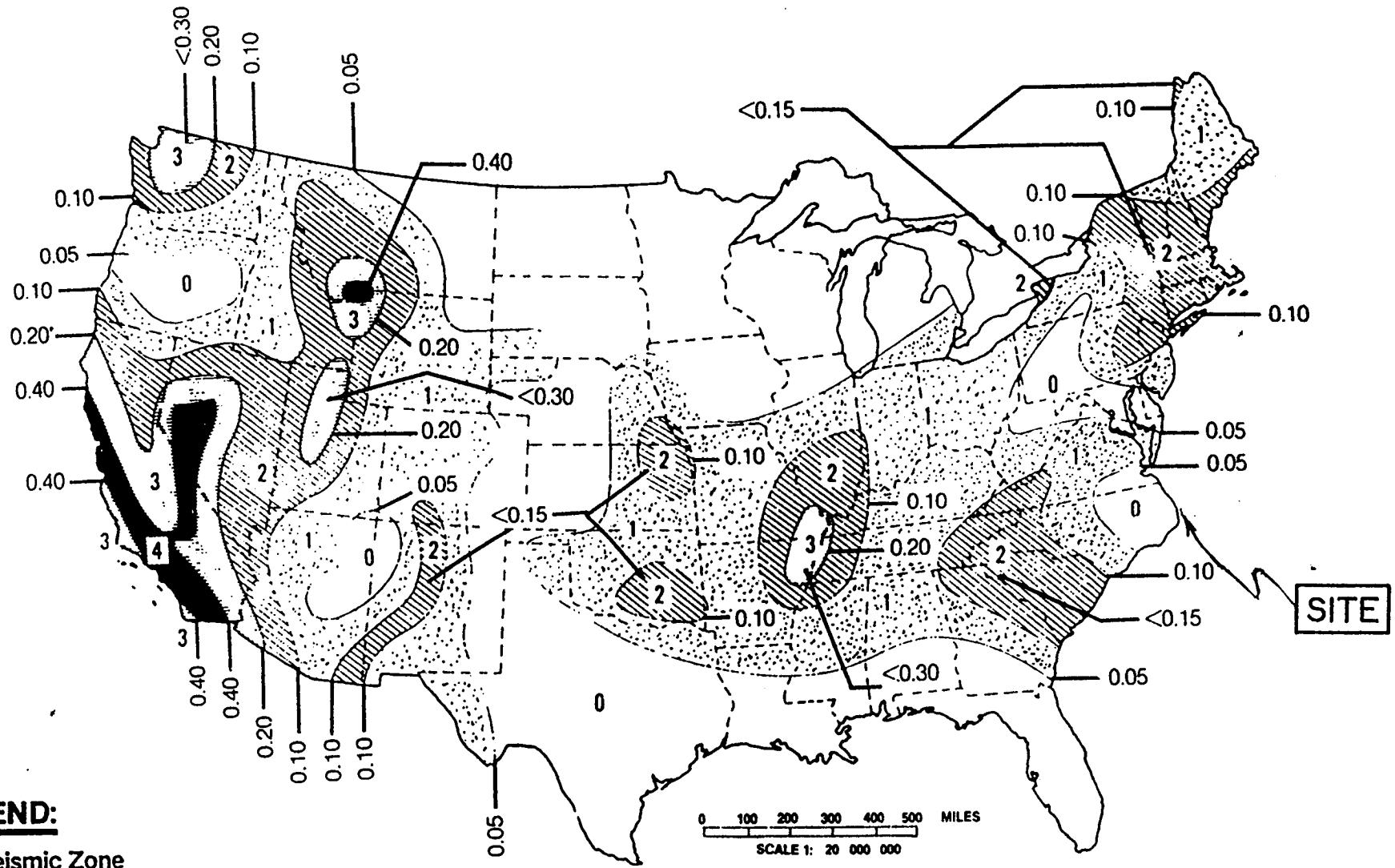
Date: 12/17/93

GRAIN SIZE DISTRIBUTION

GeoTechnologies Inc.

FIGURE 5

MAP OF SEISMIC ZONES AND EFFECTIVE PEAK VELOCITY-RELATED ACCELERATION (A_V)



LEGEND:

0-4 Seismic Zone

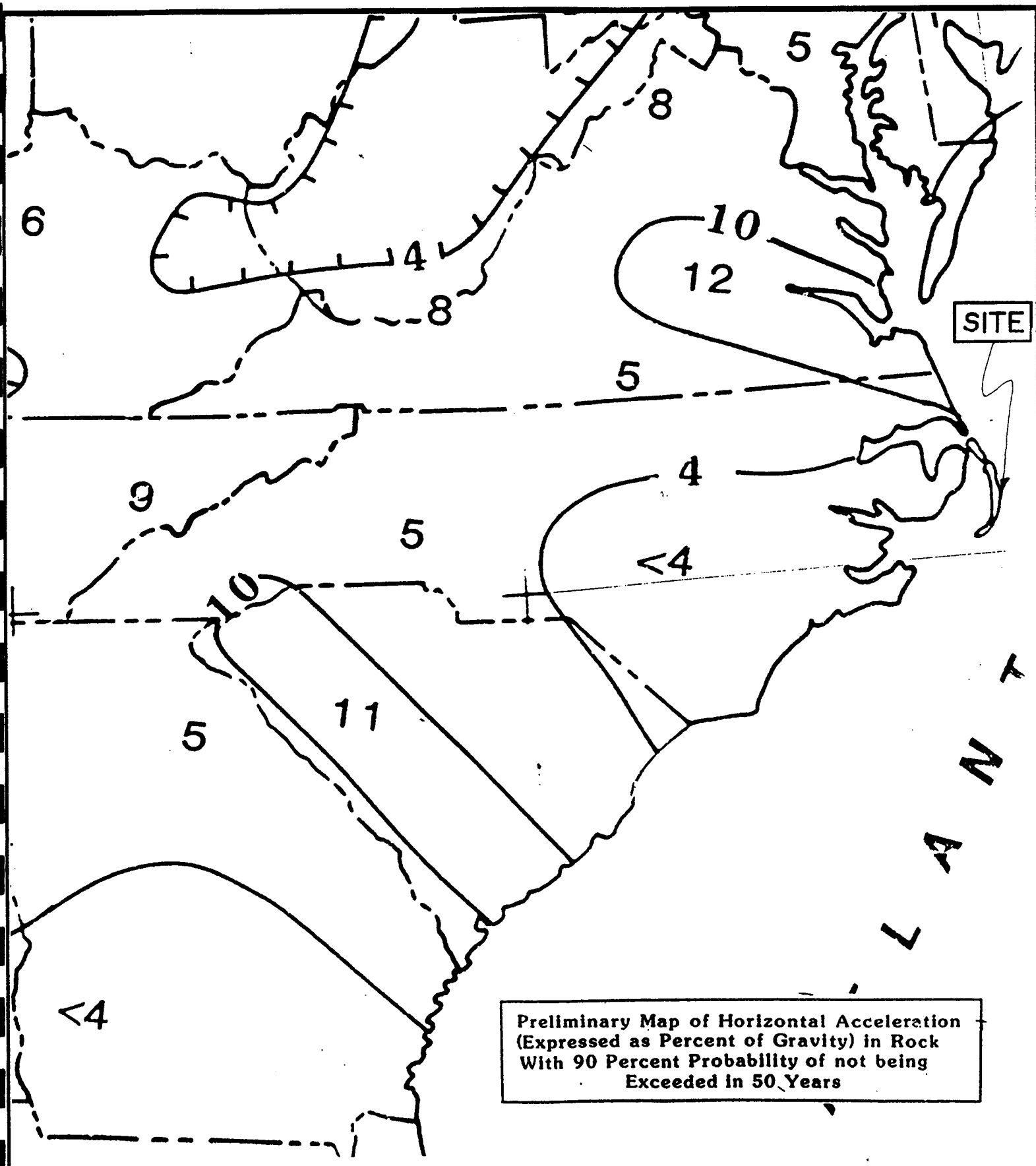
0.05-0.40 Effective Peak Velocity-Related Acceleration (A_V)

$A_v \geq 0.40$

Linear Interpolation Between Contours is Acceptable.

Standard Building Code/1988

PROJECT: Rodanthe WWTP Rodanthe, North Carolina	GeoTechnologies, Inc.	**SCALE: Not to Scale** **JOB No: 1-93-715-EA** **FIGURE No: 6**



Preliminary Map of Horizontal Acceleration (Expressed as Percent of Gravity) in Rock With 90 Percent Probability of not being Exceeded in 50 Years

PROJECT:

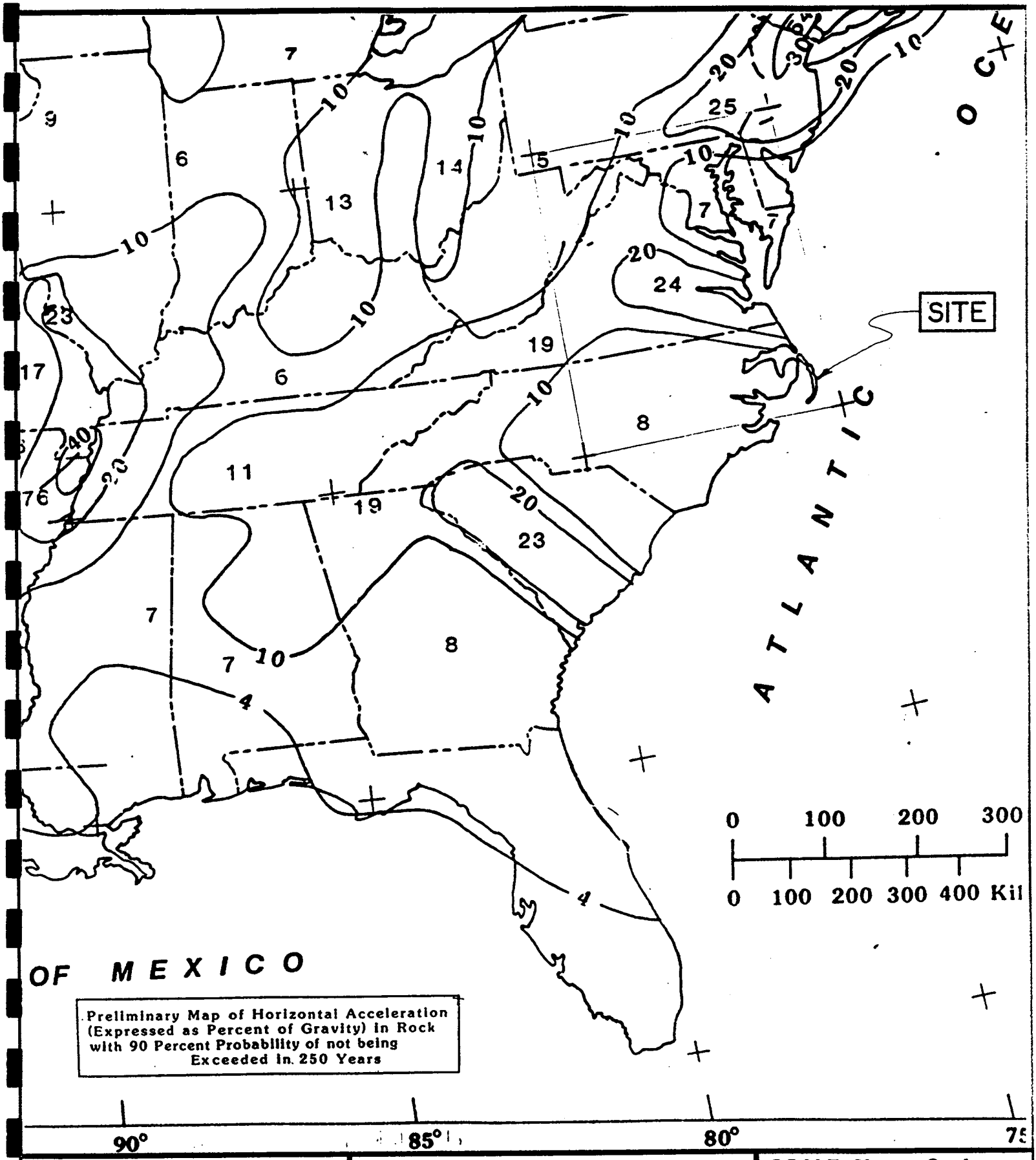
Rodanthe WWTP
Rodanthe, North Carolina

GeoTechnologies, Inc.

SCALE: Not to Scale

JOB NO: 1-93-715-EA

FIG NO: 7



PROJECT:

Rodanthe WWTP
Rodanthe, North Carolina

GeoTechnologies, Inc.

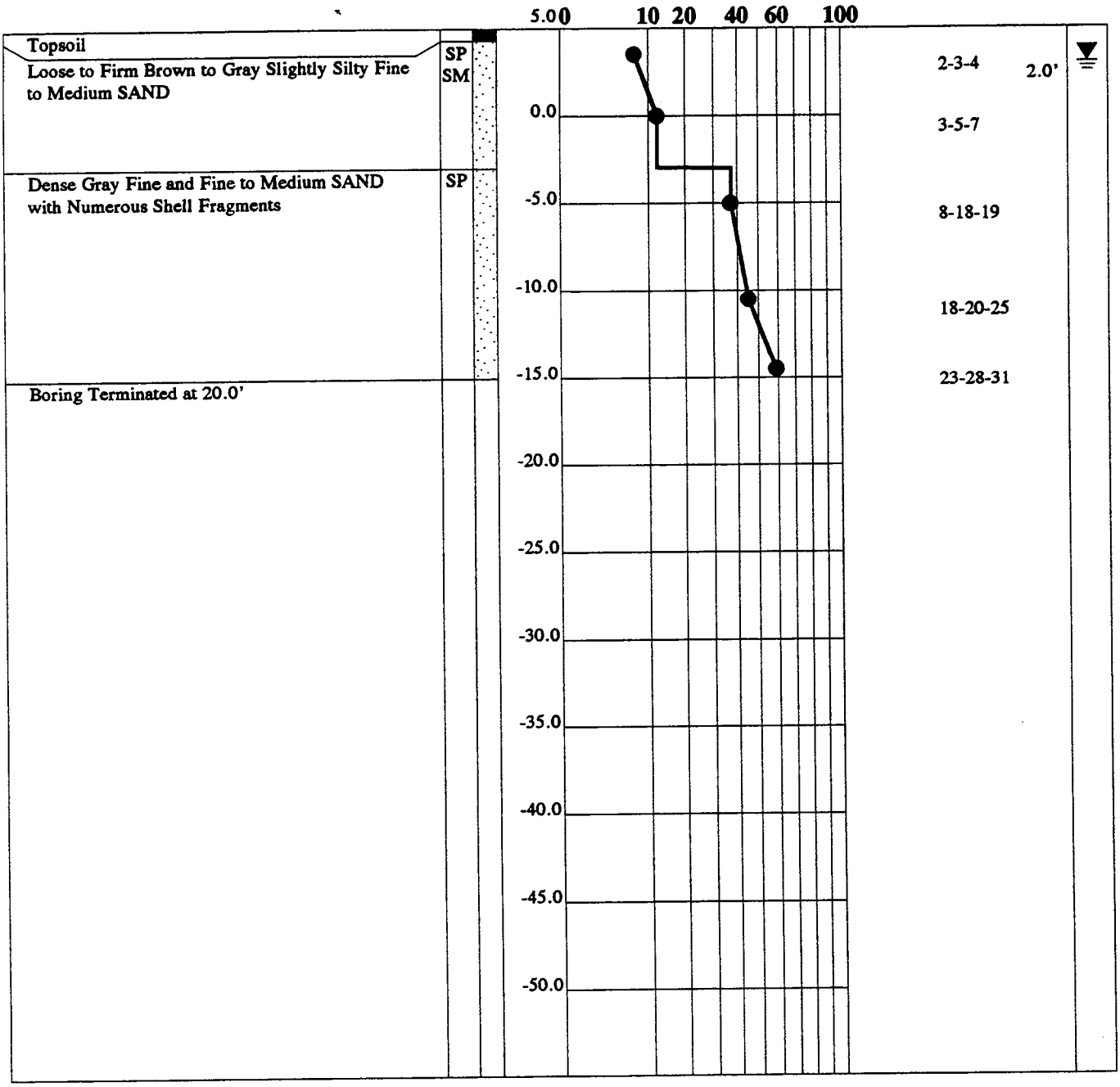
SCALE: Not to Scale

JOB NO: 1-93-715-EA

FIG NO: 8

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	PENETRATION (BLOWS/FT.)	BLOWS PER SIX INCHES
0.0		5.00	10 20 40 60 100	
0.7	Topsoil	SP		2-3-4 2.0'
	Loose to Firm Brown to Gray Slightly Silty Fine to Medium SAND	SM	0.0	3-5-7
8.0	Dense Gray Fine and Fine to Medium SAND with Numerous Shell Fragments	SP	-5.0	8-18-19
			-10.0	18-20-25
20.0			-15.0	23-28-31
	Boring Terminated at 20.0'		-20.0	
			-25.0	
			-30.0	
			-35.0	
			-40.0	
			-45.0	
			-50.0	

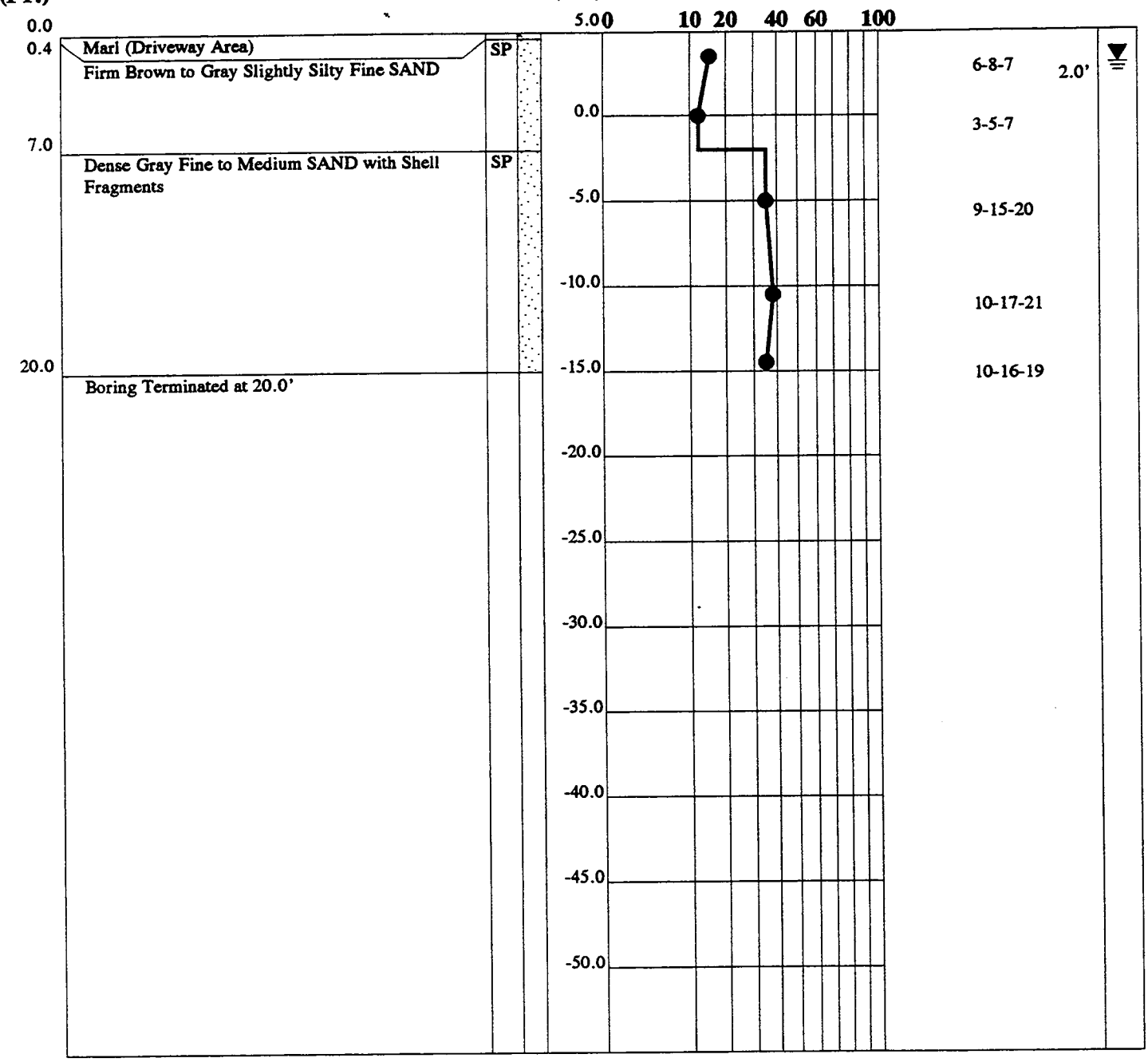


JOB NUMBER 1-93-715-EA
BORING NUMBER B-1
DATE 12-1-93

GeoTechnologies, Inc.

TEST BORING RECORD

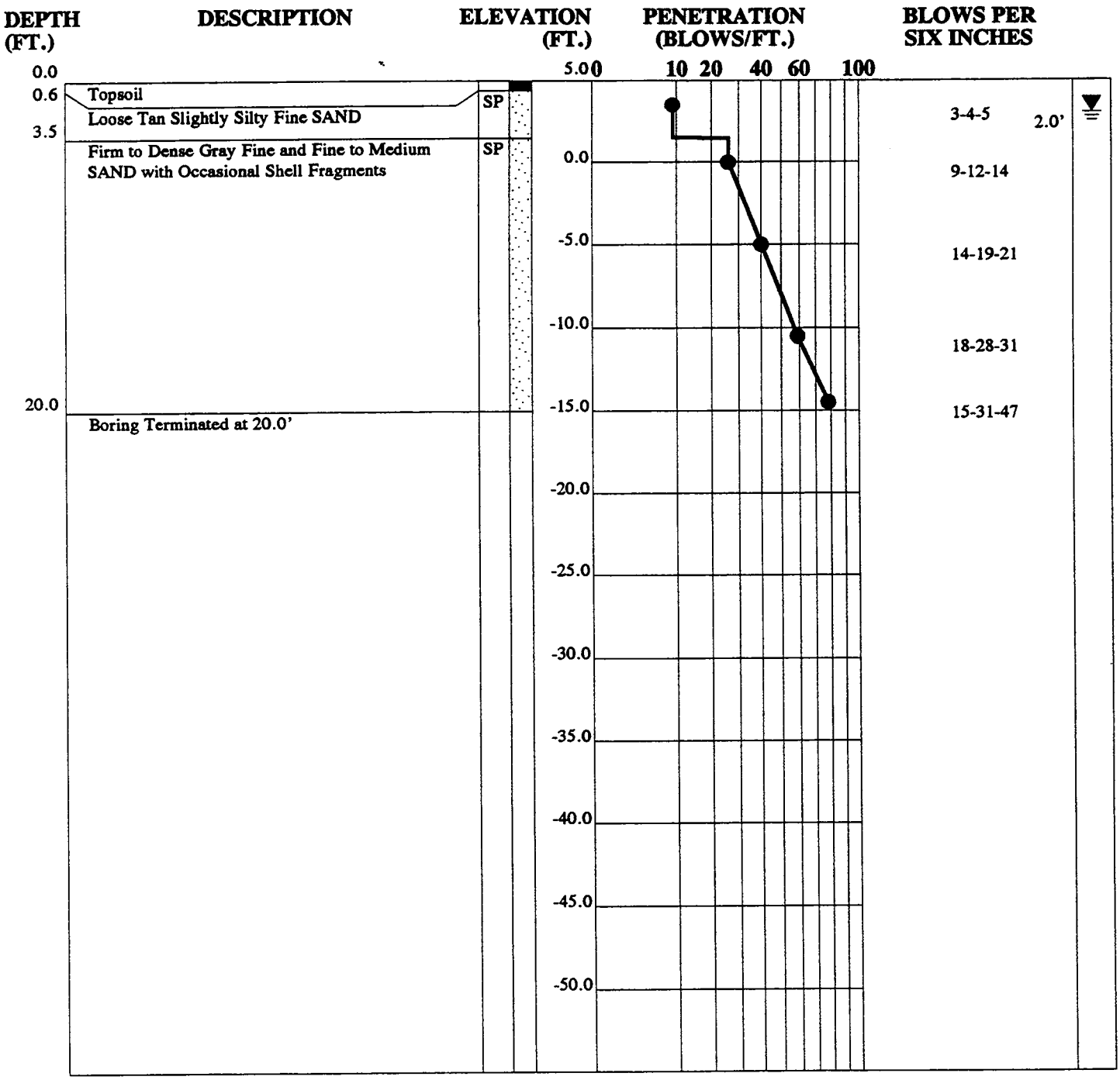
DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	PENETRATION (BLOWS/FT.)	BLOWS PER SIX INCHES
0.0		5.00	10 20 40 60 100	
0.4	Marl (Driveway Area)	SP		6-8-7 2.0'
	Firm Brown to Gray Slightly Silty Fine SAND		0.0	3-5-7
7.0				
	Dense Gray Fine to Medium SAND with Shell Fragments	SP	-5.0	9-15-20
			-10.0	10-17-21
20.0			-15.0	10-16-19
	Boring Terminated at 20.0'		-20.0	
			-25.0	
			-30.0	
			-35.0	
			-40.0	
			-45.0	
			-50.0	



JOB NUMBER 1-93-715-EA
BORING NUMBER B-2
DATE 12-2-93

GeoTechnologies, Inc.

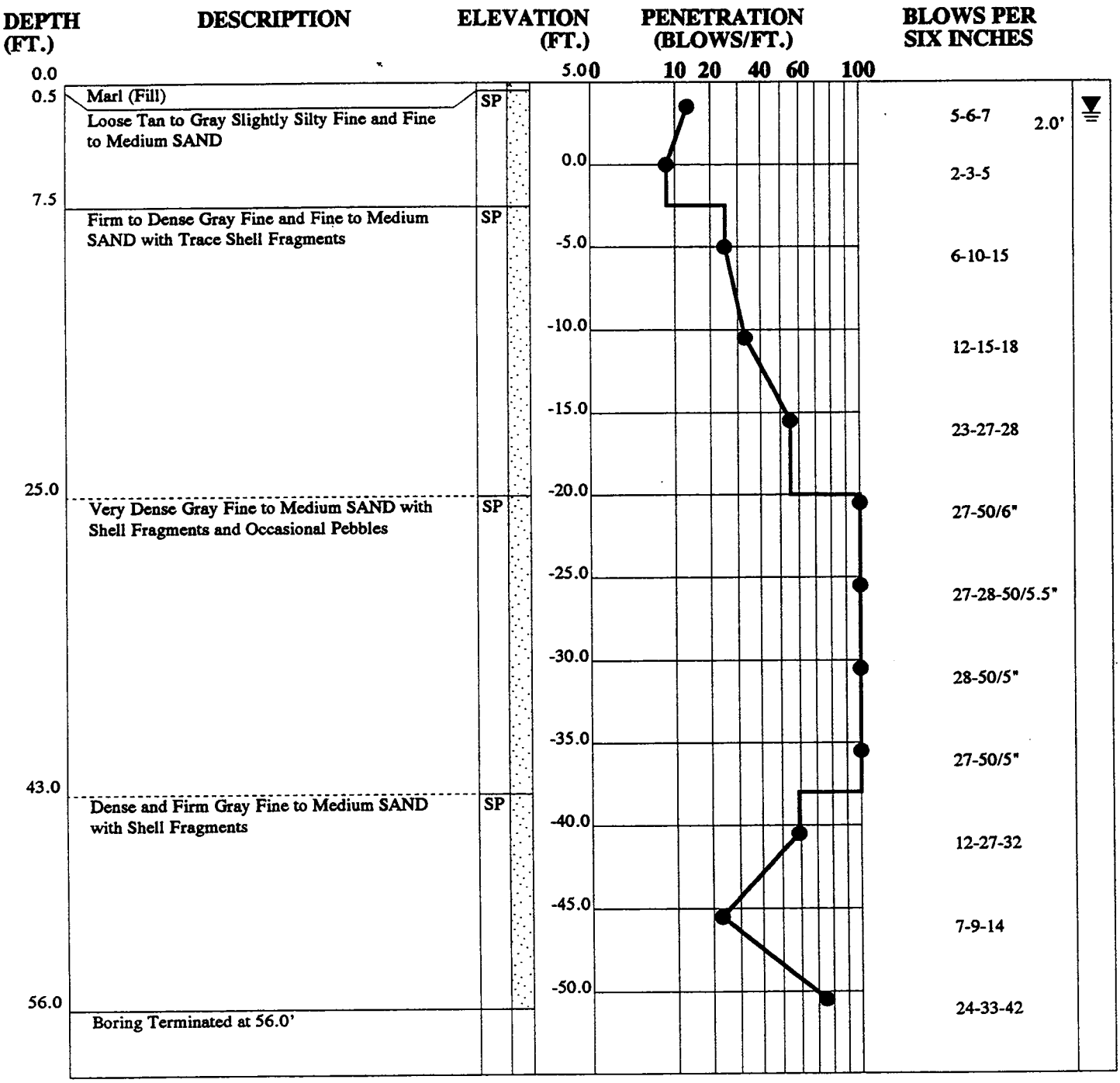
TEST BORING RECORD



JOB NUMBER 1-93-715-EA
BORING NUMBER B-3
DATE 12-2-93

GeoTechnologies, Inc.

TEST BORING RECORD



JOB NUMBER 1-93-715-EA
BORING NUMBER B-4
DATE 12-1-93

GeoTechnologies, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	PENETRATION (BLOWS/FT.)	BLOWS PER SIX INCHES
0.0			5.5	0 10 20 40 60 100	
	Loose Brown Slightly Silty Fine and Fine to Medium SAND	SP			1-3-5
			0.5		3-4-5
8.0					
	Dense Gray Fine SAND with Trace Shell Fragments	SP	-4.5		11-15-17
			-9.5		12-17-23
			-14.5		23-30-38
25.0			-19.5		38-50/4"
	Very Dense Gray Fine to Medium SAND with Occasional Shell Fragments	SP	-24.5		21-50/6"
			-29.5		50/6"
38.0					
	Dense Dark Gray Slightly Silty Fine SAND	SP	-34.5		12-18-25
41.0					
	Boring Terminated at 41.0'		-39.5		
			-44.5		
			-49.5		

2.0' ▼

JOB NUMBER 1-93-715-EA
BORING NUMBER B-5
DATE 12-2-93

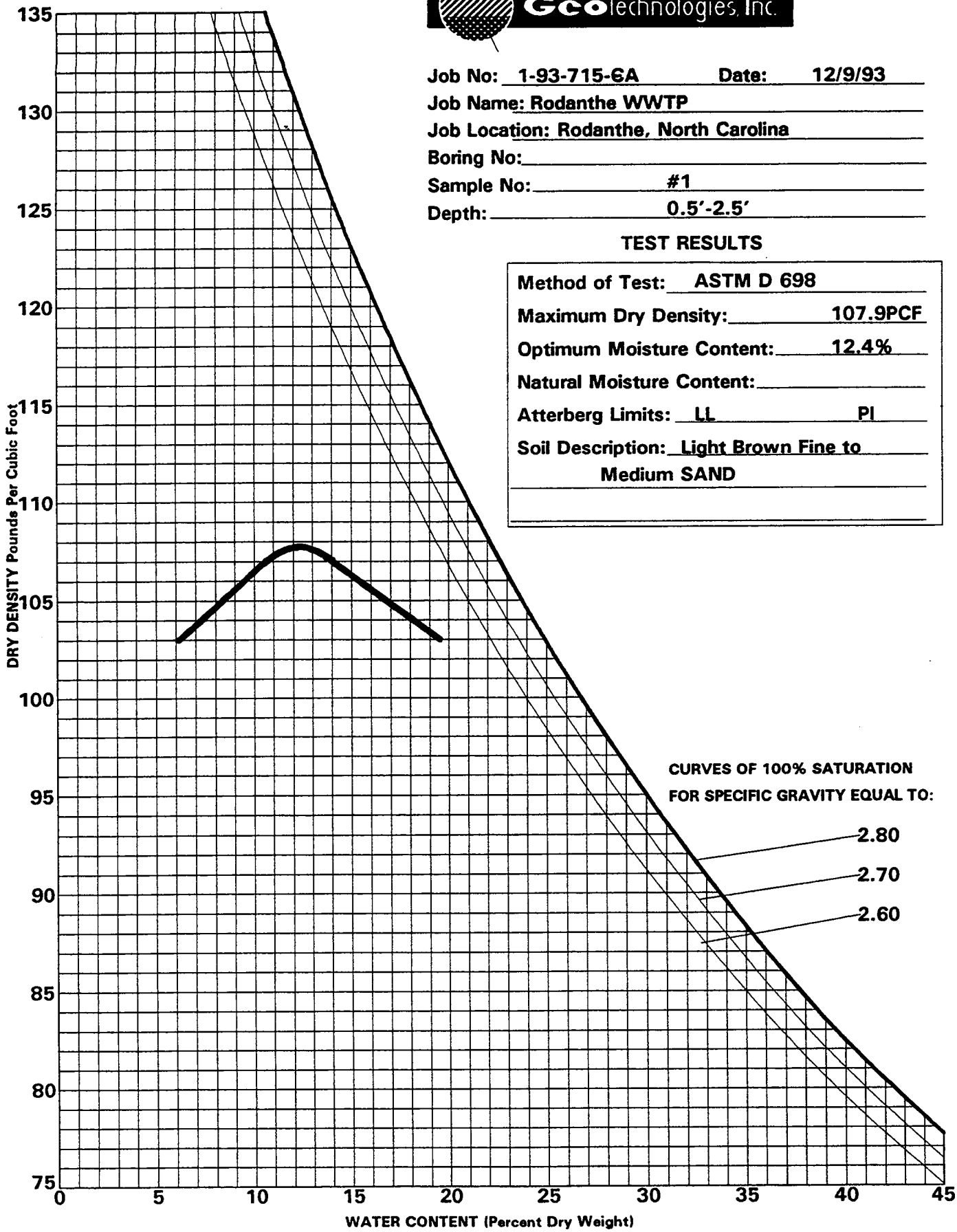
GeoTechnologies, Inc.

GeoTechnologies, Inc.

Job No: 1-93-715-GA Date: 12/9/93
Job Name: Rodanthe WWTP
Job Location: Rodanthe, North Carolina
Boring No:
Sample No: #1
Depth: 0.5'-2.5'

TEST RESULTS

Method of Test: ASTM D 698
Maximum Dry Density: 107.9PCF
Optimum Moisture Content: 12.4%
Natural Moisture Content:
Atterberg Limits: LL PI
Soil Description: Light Brown Fine to Medium SAND



MOISTURE-DENSITY RELATIONSHIP

Geotechnologies, Inc.
Raleigh, North Carolina

U.S. Standard Sieve Sizes

Grain Size In Millimeters

GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
B-1	0.5' - 2.0'	18.2				Brown Fine to Medium SAND (SP)

Project:

Rodanthe WWTP
Rodanthe, North Carolina

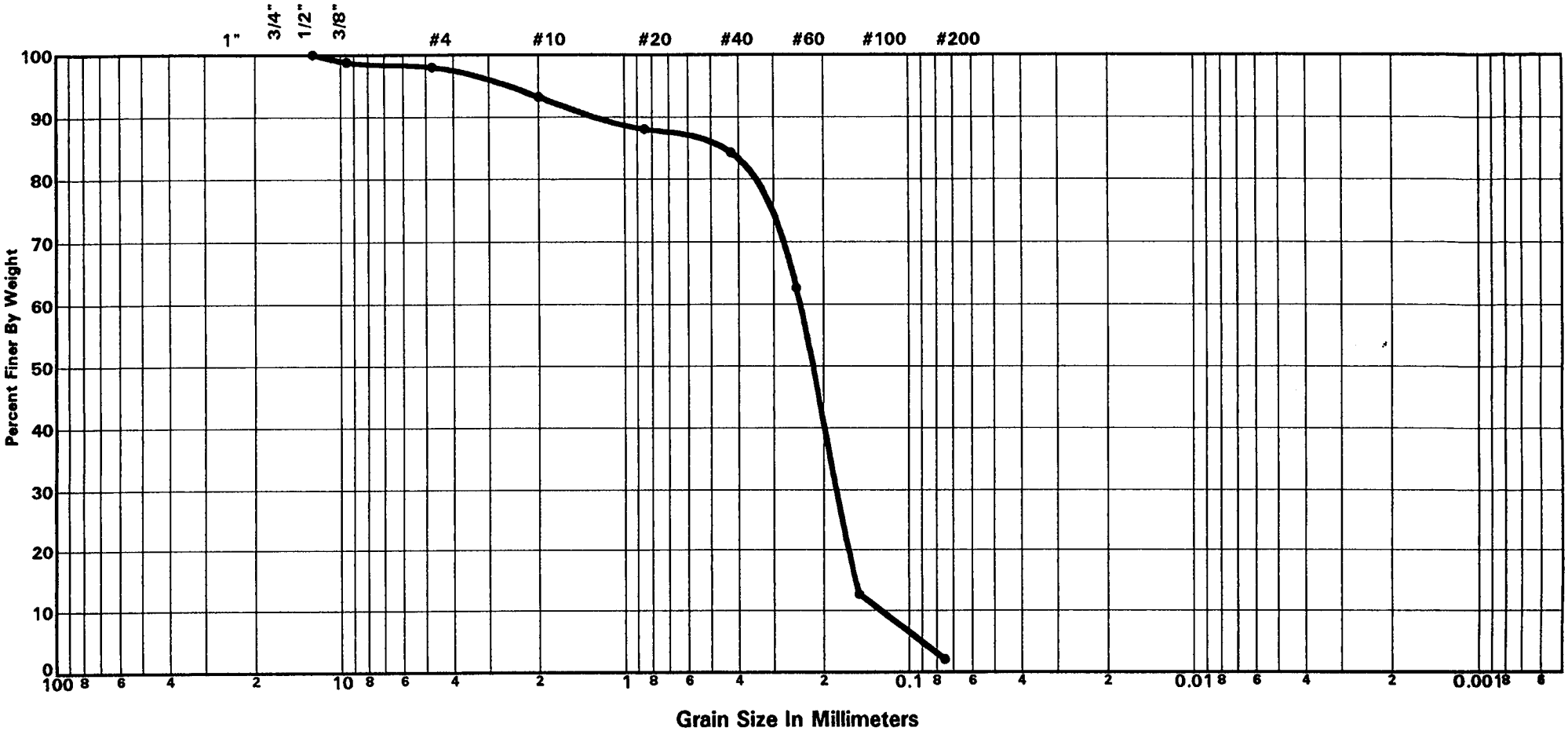
Job No.: 1-93-715-EA

Date: 12/17/93

GRAIN SIZE DISTRIBUTION

GeoTechnologies Inc.

U.S. Standard Sieve Sizes



Grain Size In Millimeters

GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
B-1	14.5' - 16.0'	21.6				Gray Fine to Medium SAND with Shell Fragments (SP)

Project:

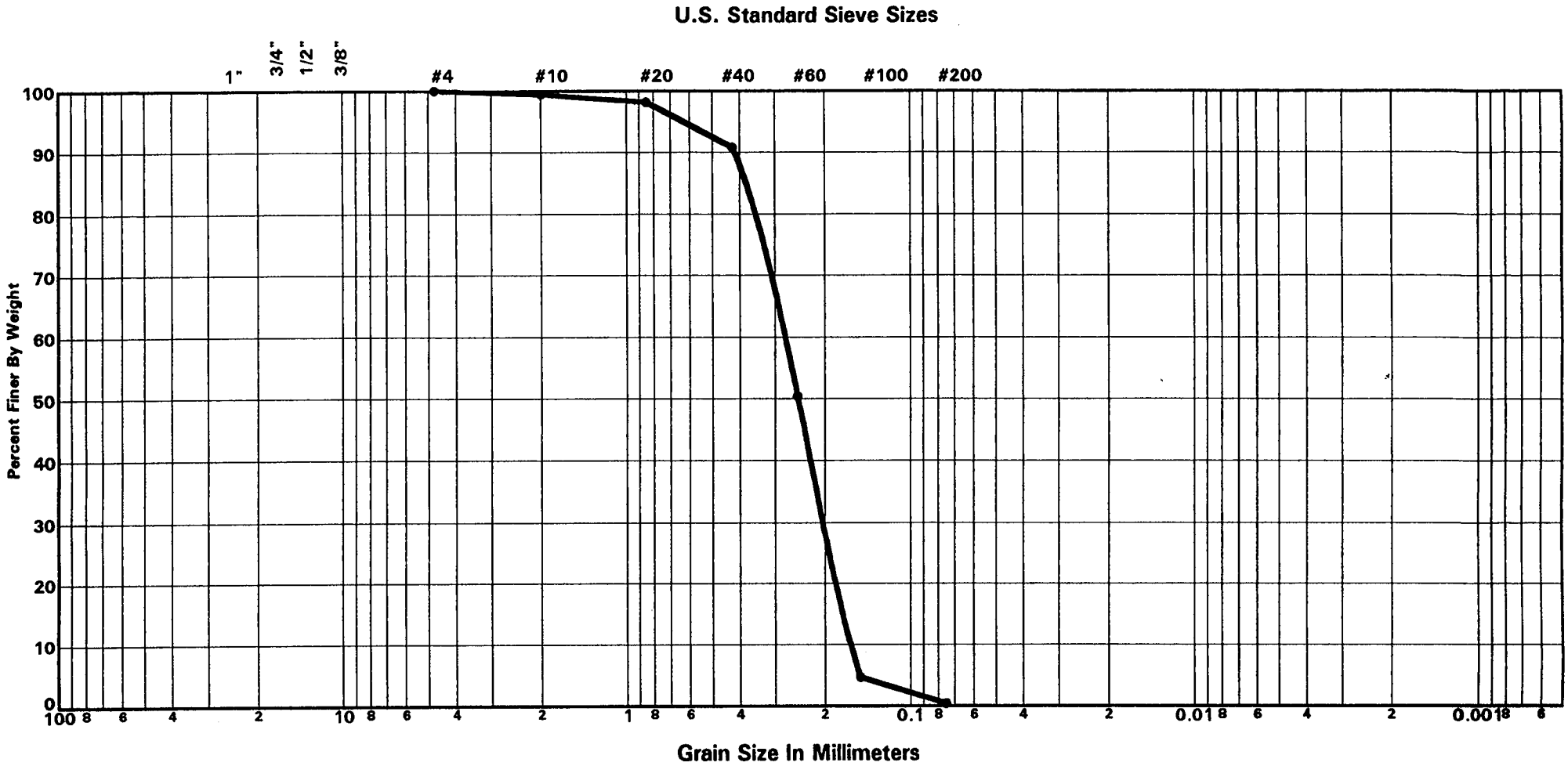
Rodanthe WWTP
Rodanthe, North Carolina

Job No.: 1-93-715-EA

Date: 12/17/93

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.



GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
B-4	4.0' - 5.5'	23.0				Gray Fine to Medium SAND (SP)

Project:

Rodanthe WWTP
Rodanthe, North Carolina

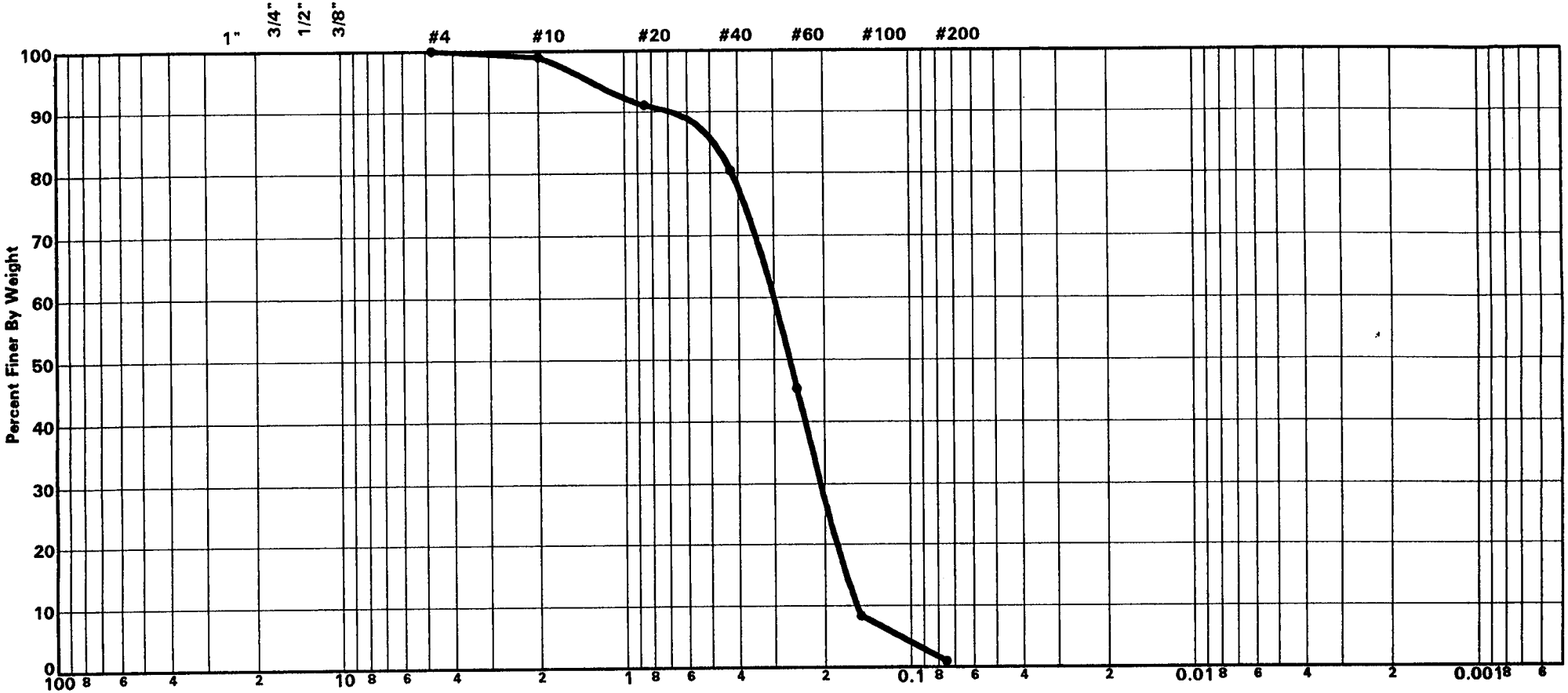
Job No.: 1-93-715-EA

Date: 12/17/93

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.

U.S. Standard Sieve Sizes



Grain Size In Millimeters

GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
B-4	0.5' - 2.0'	13.7				Gray Fine to Medium SAND (SP)

Project:

Rodanthe WWTP
Rodanthe, North Carolina

Job No.: 1-93-715-EA

Date: 12/17/93

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.

Appendix B
Well Data
Exhibits A, B, and C

Exhibit A

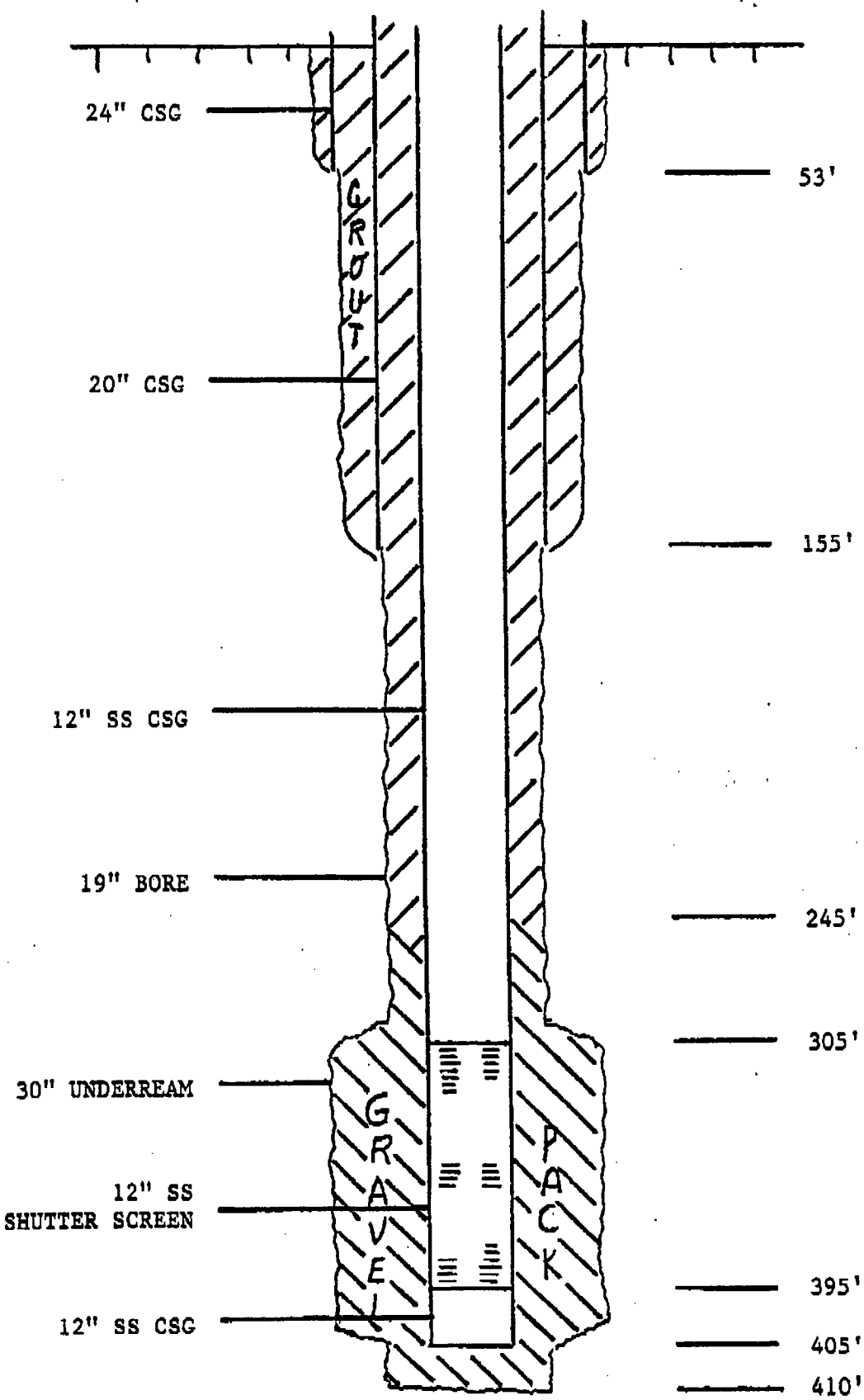
RODANTHE WELL #1, DARE COUNTY, NC

0-4	Sand
4-20	Gravel & shells
20-33 1/2	Gravel & shells
33 1/2-34	Clay streaks, blue
34-38	Fine sand
38-40	clay, blue
40-49	Fine sand
49-53	Course gravel & shells
53-60	Shells
60-80	Shells, fine sand, clay streaks
80-100	Shells & clay streaks
100-105	Shells & clay streaks
105-112	Sandy clay, gray
112-150	Clay, gray
150-153	Clay, tan
153-168	Sand & shells
168-175	Clay, tan
175-190	Sandy clay
190-193	Clay, brown
193-196	Silt
196-201	Clay, brown
201-206	Clay, brown
206-236	Sand, fine
236-270	Clay, dark green
270-329	Sand, course
329-359	Sand, fine
359-386	Sand, fine & shells
386-439	Sand & lime
439-455	Lime - shaley
455-465	Sand
465-519	Gravel - sand - shells
519-550	Sand
550-605	Gravel - sand - shells
605-625	Clay - gravel - shells
625-650	Gravel - sand - shells
650-680	Clay - shells
680-790	Gravel - clay - shells
790-955	Clay, soft
955-965	Sand
965-1042	Clay
1042-1046	Sand
1046-1227	Clay with sand streaks
1227-1388	Clay
1388-1487	Clay with sand streaks

Exhibit B

PERMANENT WELL DESIGN
RODANTHE, NC

OCT 10, 1986



AQUIFER TEST DATA

NAME: RODANTHE DEEP TEST LONG DURATION TEST DATE: 2-12 DEC 86

LOCATION: RODANTHE, N.C. PW-1 JOB# NK0766

DATE	TIME OF DAY	WATER LEVEL (FT)	DRAW DOWN (FT)	PUMPING RATE (GPM)
2 DEC 86	930 AM	29.22	0	0
2 DEC 86	1000 AM	18.25	10.97	450
2 DEC 86	1900 PM	16.29	12.93	450
3 DEC 86	700 AM	16.17	13.05	450
3 DEC 86	1900 PM	15.92	13.30	450
4 DEC 86	700 AM	15.7	13.52	450
4 DEC 86	1900 PM	14.78	14.44	450
5 DEC 86	700 AM	14.55	14.67	450
5 DEC 86	1900 PM	14.09	15.13	450
6 DEC 86	700 AM	14.09	15.13	450
6 DEC 86	1900 PM	13.98	15.24	450
7 DEC 86	700 AM	13.98	15.24	450
7 DEC 86	1900 PM	13.98	15.24	450
8 DEC 86	700 AM	13.86	15.36	450
8 DEC 86	1900 PM	13.86	15.36	450
9 DEC 86	700 AM	13.86	15.36	450
9 DEC 86	1900 PM	13.86	15.36	450
0 DEC 86	700 AM	14.09	15.13	450
0 DEC 86	1900 PM	14.09	15.13	450
1 DEC 86	700 AM	14.09	15.13	450
1 DEC 86	1900 PM	14.09	15.13	450
2 DEC 86	700 AM	14.43		
2 DEC 86	1900 PM	----		

ENGINE SLOWED
RATE DROPPED

Exhibit C

AQUIFER TEST DATA

NAME: RODANTHE DEEP TEST 24 HR TEST DATE: 25NOV86

LOCATION: RODANTHE, NC PW #1 JOB# NK0766

DATE	TIME OF DAY	ELAPSED TIME (MIN)	WATER LEVEL IN PIEZOMETER (FT)	DRAW DOWN (FT)	PUMPING RATE (GPM)
25 NOV 86	800	0	27.79	0	0
25 NOV 86	801	1	14.78	13.01	450
25 NOV 86	802	2	19.64	8.15	450
25 NOV 86	803	3	16.86	10.93	450
25 NOV 86	804	4	17.94	9.85	450
25 NOV 86	805	5	18.25	9.54	450
25 NOV 86	807	7	18.02	9.77	450
25 NOV 86	809	9	17.81	9.98	450
25 NOV 86	811	11	17.67	10.12	450
25 NOV 86	813	13	17.53	10.26	450
25 NOV 86	815	15	17.51	10.28	450
25 NOV 86	820	20	17.23	10.56	450
25 NOV 86	825	25	17.07	10.72	450
25 NOV 86	830	30	16.93	10.86	450
25 NOV 86	840	40	16.75	11.04	450
25 NOV 86	850	50	16.63	11.16	450
25 NOV 86	900	60	16.52	11.27	450
25 NOV 86	930	90	16.17	11.62	450
25 NOV 86	1000	120	16.05	11.74	450
25 NOV 86	1030	150	15.94	11.85	450
25 NOV 86	1100	180	15.82	11.97	450
25 NOV 86	1200	240	15.59	12.20	450
25 NOV 86	1300	300	15.48	12.31	450
25 NOV 86	1400	360	15.48	12.31	450
25 NOV 86	1500	420	15.48	12.31	450
25 NOV 86	1600	480	15.48	12.31	450
25 NOV 86	1700	540	15.36	12.43	450
25 NOV 86	1800	600	15.36	12.43	450
25 NOV 86	1900	660	15.02	12.77	450
25 NOV 86	2000	720	15.02	12.77	450
25 NOV 86	2100	780	15.02	12.77	450
25 NOV 86	2200	840	14.90	12.89	450
25 NOV 86	2300	900	15.02	12.77	450
25 NOV 86	2400	960	15.02	12.77	450
26 NOV 86	100	1020	15.02	12.77	450
26 NOV 86	200	1080	15.13	12.66	450
26 NOV 86	300	1140	14.90	12.89	450
26 NOV 86	400	1200	15.13	12.66	450
26 NOV 86	500	1260	15.25	12.54	450
26 NOV 86	600	1320	15.25	12.54	450
26 NOV 86	700	1380	15.25	12.54	450
26 NOV 86	800	1440	15.13	12.66	450

NON PUMPING LEVEL 1'-4" ABOVE GROUND AVG.

AQUIFER TEST DATA

DATE	TIME OF DAY	ELAPSED TIME (MIN)	WATERLEVEL (FT)	RESIDUAL DRAW DOWN (FT)	PUMPING RATE
25 NOV 86	800	0	27.79	0.00	0
[redacted] NOV 86	801	1	22.98	4.81	0
[redacted] NOV 86	802	2	23.56	4.23	0
26 NOV 86	803	3	24.26	3.53	0
[redacted] NOV 86	804	4	24.14	3.63	0
[redacted] NOV 86	805	5	24.37	3.42	0
26 NOV 86	807	7	24.49	3.30	0
[redacted] NOV 86	809	9	24.60	3.19	0
[redacted] NOV 86	811	11	24.72	3.07	0
26 NOV 86	813	13	24.83	2.96	0
26 NOV 86	815	15	24.95	2.84	0
[redacted] NOV 86	820	20	25.18	2.61	0
[redacted] NOV 86	825	25	25.53	2.26	0
26 NOV 86	830	30	25.76	2.03	0
[redacted] NOV 86	840	40	25.99	1.80	0
[redacted] NOV 86	850	50	26.22	1.57	0
26 NOV 86	900	60	26.33	1.46	0
[redacted] NOV 86	930	90	26.80	.99	0
[redacted] NOV 86	1000	120	27.14	.65	0
26 NOV 86	1030	150	27.37	.42	0
26 NOV 86	1100	180	27.49	.30	0
[redacted] NOV 86	1200	240	27.95	R	0
[redacted] NOV 86	1300	300	28.18	R	0
26 NOV 86	1400	360	28.30	R	0
[redacted] NOV 86	1500	420	28.40	R	0
[redacted] NOV 86	1600	480	28.40	R	0
26 NOV 86	1700	540	28.40	R	0
[redacted] NOV 86	1800	600	28.40	R	0
[redacted] NOV 86	1900	660	28.40	R	0
26 NOV 86	2000	720	28.40	R	0

Appendix C
HVAC Design Memorandum

BLACK & VEATCH

HVAC DESIGN MEMORANDUM

Dare County, North Carolina
Rodanthe R.O. Plant

B&V Project 24420
B&V File A
January 4, 1994

To: Distribution

From: Jim Painter

GENERAL

This memorandum describes the basis of mechanical design associated with heating, ventilating, and air conditioning (HVAC) systems.

APPLICABLE CODES AND STANDARDS

The design will be based on, but not limited to, the following publications:

American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbooks and Standards

Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Handbooks

North Carolina Administrative Code, Title 15A, Department of Environment, Health, and Natural Resources; Subchapter 18C-Water Supplies; *Rules Governing Public Water Systems* as amended April 1992

North Carolina State Building Code

Volume III, 1991 North Carolina Mechanical Code with 1993 revisions

Volume V, 1991 Fire Prevention Code with 1993 Revisions

National Fire Protection Association Recommended Practices (NFPA) and Manuals

Recommended Standards for Water Works - Great Lakes - Upper Mississippi River Board of Sanitary Engineers (10 States Standards)

HVAC DESIGN CRITERIA

A. Site Elevation
5 feet above sea level

B. Ambient Design Temperatures
Winter 20 F
Summer 92 Fdb/81 Fwb

C. Indoor Design Temperatures and Ventilation Requirements

Building Areas	Design Temperatures, F			Ventilation Notes
	Summer	Winter		
	Design	Design	Setpoint	
Administrative Areas	78	68	68	1
Rest/Locker Rooms	78	68	68	2
Control Room	78	68	68	1
Lab Area	78	68	68	3
Electrical/Mechanical Room	90			
Chemical Areas				
Chlorine Storage & Feed		70	60	4
Fluoride		60	60	5
Acid/Caustic/Scale/Corr	104	60	60	5
Pump/R.O. Unit Room	104	60	60	6

Notes:

1. A minimum ventilation of 10 percent system airflow or 20 cfm (cubic feet per minute) per person, whichever is greater.

2. Ventilation of 25 cfm per toilet or urinal and 50 cfm per shower head with a minimum of 200 cfm.

3. Ventilation as described in note 1 with the addition of fume hood exhaust system.

4. A continuous ventilation system sized at 6 ac/hr (air changes per hour) and an emergency ventilation system sized at 54 ac/hr will be provided. Exhaust will be taken within 12 inches of finished floor level.

5. A continuous ventilation system sized at 6 ac/hr will be provided.

6. Ventilation at the rate required to dissipate the internal equipment heat gain or 12 ac/hr whichever is greater, will be provided.

HVAC DESIGN DATA

A. Air Conditioned Areas

1. Zone 1 - Electrical/Mechanical Room

Designation	HP-1
Location	Mech. Room (Indoor Unit) & an outdoor unit
No. of units	1
Cooling capacity, tons	3
Airflow, cfm	1200
Motor size, hp	1/2
Dimensions, WxLxH	48 x 60 x 24
Weight, lbs	450 (indoor unit)

2. Zone 2 - Reception/Entry/Corridor/Break/JC/Office/Restrooms

Designation	HP-2
Location	Mech. Room (Indoor Unit) & outdoor unit
No. of units	1
Cooling capacity, tons	5
Airflow, cfm	2000
Motor size, hp	1
Dimensions, WxLxH	48 x 60 x 24
Weight, lbs	450 (indoor unit)

3. Zone 3 - Lab/Locker & Shower/Control Rooms

Designation	HP-3
Location	Mech. Room (Indoor Unit) & outdoor unit
No. of units	1
Cooling capacity, tons	5
Airflow, cfm	1300
Motor size, hp	1
Dimensions, WxLxH	48 x 60 x 24
Weight, lbs	450 (indoor unit)

4. Men/Women's Restrooms

Designation	CF-1
Location	above ceiling
No. of units	1
Airflow, cfm	400
Motor size, watts	130
Dimensions, WxLxH	18 X 20 X 14
Weight, lbs	40

5. Laboratory

Designation	DF-1 (fume hood auxiliary air fan)
Location	above ceiling
No. of units	1
Airflow, cfm	840
Motor size, hp	1/2
Dimensions, WxLxH	32 X 17 X 18
Fan material	Aluminum
Weight, lbs	125

Designation	EDH-1
Location	above ceiling w/DF-1
No. of units	1
Heating capacity, kw	4.5
Weight, lbs	100

Designation	DF-7 (fume hood exhaust fan)
Location	above ceiling
No. of units	1
Airflow, cfm	1200
Motor size, hp	1 1/2
Dimensions, WxLxH	17 dia. (not counting motor) X 21L
Fan material	FRP (fan exhausting corrosive air)
Weight, lbs	250

6. Locker & Shower Room /Janitor's Closet

Designation	CF-2
Location	above ceiling
No. of units	1
Airflow, cfm	300
Motor size, watts	130
Dimensions, WxLxH	18 X 20 X 14
Weight, lbs	40

B. Process and Chemical Areas

1. Pump/R.O. Unit Room

Designation	DF-2
Location	above ceiling
No. of units	1
Airflow, cfm	6300
Motor size, hp	3
Dimensions, WxLxH	46 X 33 X 32
Fan material	Aluminum
Weight, lbs	375

2. Pump/R.O. Unit Room

Designation	EUH
Location	wall mounted
No. of units	2
Heating capacity, kw	7.5
Dimensions, WxLxH	18 X 15 X 21
Weight, lbs	50

3. Chemical Area

Designation	DF-3 (for supply)
Location	above ceiling
No. of units	1
Airflow, cfm	1300
Motor size, hp	1
Dimensions, WxLxH	32 X 18 X 18
Fan material	Aluminum (fan supplying ambient air)
Weight, lbs	150
Designation	EDH-2
Location	above ceiling w/DF-3
No. of units	1
Heating capacity, kw	19
Weight, lbs	100
Designation	DF-6 (for exhaust)
Location	above ceiling
No. of units	1
Airflow, cfm	1300
Motor size, hp	1
Dimensions, WxLxH	17 dia. (not counting motor) X 21L
Fan material	FRP (fan exhausting corrosive air)
Weight, lbs	250

4. Chlorine Feed Room

Designation	DF-4
Location	wall mounted
No. of units	1
Airflow, cfm	615
Motor size, hp	1/4
Dimensions	13 dia. (not counting motor) X 20L
Fan material	FRP (fan exhausting corrosive air)
Weight, lbs	200

5. Chlorine Storage Room

Designation	DF-5
Location	wall mounted
No. of units	1
Airflow, cfm	1730
Motor size, hp	1/3
Dimensions	17 dia. (not counting motor) X 21L
Fan material	FRP (fan exhausting corrosive air)
Weight, lbs	250

lal

Appendix D
Electrical Design Memorandum

BLACK & VEATCH

MEMORANDUM

Dare County RO
Electrical Design Memo

B&V Project 24420.350
January 7, 1994

To: Distribution

From: Thad Slaton

This design memorandum presents the criteria for the design of the electrical and instrumentation systems which are to be provided as part of the Dare County RO water treatment and distribution facilities.

The facilities will be located in the Rodanthe, Waves, Salvo area on the Outer Banks of North Carolina. The facilities will consist of an RO Treatment plant and well site no. 1 located east of N.C. Highway 12 in Rodanthe approximately 300 feet south of the Chiccimacomico life saving station, well site no. 2 located approximately 2,000 feet south of the RO plant, and an elevated tank site located approximately 2,000 feet south of well site No. 1.

GENERAL

A. Electric Power Supply and Distribution.

Electrical service will be provided by Cape Hatteras EMC for all three sites. The utility contact, phone number, and mailing address is as follows:

Cape Hatteras EMC
P.O. Box 9
Buxton, North Carolina 27920
Telephone: (919) 995-5616
Contact: Rich Bauer

A pad mounted utility transformer will be located above the flood plan to provide a 480 volt, 3 phase, 4 wire underground service to the RO plant site.

A 480 volt, 3 phase, 4 wire service will be provided for well site no. 2.

It is anticipated that a 120/240 single phase service will be provided at the elevated tank site. This will need to be upgraded to a 480 volt, 3 phase, 4 wire service when the future wells are installed.

A standby generator will be provided to serve the RO plant and well no. 1 during power interruptions. The generator will be sized for the initial plant load only. Space provisions will be made for a second future generator which will be paralleled to the one supplied now. No

load banks or synchronizing controls are anticipated to be provided for the initial generator. A manual transfer switch consisting of key interlocked breakers will be provided to transfer to generator power.

No auxiliary power will be provided for well pump no 2. or the elevated tank site.

Electric service is expected to be very weak in this area and reduced voltage starting is anticipated to be required on all motors at and above 20 horsepower.

A motor control center will be located in the RO building to distribute power to equipment as required. The motor control center will be provided with enough spare capacity to feed the future expansion.

B. Telephone Requirements.

Telephone service will be provided by Carolina Telephone and Telegraph Co. The utility contact, telephone number, and mailing address is as follows:

Carolina Telephone and Telegraph Co.
P.O. Box 430
Manteo, North Carolina 27954
Contact: Unknown
Telephone: (919) 473-5373

It is anticipated a single voice grade telephone line will be provided for the site. The design will make provisions for the telephone service to terminate on a telephone terminal board in the RO building. It is anticipated the owner will furnish their own telephone equipment as needed.

C. Cable and Conduit.

Type THHN/THWN cable will be used in all applications.

SMURF TUBING?

Rigid nonmetallic schedule 40 PVC conduit will be used in all concealed indoor areas and exposed areas except the RO equipment room. Intermediate metal conduit will be used for exposed conduit in the RO equipment room only.

Rigid PVC coated steel conduit will be used in exposed outdoor locations.

Concrete encased schedule 40 PVC conduit will be used in underground ductbanks.

D. Lightning Protection, Grounding, and Surge Protection.

A lightning protection system with a ground ring encircling the building will be provided. Ground rods will be specified to be 20 feet deep. Surge protection will be provided on the incoming main service.

E. Fire Alarm and Security System.

No provisions for a fire alarm or security system are anticipated to be provided at this time.

F. Lighting Requirements.

In general fluorescent fixtures or metal halide fixtures will be used indoors as required. High pressure sodium fixtures will be used outdoors.

Outdoor lighting will consist of wall mounted light fixtures over building entrances and a possible pole mounted fixture at the engine generator. No roadway lighting or general site lighting is anticipated to be provided.

Appendix E
Schedule

BLACK & VEATCH

MEMORANDUM

Dare County
Rodanthe-Waves-Salvo
Schedule Summary

B&V Project 24420

March 28, 1994

Contract 1 - R.O. Equipment

April 10, 1994 - to QC, Client Review, State Review
May 2, 1994 - Advertise
May 19, 1994 - Open Bids
June 6, 1994 - Award
Completion October 30, 1995

Contract 2 - Generator

September 1, 1994 - to QC
October 4, 1994 - Advertise
November 3, 1994 - Bid Date
July 4, 1995 - Delivery

Contract 3 - Grading

April 15, 1994 - QC, Client Review, State Review
May 16, 1994 - Advertise
June 8, 1994 - Take Bids
July 5, 1994 - Award (July 11th)

September 12, 1994 - Substantial Completion
Final completion September 30

Contract 4 - Ground Storage Tank

May 2, 1994 - QC, Client Review, State Review
May 16, 1994 - Advertise
June 8, 1994 - Take Bids
July 5, 1994 - Award (July 11th)
(on site October)
Completion May 1, 1995

Contract 5-8 - Building General Contractors

July 25, 1994 - QC, Client Review, State Review
August 25, 1994 - Advertise
September 22, 1994 - Take Bids
Completion October 30, 1995

Dare County
Rodanthe-Waves-Salvo
Schedule Summary

Contract 9 - PLC/SCADA Hardware

May 15, 1994 - To QC
June 1, 1994 - Advertise
June 21, 1994 - Open Bids
July 5, 1994 - Award
October 5, 1994 - Submittals
Completion October 30, 1995

Contract 10 - PLC/SCADA Software

September 20, 1994 - To QC
October 20, 1994 - Advertise
November 21, 1994 - Bid
October 5, 1995 - System Operational

Contract 11 - Elevated Tank

May 2, 1994 QC, Client Review, State Review
May 16, 1994 - Advertise
June 8, 1994 - Take Bids
July 5, 1994 - Award (July 11th)

May 31, 1995 (Substantial Complete)

Contract 12 - Line Work

May 2, 1994 - QC, Client Review, State Review
May 16, 1994 - Advertise
June 8, 1994 - Take Bids
July 5, 1994 - Award (July 11th)

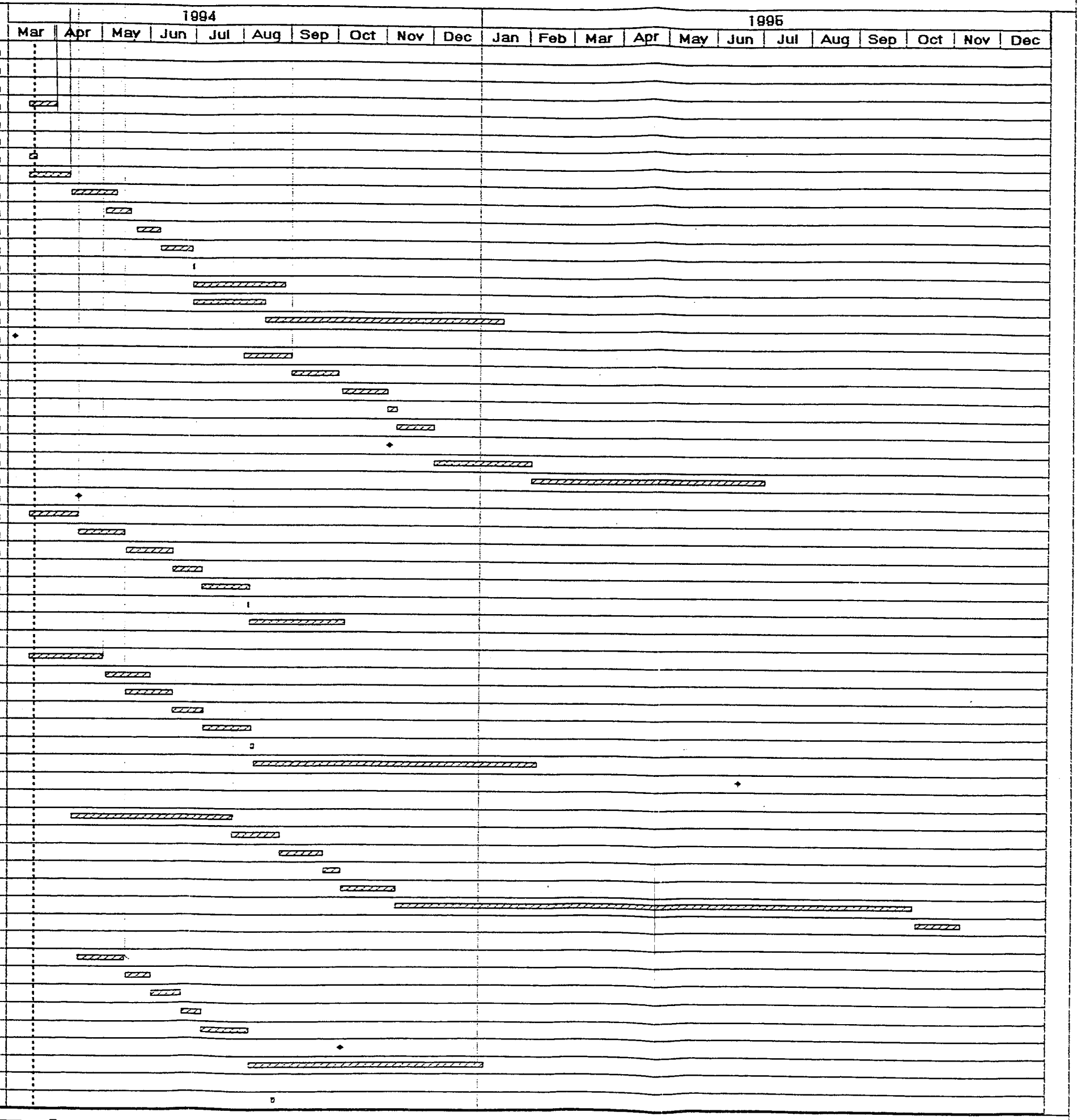
September 1, 1995 - Construction 12 months

1. Need options on land as soon as possible.
2. Need title to land by May 1, 1994.
3. Material delivered to CAMA on 2/23/94. 75 days is the normal processing time. Should have permits by June 1, 1994.

jph

DARE COUNTY

ID	Name	Scheduled Start
1	DESIGN MEMO	9/15/93 8:00am
2	Publish Preliminary	10/21/93 8:00am
3	Review Period	1/3/94 8:00am
4	Revise Final Report	3/15/94 8:00am
5	Publish Final Report	1/3/94 8:00am
6	CONTRACT 1 - RO EQU	1/17/94 5:00pm
7	Prequalification	3/15/94 8:00am
8	Bid Documents	3/15/94 8:00am
9	QC Review	4/11/94 8:00am
10	Bid Period	5/3/94 8:00am
11	Recommendation & Awa	5/23/94 8:00am
12	Contract Execution	6/7/94 8:00am
13	Notice to Proceed	6/28/94 5:00pm
14	Complete Process Desic	6/28/94 8:00am
15	Prepare Ladder Logic	6/28/94 8:00am
16	Manufacture & Deliver	8/15/94 8:00am
17	CONTRACT 2 - GENERA	3/6/94 12:00am
18	Prepare Bid Documents	8/1/94 8:00am
19	QC Review	9/1/94 8:00am
20	Bid Period	10/3/94 8:00am
21	Recommendation & Awa	11/1/94 8:00am
22	Contract Execute	11/7/94 8:00am
23	Notice To Proceed	11/2/94 8:00am
24	Submittals	12/1/94 8:00am
25	Manufacture & Deliver	2/2/95 8:00am
26	CONTRACT 3 - SITE GR/	4/15/94 8:00am
27	Prepare Bid Documents	3/15/94 8:00am
28	State and QC Reviews	4/15/94 8:00am
29	Bid Period	5/16/94 8:00am
30	Recommendations & Av	6/15/94 8:00am
31	Execute Contracts	7/5/94 8:00am
32	Notice To Proceed	8/4/94 8:00am
33	Construction Period	8/5/94 8:00am
34	CONTRACT 4 - GROUNI	12/13/93 8:00am
35	Prepare Bid Documents	3/15/94 8:00am
36	State and QC Review	5/3/94 8:00am
37	Bidding Period	5/16/94 8:00am
38	Recommendation & Aw	6/15/94 8:00am
39	Execute Contracts	7/6/94 8:00am
40	Notice To Proceed	8/6/94 8:00am
41	Construction Period	8/8/94 8:00am
42	Start-up and Debug	6/15/95 5:00pm
43	CONTRACT 5-8	9/12/93 8:00am
44	Prepare Bid Documents	4/11/94 8:00am
45	State and QC Reviews	7/25/94 8:00am
46	Bidding Period	8/25/94 8:00am
47	Recommendations & Av	9/22/94 8:00am
48	Execute Contracts	10/3/94 8:00am
49	Construction Period	11/7/94 8:00am
50	Start-up and Debug	10/9/95 8:00am
51	CONTRACT 9 - PLC AND	9/12/93 8:00am
52	Prepare Bid Documents	4/15/94 8:00am
53	State & QC Reviews	5/16/94 8:00am
54	Bidding Period	6/1/94 8:00am
55	Recommendation & Awa	6/21/94 8:00am
56	Execute Contract	7/5/94 8:00am
57	Notice To Proceed	10/3/94 8:00am
58	Manufacturing & Deliver	8/5/94 8:00am
59	CONTRACT 10 - CONTR	9/12/93 8:00am
60	Receive Ladder Logic (	8/20/94 8:00am

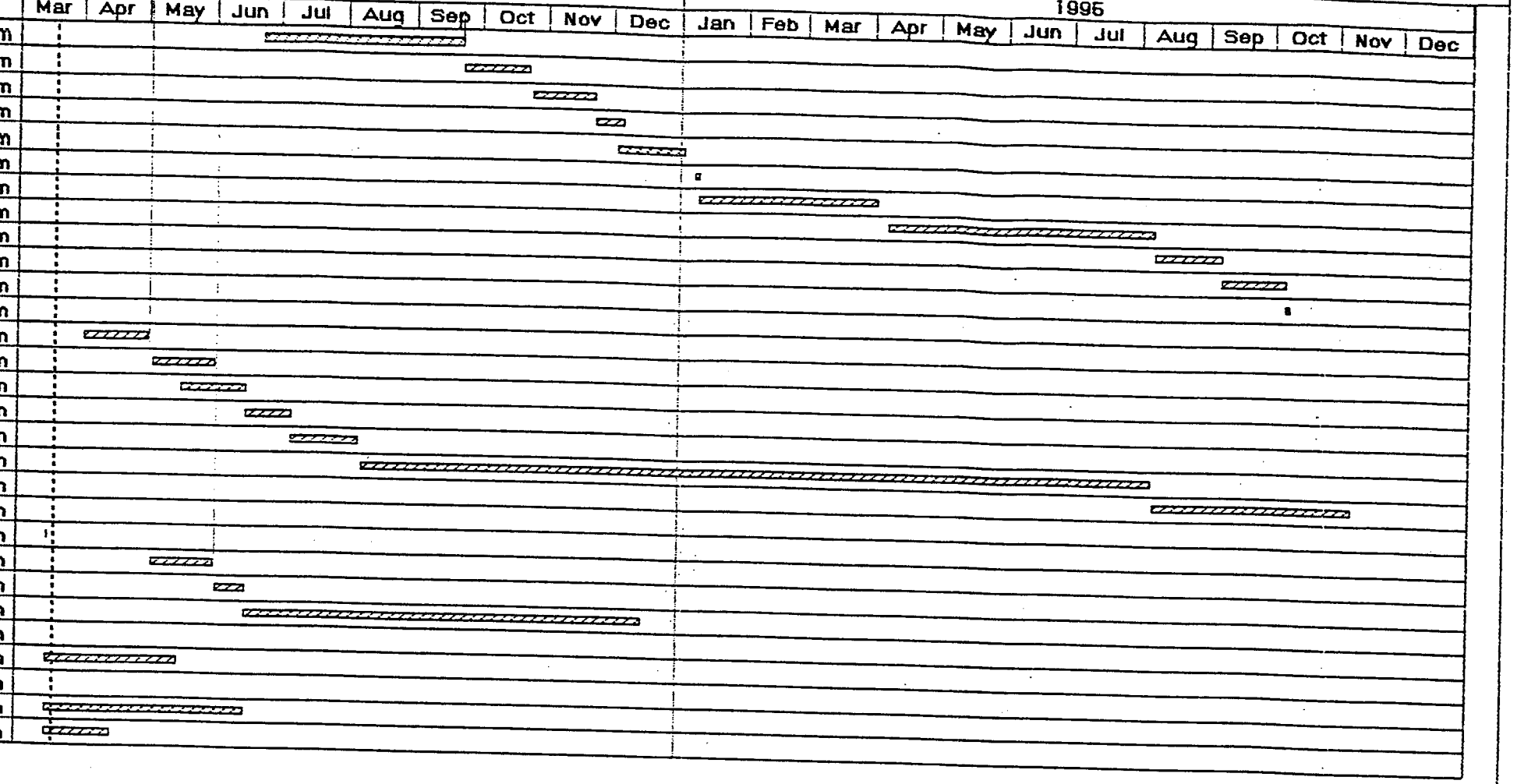


Project: DARE COUNTY WT
Date: 3/18/94

Critical — Progress — Summary
Noncritical — Milestone ◆ — Rolled Up ▫

DARE COUNTY

ID	Name	Scheduled Start
61	Prepare bid Documents	6/22/94 8:00am
62	QC Review	9/22/94 8:00am
63	Bidding Period	10/24/94 8:00am
64	Recommendation & Awa	11/22/94 8:00am
65	Execute Contracts	12/2/94 8:00am
66	Notice To Proceed	1/7/95 8:00am
67	Submittals	1/9/95 8:00am
68	Manufacturer & Delivery	4/7/95 8:00am
69	Install on Hardware (Co	8/7/95 8:00am
70	Debug	9/7/95 8:00am
71	System Operational	10/7/95 8:00am
72	CONTRACT 11-12 - TAN	9/12/93 8:00am
73	Prepare bid Documents	4/1/94 8:00am
74	State & QC Reviews	5/3/94 8:00am
75	Bidding Period	5/16/94 8:00am
76	Recommendation & Awa	6/15/94 8:00am
77	Execute Contract	7/6/94 8:00am
78	Construction Period	8/8/94 8:00am
79	Start-Up and Debug	8/7/95 8:00am
80	WELLS	9/12/93 8:00am
81	Prepare Bid Documents	3/15/94 8:00am
82	State & QC Reviews	5/3/94 8:00am
83	Execute Contracts	6/1/94 8:00am
84	Construction Period	6/15/94 8:00am
85	PERMITTING	9/12/93 8:00am
86	CAMA	3/15/94 8:00am
87	EA	10/6/93 8:00am
88	COE 404	3/15/94 8:00am
89	LAND ACQUISITION	3/15/94 8:00am



Project: DARE COUNTY WT
Date: 3/18/94

Critical
Progress
Summary
Noncritical

Appendix F
Instrument Device Schedule

INSTRUMENT DEVICE SCHEDULE

DEVICE NO.	SERVICE	LOCATION	DESCRIPTION	CALIBRATED RANGE OR SCALE	REMARKS
HS-300-1 AND 300-2	WELL PUMP CONTROL	LOCAL - AT THE WELL	SELECTOR SWITCH, 3 POSITION	ON-OFF-REMOTE	
FE/FIT-301-1 AND 301-2	RAW WELL WATER FLOW	WELL PUMP DISCHARGE	FLOWMETER, PROPELLER 8 INCH W/TRANSMITTER ✓		NOT IN THIS CONTRACT
PDSH-302	CARTRIDGE FILTERS DIFFERENTIAL PRESSURE	LOCAL - AT FILTER	PRESSURE SWITCH, DIFFERENTIAL PRESSURE	SET AT 18 PSI	
TI-303	CARTRIDGE FILTERS INLET HEADER TEMPERATURE	LOCAL - ON HEADER	THERMOMETER, DIAL	25-125 DEG F	W/304 SS WELL
PDSH-305-1 AND 305-2	CARTRIDGE FILTERS DIFFERENTIAL PRESSURE	LOCAL - AT FILTER	PRESSURE SWITCH, DIFFERENTIAL PRESSURE	SET AT 18 PSI	
AE/AIT-306	CARTRIDGE FILTER INLET CONDUCTIVITY	AFTER MIXING CHAMBER	CONDUCTIVITY ANALYZER/ TRANSMITTER	0-500 MICROSIEMENS	
AE/AIT-307	CARTRIDGE FILTER INLET	AFTER MIXING CHAMBER	TURBIDITY ANALYZER, LOW RANGE	0-2.00 NTU	
AE/AIT-309	CARTRIDGE FILTER INLET pH	AFTER MIXING CHAMBER	pH ANALYZER/TRANSMITTER	6-8 pH UNITS	
ZS-310-1 AND 310-2	RO FEED/BYPASS VALVES CONTROL	LOCAL - ON THE VALVE ACTUATOR	OPEN-CLOSED LIMIT SWITCHES		PROVIDED BY VALVE MFR
HS-310-1A AND 310-2A	RO FEED/BYPASS O-S-C CONTROL	LOCAL - ON THE VALVE ACTUATOR	PUSHBUTTONS		PROVIDED BY VALVE MFR

INSTRUMENT DEVICE SCHEDULE

DEVICE NO.	SERVICE	LOCATION	DESCRIPTION	CALIBRATED RANGE OR SCALE	REMARKS
HS-310-1B AND 310-2B	RO FEED/BYPASS LOC-REM CONTROL	LOCAL - ON THE VALVE ACTUATOR	SELECTOR SWITCH, 2 POSITION		PROVIDED BY VALVE MFR
PSL-350-1 AND 350-2	R.O. HIGH PRESS FEED PUMPS LOW INLET PRESSURE	R.O. AREA	PRESSURE SWITCHES	TRIP AT 20 PSIG	
PI-350-1 AND 350-2	R.O. HIGH PRESS FEED PUMPS INLET PRESSURE	R.O. AREA	PRESSURE GAUGE 4.5"	0-60 PSIG	
HS-355-1 AND 355-2	R.O. HIGH PRESS FEED PUMPS O-O-R CONTROL	R.O. AREA	SELECTOR SWITCH, 3 POSITION	ON-OFF-REMOTE	FURNISHED AS A PART OF THE VS DRIVE
PIT-360-1 AND 360-2	R.O. HIGH PRESS FEED PUMPS OUTLET PRESSURE	R.O. AREA	TRANSMITTER, PRESSURE	0-250 PSIG	
ZS-365-1 AND 365-2	R.O. HI PRESS FEED PUMPS DISCH VLVS POSITION	R.O. AREA	OPEN-CLOSED LIMIT SWITCHES		PROVIDED BY VALVE MFR
HS-365-1A AND 365-2A	R.O. HI PRESS FEED PUMPS DISCH VLVS O-S-C CNTRL	R.O. AREA	PUSHBUTTONS		PROVIDED BY VALVE MFR
HS-365-1B AND 365-2B	R.O. HI PRESS FEED PUMPS DISCH VLVS LOC-REM CNTRL	R.O. AREA	SELECTOR SWITCH, 2 POSITION		PROVIDED BY VALVE MFR
PI-370-1 AND 370-2	R.O. HIGH PRESS FEED PUMPS OUTLET PRESSURE	R.O. AREA	PRESSURE GUAGES 4.5"	0-250 PSIG	
PDIT-380-1 AND 380-2	R.O. UNITS STAGE 1 DIFF PRESSURE	R.O. AREA	TRANSMITTER,DIFFERENTIAL PRESSURE	0-20.0 PSID	

INSTRUMENT DEVICE SCHEDULE

DEVICE NO.	SERVICE	LOCATION	DESCRIPTION	CALIBRATED RANGE OR SCALE	REMARKS
PDIT-385-1 AND 385-2	R.O. UNITS STAGE 2 DIFF PRESSURE	R.O. AREA	TRANSMITTER,DIFFERENTIAL PRESSURE	0-20.0 PSID	W/SS REMOTE SEALS
PI-385-1 AND 385-2	R.O. UNITS STAGE 2 INLET PRESSURE	R.O. AREA	PRESSURE GUAGES 4.5"	0-250 PSIG	
PI-390-1 AND 390-2	R.O. UNITS WASTE STREAM PRESSURE	R.O. AREA	PRESSURE GUAGES 4.5"	0-250 PSIG	W/SS DIAPHRAGM SEAL
FE-390-1 AND 390-2	R.O. UNITS WASTE STREAM FLOW	R.O. AREA	FLOWMETER, MAGNETIC, 3" POLY LINER		
FIT-390-1 AND 390-2	R.O. UNITS WASTE STREAM FLOW	R.O. AREA	MAGNETIC SIGNAL COVERTER	0-150 GPM	
AE/AIT-390-1 AND 390-2	R.O. UNITS WASTE STREAM CONDUCTIVITY	R.O. AREA	TRANSMITTTER, CONDUCTIVITY	0-20,000 MICROMHOS	
PI-392	R.O. UNITS WASTE STREAM PRESSURE (LOW PRESSURE)	R.O. AREA	PRESSURE GUAGE 4.5"	0-60 PSIG	W/SS DIAPHRAGM SEAL
FIT-395-1 AND 395-2	R.O. UNITS TREATED WATER FLOW	R.O. AREA	MAGNETIC SIGNAL COVERTER	0-400 GPM	
FE-395-1 AND 395-2	R.O. UNITS TREATED WATER FLOW	R.O. AREA	FLOWMETER, MAGNETIC, 6" POLY LINER		
AE/AIT-395-1 AND 395-2	R.O. UNITS TREATED WATER CONDUCTIVITY	R.O. AREA	TRANSMITTTER, CONDUCTIVITY	0-200 MICROMHOS	

INSTRUMENT DEVICE SCHEDULE

DEVICE NO.	SERVICE	LOCATION	DESCRIPTION	CALIBRATED RANGE OR SCALE	REMARKS
ZS-400 AND 365-2	R.O. PERMEATE TO CLEANING TANK VALVE	R.O. AREA	OPEN-CLOSED LIMIT SWITCHES		PROVIDED BY VALVE MFR
AE/AIT-405	R.O. UNITS FINISHED WATER CONDUCTIVITY	R.O. AREA	TRANSMITTTER, CONDUCTIVITY	0-700 MICROMHOS	
PIT-410	R.O. UNIT FINISHED WATER PRESSURE	R.O. AREA	TRANSMITTER, PRESSURE	0-15 PSIG	
AE/AIT-415	RO UNIT FINISHED WATER pH	RO UNIT EFFLUENT LINE	pH ANALYZER/TRANSMITTER	6-8 pH UNITS	
LIT-430	FINISHED WATER STORAGE TANK LEVEL	WELL PIT	LEVEL TRANSMITTER, PRESSURE SENSING	COORDINATE W/TANK SUPPLIER	
FE/FIT-435	DISTRIBUTION WATER FLOW	DISCHARGE SIDE OF HIGH SERVICE PUMPS	FLOWMETER, PROPELLER 12 INCH W/ TRANSMITTER		
HS-440-1 -440-2,3	HIGH SERVICE PUMP CONTROL	AT HIGH SERVICE PUMPS	SELECTOR SWITCH, 3 POSITION, ON-OFF-REM		
PI-441-1 THRU 441-3	HIGH SERVICE PUMP DISCHARGE PRESSURE	PUMP DISCHARGE	PRESSURE GAUGE 4.5"	0-60 PSIG	
LIT-450	ELEVATED TANK LEVEL	AT BASE OF TANK	LEVEL TRANSMITTER, PRESSURE SENSING	COORDINATE W/TANK SUPPLIER	
LI-521	CORROSION INHIBITOR SYSTEM DAY TANK LEVEL	INHIBITOR DAY TANK	LEVEL INDICATOR		FURNISHED W/TANK

INSTRUMENT DEVICE SCHEDULE

DEVICE NO.	SERVICE	LOCATION	DESCRIPTION	CALIBRATED RANGE OR SCALE	REMARKS
HS-525-1A AND 525-2A	CORROSOIN INHIBITOR METERING PMP O-O-R CNTRL	CORROSION INHIBOTOR SYSTEM AREA	SELECTOR SWITCH, 3 POSITION		
PI-530-1 AND 530-2	CORROSION INHIBITOR FEED SYSTEM PRESSURE	CORROSION INHIBITOR FEED SYSTEM AREA	PRESSURE GUAGES 4.5"	0-30 PSIG	W/DIAPHRAGM SEAL
PSL-535	CORROSION INHIBITOR FEED PRESSURE	CORROSION INHIBITOR FEED SYSTEM AREA	PRESSURE SWITCHE	TRIP AT 10 PSIG	W/DIAPHRAGM SEAL
PI-537	CORROSION INHIBITOR ADDITION	AT THE APPLICATION POINT	PRESSURE GUAGE 4.5"	0-100 PSIG	
LI-605	R.O. CLEANING SYSTEM STORAGE TANK LEVEL	R.O. CLEANING SYSTEM AREA	LEVEL INDICATOR		FURNISHED W/TANK
TI-610	R.O. CLEANING SYSTEM STORAGE TANK TEMPERATURE	R.O. CLEANING SYSTEM TANK	THERMOMETER, DIAL		W/316SS THERMOWELL
HS-615	R.O. CLEANING SYSTEM PUMP ON-OFF CONTROL	R.O. CLEANING SYSTEM AREA	SELECTOR SWITCH, 2 POSITION		
AE/AI-620	R.O. CLEANING SYSTEM EFFLUENT pH	R.O. CLEANING SYSTEM AREA	PH ANALYZER	2-8 pH UNITS	
FE/FI-625	R.O. CLEANING SYSTEM EFFLUENT FLOW	R.O. CLEANING SYSTEM PUMP DISCH.	FLOW INDICATOR, BYPASS ROTAMETER	0-500 GPM	
PI-630	R.O. CLEANING SYSTEM EFFLUENT PRESSURE	R.O. CLEANING SYSTEM AREA	PRESSURE GUAGE 4.5"	0-160 PSIG	W/DIAPHRAGM SEAL

INSTRUMENT DEVICE SCHEDULE

DEVICE NO.	SERVICE	LOCATION	DESCRIPTION	CALIBRATED RANGE OR SCALE	REMARKS
PDSH-635	R.O. CLEANING SYSTEM CARTRIDGE FLT DIFF PRESS	R.O. CLEANING SYSTEM AREA	PRESSURE SWITCH, DIFFERENTIAL PRESSURE	SET AT 18 PSI	
PDAH-635	R.O. CLEANING SYSTEM CARTRIDGE FLT DIFF PRESS	R.O. CLEANING SYSTEM AREA	INDICATING LIGHT TRANSFORMER TYPE	RED LIGHT	
LI-651	ANTISCALANT FEED SYSTEM DAY TANK LEVEL	ANTISCALANT FEED SYSTEM AREA	LEVEL INDICATOR		FURNISHED W/TANK
HS-665-1A HS-665-2A	ANTISCALANT FEED SYSTEM METERING PMP O-O-R CNTRL	ANTISCALANT FEED SYSTEM AREA	SELECTOR SWITCH, 3 POSITION		
PI-670-1 PI-670-2	ANTISCALANT FEED SYSTEM PRESSURE	ANTISCALANT FEED SYSTEM AREA	PRESSURE GUAGES 4.5"	0-100 PSIG	W/DIAPHRAGM SEAL
PI-677	ANTISCALANT ADDITION	AT THE APPLICATION POINT	PRESSURE GUAGE 4.5"	0-100 PSIG	
LI-716	ACID FEED SYSTEM STORAGE TANK LEVEL	ACID FEED SYSTEM AREA	LEVEL INDICATOR		
LI-721	ACID FEED SYSTEM DAY TANK LEVEL	ACID FEED SYSTEM AREA	LEVEL INDICATOR		FURNISHED W/TANK
HS-725-1A HS-725-2A	ACID FEED SYSTEM METERING PMP O-O-R CNTRL	ACID FEED SYSTEM AREA	SELECTOR SWITCH, 3 POSITION		
PI-730-1 PI-730-2	ACID FEED SYSTEM EFFLUENT PRESSURE	ACID FEED SYSTEM AREA	PRESSURE GUAGES 4.5"	0-100 PSIG	W/DIAPHRAGM SEAL

INSTRUMENT DEVICE SCHEDULE

DEVICE NO.	SERVICE	LOCATION	DESCRIPTION	CALIBRATED RANGE OR SCALE	REMARKS
PSL-735	ACID FEED SYSTEM LOW PRESSURE	ACID FEED SYSTEM AREA	PRESSURE SWITCHE	TRIP AT 45 PSIG	W/DIAPHRAGM SEAL
PI-737	ACID ADDITION	AT THE APPLICATION POINT	PRESSURE GUAGE 4.5" W/ ALLOY 20 DIAPHRAGM SEAL	0-100 PSIG	
WI-801-1 AND 801-2	CHLORINE AVAILABILITY	CHLORINE STORAGE ROOM	WEIGHT INDICATOR	0-2000 LBS	
PI-805-1 PI-805-2	CHLORINE FEED SYSTEM EFFLUENT PRESSURE	CHLORINE FEED SYSTEM AREA	PRESSURE GUAGES 4.5"	0-160 PSIG	
AE/ASH-807-1 AND 807-2	CHLORINE LEAK DETECTION	CL2 STORAGE & FEED ROOMS	CHLORINE LEAK DETECTOR		
PI-809	CHLORINE ADDITION	AT THE APPLICATION POINT	PRESSURE GUAGE 4.5"	0-100 PSIG	
HS-810-1 AND 810-2	CHLORINE FEED SYSTEM CONTROL	AT CHLORINE FEEDERS	SELECTOR SWITCH, 2 POSITION, ON-OFF		
LI-821	FLUOSILSIC ACID FEED SYSTEM DAY TANK LEVEL	ACID DAY TANK	LEVEL INDICATOR		FURNISHED W/TANK
HS-825-1A AND 825-2A	FLUOSILSIC ACID SYSTEM METERING PMP O-O-R CNTRL	ACID FEED SYSTEM AREA	SELECTOR SWITCH, 3 POSITION		
PI-830-1 AND 830-2	FLUOSILSIC ACID FEED SYSTEM PRESSURE	FLUOSILSIC ACID FEED SYSTEM AREA	PRESSURE GUAGES 4.5"	0-30 PSIG	W/DIAPHRAGM SEAL

INSTRUMENT DEVICE SCHEDULE

DEVICE NO.	SERVICE	LOCATION	DESCRIPTION	CALIBRATED RANGE OR SCALE	REMARKS
[illegible]	FLUOSILSIC ACID FEED PRESSURE	FLUOSILSIC ACID FEED SYSTEM AREA	PRESSURE SWITCHE	[illegible]	W/DIAPHRAGM SEAL
PI-837	FLUOSILICIC ACID ADDITION	AT THE APPLICATION POINT	PRESSURE GUAGE 4.5" W/ ALLOY 20 DIAPHRAGM SEAL	0-100 PSIG	
LI-866	CAUSTIC FEED SYSTEM STORAGE TANK LEVEL	CAUSTIC FEED SYSTEM AREA	LEVEL INDICATOR		
LI-871	CAUSTIC FEED SYSTEM DAY TANK LEVEL	CAUSTIC FEED SYSTEM AREA	LEVEL INDICATOR		FURNISHED W/TANK
HS-875-1A HS-875-2A	CAUSTIC FEED SYSTEM METERING PMP O-O-R CNTRL	CAUSTIC FEED SYSTEM AREA	SELECTOR SWITCH, 3 POSITION		
PI-880-1 PI-880-2	CAUSTIC FEED SYSTEM EFFLUENT PRESSURE	CAUSTIC FEED SYSTEM AREA	PRESSURE GUAGES 4.5"	0-60 PSIG	W/DIAPHRAGM SEAL
PSL-885	CAUSTIC FEED SYSTEM PRESSURE	CAUSTIC FEED SYSTEM AREA	PRESSURE SWITCHE	TRIP AT 45 PSIG	W/DIAPHRAGM SEAL
PI-887	CAUSTIC ADDITION	AT THE APPLICATION POINT	PRESSURE GUAGE 4.5"	0-100 PSIG	
LI-965	CORROSION INHIBITOR SYSTEM DAY TANK LEVEL	INHIBITOR DAY TANK	LEVEL INDICATOR		FURNISHED W/TANK
PI-980-1 980-2	AND CORROSION INHIBITOR FEED SYSTEM PRESSURE	CORROSION INHIBITOR FEED SYSTEM AREA	PRESSURE GUAGES 4.5"	0-?? PSI SCALE	W/DIAPHRAGM SEAL