Crystal River Unit 3 Nuclear Generating Plant License Renewal

Revised Environmental Site Audit Needs List

Aquatic Ecology
(Except AQ-3)

Archaeology

Aquatic Ecology

AQ-1

US Fish and Wildlife FWS Log No. 41910-I-0015, October 28, 2008

United States Department of the Interior

U. S. FISH AND WILDLIFE SERVICE

7915 BAYMEADOWS WAY, SUITE 200
JACKSONVILLE, FLORIDA 32256-7517

IN REPLY REFER TO:

FWS Log No. 41910-I-0015

October 28, 2008

Progress Energy
Crystal River Nuclear Plant
15760 W. Powerline Street
Crystal River, FL 34428
Attn: Jan Kozyra, Lead Engineer – License Renewal

Dear Mr. James W. Holt:

We received your letter dated September 25, 2008 regarding your request for information on listed species and sensitive habitats in order to assess the impact of the proposed license renewal of the Progress Energy Crystal River Unit 3 (CR-3) in Crystal River, Florida. We provide this response under section 7 of the Endangered Species Act of 1973, (ESA) as amended (16 U.S.C. 1531 *et seq.*).

You have stated that CR-3 is part of a larger Crystal River Energy Complex and that renewal of the CR-3 operating license would not involve any land disturbance, any changes to plant operation, or any modification of the transmission system that connects the plant to the regional electric grid. There are plans to replace the CR-3 steam generators in the fall of 2009, but this will occur before the current operating license expires. These generators would not have been replaced unless there were plans to renew the current license which expires in 2016 and is thus considered a connected action. Continued operation of CR-3 includes the maintenance of the transmission lines over the license renewal period which is 20 years in duration. Transmission lines totaling 130.3 miles are located in Citrus, Marion, Sumter, Hernando, Pasco, and Pinellas Counties. You believe that continued operation of CR-3 would not adversely affect any threatened or endangered species.

As you probably know, the endangered Florida manatee (*Trichechus manatus latirostris*) uses warm water discharges from power generating facilities as a winter refuge in addition to natural warm water springs. The Crystal River has several springs which are important warm water sources for approximately 150 manatees during the winter months and we believe that some manatees do, on occasion, visit your facility as well. If renewal of this license and replacement of the steam generators in CR-3 will result in a decrease in the temperature of discharge waters from this facility and thus result in a potential change to manatee winter use, we suggest that formal consultation under the ESA be requested by the Federal action agency.

Also, the threatened eastern indigo snake (*Drymarchon corais couperi*) occurs throughout Florida in a variety of habitats, but is known to use gopher tortoise burrows as a refuge. Gopher tortoises will inhabit maintained transmission lines. Therefore, we recommend that maintenance activity associated with transmission lines such as mowing, grubbing, disking, burning etc. be conducted using the *Standard Protection Measures for the Eastern Indigo Snake* (may be obtained from our website, www.fws.gov/northflorida) with the following changes for each numbered measure:

1) Per the Standard Conditions with the following changes:
 * wording should be changed from "construction personnel" to "maintenance personnel";
 * a protection/education plan needs to be submitted to us for our approval only once to include all transmission line maintenance activity (mowing, grubbing, disking, burning, etc) for the life of the permit until a proposed change in the protection plan is proposed;
 * informational signs on site are not necessary for a trained crew unless there is more than three individuals working in the same area and they will be working in the same area for more than one day; all subcontracted maintenance personnel must have received the identified training components or a sign must be placed every 100 linear feet on the transmission corridor that has a color photo of the eastern indigo snake and a description of the restriction on take and the potential consequences for take under the law, and a telephone number to report any dead eastern indigo snakes (this must be in a language that all personnel can read);
 * refer to our website to obtain a telephone number for our North Florida Field Office to report any dead eastern indigo snakes.
2) Per the Standard Conditions
3) A monitoring report to the Service is not required.

Service approval of the protection/educational plan for the eastern indigo snake is equivalent to a "may affect, not likely to adversely affect" determination for this species and should be made prior to license renewal.

We understand that the U.S. Nuclear Regulatory Commission is the Federal permitting authority and we believe the information we have provided herein will enable them to determine whether the renewal of the license for CR-3 is likely to result in adverse effects to Federally-listed species. If you have any questions, please contact Ms. Linda S. Smith of our St. Petersburg sub-office at 600 Fourth Street South, St. Petersburg, Florida 33701, or by calling (904) 868-4044.

Sincerely,

David L. Hankla
Field Supervisor

Aquatic Ecology

AQ-3

Provided in a separate binder

Aquatic Ecology

AQ-4

1. Jacksonville District Corps of Engineers letter dated November 12, 2008
2. FDEP letter dated may 29, 2008

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
GAINESVILLE REGULATORY OFFICE
2831 NW 41ST STREET, SUITE K
GAINESVILLE, FLORIDA 32606

REPLY TO
ATTENTION OF

Pensacola Section
SAJ-2008-02893(LP-SEG)

November 12, 2008

RECEIVED
NOV 17 2008
Environmental Services

Florida Power Corporation
Progress Energy Florida, Inc.
P.O. Box 14042
St. Petersburg, Florida 33733

Dear Mr. Applicant:

This is in reference to your request for a Department of the Army (DA) permit to perform work in or affecting waters of the United States. If you determine that the permit provided is acceptable in its entirety and you have chosen to proceed with the authorized activity, then upon recommendation of the Chief of Engineers, pursuant to Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403), you are authorized under a Letter of Permission

to dredge 5,631 cubic yards of material from an existing turning basin

at the end of West Power Line Road, in Sections 32 & 33, Township 17 South, Range 16 East, City of Crystal River, Citrus County, Florida.

Geographic Position: Latitude: 28° 57′ 20.694″ North
Longitude: 82° 42′ 16.735″ West

The project must be completed in accordance with the enclosed construction drawings, and the general and special conditions which are incorporated in, and made a part of, the permit.

Special Conditions:

1. Submittals required herein shall be directed to:

Department of the Army
Jacksonville District Corps of Engineers
Regulatory Division, Enforcement Section
P.O. Box 4970
Jacksonville, Florida 32232-0019

2. Within 60 days of completion of the work authorized and any mitigation requirements, the attached "Self-Certification Statement of Compliance" shall be completed and submitted to the U.S. Army Corps of Engineers.

3. The permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structures or work herein authorized, or if in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee will be required, upon due notice from the Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

4. The Permittee shall comply with the "Standard Manatee Conditions for In-Water Work - July 2005" provided in Attachment 1 of this permit.

5. The permittee shall notify the District Engineer's representative, at the Regulatory Division, Enforcement Section of:

a. The date of commencement of work;

b. The dates of work suspensions and resumption's if work is suspended over a week; and,

c. The date of final completion.

6. Prior to the initiation of any of the work authorized by this permit the Permittee shall install floating turbidity barriers with weighted skirts that extend to within 1 foot of the bottom around all work areas that are in, or adjacent to, surface waters. The turbidity barriers shall remain in place and be maintained until the authorized work has been completed and all erodible materials have been stabilized.

7. The Permittee shall comply with the "Sea Turtle and Smalltooth Sawfish Construction Conditions-dated March 23, 2006" provided in Attachment 2 of this permit.

If the work authorized is not completed on or before **November 12, 2013**, authorization, if not previously revoked or specifically extended, shall cease and be null and void.

This letter contains a proffered permit for your subject permit application. If you object to this decision, you may request an administrative appeal under Corps' regulations at 33 CFR Part 331. Enclosed you will find a Notification of Appeal Process fact sheet and Request for Appeal (RFA) form. If you request to appeal this decision, you must submit a completed RFA form to the South Atlantic Division Office at the following address:

Mr. Michael F. Bell
South Atlantic Division
U.S. Army Corps of Engineers
CESAD-CM-CO-R, Room 9M15
60 Forsyth St., SW.
Atlanta, Georgia 30303-8801.

Mr. Bell can be reached by telephone number at 404-562-5137, or by facsimile at 404-562-5138.

In order for an RFA to be accepted by the Corps, the Corps must determine that it is complete, that it meets the criteria for appeal under 33 CFR Part 331.5, and that it has been received by the Division office within 60 days of the date of the RFA. Should you decide to submit an RFA form, it must be received at the above address by November 9, 2008. It is not necessary to submit an RFA form to the Division office, if you do not object to the decision in this letter.

Should you have any questions regarding this letter, please contact the project manager Shaun Gallagher in writing at the letterhead address, by telephone at 352-264-7672, or by email at: shaun.e.gallagher@usace.army.mil.

The Corps Jacksonville District Regulatory Division is committed to improving service to our customers. We strive to perform our duty in a friendly and timely manner while working to preserve our environment. We invite you to take a few minutes to visit the following link and complete our automated Customer Service Survey: http://regulatory.usacesurvey.com/. Your input is appreciated - favorable or otherwise.

BY AUTHORITY OF THE SECRETARY OF THE ARMY:

FOR Paul L. Grosskruger
Colonel, U.S. Army
District Commander

Enclosures:

Manatee Construction Conditions

Copy/ies Furnished:

CESAJ-RD-PE (w/ enclosures)

REQUEST PERMIT TRANSFER: PERMIT NUMBER: ______________________

When the structures or work verified by this permit are still in existence at the time the property is transferred, the terms and conditions of this permit will continue to be binding on the new owner(s) of the property. To validate the transfer of this permit and the associated liabilities associated with compliance with its terms and conditions, the present permittee and the transferee should sign and date below. This document must then be provided to the U.S. Army Corps of Engineers, Regulatory Division, Post Office Box 4970, Jacksonville, Florida 32232-0019.

______________________________ ______________

(PRESENT PERMITTEE SIGNATURE) (DATE)

______________________________ ______________

(TRANSFEREE SIGNATURE) (DATE)

______________________________ ______________

(Name - Printed) Lot/Block of site

____

(Street Address)

____

(City, State, and Zip Code)

Flood Plain Information:

This Department of the Army permit does not give absolute authority to perform the work as specified on your application. The proposed work may be subject to local building restrictions. You should contact the local office in your area that issues building permits to determine if your site is located in a flood-prone or floodway area, and if you must comply with the local building requirements mandated by the National Flood Insurance Program. If your local office cannot provide you the necessary information, you may request a flood hazard evaluation of the site by providing this office with a letter and a small scale map showing the location of the site. The request should be addressed to the **Chief, Flood Control and Floodplain Management Branch, Jacksonville District, U.S. Army Corps of Engineers, P.O. Box 4970, Jacksonville, Florida 32232-0019**. Phone inquiries may be made at 904-232-2515.

GENERAL CONDITIONS
33 CFR PART 320-330
PUBLISHED FR DATED 13 NOVEMBER 1986

1. The time limit for completing the work authorized ends on the date noted in the permit letter. If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.

2. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.

3. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and state coordination required to determine if the remains warrant a recovery effort of if the site is eligible for listing in the National Register of Historic Places.

4. If you sell the property associated with this permit you must obtain the signature of the new owner in the space provided and forward a copy of the permit to this office to validate the transfer of this authorization.

5. If a conditioned water quality certification has been issued for your project, you must comply with the conditions specified in the certification as special conditions to this permit. For your convenience, a copy of the certification is attached if it contains such conditions.

6. You must allow a representatives from this office to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished in accordance with the terms and conditions of your permit.

SELF-CERTIFICATION STATEMENT OF COMPLIANCE

Permit Number: SAJ-2008-02893(LP-SEG)

Permittee's Name & Address (please print or type):

____

____

____

Telephone Number: ______________________________

Location of the Work: ______________________________

____

Date Work Started: _______________ Date Work Completed: _______________

Description of the Work (e.g. bank stabilization, residential or commercial filling, docks, dredging, etc.):

____

____

Acreage or Square Feet of Impacts to Waters of the United States:

____

Describe Mitigation completed (if applicable): _______________

____

____

Describe any Deviations from Permit (attach drawing(s) depicting the deviations):

____

____

____

****

I certify that all work, and mitigation (if applicable) was done in accordance with the limitations and conditions as described in the permit. Any deviations as described above are depicted on the attached drawing(s).

____
Signature of Permittee

____
Date

NOTIFICATION OF ADMINISTRATIVE APPEAL OPTIONS AND PROCESS AND REQUEST FOR APPEAL

Applicant: Progress Energy		File Number: SAJ-2008-02893	Date: November 12, 2008
Attached is:			See Section below
	INITIAL PROFFERED PERMIT (Standard Permit or Letter of permission)		A
X	PROFFERED PERMIT (Standard Permit or Letter of permission)		B
	PERMIT DENIAL		C
	APPROVED JURISDICTIONAL DETERMINATION		D
	PRELIMINARY JURISDICTIONAL DETERMINATION		E

SECTION I - The following identifies your rights and options regarding an administrative appeal of the above decision. Additional information may be found at http://usace.army.mil/inet/functions/cw/cecwo/reg or Corps regulations at 33 CFR Part 331.

A: INITIAL PROFFERED PERMIT: You may accept or object to the permit.

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- OBJECT: If you object to the permit (Standard or LOP) because of certain terms and conditions therein, you may request that the permit be modified accordingly. You must complete Section II of this form and return the form to the district engineer. Your objections must be received by the district engineer within 60 days of the date of this notice, or you will forfeit your right to appeal the permit in the future. Upon receipt of your letter, the district engineer will evaluate your objections and may: (a) modify the permit to address all of your concerns, (b) modify the permit to address some of your objections, or (c) not modify the permit having determined that the permit should be issued as previously written. After evaluating your objections, the district engineer will send you a proffered permit for your reconsideration, as indicated in Section B below.

B: PROFFERED PERMIT: You may accept or appeal the permit

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- APPEAL: If you choose to decline the proffered permit (Standard or LOP) because of certain terms and conditions therein, you may appeal the declined permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

C: PERMIT DENIAL: You may appeal the denial of a permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

D: APPROVED JURISDICTIONAL DETERMINATION: You may accept or appeal the approved JD or provide new information.

- ACCEPT: You do not need to notify the Corps to accept an approved JD. Failure to notify the Corps within 60 days of the date of this notice, means that you accept the approved JD in its entirety, and waive all rights to appeal the approved JD.
- APPEAL: If you disagree with the approved JD, you may appeal the approved JD under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

E: PRELIMINARY JURISDICTIONAL DETERMINATION: You do not need to respond to the Corps regarding the preliminary JD. The Preliminary JD is not appealable. If you wish, you may request an approved JD (which may be appealed), by contacting the Corps district for further instruction. Also you may provide new information for further consideration by the Corps to reevaluate the JD.

SECTION II - REQUEST FOR APPEAL or OBJECTIONS TO AN INITIAL PROFFERED PERMIT		
REASONS FOR APPEAL OR OBJECTIONS: (Describe your reasons for appealing the decision or your objections to an initial proffered permit in clear concise statements. You may attach additional information to this form to clarify where your reasons or objections are addressed in the administrative record.)		
ADDITIONAL INFORMATION: The appeal is limited to a review of the administrative record, the Corps memorandum for the record of the appeal conference or meeting, and any supplemental information that the review officer has determined is needed to clarify the administrative record. Neither the appellant nor the Corps may add new information or analyses to the record. However, you may provide additional information to clarify the location of information that is already in the administrative record.		
POINT OF CONTACT FOR QUESTIONS OR INFORMATION:		
If you have questions regarding this decision and/or the appeal process you may contact: Project Manager as noted in letter	If you only have questions regarding the appeal process you may also contact: Michael F. Bell 404-562-5137	
RIGHT OF ENTRY: Your signature below grants the right of entry to Corps of Engineers personnel, and any government consultants, to conduct investigations of the project site during the course of the appeal process. You will be provided a 15 day notice of any site investigation, and will have the opportunity to participate in all site investigations.		
Signature of appellant or agent.	Date:	Telephone number:

STANDARD MANATEE CONDITIONS FOR IN-WATER WORK
July 2005

The Permittee shall comply with the following conditions intended to protect manatees from direct project effects:

a. All personnel associated with the project shall be instructed about the presence of manatees and manatee speed zones, and the need to avoid collisions with and injury to manatees. The Permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing manatees, which are protected under the Marine Mammal Protection Act, the Endangered Species Act, and the Florida Manatee Sanctuary Act.

b. All vessels associated with the construction project shall operate at "Idle Speed/No Wake" at all times while in the immediate area and while in water where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will follow routes of deep water whenever possible.

c. Siltation or turbidity barriers shall be made of material in which manatees can not become entangled, shall be properly secured, and shall be regularly monitored to avoid manatee entanglement or entrapment. Barriers must not impede manatee movement.

d. All on-site project personnel are responsible for observing water-related activities for the presence of manatee(s). All in-water operations, including vessels, must be shutdown if a manatee(s) comes within 50 feet of the operation. Activities will not resume until the manatee(s) has moved beyond the 50-foot radius of the project operation, or until 30 minutes elapses if the manatee(s) has not reappeared within 50 feet of the operation. Animals must not be herded away or harassed into leaving.

e. Any collision with or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. Collision and/or injury should also be reported to the U.S. Fish and Wildlife Service in Jacksonville (1-904-232-2580) for north Florida or Vero Beach
(1-561-562-3909) for south Florida.

f. Temporary signs concerning manatees shall be posted prior to and during all in- water project activities. All signs are to be removed by the Permittee upon completion of the project. Awareness signs that have already been approved for this use by the Florida Fish and Wildlife Conservation Commission (FWC) must be used. One sign measuring at least 3 ft. by 4 ft., which reads *Caution: Manatee Area* must be posted. A second sign measuring at least 81/2" by 11" explaining the requirements for "Idle Speed/No Wake" and the shut down of in-water operations must be posted in a location prominently visible to all personnel engaged in water-related activities.

FWC Approved Manatee Educational Sign Suppliers

ASAP Signs & Designs
624-B Pinellas Street
Clearwater, FL 33756
Phone: (727) 443-4878
Fax: (727) 442-7573

Wilderness Graphics, Inc.
P. O. Box 1635
Tallahassee, FL 32302
Phone: (850) 224-6414
Fax: (850) 561-3943
www.wildernessgraphics.com

Cape Coral Signs & Designs
1311 Del Prado Boulevard
Cape Coral, FL 33990
Phone: (239) 772-9992
Fax: (239) 772-3848

Municipal Supply & Sign Co.
1095 Fifth Avenue, North
P. O. Box 1765
Naples, FL 33939-1765
Phone: (800) 329-5366 or
(239) 262-4639
Fax: (239) 262-4645
www.municiDalsiqns.com

Vital Signs
104615 Overseas Highway
Key Largo, FL 33037
Phone: (305) 451-5133
Fax: (305) 451-5163

Universal Signs & Accessories
2912 Orange Avenue
Ft. Pierce, FL 34947
Phone: (800) 432-0331 or
(772) 461-0665
Fax: (772) 461-0669

New City Signs
182928 Street North
St. Petersburg, FL 33713
Phone: (727) 323-7897
Fax: (727) 323-1897

United Rentals Highway Technologies
309 Angle Road
Ft. Pierce, FL 34947
Phone: (772) 489-8772 or
(800) 489-8758 (FL only)
Fax: (772) 489-8757

CAUTION: MANATEE HABITAT

All project vessels

IDLE SPEED / NO WAKE

When a manatee is within 50 feet of work
all in-water activities must

SHUT DOWN

Report any collision or injury to :
1-888-404-FWCC (1-888-404-3922)

Florida Fish and Wildlife Conservation Commission

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, FL 33701

SEA TURTLE AND SMALLTOOTH SAWFISH CONSTRUCTION CONDITIONS

The permittee shall comply with the following protected species construction conditions:

a. The permittee shall instruct all personnel associated with the project of the potential presence of these species and the need to avoid collisions with sea turtles and smalltooth sawfish. All construction personnel are responsible for observing water-related activities for the presence of these species.

b. The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles or smalltooth sawfish, which are protected under the Endangered Species Act of 1973.

c. Siltation barriers shall be made of material in which a sea turtle or smalltooth sawfish cannot become entangled, be properly secured, and be regularly monitored to avoid protected species entrapment. Barriers may not block sea turtle or smalltooth sawfish entry to or exit from designated critical habitat without prior agreement from the National Marine Fisheries Service's Protected Resources Division, St. Petersburg, Florida.

d. All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water depths where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will preferentially follow deep-water routes (e.g., marked channels) whenever possible.

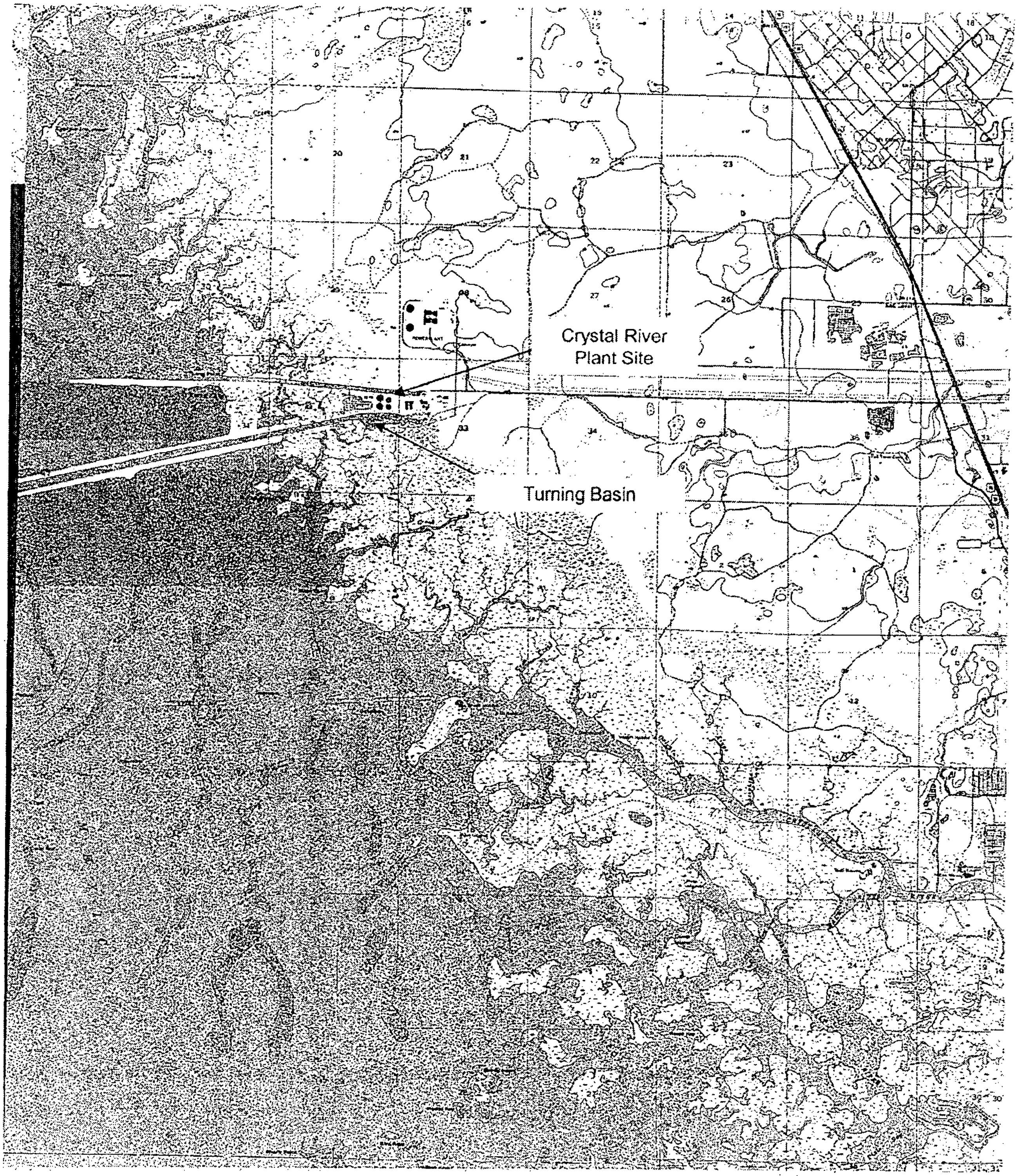
e. If a sea turtle or smalltooth sawfish is seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 feet of a sea turtle or smalltooth sawfish. Operation of any mechanical construction equipment shall cease immediately if a sea turtle or smalltooth sawfish is seen within a 50-ft radius of the equipment. Activities may not resume until the protected species has departed the project area of its own volition.

f. Any collision with and/or injury to a sea turtle or smalltooth sawfish shall be reported immediately to the National Marine Fisheries Service's Protected Resources Division (727-824-5312) and the local authorized sea turtle stranding/rescue organization.

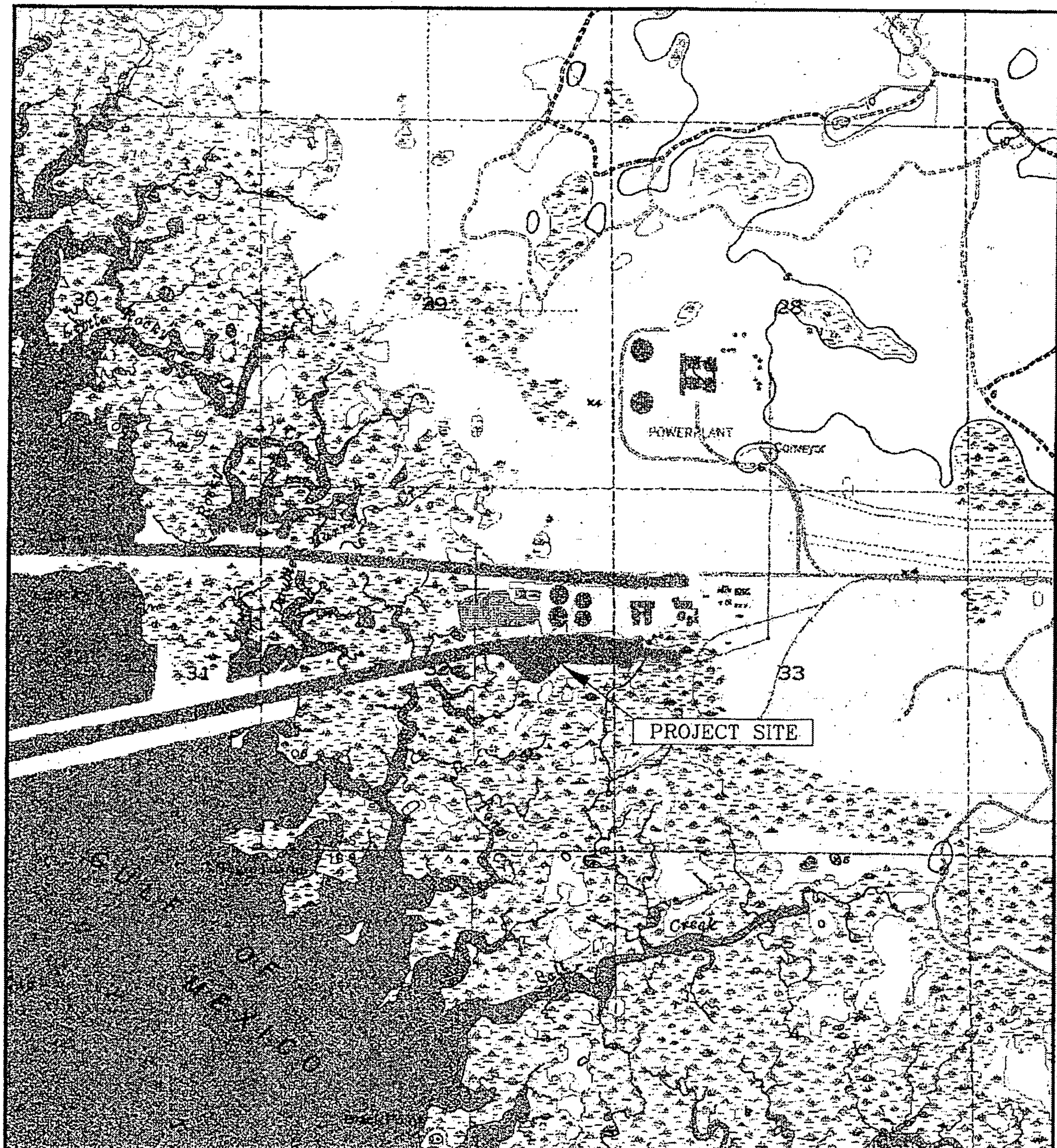
g. Any special construction conditions, required of your specific project, outside these general conditions, if applicable, will be addressed in the primary consultation.

Revised: March 23, 2006
O:\forms\Sea Turtle and Smalltooth Sawfish Construction Conditions.doc

USGS Quadrangle



Progress Energy



U.S.G.S. QUAD RED LEVEL

PREPARED FOR:	Crystal River Turning Basin	REVISED	BY	DATE	DESCRIPTION
Progress Energy P.O. Box 1551 Raleigh, NC 27602-1551	Cover Sheet SECTION 32,33, TOWNSHIP 17 S., RANGE 16 E.				

	INITIALS	DATE
CREW CHIEF	JT	4/19/06
DRAWN	WGR	2/08/08
CHECKED	GSN	2/11/08
FIELD BOOK	CR	
FIELD DATE	4/19/06	

Greg S. Nipper PSM LS 5683

DATE

Since 1919

George F. Young, Inc.

299 DR. MARTIN LUTHER KING JR. STREET, N. ST. PETERSBURG, FLORIDA 33701
PHONE (727) 822-4317 FAX (727) 822-2919
BUSINESS ENTITY LB21
ARCHITECTURE-ENGINEERING-ENVIRONMENTAL-LANDSCAPE-PLANNING-SURVEYING-UTILITIES
GAINESVILLE-LAKEWOOD RANCH-ORLANDO-PALM BEACH GARDENS-ST. PETERSBURG-TAMPA-VENICE

JOB NO. 0613035902

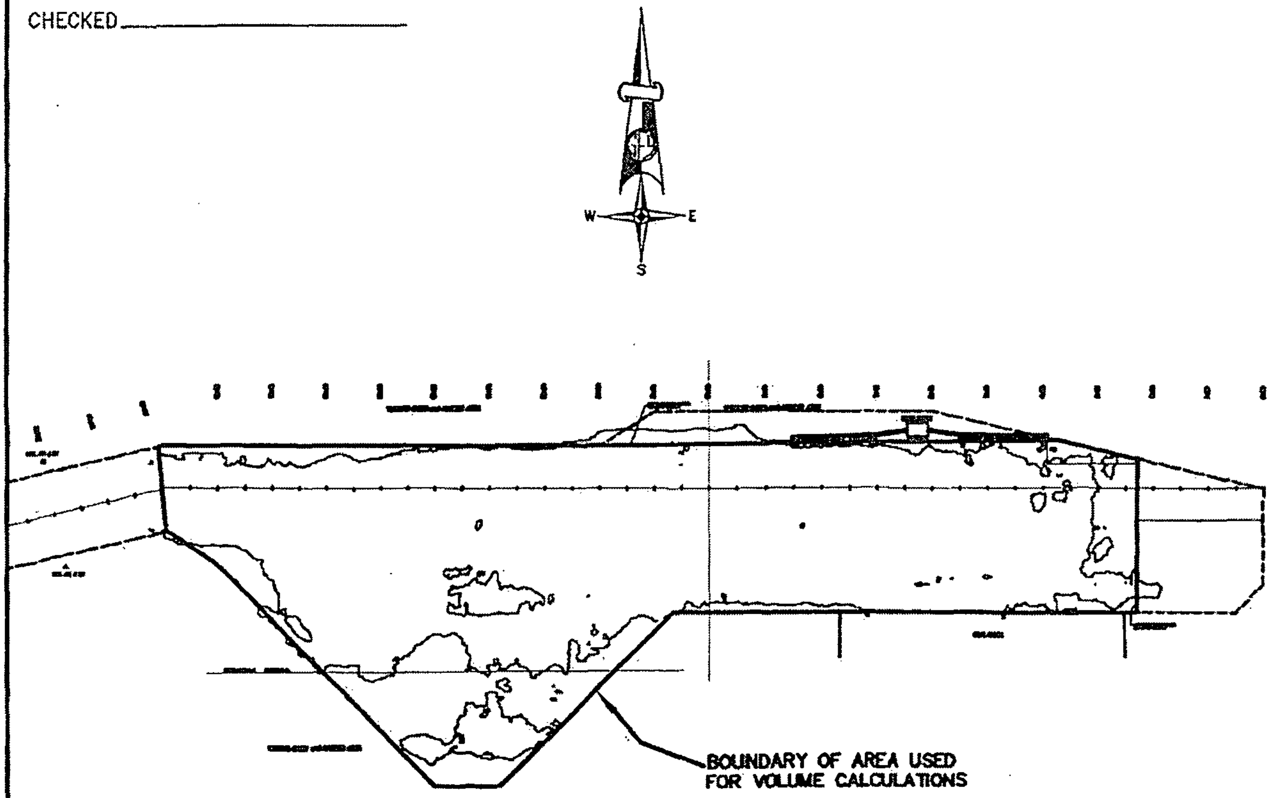
SHEET NO. 1 OF 9

FILE: I:\PROJECT\SUR\0613035902\DWG\0613035902.DWG LOGIN: ROBBINS PLOTTED: 02/14/08 11:57:27

DRAWN ______________

CHECKED ______________

SEC.____ TWP.____ S., RNG.____ E.



Site Volume Table: Unadjusted

Site	Stratum	Surf1	Surf2	Cut yards	Fill yards	Net yards	Method
0613-0359-00							
	eg to -21	harbor	-21-reduced	3861	47331	43470 (F)	Composite

TOTAL VOLUME TO BE REMOVED TO -21 FT. = 3861 CU. YDS.

CRYSTAL RIVER VOLUME CHART
TURNING BASIN EXHIBIT

PROJECT #: 06-13-0359-01

George F. Young, Inc.

LICENSED BUSINESS 021

ARCHITECTURE-ENGINEERING-ENVIRONMENTAL-LANDSCAPE ARCHITECTURE-PLANNING-SURVEYING

ST. PETERSBURG - BRADENTON - GAINESVILLE - ORLANDO - PALM BEACH - SARASOTA - TAMPA

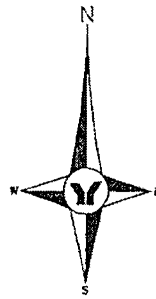
RESPONSIBLE OFFICE: 299 Dr. Martin Luther King Jr. Street North
St. Petersburg FL 33701-0683
Tel.: (727) 822-4317 Fax: (727) 822-2919

Since 1919

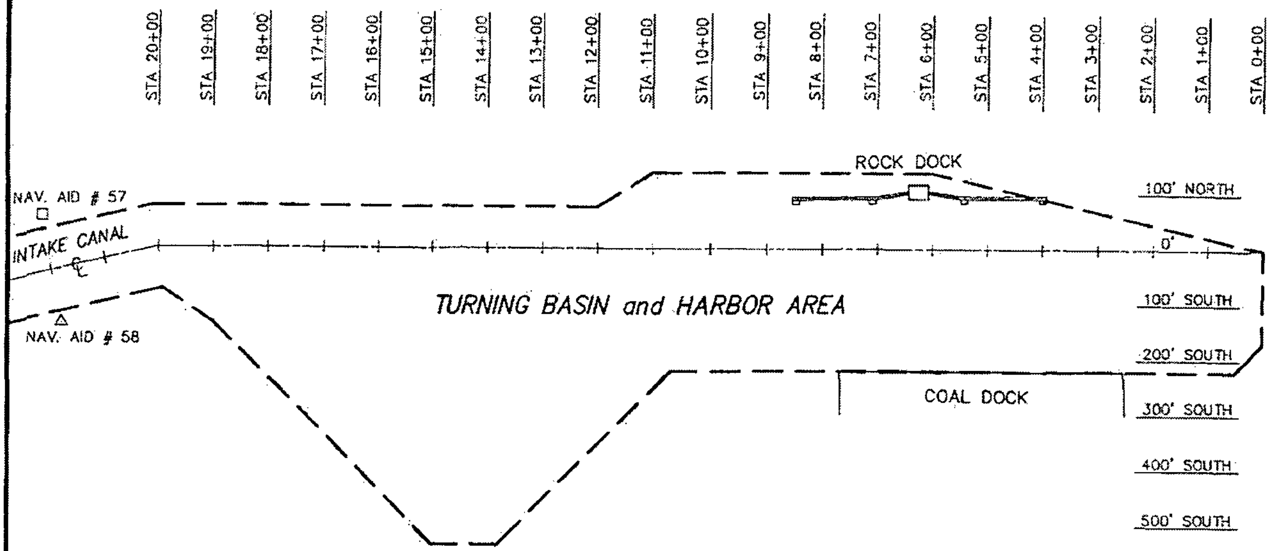
PLOTTED: LOGIN: FILE:

LEGEND:

℄	Centerline
PSM	Professional Surveyor and Mapper
N.	North
NAV. AID	Navigation Aid
S.	South
STA	Station



SCALE: 1" = 300'



NOTES:

1. ALL ELEVATIONS REFER TO MEAN LOW WATER.
2. 0.0 MEAN LOW WATER = (−)0.8 N.G.V.D. (NATIONAL GEODETIC VERTICAL DATUM OF 1929).
3. VERTICAL CONTROL IS BASED ON RIVET AND DISK LOCATED IN COAL SHUTE, ELEVATION = 11.86 FEET M.L.W. (ESTABLISHED BY PRIOR SURVEY)
4. THE INFORMATION DEPICTED HEREON REPRESENTS A SURVEY MADE ON 04/18/06 AND 04/19/06 AND CAN ONLY INDICATE THE GENERAL CONDITIONS EXISTING ON SAID DATES.
5. THE CHANNEL DESIGN AS SHOWN IS TAKEN FROM PRIOR SURVEYS.

PREPARED FOR:
Progress Energy
P.O. Box 1551
Raleigh, NC 27602-1551

Crystal River Turning Basin
Plan View

SECTION 32,33, TOWNSHIP 17 S., RANGE 16 E.

REVISED	BY	DATE	DESCRIPTION

	INITIALS	DATE
CREW CHIEF	JT	4/19/06
DRAWN	WGR	2/08/08
CHECKED	GSN	2/11/08
FIELD BOOK	CR	
FIELD DATE	4/19/06	

NOTE: SEE SHEET NO. 1 FOR SIGNATURE AND SEAL.

Since 1919

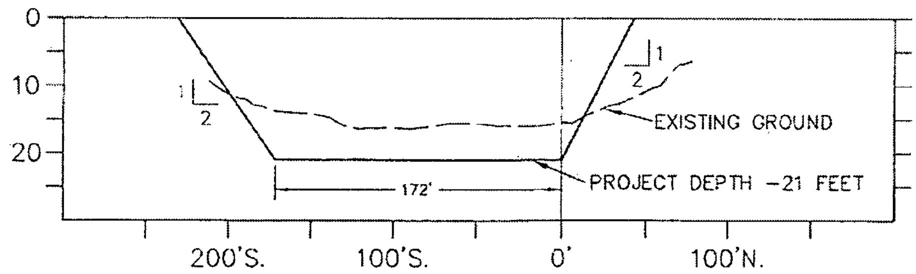
George F. Young, Inc.

299 DR. MARTIN LUTHER KING JR. STREET, N. ST. PETERSBURG, FLORIDA 33701
PHONE (727) 822-4317 FAX (727) 822-2919
BUSINESS ENTITY LB21
ARCHITECTURE·ENGINEERING·ENVIRONMENTAL·LANDSCAPE·PLANNING·SURVEYING·UTILITIES
GAINESVILLE·LAKEWOOD RANCH·ORLANDO·PALM BEACH GARDENS·ST. PETERSBURG·TAMPA·VENICE

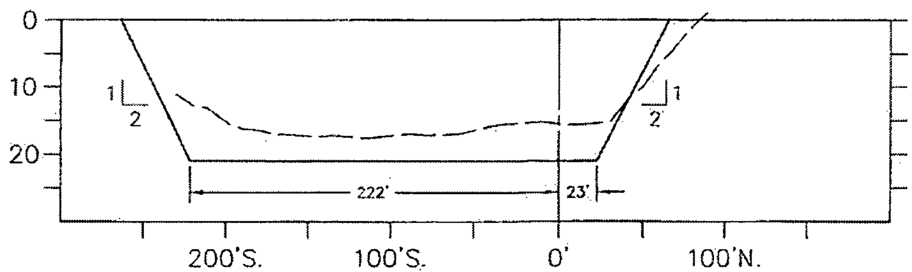
JOB NO. 0613035902

SHEET NO. 2 OF 9

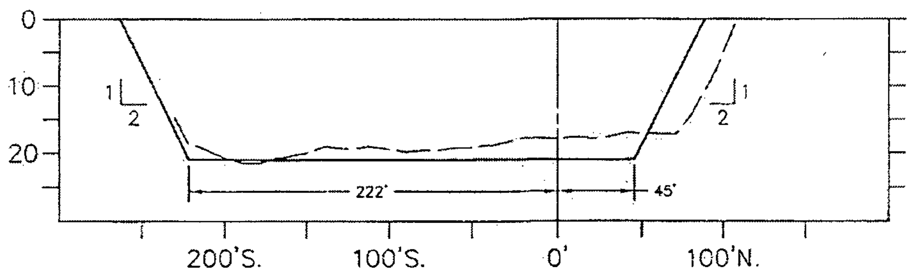
FILE: I:\PROJECT\SURV\0613035902\DWG\0613035902.DWG LOGIN: ROBBINS PLOTTED: 02/14/08 11:58:52



STA 0+00



STA 1+00



STA 2+00

NOTE: SEE SHEET NO. 2 FOR NOTES AND LEGEND.

PREPARED FOR:
Progress Energy
P.O. Box 1551
Raleigh, NC 27602-1551

Crystal River Turning Basin
Cross Sectional Views

SECTION 32,33, TOWNSHIP 17 S., RANGE 16 E.

REVISED	BY	DATE	DESCRIPTION

	INITIALS	DATE
CREW CHIEF	JT	4/19/06
DRAWN	WGR	2/08/08
CHECKED	GSN	2/11/08
FIELD BOOK	CR	
FIELD DATE	4/19/06	

NOTE: SEE SHEET NO. 1 FOR SIGNATURE AND SEAL.

Since 1919

George F. Young, Inc.
299 DR. MARTIN LUTHER KING JR. STREET N. ST. PETERSBURG, FLORIDA 33701
PHONE (727) 822-4317 FAX (727) 822-2919
BUSINESS ENTITY LB21
ARCHITECTURE·ENGINEERING·ENVIRONMENTAL·LANDSCAPE·PLANNING·SURVEYING·UTILITIES
GAINESVILLE·LAKEWOOD RANCH·ORLANDO·PALM BEACH GARDENS·ST. PETERSBURG·TAMPA·VENICE

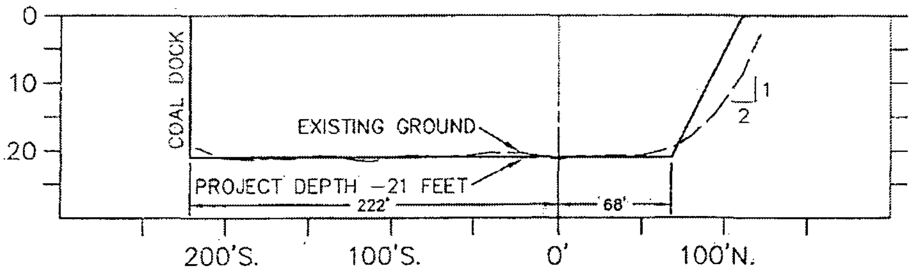
JOB NO. 0613035902

SHEET NO. 3 OF 9

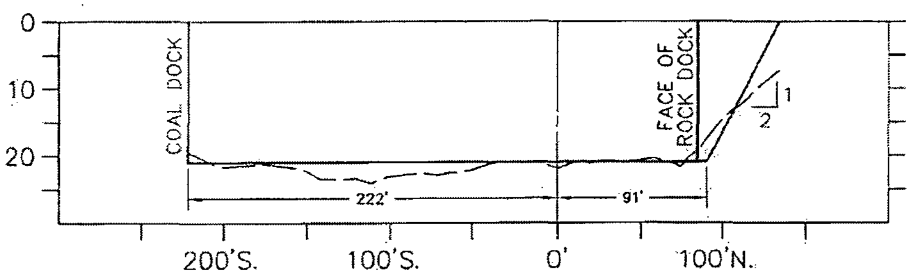
FILE: I:\PROJECT\SUR\0613035902\DWG\0613035902.DWG

LOGIN: ROBBINS

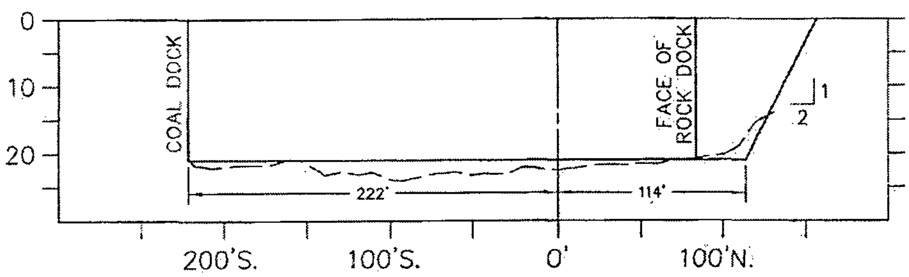
PLOTTED: 02/14/08 11:59:43



STA 3+00



STA 4+00



STA 5+00

NOTE: SEE SHEET NO. 2 FOR NOTES AND LEGEND.

PREPARED FOR:
Progress Energy
P.O. Box 1551
Raleigh, NC 27602-1551

Crystal River Turning Basin
Cross Sectional Views

SECTION 32,33, TOWNSHIP 17 S., RANGE 16 E.

REVISED	BY	DATE	DESCRIPTION

	INITIALS	DATE
CREW CHIEF	JT	4/19/06
DRAWN	WGR	2/08/08
CHECKED	GSN	2/11/08
FIELD BOOK	CR	
FIELD DATE	4/19/06	

NOTE: SEE SHEET NO. 1 FOR SIGNATURE AND SEAL.

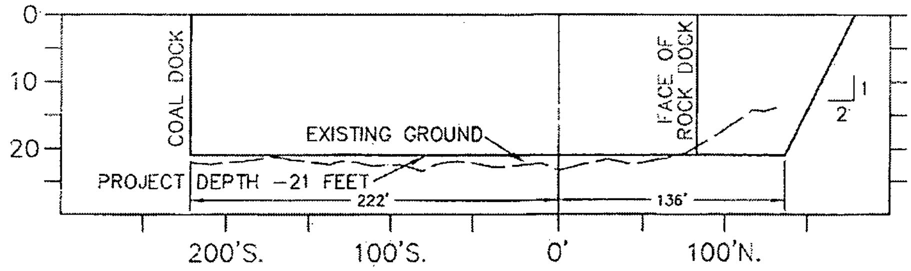
Since 1919

George F. Young, Inc.
299 DR. MARTIN LUTHER KING JR. STREET N. ST. PETERSBURG, FLORIDA 33701
PHONE (727) 822-4317 FAX (727) 822-2919
BUSINESS ENTITY LB21
ARCHITECTURE·ENGINEERING·ENVIRONMENTAL·LANDSCAPE·PLANNING·SURVEYING·UTILITIES
GAINESVILLE·LAKEWOOD RANCH·ORLANDO·PALM BEACH GARDENS·ST. PETERSBURG·TAMPA·VENICE

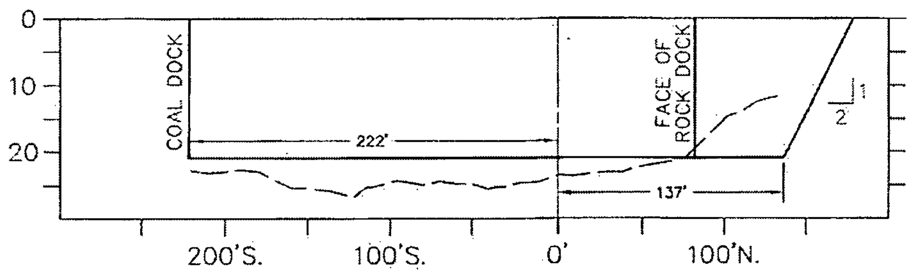
JOB NO. 0613035902

SHEET NO. 4 OF 9

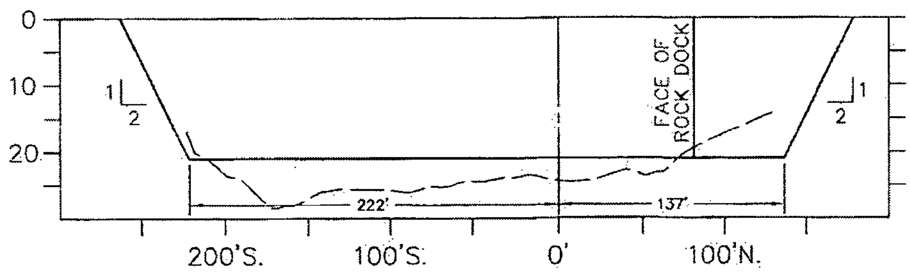
FILE: I:\PROJECT\SUR\0613035902\DWG\0613035902.DWG LOGIN: ROBBINS PLOTTED: 02/14/08 12:00:12



STA 6+00



STA 7+00



STA 8+00

NOTE: SEE SHEET NO. 2 FOR NOTES AND LEGEND.

PREPARED FOR:
Progress Energy
P.O. Box 1551
Raleigh, NC 27602-1551

Crystal River Turning Basin
Cross Sectional Views
SECTION 3233, TOWNSHIP 17 S., RANGE 16 E.

REVISED	BY	DATE	DESCRIPTION

	INITIALS	DATE
CREW CHIEF	JT	4/19/06
DRAWN	WGR	2/08/08
CHECKED	GSN	2/11/08
FIELD BOOK	CR	
FIELD DATE	4/19/06	

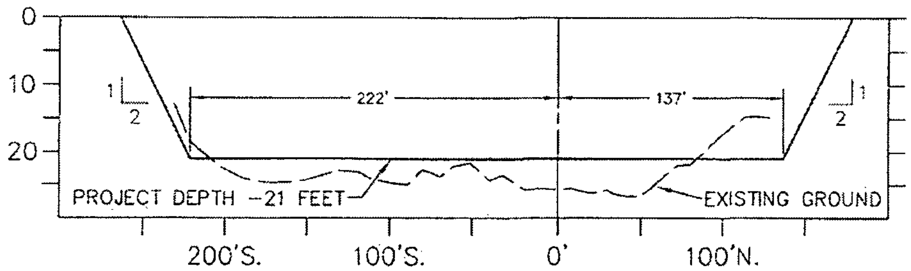
NOTE: SEE SHEET NO. 1 FOR SIGNATURE AND SEAL.

Since 1919

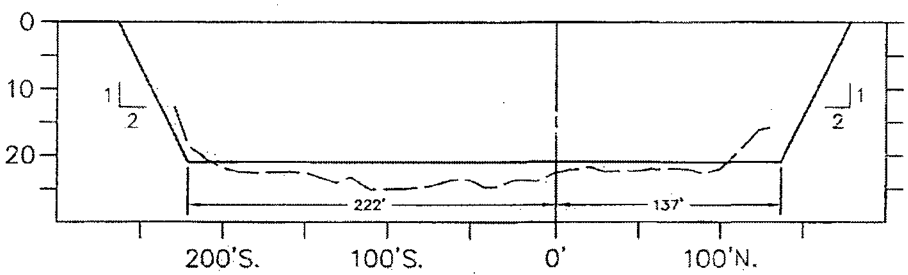
George F. Young, Inc.
299 DR. MARTIN LUTHER KING JR. STREET, N. ST. PETERSBURG, FLORIDA 33701
PHONE (727) 822-4317 FAX (727) 822-2919
BUSINESS ENTITY LB21
ARCHITECTURE·ENGINEERING·ENVIRONMENTAL·LANDSCAPE·PLANNING·SURVEYING·UTILITIES
GAINESVILLE·LAKEWOOD RANCH·ORLANDO·PALM BEACH GARDENS·ST. PETERSBURG·TAMPA·VENICE

JOB NO. 0613035902
SHEET NO. 5 OF 9

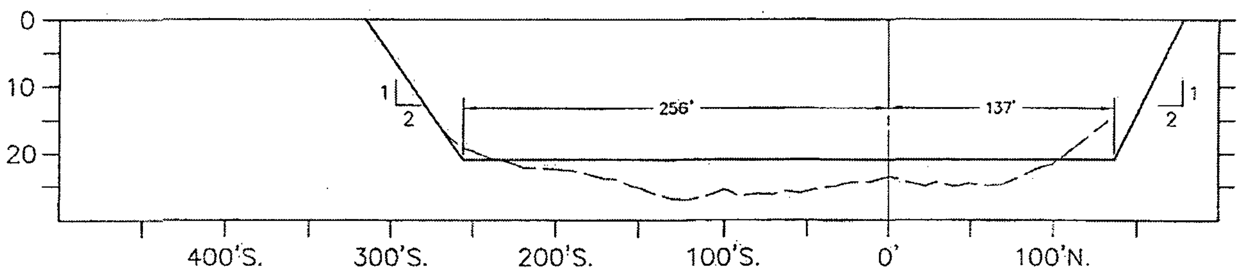
FILE: I:\PROJECT\SUR\0613035902\DWG\0613035902.DWG
LOGIN: ROBBINS
PLOTTED: 02/14/08 12:00:12



STA 9+00



STA 10+00



STA 11+00

NOTE: SEE SHEET NO. 2 FOR NOTES AND LEGEND.

PREPARED FOR:
Progress Energy
P.O. Box 1551
Raleigh, NC 27602-1551

Crystal River Turning Basin
Cross Sectional Views
SECTION 32,33, TOWNSHIP 17 S., RANGE 16 E.

REVISED	BY	DATE	DESCRIPTION

	INITIALS	DATE
CREW CHIEF	JT	4/19/06
DRAWN	WGR	2/08/08
CHECKED	CSN	2/11/08
FIELD BOOK	CR	
FIELD DATE	4/19/06	

NOTE: SEE SHEET NO. 1 FOR SIGNATURE AND SEAL.

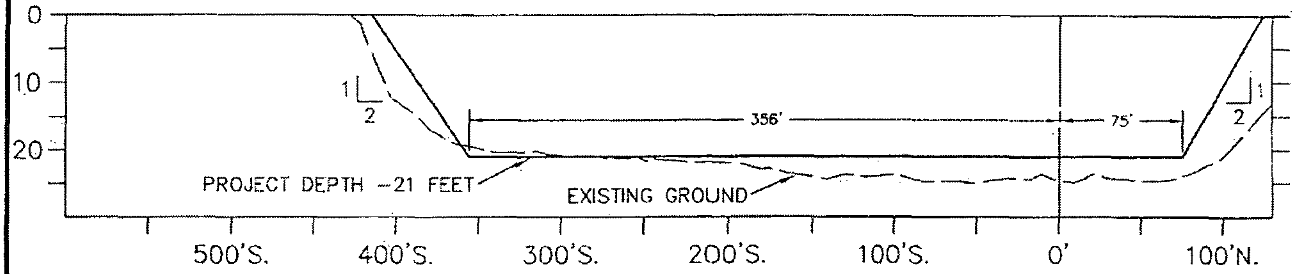
Since 1919

George F. Young, Inc.
299 DR. MARTIN LUTHER KING JR. STREET N. ST. PETERSBURG, FLORIDA 33701
PHONE (727) 822-4317 FAX (727) 822-2919
BUSINESS ENTITY LB21
ARCHITECTURE·ENGINEERING·ENVIRONMENTAL·LANDSCAPE·PLANNING·SURVEYING·UTILITIES
GAINESVILLE·LAKEWOOD RANCH·ORLANDO·PALM BEACH GARDENS·ST. PETERSBURG·TAMPA·VENICE

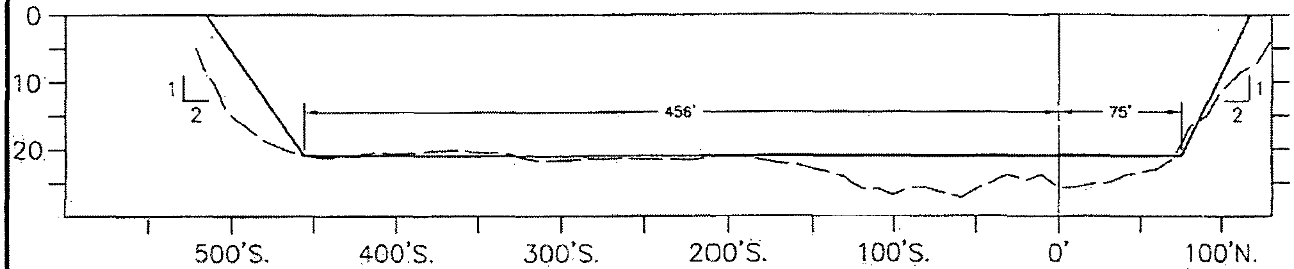
JOB NO. 0613035902

SHEET NO. 6 OF 9

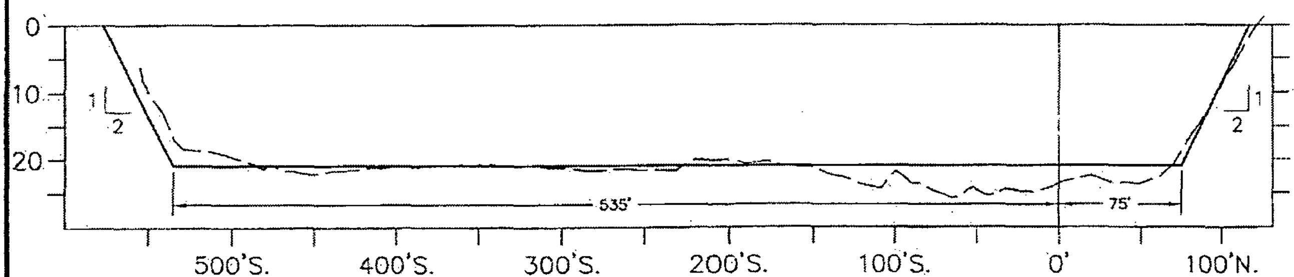
FILE: I:\PROJECT\SUR\0613035902\DWG\0613035902.DWG LOGIN: ROBBINS PLOTTED: 02/14/08 12:00:12



STA 12+00



STA 13+00



STA 14+00

NOTE: SEE SHEET NO. 2 FOR NOTES AND LEGEND.

PREPARED FOR:
Progress Energy
P.O. Box 1551
Raleigh, NC 27602-1551

Crystal River Turning Basin
Cross Sectional Views
SECTION 32,33 TOWNSHIP 17 S., RANGE 16 E.

REVISED	BY	DATE	DESCRIPTION

	INITIALS	DATE
CREW CHIEF	JT	4/19/06
DRAWN	WGR	2/08/08
CHECKED	GSN	2/11/08
FIELD BOOK	GR	
FIELD DATE	4/19/06	

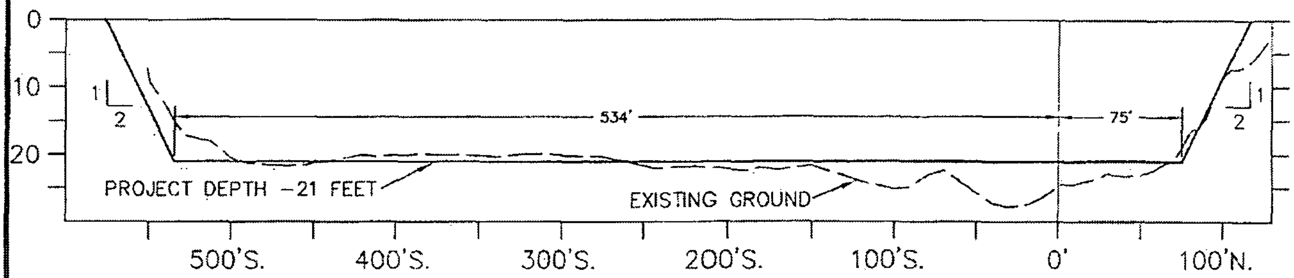
NOTE: SEE SHEET NO. 1 FOR SIGNATURE AND SEAL.

Since 1919

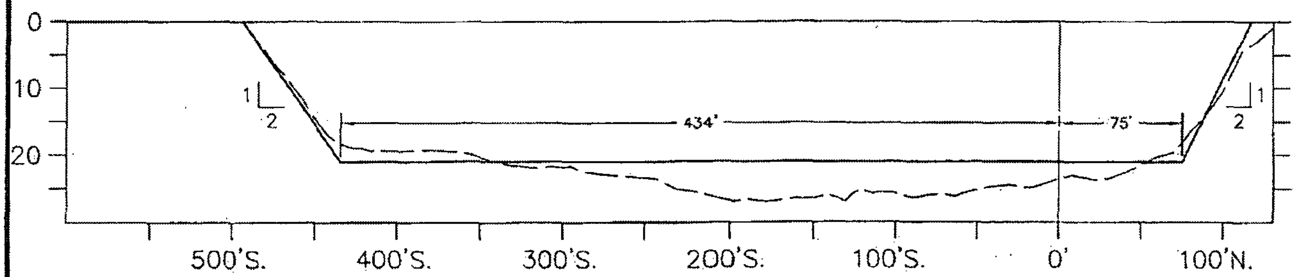
George F. Young, Inc.
299 DR. MARTIN LUTHER KING JR. STREET N. ST. PETERSBURG, FLORIDA 33701
PHONE (727) 822-4317 FAX (727) 822-2919
BUSINESS ENTITY LB21
ARCHITECTURE·ENGINEERING·ENVIRONMENTAL·LANDSCAPE·PLANNING·SURVEYING·UTILITIES
GAINESVILLE·LAKEWOOD RANCH·ORLANDO·PALM BEACH GARDENS·ST. PETERSBURG·TAMPA·VENICE

JOB NO. 0613035902
SHEET NO. 7 OF 9

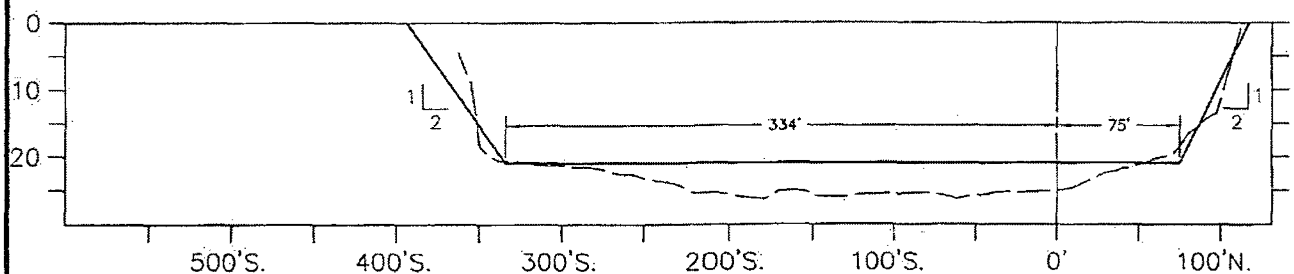
FILE: I:\PROJECT\SUR\0613035902\DWG\0613035902.DWG
LOGIN: ROBBINS
PLOTTED: 02/14/08 12:00:12



STA 15+00



STA 16+00



STA 17+00

NOTE: SEE SHEET NO. 2 FOR NOTES AND LEGEND.

PREPARED FOR:
Progress Energy
P.O. Box 1551
Raleigh, NC 27602-1551

Crystal River Turning Basin

Cross Sectional Views

SECTION 32,33, TOWNSHIP 17 S., RANGE 16 E.

REVISED	BY	DATE	DESCRIPTION

	INITIALS	DATE
CREW CHIEF	JT	4/19/06
DRAWN	WGR	2/08/08
CHECKED	GSN	2/11/08
FIELD BOOK	CR	
FIELD DATE	4/19/06	

NOTE: SEE SHEET NO. 1 FOR SIGNATURE AND SEAL.

Since 1919

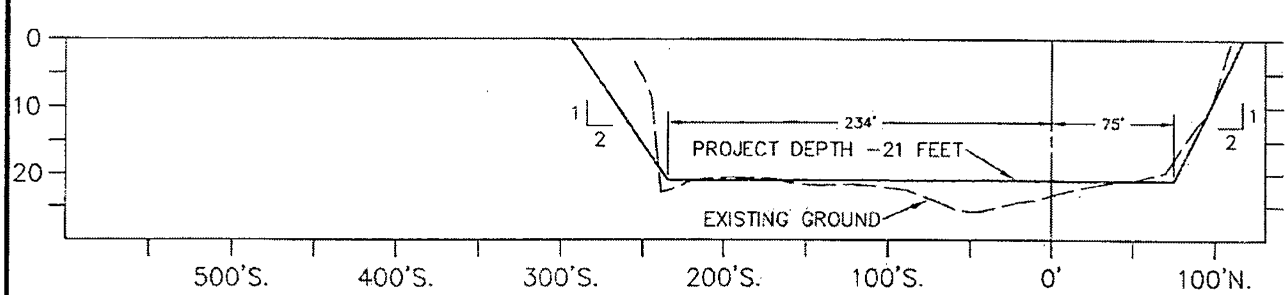
George F. Young, Inc.

299 DR. MARTIN LUTHER KING JR. STREET, N. ST. PETERSBURG, FLORIDA 33701
PHONE (727) 822-4317 FAX (727) 822-2919
BUSINESS ENTITY LB21
ARCHITECTURE·ENGINEERING·ENVIRONMENTAL·LANDSCAPE·PLANNING·SURVEYING·UTILITIES
GAINESVILLE·LAKEWOOD RANCH·ORLANDO·PALM BEACH GARDENS·ST. PETERSBURG·TAMPA·VENICE

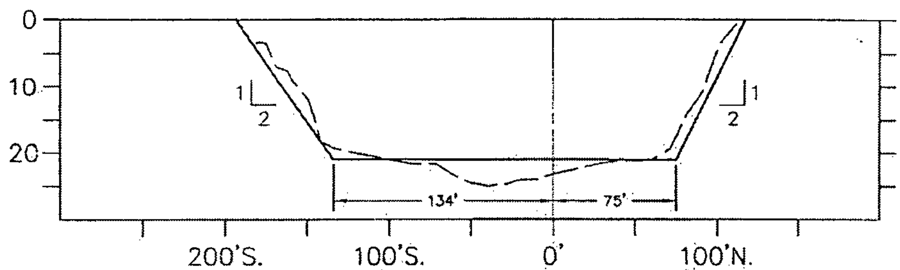
JOB NO. 0513035902

SHEET NO. 8 OF 9

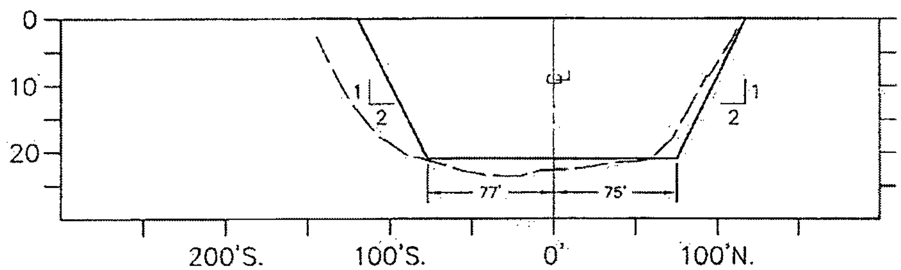
PLOTTED: 02/14/08 12:00:12 LOGIN: ROBBINS FILE: I:\PROJECT\SUR\0513035902\DWG\0513035902.DWG



STA 18+00



STA 19+00



STA 20+00

NOTE: SEE SHEET NO. 2 FOR NOTES AND LEGEND.

PREPARED FOR:
Progress Energy
P.O. Box 1551
Raleigh, NC 27602-1551

Crystal River Turning Basin
Cross Sectional Views

SECTION 3233,TOWNSHIP 17 S., RANGE 16 E.

REVISED	BY	DATE	DESCRIPTION

	INITIALS	DATE
CREW CHIEF	JT	4/19/06
DRAWN	WGR	2/08/08
CHECKED	GSN	2/11/08
FIELD BOOK	CR	
FIELD DATE	4/19/06	

NOTE: SEE SHEET NO. 1 FOR SIGNATURE AND SEAL.

Since 1919

George F. Young, Inc.
299 DR. MARTIN LUTHER KING JR. STREET, N. ST. PETERSBURG, FLORIDA 33701
PHONE (727) 822-4317 FAX (727) 822-2919
BUSINESS ENTITY LB21
ARCHITECTURE·ENGINEERING·ENVIRONMENTAL·LANDSCAPE·PLANNING·SURVEYING·UTILITIES
GAINESVILLE·LAKEWOOD RANCH·ORLANDO·PALM BEACH GARDENS·ST. PETERSBURG·TAMPA·VENICE

JOB NO. 0613035902

SHEET NO. 9 OF 9

FILE: I:\PROJECT\SUR\0613035902\DWG\0613035902.DWG

LOGIN: ROBBINS

PLOTTED: 02/14/08 12:00:12

Florida Department of Environmental Protection

Southwest District Office
13051 North Telecom Parkway
Temple Terrace, Florida 33637-0926

Charlie Crist
Governor

Jeff Kottkamp
Lt. Governor

Michael W. Sole
Secretary

MAY 29 2008

Florida Power Corp.
DBA Progress Energy Florida, Inc.
c/o Bernie M. Cumbie
15760 W. Powerline Road
Crystal River, FL 34428

File No.: 09-0238683-003, Citrus County

Dear Mr. Cumbie:

Thank you for your request to the Department for authorization to maintenance dredge 3,861 cubic yards of sediment from a man-made turning basin contagious with the Gulf of Mexico, a Class II Outstanding Florida Waterbody. The spoil material will be dewatered in an industrial wastewater pond and transferred to an onsite ash disposal area. The project site is located at 15760 West Powerline Road, Crystal River, Sections 31, 32 and 33, Township 17 South, Range 16 East, in Citrus County.

This type of activity requires a regulatory authorization for construction and operation of the project pursuant to Part IV, Chapter 373, Florida Statute (F.S.), unless otherwise exempt by statute or rule, proprietary authorization to use state-owned submerged lands Chapters 253 and 258, F.S., and federal authorization for works in waters of the United States through the State Programmatic General Permit (SPGP) program. Your request has been reviewed for all three authorizations. The authorizations you have been granted are listed below. Please read each section carefully. Your project may not have qualified for all three authorizations. If your project did not qualify for one or more of the authorizations, that specific section will advise you how to obtain it. You may NOT commence your project without all three authorizations. <u>If you change the project from what you submitted, the authorization(s) granted may no longer be valid at the time of commencement of the project.</u> <u>Please contact us prior to beginning your project if you wish to make any changes.</u>

<u>REGULATORY REVIEW - APPROVED</u>

Pursuant to Part IV, Chapter 373, F.S., and based upon the forms, drawings, and documents submitted on May 2, 2008, the proposed project appears to qualify as an activity which is exempt from the need for a Department Environmental Resource regulatory permit under Chapter 40D-4.051(8)(d), Florida Administrative Code (F.A.C.). A copy of the applicable language for this exemption is attached. This determination is based solely on the information provided to the Department and the statutes and rules in effect when the application was submitted and is effective only for the specific activity proposed. This determination shall automatically expire if site conditions materially change, or the governing statutes or rules are amended. In addition, any substantial modifications in your plans should be submitted to the Department for review, as changes may result in a permit being required. In any event, this determination shall expire after one year.

This determination that your activity qualifies for an exemption does not relieve you from the need to comply with all applicable water quality standards during the construction and operation of the facility. Activities conducted under this exemption must be constructed and operated using appropriate best management practices and in a manner which does not cause water quality violations, pursuant to Rule 62-302, F.A.C.

The determination that your project qualifies as an exempt activity pursuant to Rule 40D-4.051(8)(d), F.A.C., may be revoked if the installation is substantially modified, if the basis for the exemption is determined to be materially incorrect, or if the installation results in water quality violations. Any changes made in the construction plans or location of the project may necessitate a permit or certification from the Department. Therefore, you are advised to contact the Department before beginning the project and before beginning any work in waters or wetlands, which is not specifically described in your submittal.

Authority for review- Part IV of Chapter 373, F.S., Title 62, F.A.C. and in accordance to operating agreements executed between the Department and the water management districts, as referenced in Chapter 62-113, F.A.C.

PROPRIETARY REVIEW – APPROVED

This letter is your authorization to use state-owned submerged land (if applicable) for the construction of your project, as required by Chapter 253.77, F.S., and Chapters 18-20 and 18-21, F.A.C.

Please be advised that any use of sovereign submerged lands without specific prior authorization from the Board of Trustees will be considered a violation of Chapter 253, F.S., and may subject the affected upland riparian property owners to legal action as well as potential fines for the prior unauthorized use of sovereign land.

Authority for review - Chapter 253 and Chapter 258, F.S., and Chapter 18-21, F.A.C. and Chapter 18-20, F.A.C. if located in an aquatic preserve, and Section 62-343.075, F.A.C., as required.

SPGP REVIEW – NOT APPROVED

A copy of your application also has been sent to the U.S. Army Corps of Engineers (USACOE) for review. The USACOE may require a separate permit. Failure to obtain this authorization prior to construction could subject you to enforcement action by that agency. For further information, you should contact the USACOE Tampa Regulatory Field Office at (813) 769-7060 or the Gainesville Regulatory Field Office at (352) 332-6993.

Authority for review - an agreement with the USACOE entitled "Coordination Agreement Between the U. S. Army Corps of Engineers (Jacksonville District) and the Florida Department of Environmental Protection or Duly Authorized Designee, State Programmatic General Permit", Section 10 of the Rivers and Harbor Act of 1899, and Section 404 of the Clean Water Act.

Please see the copies of the exemption attached to this letter and note that all specific conditions in the rule must be met in order to qualify for this exemption. If you have any questions, please contact Michael Sears at (813) 632-7600 extension, 331. When referring to this project, please use the file number listed above.

Sincerely,

Michael Sears
Environmental Specialist I
Environmental Resource Management

Albert A. Gagne, Jr.
Environmental Manager
Environmental Resource Management

Enclosures:
Chapter 40D-4.051(8)(d), F.A.C.
Notice of Rights of Substantially Affected Persons
General Consent Conditions for Use of Sovereignty Submerged Lands
Standard Manatee Construction Conditions
Attachment "A" For Discretionary Publication

Chapter 40D-4.051(8)(d), F.A.C.

In accordance with the provisions of Section 403.813(2), F.S., no permit shall be required under Chapters 40D-4, 40D-40 or 40D-400, Florida Administrative Code for the following activities:

(d) The performance of maintenance dredging of existing manmade canals, channels, basins, berths, intake and discharge structures, and previously dredged portions of natural water bodies within drainage rights-of-way or drainage easements which have been recorded in the public records of the county, where the spoil material is to be removed and deposited on a self-contained, upland spoil site which will prevent the escape of the spoil material into waters of the state, provided that no more dredging is performed than is necessary to restore the canals, channels, basins, berths, and intake and discharge structures, and previously dredged portions of natural water bodies, to original design specifications, provided that the work is conducted in compliance with Section 370.12(2)(d), F.S., provided that no significant impacts occur to previously undisturbed natural areas, and provided that control devices for return flow and best management practices of erosion and sediment control are utilized to prevent bank erosion and scouring and to prevent turbidity, dredged material, and toxic or deleterious substances from discharging into adjacent waters during maintenance dredging. Further, for maintenance dredging of previously dredged portions of natural water bodies within recorded drainage rights-of-way or drainage easements, an entity that seeks an exemption must notify the department or water management district, as applicable, at least 30 days prior to dredging and provide documentation of original design specifications or configurations where such exist. This exemption shall apply to all canals and previously dredged portions of natural water bodies within recorded drainage rights-of-way or drainage easements constructed before April 3, 1970, and to those canals and previously dredged portions of natural water bodies constructed on or after April 3, 1970, pursuant to all necessary state permits. This exemption shall not apply to the removal of a natural or manmade barrier separating a canal or canal system from adjacent wetlands or other surface waters. Where no previous permit has been issued by the Board of Trustees of the Internal Improvement Trust Fund, the Department, the District or the United States Army Corps of Engineers for construction or maintenance dredging of the existing manmade canal, channel, basin, berth or intake or discharge structure, such maintenance dredging shall be limited to a depth of no more than 5 feet below mean low water.

RIGHTS OF AFFECTED PARTIES

This letter acknowledges that the proposed activity is exempt from Environmental Resource Permitting requirements under Chapter 403.813(2)(f), F.S., and Chapter 40D-4.051(8)(d), F.A.C. This determination is final and effective on the date filed with the Clerk of the Department unless a sufficient petition for an administrative hearing is timely filed under sections 120.569 and 120.57 of the Florida Statutes as provided below. If a sufficient petition for an administrative hearing is timely filed, this determination automatically becomes only proposed agency action subject to the result of the administrative review process. Therefore, on the filing of a timely and sufficient petition, this action will not be final and effective until further order of the Department. The procedures for petitioning for a hearing are set forth in the attached notice.

This determination is based on the information you provided the Department and the statutes and rules in effect when the application was submitted and is effective only for the specific activity proposed. This determination shall automatically expire if site conditions materially change or the governing statutes or rules are amended. In addition, any substantial modifications in your plans should be submitted to the Department for review, as changes may result in a permit being required. In any event, this determination shall expire after one year.

Be advised that your neighbors and other parties who may be substantially affected by the proposed activity allowed under this determination of exemption have a right to request an administrative hearing on the Department's decision that the proposed activity qualifies for this exemption. Because the administrative hearing process is designed to re-determine final agency action on the application, the filing of a petition for an administrative hearing may result in a final determination that the proposed activity is not authorized under the exemption established under Chapter 403.813(2)(f), F.S., and Chapter 40D-4.051(8)(d) F.A.C.

The Department will not publish notice of this determination. Publication of this notice by you is optional and is not required for you to proceed. However, in the event that an administrative hearing is held and the Department's determination is reversed, proceeding with the proposed activity before the time period for requesting an administrative hearing has expired would mean that the activity was conducted without the required permit.

If you wish to limit the time within which all substantially affected persons may request an administrative hearing, you may elect to publish, at your own expense, the enclosed notice (Attachment A) in the legal advertisement section of a newspaper of general circulation in the county where the activity is to take place. A single publication will suffice.

If you wish to limit the time within which any specific person(s) may request an administrative hearing, you may provide such person(s), by certified mail, a copy of this determination, including Attachment A. For the purposes of publication, a newspaper of general circulation means a newspaper meeting the requirements of sections 50.011 and 50.031 of the Florida Statutes. In the event you do publish this notice, within seven days of publication, you must provide to the following address proof of publication issued by the newspaper as provided in section 50.051 of the Florida Statutes. If you provide direct written notice to any person as noted above, you must provide to the following address a copy of the direct written notice.

SUBMERGED LANDS AND ENVIRONMENTAL RESOURCES PROGRAM
GENERAL CONSENT CONDITIONS FOR USE OF SOVEREIGNTY SUBMERGED LANDS

Chapter 18-21.004(7), F.A.C., provides that all authorizations granted by rule or in writing under Rule 18-21.005, F.A.C., except those for aquaculture activities and geophysical testing, shall be subject to the general conditions as set forth in paragraphs (a) through (i) below. The general conditions shall be part of all authorizations under this chapter, shall be binding upon the grantee, and shall be enforceable under Chapter 253 or Chapter 258, Part II, F.S.

Chapter 18-21.004(7), F.A.C., General Conditions for Authorizations:
(a) Authorizations are valid only for the specified activity or use. Any unauthorized deviation from the specified activity or use and the conditions for undertaking that activity or use shall constitute a violation. Violation of the authorization shall result in suspension or revocation of the grantee's use of the sovereignty submerged land unless cured to the satisfaction of the Board.

(b) Authorizations convey no title to sovereignty submerged land or water column, nor do they constitute recognition or acknowledgment of any other person's title to such land or water.

(c) Authorizations may be modified, suspended or revoked in accordance with their terms or the remedies provided in Sections 253.04 and 258.46, F.S., or Chapter 18-14, F.A.C.

(d) Structures or activities shall be constructed and used to avoid or minimize adverse impacts to sovereignty submerged lands and resources.

(e) Construction, use, or operation of the structure or activity shall not adversely affect any species which is endangered, threatened or of special concern, as listed in Rules 68A-27.003, 68A-27.004, and 68A-27.005, F.A.C.

(f) Structures or activities shall not unreasonably interfere with riparian rights. When a court of competent jurisdiction determines that riparian rights have been unlawfully affected, the structure or activity shall be modified in accordance with the court's decision.

(g) Structures or activities shall not create a navigational hazard.

(h) Structures shall be maintained in a functional condition and shall be repaired or removed if they become dilapidated to such an extent that they are no longer functional. This shall not be construed to prohibit the repair or replacement subject to the provisions of Rule 18-21.005, F.A.C., within one year, of a structure damaged in a discrete event such as a storm, flood, accident, or fire.

(i) Structures or activities shall be constructed, operated, and maintained solely for water dependent purposes, or for non-water dependent activities authorized under paragraph 18-21.004(1)(f), F.A.C., or any other applicable law.

[NOTE: These conditions were adopted in rule March 8, 2004, and replace the previous General Consent Conditions.]

(3/08/2004)

STANDARD MANATEE CONSTRUCTION CONDITIONS

1. The permittee shall instruct all personnel associated with the project of the potential presence of manatees and the need to avoid collisions with manatees. All construction personnel are responsible for observing water-related activities for the presence of manatee(s).

2. The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing manatees, which are protected under the Marine Mammal Protection Act of 1972, the Endangered Species Act of 1973, and the Florida Manatee Sanctuary Act of 1978. The permittee and/or contractor may be held responsible for any manatee harmed, harassed, or killed as a result of construction activities.

3. Siltation barriers shall be installed and shall be made of material in which manatees cannot become entangled, shall be properly secured, and shall be monitored regularly to avoid manatee entrapment. Barriers shall not block manatee entry to or exit from essential habitat.

4. All vessels associated with the project shall operate at "no wake/idle" speeds at all times while in water where the draft of the vessel provides less than four feet clearance from the bottom and that vessels shall follow routes of deep water whenever possible.

5. If a manatee is sighted within 100 yards of the project area, all appropriate precautions shall be implemented by the permittee/contractor to ensure protection of the manatee. These precautions shall include the operation of all moving equipment no closer than 50 feet to a manatee. Operation of any equipment closer than 50 feet to a manatee shall necessitate immediate shutdown of that equipment. Activities will not resume until the manatee(s) has departed the project area of its own volition.

6. Any collision with and/or injury to a manatee shall be reported immediately to the "Manatee Hotline" at 1-888-404-FWCC (1-800-404-3922). Collision and/or injury should also be reported to the U.S. Fish and Wildlife Service in Jacksonville (1-904-232-2580) for north Florida or Vero Beach (1-561-562-3909) in south Florida.

7. Temporary signs concerning manatees shall be posted prior to and during construction/dredging activities. All signs are to be removed by the lessee/grantee upon completion of the project. A sign measuring at least 3 feet by 4 feet which reads Caution: Manatee Area will be posted in a location prominently visible to water related construction crews. A second sign should be posted if vessels are associated with the construction, and should be placed visible to the vessel operator. The second sign should be at least 8 1/2 inches by 11 inches, which reads:

Caution: Manatee Habitat. Idle speed is required if operating a vessel in the construction area. All equipment must be shutdown if a manatee comes within 50 feet of the operation. A collision with and/or injury to a manatee shall be reported immediately to the Florida Marine Patrol at 1-888-404-FWCC (1-800-404-3922) and the U.S. Fish and Wildlife Service at (1-904-232-2580) for north Florida or (1-561-562-3909) for South Florida.

8. <u>No</u> permanent manatee awareness sign(s) shall be installed and maintained at the docking facility. The sign shall be three feet by four feet, 125 gauge 61TS aluminum, covered with white, engineer grade, reflective sheeting; black, painted lettering; black screened design; and orange, engineer grade, reflective tape border. The 3 feet wide by 4 feet long sign shall conform to the Florida Uniform Waterway Marking System in accordance with F.S. 327.40-1. The installation of the sign shall be made in accordance with DEP specification for such signs.

9. Verification (photos) that signs have been installed at designated locations shall be provided to the FWS and the Corps before the docking facility begins operations. Signs and pilings remain the responsibility of the owner(s) and are to be maintained for the life of the docking facility in a manner acceptable to the Corps of Engineers.

ATTACHMENT "A" FOR DISCRETIONARY PUBLICATION OF NOTICE OF DETERMINATION OF QUALIFICATION FOR AN EXEMPTION

In the Matter of an Application
for a Determination of Qualification
for an Exemption by:

DEP File No.: 09-0238683-003

Florida Power Corp.
DBA Progress Energy Florida, Inc.
c/o Bernie M. Cumbie
15760 W. Powerline Road
Crystal River, FL 34428

County: Citrus

The Department of Environmental Protection gives notice that it has received a request from Bernie M. Cumbie for authorization to maintenance dredge 3,861 cubic yards of sediment from a man-made turning basin contagious with the Gulf of Mexico, a Class II Outstanding Florida Waterbody. The spoil material will be dewatered in an industrial wastewater pond and transferred to an onsite ash disposal area. The project site is located at 15760 West Powerline Road, Crystal River, Sections 31, 32 and 33, Township 17 South, Range 16 East, in Citrus County. The Department has determined that the project qualifies for an exemption established under 40D-4.051(8)(d), F.A.C.

A person whose substantial interests are affected by the Department's action may petition for an administrative proceeding (hearing) under sections 120.569 and 120.57 of the F.S. The petition must contain the information set forth below and must be filed (received by the clerk) in the Office of General Counsel of the Department at 3900 Commonwealth Boulevard, Mail Station 35, Tallahassee, Florida 32399-3000.

Mediation is not available.

If a timely and sufficient petition for an administrative hearing is filed, other persons whose substantial interests will be affected by the outcome of the administrative process have the right to petition to intervene in the proceeding. Intervention will be permitted only at the discretion of the presiding officer upon the filing of a motion in compliance with rule 28-106.205 of the Florida Administrative Code.

In accordance with rule 62-110.106(3), F.A.C., petitions for an administrative hearing must be filed within 21 days of publication of the notice or receipt of written notice, whichever occurs first. Under rule 62-110.106(4) of the F.A.C., a person whose substantial interests are affected by the Department's action may also request an extension of time to file a petition for an administrative hearing. The Department may, for good cause shown, grant the request for an extension of time. Requests for extension of time must be filed with the Office of General Counsel of the Department at 3900 Commonwealth Boulevard, Mail Station 35, Tallahassee, Florida 32399-3000 prior to the applicable deadline. A timely request for extension of time shall toll the running of the time period for filing a petition until the request is acted upon. Upon motion by the requesting party showing that the failure to file a request for an extension of time before the deadline was the result of excusable neglect, the Department may also grant the requested extension of time.

The petitioner shall mail a copy of the petition to the applicant at the address indicated above at the time of filing. The failure of any person to file a petition for an administrative hearing within the appropriate time period shall constitute a waiver of that right.

A petition that disputes the material facts on which the Department's action is based must contain the following information:

(a) The name and address of each agency affected and each agency's file or identification number, if known;
(b) The name, address, and telephone number of the petitioner; the name, address, and telephone number of the petitioner's representative, if any, which shall be the address for service purposes during the course of the proceeding; and an explanation of how the petitioner's substantial interests are or will be affected by the agency determination;
(c) A statement of when and how the petitioner received notice of the agency decision;
(d) A statement of all disputed issues of material fact. If there are none, the petition must so indicate;

(e) A concise statement of the ultimate facts alleged, including the specific facts the petitioner contends warrant reversal or modification of the agency's proposed action;

(f) A statement of the specific rules or statutes that the petitioner contends require reversal or modification of the agency's proposed action; and

(g) A statement of the relief sought by the petitioner, stating precisely the action that the petitioner wishes the agency to take with respect to the agency's proposed action.

A petition that does not dispute the material facts on which the Department's action is based shall state that no such facts are in dispute and otherwise shall contain the same information as set forth above, as required by rule 28-106.301, F.A.C.

Under sections 120.569(2)(c) and (d) of the Florida Statutes, a petition for administrative hearing shall be dismissed by the agency if the petition does not substantially comply with the above requirements or is untimely filed.

Complete copies of all documents relating to this determination of exemption are available for public inspection during normal business hours, 8:00 a.m. to 5:00 p.m., Monday through Friday, at the Department's Southwest District Office, 13051 North Telecom Parkway, Temple Terrace, FL 33637-0926.

FINAL REPORT

CRYSTAL RIVER 316 STUDIES

January 15, 1985

CONTRACTOR
Stone & Webster Engineering Corporation

SUBCONTRACTOR
Mote Marine Laboratory

Prepared for
Florida Power Corporation

CRYSTAL RIVER 316 STUDIES

Prepared for

FLORIDA POWER CORPORATION

By

STONE & WEBSTER ENGINEERING CORPORATION

JANUARY 15, 1985

APPROVED BY: ____________ Program Manager ____________ Division Head

____________ Engineering Management

Stone & Webster Engineering Corporation
Boston, Massachusetts 02107

TABLE OF CONTENTS

Appendices

1.0 INTRODUCTION

In response to requirements of Part III-H, NPDES Permit No. FL0000159 dated July 9, 1979 for Crystal River Units 1, 2, and 3, Florida Power Corporation (FPC) has conducted an ecological monitoring program for the area adjacent to the Crystal River Power Station site. The sampling program was designed to address the effects of plant operation including: 1) thermal impacts on water quality, benthos, macrophytes, salt marsh and fisheries and 2) intake effects in the form of plankton entrainment and adult impingement. Thermal considerations are based primarily on comparison of control and thermally affected areas. Hydrodynamic and hydrothermal modeling were conducted to simulate offshore temperature increases under known plant operating conditions. Impingement and entrainment effects are quantified and compared to relevant population statistics. The elements of the program were grouped into four categories: Benthos, Impingement and Entrainment, Fisheries, and Physical Studies. These headings will be used in subsequent sections to provide specific information on field and laboratory procedures, results and impact assessments.

2.0 CRYSTAL RIVER UNITS 1, 2, AND 3

The Crystal River Power Station is located in Citrus County, Florida, about 13.7 km north of the town of Crystal River (see Figure 2.0-1). The site contains five units arranged as shown in Figure 2.0-2. Units 1 and 2 are coal-fired and Unit 3 is nuclear. These units utilize once through condenser cooling with water drawn from the Gulf of Mexico. Units 4 and 5 are coal-fired and have closed cycle cooling using natural draft cooling towers. Unit 4 went into operation shortly before initiation of field collections for the present program. Unit 5 became operational in October 1984, after data collection ended. Makeup for Units 4 and 5 is drawn from and blowdown is discharged to the discharge canal serving Units 1, 2, and 3. Thus, the physical and chemical environment of the discharge canal is related to operation of all operating units. However, neither the conditions of the discharge permit nor the plan of study (POS) included any separate consideration of Units 4 and 5. Therefore, the environmental descriptions and impact assessments are addressed solely in terms of Units 1, 2, and 3.

Construction at the site began in 1964 and has continued to date. Major offshore construction was completed in 1966, although dredging of the intake canal to increase the depth took place in 1979-1980. Spoil from initial offshore construction was used to create dikes adjacent to the intake and discharge channels.

Startup of Units 1, 2, and 3 spanned 12 years as shown in Table 2.0-1. Rated generating capacity, cooling water flow and condenser temperature rise are also given in the table. Actual operating conditions, however, exhibit considerable variation. Table 2.0-2 includes weekly average values of megawatts generated and temperature rise for each unit. Cooling water flows vary similarly. This variation occurs despite the units being operated to maximize operational efficiency within permitted limits. Planned or unplanned time offline is kept to a minimum. During the periods of field collection, Units 1, 2, and 3 were only offline for 72,66, and 87 days, respectively. The units were offline for periods of a week and more at the times shown in Table 2.0-2.

2.1 INTAKES

Water for all three units is drawn through a common canal located south of the units and extending generally westward into the Gulf of Mexico as shown on Figure 2.1-1. The canal has been dredged to -20 feet at MLW and is used to bring coal barges into the site. The barges dock on the south side of the canal just west of the intakes for Units 1 and 2. The dredged channel is confined between two dikes for about 5.5 km, at which point the southern dike terminates. The northern dike parallels the channel for another 8.5 km with the first opening at Fisherman's Pass occurring 2.3 km past the southern dike. Other openings occur at irregular intervals. Water flows eastward in the canal. Current velocities at the mouth of the canal were measured in August 1983 and January 1984 and ranged from 0.2 to 0.8 meters/second. Much of this range is accounted for by tidal rather than seasonal variation, however. Current velocities measured over a tidal cycle in August 1983 ranged from 0.2 to 0.6 meters/second.

2.2 DISCHARGES

The common discharge canal for all units is located just north of Units 1, 2, and 3. The canal extends WNW for almost 2.6 km to the point-of-discharge (POD) at the shoreline, where the canal opens into a bay. The dredged channel, bordered to the south by a spoil bank, continues for another 1.9 km. Water depth in the canal is about 3 meters.

The discharges of the three units enter the canal near the eastern end. They are located as shown in Figure 2.1-2. The designs of the three discharges are all similar. Four circulating water lines enter an open, concrete discharge chamber. The pipes turn downward, discharging the flow in a basin. The discharge exits the chamber over a short weir and mixes immediately with water in the canal.

TABLE 2.0-2

CRYSTAL RIVER PLANT DATA
JUNE 1983 TO AUGUST 1984
MEAN VALUES FOR 7 DAY PERIODS STARTING ON SUNDAY

Date	Unit 1			Unit 2			Unit 3			POD
	MWe	Flow (10^3 gpm)	ΔT (°F)	MWe	Flow (10^3 gpm)	ΔT (°F)	MWe	Flow (10^3 gpm)	ΔT (°F)	Temp. (°F)
01JUN83*	346.61	301.12	13.73	458.14	322.02	14.11		170.00		94.04
05JUN83	352.75	306.31	11.93	433.52	300.10	12.98		170.00	1.07	93.28
12JUN83	362.32	308.62	11.80	423.52	322.14	12.01		181.13	1.20	91.43
19JUN83	358.91	310.00	13.17	480.03	328.00	13.34		170.00	1.07	94.20
26JUN83	330.07	297.93	12.85	466.81	326.53	13.71		208.68	0.68	95.29
03JUL83	369.13	310.00	13.60	422.74	317.26	12.26		366.31	0.77	95.45
10JUL83	357.40	310.00	14.18	473.73	325.56	13.48		342.02	0.45	94.88
17JUL83	359.63	310.00	14.08	453.46	328.00	13.11		443.21	0.48	95.29
24JUL83	334.98	290.16	14.39	459.07	325.07	14.40	274.51	629.40	4.66	95.00
31JUL83	352.08	310.00	14.42	425.44	328.00	13.30	539.75	620.30	12.83	97.35
07AUG83	309.40		14.53	429.54		14.14	616.50	678.99	13.25	99.18
14AUG83	357.42		14.50	344.47		16.72	637.76	680.00	13.47	99.89
21AUG83	356.48		15.03	374.76		13.56	549.74	579.22	12.35	100.09
28AUG83	326.03	305.69	14.61	455.18	328.00	13.44	616.81	622.32	14.57	99.54
04SEP83	345.41	309.08	14.66	447.45	328.00	13.95	631.21	642.56	13.37	98.46
11SEP83	341.52	292.47	15.16	413.99	321.17	14.43	536.24	614.23	13.54	96.31
18SEP83	348.06	310.00	15.27		129.83		646.10	680.00	13.26	92.73
25SEP83	324.87	293.85	15.67		135.69		626.59	571.73	13.65	85.78
02OCT83	349.06	306.77	14.52	454.66	291.88	12.20		474.83	1.47	85.51
09OCT83	280.81	308.15	14.16	466.38	313.85	13.14	811.46	631.91	3.80	87.15
16OCT83		298.93		459.47	328.00	13.04	753.02	656.73	7.96	86.81
23OCT83		307.31		452.59	328.00	12.93	863.18	680.00	16.62	87.86
30OCT83		310.00		426.33	325.56	11.91	885.32	680.00	17.30	85.08
06NOV83	356.15	309.54	16.81	452.46	327.02	13.03	826.19	643.57	16.18	83.83
13NOV83	317.21	289.24	16.41	445.87	328.00	13.10	823.29	657.74	16.80	80.26
20NOV83	283.89	268.48	15.85	395.05	328.00	12.69	817.95	637.50	16.35	78.13
27NOV83	311.83	305.39	15.26	335.36	327.02	10.09	899.85	680.00	17.28	78.65
04DEC83	276.94	306.77	14.38	337.84	328.00	9.35	894.74	680.00	17.39	79.09
11DEC83	282.75	289.24	14.91	347.27	291.27	10.62	808.00	626.37	17.06	75.01
18DEC83	309.97	304.46	17.02	312.72	328.00	10.14	891.36	673.93	17.46	74.85
25DEC83	325.40	291.55	19.53	426.74	308.96	14.70	786.96	630.12	16.32	65.67

*4 day average

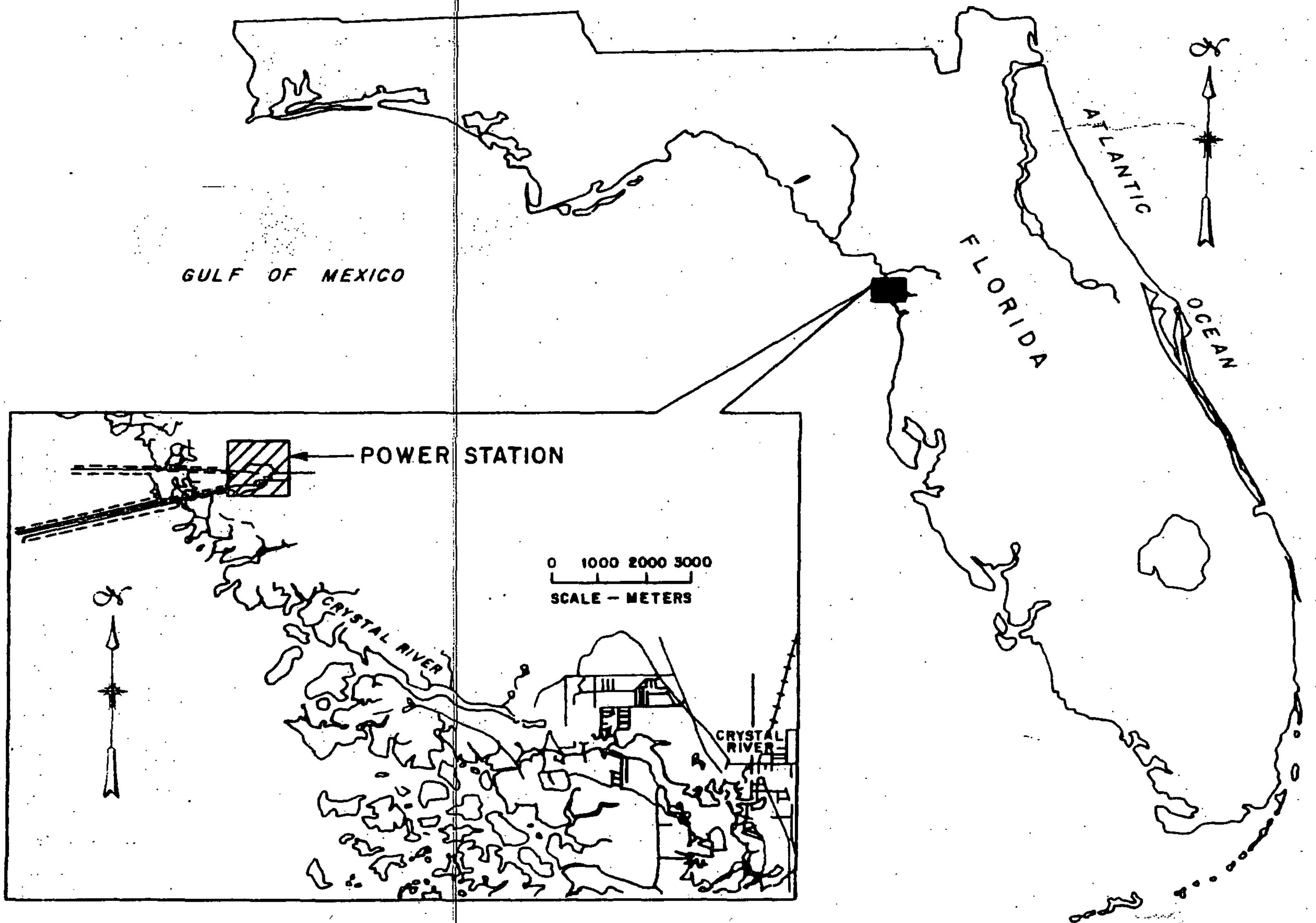


FIGURE 2.0-1

LOCATION OF THE
CRYSTAL RIVER POWER STATION
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

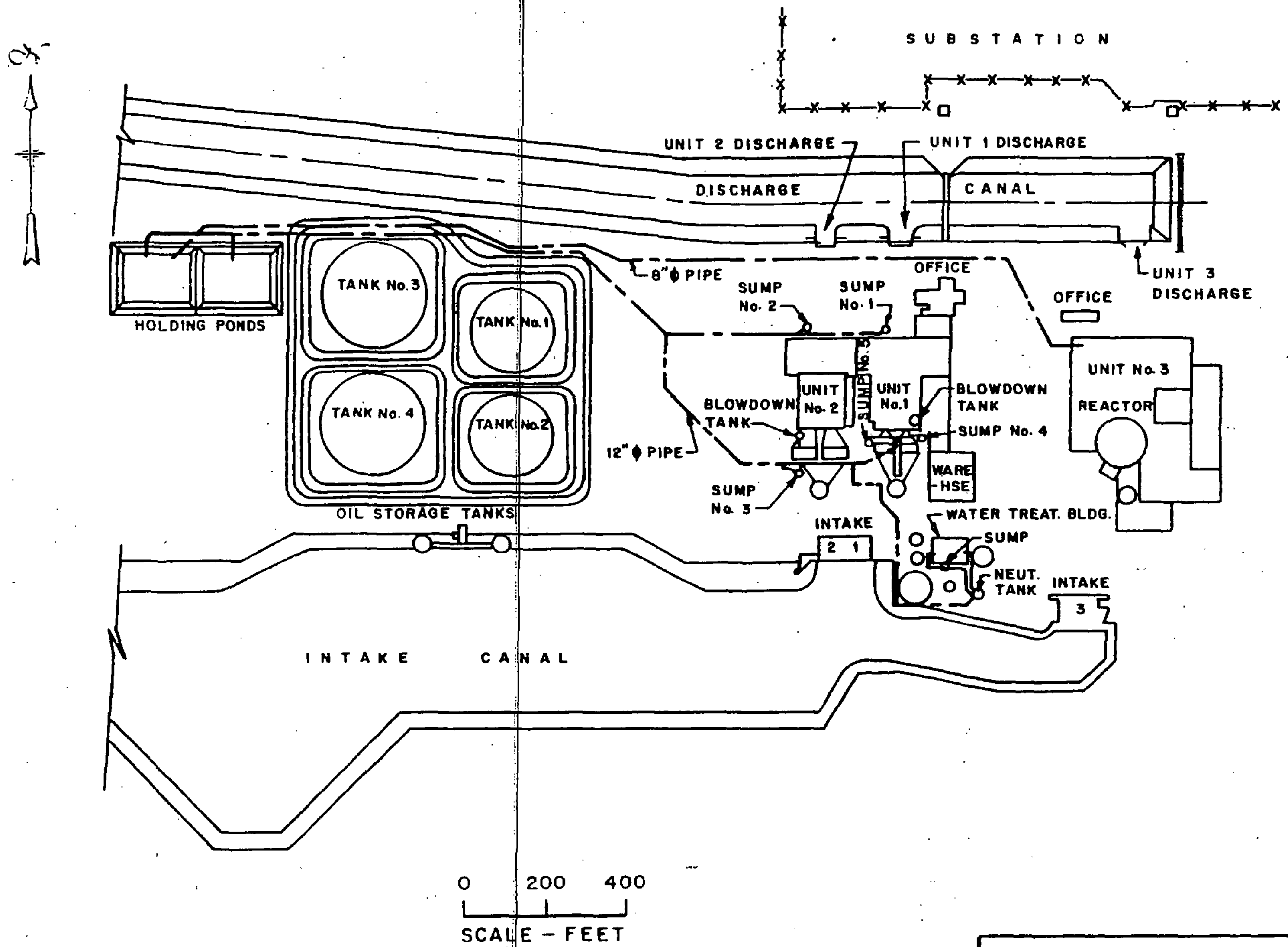


FIGURE 2.1-2

LOCATION OF INTAKES
AND DISCHARGES
FOR UNITS 1, 2 AND 3
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

3.0 DESCRIPTION OF CRYSTAL BAY

Navigation charts covering the area of the Gulf of Mexico adjacent to the Crystal River Power Station designate the waters off the mouth of the Crystal River as Crystal Bay (see Figure 3.0-1). This term will be used here to refer to that same area as well as the inshore waters north of the intake spoil as far as the mouth of the Withlacoochee River. The study area encompasses all of Crystal Bay and extends offshore about 16 km from the power plant as shown in Figure 2.1-1.

Crystal River enters Crystal Bay from the southeast. A navigation channel is maintained in the river and for several kilometers offshore. The Withlacoochee River enters the Bay from the northeast. It is somewhat smaller than the Crystal River, but it is navigable, and an offshore channel is maintained. About 1.6 km south of the Withlacoochee River lies the western terminus of the Cross Florida Barge Canal (CFBC). While the canal was never completed, the canal was dug far enough to the east to alter the local watershed and to permit drainage through the canal and into the Gulf. Flows in the canal are regulated by locks.

Offshore of the CFBC, a deep channel was dredged extending WSW from the canal. Dredge spoil was deposited south of the channel creating a series of islands paralleling the channel. Several natural islands also occur in Crystal Bay; these are generally close to shore. Larger islands such as Thumb, Drum, and Lutrell are located north of the discharge and Negro Island, and a few small islands, are found near Cutoff and Salt Creeks, south of the intake. Shell Island is located at the mouth of the Crystal River.

Crystal Bay tends to be very shallow; depths rarely reach 3 m as far out as Fisherman's Pass, and depths of 6 m infrequently occurred at the furthest offshore stations. The shallow inshore environment is dominated by oyster reefs or bars which are generally oriented parallel to shore at intervals from the shoreline. The reefs are composed of oyster shell with the bulk of the reef being composed of broken shell. Clumps of shells are apparent on the surface. The reefs are exposed at low tide, but almost all are covered at high tide. Sections of reef tend to be short with narrow passages between sections. When viewed from above, the pattern of reefs appears to define a series of basins with slightly deeper water in the center and the bottom gently sloping up to the surrounding reefs. Previous reports on Crystal Bay have defined and numbered the basins as shown in Figure 2.1-1.

The coastal area of Crystal Bay is characterized by salt marsh dominated by *Juncus roemerianus* with bands of *Spartina alterniflora*. The marshes are fairly flat and extend inland for about 1.6 km in places. A number of small creeks drain the marshes. The creek system adjacent to Basin 1 is particularly extensive.

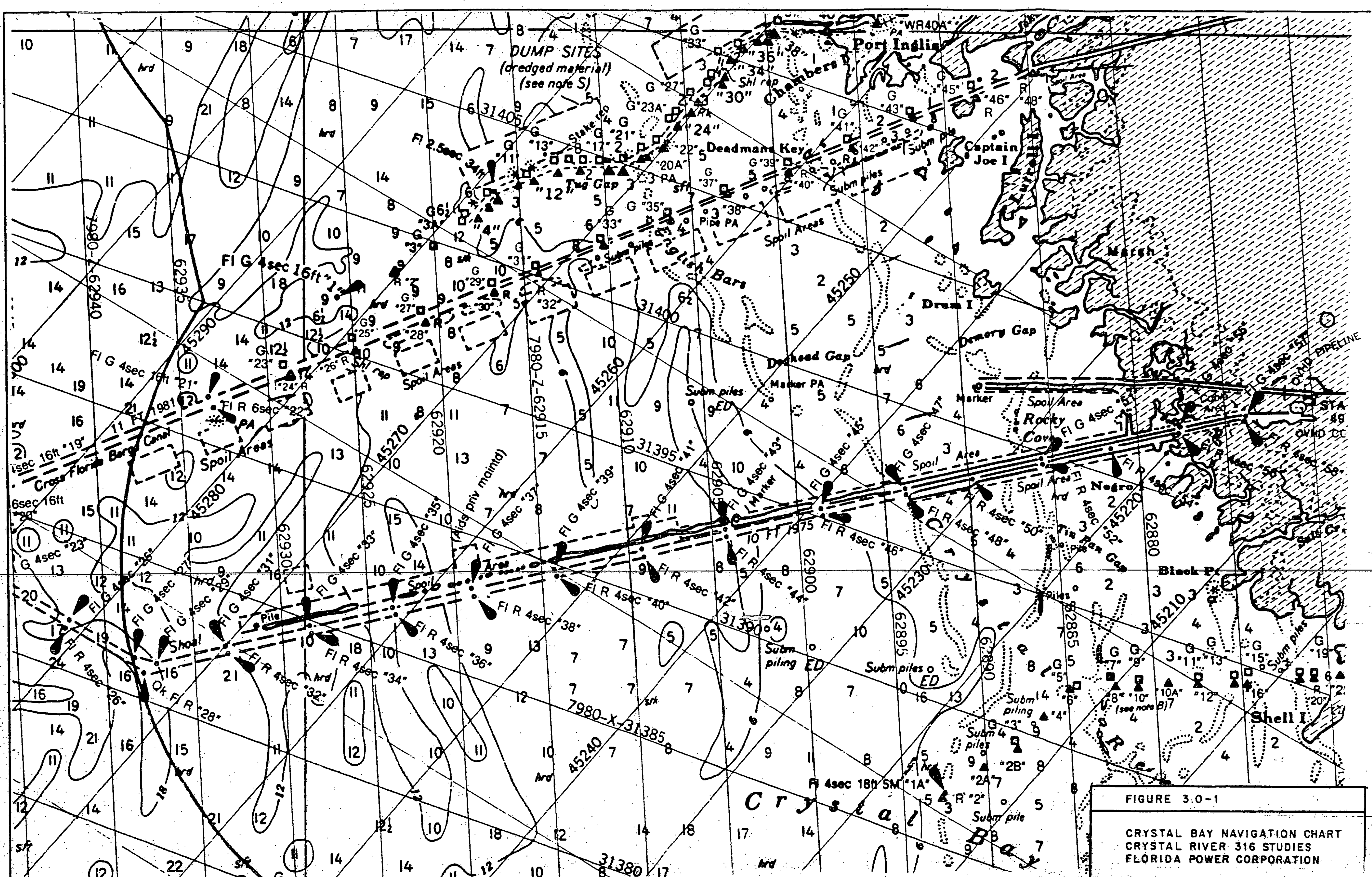


FIGURE 3.0-1

CRYSTAL BAY NAVIGATION CHART
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

4.0 PREVIOUS STUDIES

The present program is one in a series of studies conducted at the Crystal River site. Most of the studies were intended to address the effects of power plant construction and operation on the local ecosystem. Three exceptions were Dawson's (1955) early study of oyster biology and hydrology, Phillips' (1960) study of marine plants, and the more recent study conducted by CH2M Hill (1983) to provide data for the Withlacoochee Regional Planning Council.

Comprehensive studies relating to the power plants essentially began in 1969 at which time Unit 1 was in operation, Unit 2 was starting up, and a construction permit had been issued for Unit 3. The studies were performed by the Florida Department of Natural Resources (DNR) and a series of publications resulted (Grimes 1971; Lyons et al 1971; Quick 1971; Steidinger and Van Breedveld 1971; Grimes and Mountain 1971; and Mountain 1972). The last data collection took place in 1971. In approximately the same time frame, the University of South Florida initiated studies of thermal effects (Carder 1970; Klausewitz 1972). Plume mapping and modeling were emphasized.

Licensing activities related to Unit 3 resulted in initiation of further studies in 1972. Personnel from the University of Florida performed a variety of studies; other participants were the University of South Florida, Gilbert and Associates, and Dames and Moore. In 1973, the studies came under the auspices of a specially formed Interagency Research Advisory Committee. Study results were presented in a multiple volume report (FPC 1974a) and several supplemental publications (FPC 1974b; FPC 1975; Osterling 1976). Predictive hydrothermal modeling continued through 1975 and into 1976. Results of the modeling addressed the effects of future operation of Unit 3 (Carder et al 1976).

Unit 3 began commercial operation in March 1977, and an operational monitoring program required by the environmental technical specifications began at that time. Initial participants in the program were the University of Florida, NUS and Connell, Metcalf and Eddy. Applied Biology held a contract in the later stages. Although the scope of the program varied over time, elements of the studies continued through 1981. Results were reported in a series of annual reports (FPC 1978a; 1978b; 1979a; 1979b; 1980; 1981; 1982a) and summarized in two publications (FPC 1982b; Applied Biology, 1983).

The publications cited above report studies of essentially all components of the Crystal Bay ecosystem; however, the results from almost all of these studies cannot be directly compared to results from the present study. Comparisons are limited because: 1) plant construction and operating conditions did not approximate present conditions until 1981, 2) collection techniques for particular biotic groups varied, and 3) laboratory and analytical techniques varied. The data from these previous studies were used in designing the present study.

REFERENCES FOR 4.0

Applied Biology, Inc. 1983. Post operational ecological monitoring program. Crystal River Units 1, 2, and 3, 1977-1982, Summary Report, Benthic Community Structure Studies, 45 p.

Carder, K. L. 1970. Data report no. 001 on independent environmental study of thermal effects of power plant discharge. Report to FPC. Inst. Mar. Sci., University of South Florida, 23 p.

Carder, K. L., S. L. Palmer, B. A. Rodgers, and P. J. Behrens. 1976. Calibration of a thermal enrichment model for shallow, barricaded estuaries. University of South Florida, Final Report to OWRT.

CH2M Hill. 1983. Withlacoochee Marine Biology Study, 1982. Report to Withlacoochee Regional Planning Council, 32 p.

Dawson, C. E. 1955. A study of the oyster biology and hydrography at Crystal River, Florida. Publ. Inst. Mar. Sci., University of Texas 4 (1): 279-302.

Florida Power Corporation. 1974a (reprinted 1977). Crystal River power plant, environmental considerations. Final Report to the Interagency Research Advisory Committee, 4 Volumes.

FPC. 1974b. Addendum I, Third Crystal River progress report. Federal Interagency Research Advisory Committee.

FPC. 1975. Summary analysis and supplemental data. report to Interagency Research Advisory Committee.

FPC 1978a. Annual environmental operating report, Vol. 1 nonradiological, 1/14/77-12/31/77, Suppl. 1.

FPC. 1978b. Environmental technical specifications, Crystal River Unit 3, Impingement Report. March 13, 1977 to March 13, 1978.

FPC. 1979a. Post operational ecological monitoring program. Crystal River Units 1, 2, and 3. Annual Report, 1978. Two volumes.

FPC. 1979b. Special surveillance studies, Suppl. 1, Crystal River, Unit 3. Docket No. 50-302.

FPC. 1980. Post operational ecological monitoring program. Crystal River Units 1, 2, and 3. Annual Report, 1979. Two volumes.

FPC. 1981. Post Operational ecological monitoring program. Crystal River Units 1, 2, and 3. Annual Report, 1980. Two volumes.

FPC. 1982a. Post operational ecological monitoring program, Crystal River Units 1, 2, and 3. Annual Report, 1981. One volume.

FPC. 1982b. Post operational ecological monitoring program, Crystal River, Units 1, 2, and 3. Final Report on Estuarine and Salt Marsh Metabolism Studies, 1977-1981. One volume.

Grimes, C. B. 1971. Thermal Addition Studies of the Crystal River steam electric station. Prof. Pap Ser. No. 11, Florida Dept. Nat. Res.

Grimes, C. B. and J. A. Mountain. 1971. Effects of thermal effluent upon marine fishes near the Crystal River steam electric station. Prof. Pap. Ser. No. 17, Florida Dept. Nat. Res.

Klausewitz, R. H. 1972. Independent environmental study of thermal effects of power plant discharge at Crystal River. FPC Fourth Semi-Annual Rev. Environm. Res. Prog., May 5, 1972.

Lyons, W. G., S. P. Cobb, D. K. Camp, J. A. Mountain, T. Savage, L. Lyons, and E. A. Joyce, Jr. 1971. Preliminary inventory of marine invertebrates collected near the electrical generating plant, Crystal River, Florida, in 1969. Prof. Pap. Ser. No. 14, Florida Dept. Nat. Res.

Mountain, J. A.. 1972. Further Thermal Addition Studies at Crystal River, Florida, with an annotated checklist of marine fishes collected 1969-1971. Prof. Pap. Ser. No. 20, Florida Dept. Nat. Res.

Oesterling, M. J. 1976. Population structure, dynamics, and movement of the blue crab (Callinectes sapidus Rathbun) at Crystal River, Florida. Thesis, Univ. of Florida.

Phillips, R. C. 1960. The ecology of marine plants of Crystal Bay, Florida. Quart. Jour. Florida Acad. Sci. 23(4): 328-337.

Quick, J. A., Jr., ed. 1971. A preliminary investigation: the effect of elevated temperature on the American oyster, Crassostrea virginica (Gmelin). Prof. Pap. Ser. No. 15, Florida Dept. Nat. Res.

Steidinger, K. A. and J. F. Van Breedveld. 1971. Benthic marine algae from waters adjacent to the Crystal River electric power Plant (1969 and 1970). Prof. Pap. Ser. No. 16, Florida Dept. Nat. Res.

5.0 DEVELOPMENT OF THE PLAN OF STUDY

Field sampling conducted at Crystal River is described for each program element in subsequent sections of this report. The program originally was designed for FPC by a series of contractors and was described in the document entitled "Plan of Study, Crystal River 1, 2, and 3 NPDES 316(a) and 316(b) Ecological Monitoring Program." The Plan of Study (POS) was prepared in August 1979 and revised in November 1982. It was submitted to the U.S. Environmental Protection Agency (EPA) for approval on November 15, 1982.

Subsequent to approval of the POS, Mote Marine Laboratory (MML) reviewed the program and proposed changes to the Benthos, Impingement and Entrainment, and Fisheries sections. The changes were presented in "Proposed Revisions to Plan of Study, Crystal River 1, 2, and 3 NPDES 316." More limited changes were also proposed for water quality aspects of the Physical Studies section. FPC accepted the proposed revisions, obtained preliminary approval from regulatory personnel and submitted a request for proposal for the revised POS. Stone & Webster Engineering Corporation's (SWEC) proposal was to implement the program as written with the exception of the hydrodynamic/hydrothermal modeling which would accomplish the objectives using different models. Field collections remained unchanged. The proposed revisions and the pertinent proposal material were submitted to the EPA on February 22, 1983. In March 1983, SWEC was awarded the contract to implement the program. The field work and preparation of the Benthos section of the report were conducted by MML under contract to SWEC. MML utilized personnel from Mangrove Systems, Inc. to work on the macrophyte component. Personnel responsible for specific program elements are listed in Appendix I.

As the field program began in June 1983, some modifications to the sampling program were needed to accommodate local conditions or to enhance analysis of the resulting data. These changes were summarized in the First Quarterly Progress Report (SWEC 1983) and presented orally at the First Quarterly Progress Meeting held on October 27, 1983. All changes were discussed before implementation and written notice was provided to EPA and to the Florida Department of Environmental Regulation (DER). Formal approval of all changes in the program was received by FPC on April 17, 1984.

Throughout the program, quarterly reports have been issued containing summary data tables for the field components and other related information (SWEC 1983, 1984a, b, c, d). These reports were submitted to U.S. Fish and Wildlife Services (FWS) National Marine Fisheries Service (NMFS), EPA, DER, and the Nuclear Regulatory Commission (NRC). In addition to data tables, a tape of computerized data will be made available to EPA at the program's completion. Quarterly progress meetings have been held with state and federal regulatory agency personnel invited to participate. Regular participants have included the EPA and the DER. As a result of the meetings, phone conversations, correspondence or other discussions, any program changes initiated after the start of field sampling have been subject to prior approval by the agencies.

FPC summarized the above information in "Crystal River 316 Study, Plan of Study - Summary," to provide a single document outlining the program in its final form. Table 3.0-1 summarizes the field program and provides for each component the pertinent number of stations, replicates, samples, sampling frequency, and period of study. Field collections were completed in August

1984. The dates of these collections were summarized in the Fifth Quarterly Progress Report (SWEC, 1984d).

After collection and laboratory analysis of samples and summarization in the quarterly reports, the data were analyzed in a variety of ways for presentation in this report. Nearly all of the statistical summaries and analyses of data were done with Version 82.3 of the Statistical Analysis System (SAS) (SAS 1982). This system offers a high level language of commands (called PROCs) which follow many of the standardized statistical procedures found in most statistical methods texts such as Snedecor and Cochran (1967). The most frequently used SAS PROC for this study is the Generalized Linear Model (GLM) procedure. A linear model in this case could be represented as:

$$Y = b_1X_1 + b_2X_2 = b_3X_3$$

where Y represents the dependent variable (such as surface temperature), X represents a discrete (such as station) or continuous (water depth) independent variable or treatment, and b represents the i^{th} treatment mean or deviation of the i^{th} treatment mean (for the discrete case) or the slope of the least squares relation of Y on X (for the continuous case).

This SAS procedure provides an analysis of variance type summary of the relative importance of the independent variables in the model. The procedure also provides estimates of the values of the b's in the model. For nearly all the GLM analyses a Tukey's Honestly Significant Difference (HSD) test was provided. The anova type format confirms if at least one individual level, e.g., station, of an independent variable is statistically significantly different from at least one other level (station) of the same variable. The HSD test identifies which of the levels is different.

REFERENCES FOR 5.0

SAS Institute Inc. 1982. SAS User's Guide: Statistics, 1982 Edition. Cary, N.C., SAS Institute Inc., 584 pp.

Snedecor, G. W., and W. G. Cochran. 1967. Statistical Methods, Sixth Edition. Iowa State University Press, Ames, Iowa. 593 pp.

SWEC. 1983. First Quarterly Progress Report. Crystal River Studies. Report to FPC, October 1983.

SWEC. 1984a. Second Quarterly Progress Report. Crystal River Studies. Report to FPC, January 1984.

SWEC. 1984b. Third Quarterly Progress Report. Crystal River Studies. Report to FPC, April 1984.

SWEC. 1984c. Fourth Quarterly Progress Report. Crystal River Studies. Report to FPC, July 1984.

SWEC. 1984d. Fifth Quarterly Progress Report. Crystal River Studies. Report to FPC, November 1984.

TABLE 5.0-1

SUMMARY OF ECOLOGICAL PROGRAM
CRYSTAL RIVER STUDIES

Study Component	No. of Stations	No. of Rep.	Frequency	Total No. Samples	Study Period
I. Benthos					
A. Benthic core	20	6(+2)	Quarterly	600	15 mos
	20	6(+2)	6 wks	1200	15 mos
B. Macrophyte mapping	50	10	Quarterly + 1 Preliminary	3000	15 mos
	9(intens.)	10	6 wks	900	15 mos
	9(intens.)	5	6 wks	450	15 mos
	9(intens.)	3	6 wks	270	15 mos
C. Aerial photographs	1	1	3 times	3	15 mos
D. Oyster reef	9	90	Monthly & Bimonthly	14580	12 mos
E. Salt marsh program	8	24	6 wks	1920	15 mos
F. Physical					
a. Chlorophyll 'a'	8	2 depths	Weekly	1040	15 mos
b. Sediment	40	3	Quarterly	1200	15 mos
c. Photometry	40	1 profile	Weekly	2600	15 mos
d. Turbidity, D.O., pH, Salinity, Temperature	40	multiple depth	Weekly	5200	15 mos
e. Sediment Temperature, Eh	40	1 depth	Quarterly	200	15 mos
	20	1 depth	6 wks	200	15 mos

TABLE 5.0-1 (Cont)

Study Component	No. of Stations	No. of Rep.	Frequency	Total No. Samples	Study Period
II. Impingement and Entrainment					
A. Impingement	3	4	Weekly + 3 times	660	12 mos
B. Entrainment	15	3	Biweekly day/night	2880	15 mos
III. Fisheries					
A. Trawl	9	7	Monthly (night)	756	12 mos
B. Seines	4	2	Monthly	96	12 mos
C. Drop net	2	2	Monthly	48	12 mos
D. Creek trawls	4	7	Monthly (day)	336	12 mos
E. Crab traps	120	1	17 times	2040	4 mos
F. Crab impingement	1	1	17 times	17	4 mos
IV. Physical Studies					
A. Suspended loads	40	4 analyses	Biweekly	5120	15 mos
B. Bathymetry				1 survey	
C. Short-term	16	1		Variable	2 mos
D. Long-Term	51	1 or 2	Continuous	Variable	12 mos
E. Meteorology	1	1	Continuous	Variable	15 mos
F. Temperature profiles	Variable	2	Variable	Variable	2 mos

6.0 BENTHOS

The benthos component of the present study includes the following elements: water quality, sediments, benthic infauna, macrophytes, salt marsh, and oyster reefs. Each of these elements was sampled by unique methods and these methods, as well as results from each type of sampling, will be described separately in subsequent sections. For the biotic elements, impact assessment associated primarily with the station discharge will be addressed.

6.1 WATER QUALITY

6.1.1 Sampling and Laboratory Analysis

Water quality investigations during this study included both in situ and laboratory determinations performed weekly at 40 stations over a period of approximately 15 months, from June 9, 1983 to August 27, 1984. Station locations are shown in Figure 6.1-1. Sampling dates were selected to provide information for both high and low tide conditions.

Actual sampling times on each day were designed around two temporal windows. During a 90 minute interval centered on the predicted time of high or low tide, in situ temperature and conductivity data alone were collected at 27 selected stations (4-30). The second window was a 4 hour interval centered on local noon, during which measurements of water column depth, temperature, conductivity, pH, dissolved oxygen, and light penetration were made at all 40 stations. Salinities and corrected dissolved oxygen values were later calculated from these data.

Water samples for laboratory analysis were also collected from all stations during the 4 hours centered on local noon, the photometry window. Determinations of turbidity at the surface and bottom of each station were made weekly. Samples for chlorophyll analysis were collected at a randomly chosen eight of the 40 stations. On alternate weeks, surface and bottom samples were collected for suspended load analysis (total and volatile nonfilterable residue).

Station locations were typically identified by the use of onboard Loran C (Sitex Koden C787). Water column depths were recorded with either calibrated fathometers or with marked leadlines.

In situ measurements of temperature and conductivity were made with Beckman RS5-3 inductive salinometers. Surface and bottom measurements were made in depths less than 1 meter. For water column depths of 1-3 meters or less, surface, mid-depth, and bottom readings were taken. In depths greater than 3 meters, data were recorded from surface, one-quarter depth, mid-depth, three-quarters, and bottom. Calculations of salinity from these data were performed later using equations developed by Cox et al (1967), UNESCO (1966) oceanographic tables, and the salinity-conductivity relationships of Jaeger (1973).

Dissolved oxygen measurements were performed with YSI 57 dissolved oxygen meters and polarographic membrane electrodes. Measurement depths were surface and bottom for depths of 1 meter or less, and surface, mid-depth, and bottom for depths greater than 1 meter. These instruments were operated without the salinity correction function to minimize possibility of sampler error. Dissolved oxygen readings so obtained were later corrected for salinity and percent saturations were calculated using the polynomial relationship developed by Weiss (1970, cited in Riley and Skirrow 1975).

Measurements of pH were performed with Martek Mark VII multiparameter meters and/or an Orion 201 pH meter. Measurement frequencies were at the same depths as previously described for dissolved oxygen.

Quality assurance measures for these in situ parameters included: full bench calibration of meters before and after sampling; field calibration of salinometers and D.O. meters; a repetition of all water column measurements at one station out of ten; verification of the temperature function of the Beckman salinometers against thermometer readings or the temperature function of the Martek Mark VII meters; and collection of water samples at a rate of 1 for every 10 measurements for laboratory analysis of pH, dissolved oxygen, and conductivity. These water samples were preserved appropriately and the analytical values obtained were compared to the recorded field values.

Photometry measurements, quantification of solar radiation and extinction, were made in situ using LiCor integrating quantum radiometers. These instruments are sensitive in the photosynthetic spectrum of 400-700 nm and measurements were made in air, just below the water's surface, at secchi depth, and/or at bottom. The secchi depth and percent cloud cover were also recorded. The deck and submersible sensors for these instruments were calibrated by the manufacturer on an annual basis and checks of the mechanical zero were performed at the beginning of each sampling episode.

Surface water samples were collected from just below the surface as grab samples. Samples at depth were secured using a Niskin or Kemmerer type sampler. Samples for pH and conductivity analysis were maintained at ambient temperature, those for dissolved oxygen determinations were fixed with manganous sulfate and alkaline azide iodide solutions for later Winkler titrations. All remaining samples for turbidity, chlorophyll, and suspended load analyses were iced on collection and maintained either on ice or at 4°C until analysis.

Laboratory analyses were performed within the EPA recommended, parameter specific, holding times. Analytical methods employed were as follows:

Conductivity: Method 205, platinum electrode (APHA 1980).

Dissolved Oxygen: Method 360.2, azide modification of Winkler analysis, full bottle technique (EPA 1979).

pH: Method 150.1, electrometric (EPA 1979).

Turbidity: Method 180.1, nephelometric (EPA 1979).

Chlorophyll 'a': Method 1002G, spectrophotometric determination of chlorophyll 'a', corrected for pheophytin 'a' (APHA 1980).

Total and Volatile Nonfilterable Residue: Method 209D and 209G, total nonfilterable residue dried at 103-105°C and volatile nonfilterable residue ashed at 550°C (APHA 1980).

Water quality data were analyzed using the SAS GLM procedures. The specific analysis varied with the parameter, however weekly values, either individually or averaged over depth, were most often evaluated by quarter and station. Other variables used included tide, depth, occurrence of storms, and barge traffic. Where appropriate, variation based on other water quality parameters was considered. For example, turbidity values were analyzed for variation with quarter, station, depth, storms, barge traffic, total suspended solids, conductivity and chlorophyll a.

6.1.2 Results

Samplings were divided into five groups of thirteen episodes each. Months were divided as follows: Summer - Quarter I, June, July, August; Fall - Quarter II, September, October, November, first week of December; Winter - Quarter III, December remaining, January, February; Summer - Quarter IV, March, April, May; Quarter V, June, July, August. Tabular means of parameter values are presented in Appendix II for each quarter and for the project as a whole. It should be noted that project means (Quarters I-V) cannot be used as annual averages, as they are biased by the inclusion of two summer quarters.

Tables of quarterly values were generated from the entire data base for all parameters except pH, dissolved oxygen, turbidity, and total suspended load. These means were computed during analyses of variance as a function of four or more independent variables. Occasionally, when an independent variable was missing, the dependent variable was not included in either the statistical analysis or the calculated mean.

The historical water quality data bases for the study site consist primarily of temperature and salinity observations collected either in conjunction with biological community analyses (Grimes 1971; Applied Biology 1982) or for numerical model calibration and verification efforts (Klausewitz 1973). Efforts have been made to separate the thermal effects attributable to the power plant from those produced by seasonal and daily insolation (Carder 1974). Modeling efforts have centered on prediction of the areal extent of the thermal plume under a number of seasonal, tidal, and plant operation conditions and to accurately simulate interbasin flows forced by the dredged spoil islands and naturally occurring oyster reefs (Klausewitz 1979).

Dissolved oxygen and chlorophyll levels were frequently recorded during previous studies of macrophytes and of phytoplankton communities and productivity/respiration ratios (FPC 1975; FPC 1980).

Subsequent to the construction of the intake and discharge dikes and the redirection of Double Barrel Creek, mapping of bottom types indicated a highly depositional environment in the discharge vicinity and was attributed to the rapid erosion of new stream beds (FPC 1975; Cottrell 1974). With the concern over the effect of light attenuation and non-catastrophic siltation on attached macrophytes and sessile infauna, turbidity, extinction coefficients (secchi depths), and sedimentation rates were quantified (Cottrell 1978; Knight and Coggins 1982; CH2M Hill 1983).

The present study was designed to provide a detailed record of local water quality conditions in the area. Sources of turbidity and suspended load were to be identified as possible sources of light attenuation. The effect of storms and plant related activities (barge traffic) on these parameters was also to be investigated. Chlorophyll concentrations were to be used as a first approximation of the distribution of phytoplankton (for input to the turbidity analyses.)

Temperature

Temperature data and other water quality data presented below were subjected to analyses of variance (ANOVA) using a Generalized Linear Model (GLM) procedure. These statistical procedures are designed for unbalanced data with more than one treatment variable. Comparisons of quarterly and station means were made with Tukey's Studentized Range Test (honestly significant difference) and at a confidence level of 95% (alpha = 0.05). Results of the ANOVA's are provided in Appendix II.

Individual analyses of variance were performed on surface temperatures (ST), and bottom temperatures (BT) as a function of quarter, station, tide, station-tide interaction, and depth. If more than one observation was made at a station during a sampling episode, only that taken closest to the time of predicted slack water was selected for analysis. The models generated for both dependent parameters were highly significant.

For surface and bottom temperatures, both quarter and station terms accounted for a significant portion of the data variability. Seasonal dependence of all temperatures at the site were indicated. The contribution of the station term suggested a constant spatial distribution of temperatures once seasonal fluctuations had been removed. This areal pattern could be the result of the thermal influence of the discharge, insolation and warming of shallow water bodies, or any other relatively constant heat source or sink in the study area.

Seasonal changes in water temperature resulted in quarterly mean surface and bottom values (all stations combined) that were significantly different from one another. The two summer quarters were also significantly different, although the absolute value of the difference between the means was only 0.70 and 0.56°C for surface and bottom temperatures. Temperature plots during those seasons with the lowest and highest mean bottom temperatures are presented in Figures 6.1-2 and 6.1-3.

Station by station statistical comparisons of tidally averaged surface and bottom temperatures (Figures 6.1-4 and 6.1-5) were compiled and stations were grouped based on the pattern of significant differences with other stations. Stations are in order of decreasing temperature means as determined by the GLM with Level A stations having the highest overall temperatures, and presumably the most direct thermal impacts, Level B the next highest, etc.

The highest mean temperatures were recorded at Station 17, the station most proximate to the POD and most likely to be directly influenced by the thermal discharge. Station comparisons produced a core group of four additional stations (13, 18, 19, 29) which are not dissimilar from Station 17. These five stations comprised Level A for both surface and bottom temperatures.

Level B stations, the group with the next highest project temperature means, were comprised of slightly different stations for surface and bottom observations. In addition to Stations 14, 20-22, 28, and 30, Stations 23 and 27 were included for surface but not for bottom temperatures, while Stations 4 and 5, near the CFBC, were included for bottom but not for surface.

Level C stations were those significantly different from the three warmest (17, 18 and 19) and were comprised of Stations 5, 6, 7, 15, and 16 for surface temperatures, and 15, 23, and 27 for bottom values. Level D surface stations were 4, 8, 9, and 24; bottom stations were 6, 7, and 16. These divisions are illustrated in Figures 6.1-6 and 6.1-7).

For the ST model and the BT model, depth did not contribute significantly. As the depth term was applied last in the analysis, and as the station variable is not truly independent of the depth observed on station, it is possible that such phenomena as solar warming of shallow water masses were already evaluated by the station variation.

The results of the ANOVA imply that as the tide term was not significant, there was no consistent fluctuation of temperatures with tide over the study area as a whole. The station-tide interactive term also indicated no significant interaction or multiplicative effect between these two parameters once the variability due to station has been removed. However, despite the insignificant effect of tide in the GLM procedures, isotherms of high and low tide means for the duration of the project showed large differences in the areas enclosed by selected isotherms (Figures 6.1-8 and 6.1-9) and temperature differentials of up to 2°C were observed at several stations (22, 23, 29, 30). A more continuous deseasonalization based on maximum daily air temperature or isolation (Figure 6.1-10) or the inclusion of plant operations (Figure 6.1-11) in the statistical model might have prevented the masking of temperature fluctuation due to tidal stage. Unfortunately, gaps in the meteorological record decreased the utility of this data base and the fluctuations apparently produced by plant discharges appeared to be less than those due to seasonal climatic temperature changes.

As illustrated in Figures 6.1-8 and 6.1-9, during low tides the thermal plume turns SW and includes Station 29 in the stations classified as Level A. During high tides, a steeper thermal gradient was maintained in the immediate discharge area, and temperatures at stations to the north (4, 5, 13) were elevated. These observations were compatible with the modeling and short term results (see Section 10).

Concern has been voiced previously (Carder 1974) that a large portion of the acreage of the observed thermal plumes was an artifact of water flowing from the CFBC and entering the study area, particularly on an ebbing tide. This water would have been confined and subject to warming from solar radiation and the effect should have been most evident at Stations 4 and 5. This solar warming phenomena was not observed to be the most influential factor on bottom temperatures at Stations 4 and 5 of the present study, although freshwater inputs from the CFBC to the study area were apparent. During low tide samplings, when CFBC influence was highest (lowest salinities) and surface to bottom salinity gradients were most pronounced. Warmer, more saline water was found at the bottom of the water column. More pronounced temperature differences (bottom higher) were observed at high tides. This pattern was observed during all quarters of the study, including Quarters I and V when maximum insolation and warming of the less saline waters of the Canal was expected.

Radiation absorption and subsequent heat transfer to the water column by bottom sediments was apparently not a factor in producing this temperature gradient at Stations 4 and 5, as only approximately 2% of the subsurface light reached the bottom on the average. Stations of comparable depths, south of the intake, did not develop thermal inversions to this extent even though 25% of the subsurface light reached the bottom.

Surface temperatures did not show an obvious effect of heat input from the CFBC. Tidally averaged surface temperatures of Stations 4, 5, and 6 during the summer (Quarter I, maximum insolation) (Figure 6.1-12) were cooler than adjacent stations (1, 7, or 14) and were comparable to Stations 31 and 38, nearshore stations south of the intake and less subject to freshwater influences. Finally, mean surface temperatures observed during low tides at Stations 4 and 5, when salinity indicated maximum input from the CFBC, were again less than observations at high tide (Figures 6.1-13 and 6.1-14).

Thermal stratification was investigated by an ANOVA of DT, surface temperature minus bottom temperature, as a function of quarter, station, tide, station-tide, and depth. Again quarter and station were the most significant factors in accounting for the variation in observed data. For this model, however, the F value produced for the quarter term, while still significant, was two orders of magnitude less than for the models of ST and BT, indicating seasonal fluctuations are less statistically significant. The station-tide interactive term and depth (a function of station) also contributed significantly to the variations observed.

Mean vertical gradients of temperature were inverted (negative values of DT) in Basins 2 and 3. This previously observed (Grimes and Mountain 1971), phenomenon was attributed to the withdrawal of waters from approximately 5.5 km offshore (salinity 23-24 o/oo) and discharge into a nearshore, less saline environment. The warmed discharge, however, was still denser than the receiving waters, and higher temperatures were observed by the authors at the bottom of the water column until mixing produced a more homogenous water mass.

During the project, repetitive temperature measurements made on a single station visit differed by an average of 0.06°C and the instrumental precision criterion that was generated allowed the detection of differing water masses when temperature differentials exceeded 0.22°C. Station means for the project showed thermal inversions of 0.22°C or more at Stations 4, 5, 13, 14, and 20 over the course of the project. The maximum inverted gradient, -0.68°C, was observed at Station 4. These stations were all considered Level A and B thermal stations for bottom waters. Salinities at Station 17 indicated that both surface and bottom waters were relatively uniform and highly saline. The station was also extremely shallow, and almost complete displacement of nearshore waters by the plume was assumed to have prevented any large thermal inversion from occurring. Salinities at Station 19 indicated that some mixing had occurred, again decreasing the thermal inversion.

Vertical temperature gradients were positive in Basins 4 and 5 with the maximum (0.68°C) observed at Station 23. Isotherms of DT were compressed in the vicinity of the oyster bars separating Basin 3 from Basin 5, indicating a zone of rapid change. The plume, approximately 4 km offshore, was in that area mixing with salinities comparable to its origin, although still several degrees warmer than the point of intake (Station 34). The resulting density gradient favored the warmer water on the surface. This result was most prominent during low water (Figure 6.1-15).

Salinity

Salinity patterns in the study area are complex, but are simplistically summarized as two freshwater inputs to an estuary, with a saline input (the plant discharge) situated between. Average flows of the Crystal River and the Withlacoochee River have been reported as approximately 785 and 1183 cfs, respectively (Applied Biology 1982). The flow in the CFBC has been reported to vary between 100 and 3980 cfs (Carder 1974). The plant discharge is approximately 2937 cfs.

The salinity data collected nearest the time of predicted tide during each sampling episode were subjected to GLM procedures. Surface and bottom salinity (SC and BC), as well as the salinity gradient present (DC, surface minus bottom values) were each analyzed as a function of quarter, station, tide, station-tide, and depth. All three salinity models generated were highly significant. Each independent term accounted for a significant portion of the data variability with the single exception of the depth term in the model of DC.

Seasonal salinity differences, a typical response to variable freshwater flows and tidal heights, were strong enough for most quarters to be significantly different from one another. Surface quarterly means were highest in fall, Quarter II (SC, 22.45 o/oo) and lowest in the spring, Quarter IV (17.27 o/oo). Mean bottom salinities ranged between 24.21 o/oo during the second summer (Quarter V, Figure 6.1-16) and 18.31 o/oo in the spring (Quarter IV, Figure 6.1-17).

The seasonal salinity variations observed had no close relationship to rainfalls recorded either at the Crystal River Power Station (incomplete data) or in the Crystal River/Inglis area (National Weather Service unofficial monthly totals, Figure 6.1-18). Flows from the Crystal River, a spring fed river with a low piezometric elevation, have been reported to vary inversely with seasonal tidal heights (Mann and Cherry, 1970). Maximum discharge from this system would then be expected to have occurred during January and February, during periods of lowest predicted tides. Minimum salinities in the study area, however, were observed in March, April, and May.

The variation in salinity during the spring, however, was more pronounced for inshore stations, arguing a variable terragenic source of fresh water. On April 12, 1984, and April 18, 1984, high turbidities were recorded simultaneously with low salinities and indicated either storm conditions (when strong winds may alter times and heights of actual tides from predicted) or pulses of runoff with high suspended solids. A more extensive compilation of watershed rainfall records, assessment of antecedent conditions and soil types, and flow and stage records of the freshwater inputs would be required to fully relate the salinities observed in the study area to precipitation and tides.

The significance of the station term in the salinity ANOVAs illustrated that, once seasonal variations were removed, a relatively constant gradient of salinities existed across the study area. This distribution across the study area was strongly affected by tidal stage, and a station-tide interactive term was significant for models of surface and bottom salinities.

The maximum tidal change was observed at Station 1 (near the Withlacoochee River), approximately 5-6 o/oo. Minimum tidal differences were observed in the region of the discharge canal at Stations 17, 18, and 19 (Figure 6.1-19).

A compilation of station to station statistical comparisons showed a much more continuous distribution of salinities than of temperature in the study area. Groups of similar stations based on the pattern of significant differences were therefore smaller, and as there are two freshwater inputs to this system, similar stations were not always contiguous, occasionally being divided by the intake and discharge spoil dikes.

Maxima of vertical salinity gradients, DC, were observed near the regions of freshwater input (Figure 6.1-20). Negative values represent less saline lenses of water overriding denser, more saline water. Station 17 exhibited the least amount of stratification during both high and low tide conditions. Based on salinity observations, both surface and bottom waters at this station were primarily comprised of discharge from the plant, the volume of saline water discharged by the plant (2937 cfs) apparently overshadowing any less saline flow from the nearby marshes.

Dissolved Oxygen

Two different selections of independent variables were used for ANOVA of the dissolved oxygen (DO) data base. Values from the surface (DO1) and bottom (DO3) of the water column and the percent of dissolved oxygen saturation relative to equilibrium conditions at surface and bottom (DSS and DSB) were all treated separately. The first model type included quarter, station, temperature and chlorophyll concentrations as independent variables. The relatively small number of chlorophyll data points limited the amount of DO data subject to this treatment. Chlorophyll concentrations were found not to account for any significant variability in DO or percent saturation data. GLM procedures were repeated after elimination of the chlorophyll variable. The quarter, station and temperature and salinity terms all accounted for highly significant portions of the variation in the dissolved oxygen data.

Seasonal variations in DO were related to those produced by temperatures. The temperature dependence was to be expected from the thermodynamic laws governing the solubility of all gases in water and the inverse relationship of absolute concentrations to temperature. Solubilities at equilibrium conditions are also inversely related to salinity. Station related variables affecting DO concentrations in addition to those addressed by the GLM could have been the presence of productive submerged grass beds or algal mats, or unvegetated bottom types exerting a benthic oxygen demand. Seasons with minimum and maximum DO means are illustrated in Figures 6.1-21 and 6.1-22.

Spatial patterns of dissolved oxygen were mixed for surface and bottom waters. Station 17, as may have been expected from the elevated temperature observed, had the lowest mean surface DO, 6.7 mg/l. That value was not significantly different from those at stations in Basin 3 and the southern half of Basin 2. These stations were all within Levels A and B of the thermal impact stations.

Due to the number of stations that typically experienced salinity stratifications, dissolved oxygen levels were expected to be less at the bottom of the water column. In addition, this gradient would be exacerbated wherever thermal inversions occurred. Those stations with low bottom DO concentrations, however, were not exclusively the Level A or B thermal stations. Three stations in Basin 4 (7, 8 and 15) had low bottom DO values. Total organic carbon, percent silt clay and free sulfide levels in sediments at these stations imply a depositional environment with low water velocities and a potentially high benthic oxygen demand.

Macrophyte aerial surveys confirmed that Level A and B Thermal Stations that did not have low DO3 concentrations all had seagrass and algae accumulations. Station 38, with highest mean DO levels, was also heavily vegetated.

Models of percent saturation of DO, using the same variables of quarter, station, temperature and salinity, were also highly significant. All independent variables removed a significant portion of the sum of the squares with the exception of salinity for surface values. The difference between surface and bottom saturations was greatest and the overall percent of saturation at bottom was the least (91 percent) during the two summer quarters. This is consistent with elevated benthic demands during warmer weather. Surface waters were closer to equilibrium for all quarters.

The spatial patterns of percent saturation of DO also indicated contributing factors other than equilibrium solubilities as a function of temperature and salinity. The highest percent saturation, 100 and 103 percent for surface and bottom, was recorded at Station 38, where concentrations of seagrasses were observed. The lowest saturations were observed on the bottom at Stations 3-9, 14 and 15, in general those stations immediately south of the CFBC spoil islands and at the northern edge of the influence of the thermal plume (Figure 6.1-23). Absolute DO concentrations, however, were little different from the discharge. Saturation deficits were produced by the decrease in temperature between the discharge and these stations, or sediments producing an increase in theoretical solubility of DO with no change in the absolute concentration. The thermal and salinity stratification also observed would reduce the reaeration rates of bottom waters.

pH

Changes in temperature will affect the distribution of carbon dioxide among its various species. With a constant total carbon dioxide concentration, pH will fall with increasing temperature. Biological respiration and photosynthesis that deplete the total concentration of carbon dioxide present will also elevate pH values to daily maxima in late afternoon after periods of high productivity. Seasonal trends in pH are generally apparent in open oceans. Lowest carbon dioxide and highest pH values are observed in warmer months when productivity is high. This pattern is complicated nearshore by local weather conditions. The wet season in Florida typically occurs during the warmer months, and acidic runoff (low pH) is greatest when pH values are expected to be at a maximum.

Initial statistical analyses of pH data from Crystal Bay found chlorophyll to account for an insignificant portion of the variability in pH values. The ANOVA's were subsequently repeated after eliminating chlorophyll. Models generated were highly significant for surface (PH1) and bottom (PH3) values. The quarter, station, and temperature contributions to the model were all significant, and salinity was significant for PH3 but not for PH1.

Over all stations, the highest pH values were recorded during Quarter I, the first summer quarter (Figure 6.1-24). Lowest pH values occurred in the fall rather than during the spring quarter when runoff was most apparent and low pH values would be expected.

Based on the pattern of differences, two groups of stations were identified, one with low values over the course of the project, the other with high values. Those stations with low values included nearshore stations north of the discharge dike, both thermal (Stations 13, 14, and 17) as well as those most affected by the CFBC and the Withlacoochee River (Stations 1, 2, 4-7). Stations with elevated pH values were those nearshore in both thermal and nonthermal areas (Stations 27-34, 38, and 39). Although both temperature and salinity contribute to observed pH variations, the controlling influence on pH values appears to be a biological system other than phytoplankton that affects the carbonate - bicarbonate - carbon dioxide equilibria.

Photometry

Extinction coefficients were computed from submersible photometer readings using the equation:

$$K = (\ln (Iz / Io)) / -Z$$

where K = extinction coefficient in ft^{-1}

Io = light below the water surface

Iz = light at depth

Z = depth in feet

Measurements made at secchi depth (12 inch diameter) and surface were used to calculate a KS, and at bottom and surface to calculate a KB. When secchi depths were greater than the water column depth, no KS was calculated. Analyses of variance with independent variables of quarter, storm (quarter), station, depth, and turbidity were performed. All input variables were found to be highly significant.

Seasonal growth patterns of phytoplankton are possibly responsible for the significance of the quarter term in the models generated. The mean KS and KB of all stations during Quarter III was the lowest of any of the five quarters sampled (highest clarity waters). This coincides with temperature and chlorophyll concentration minima.

The storms were identified from the intermittent meteorological data and defined as four consecutive days with wind velocities averaging over 7 mph. The shallow waters of Crystal Bay made resuspension of unconsolidated sediments and erosion of the numerous spoil islands extremely likely during periods of prolonged high winds and resultant wave action. Depth of the water column also controlled the amount of resuspension generated by any given wave height. Since only 5 storms were identified, no attempt was made to weight storms for wind direction, velocity and variability.

The amount of light scattered or absorbed by suspended and dissolved materials in the water column (turbidity) will directly decrease the amount of light reaching a given depth. Turbidity accounted for a highly significant amount of the variability of KB and KS, and the distribution of extinction coefficients matched closely with turbidity isopleths.

The significance of the station term indicated that a consistent spatial pattern of light extinction existed. The highest mean values of KB, and therefore, the waters of lowest clarity, were observed at Stations 1, 2, 4, 5, 6, 7, and 8, those stations nearest the CFBC and the Withlacoochee River (Figure 6.1-25). Lowest coefficients were measured at the offshore stations and south of the intake dike.

The Crystal River, with groundwater as its primary source, had much lower color values than a "blackwater" river such as the Withlacoochee (MML, unpublished data) in addition to much lower flows. Suspended load data from the two rivers were quite comparable. The absorption of light by dissolved organics (humic acids), marsh export detritus, or erosional material from the CFBC spoil islands was believed primarily responsible for the differences in KB.

Differences between KS and KB values were examined to determine if salinity or thermal stratification decreased penetrant light. No consistent pattern was observed in quarterly station means for those stations closest to thermal or freshwater sources.

Quarter I, the quarter with the highest mean value of KB, was further analyzed by back calculating from KB the depths to which 10, 5, and 1 percent of the incident light would penetrate (Table 6.1-1). These depths were then compared to the mean depths recorded on station during that quarter. (Summer tides were among the highest predicted and water column depths and extinction coefficients during this quarter represent a worst case situation.) During Quarter I, quite a number of stations had average water column depths in excess of Z(10 percent), the depth at which all but 10 percent of the incident light has been absorbed. None, however, had depths which exceeded Z(1 percent). The average percent of surface radiation that reached the bottom is illustrated in Figure 6.1-26.

Turbidity

Initial GLM procedures on both surface and bottom turbidity data bases produced highly significant models using quarter, storm (quarter), station, depth, salinity, total suspended load, and chlorophyll as independent variables. The rationale for including many of these parameters was entirely analogous to their selection for the analysis of extinction coefficients and storm dates utilized were the same. Suspended loads should influence turbidity values directly and high chlorophyll concentrations would indicate a phytoplankton population that would also produce considerable light scattering and absorption.

Chlorophyll accounted for a significant portion of the variability in turbidity data but its inclusion in the model limited the number of turbidity values analyzed. For this reason, GLM procedures were repeated after replacing chlorophyll with temperature as an independent variable. Waters of extreme temperatures, either high or low, might be expected to have decreased biomass concentrations, and therefore lower turbidities.

The second set of models for turbidity were also highly significant. Temperature (other than that contained in the quarter variable) did not account for a significant portion of the variation in either model. Suspended load accounted for the greatest portion of the variation in the model. As expected, bottom turbidity values were higher overall than surface values, and more variability was observed at the bottom for a given station.

Highest surface and bottom turbidities were observed during the spring, Quarter IV, the period of lowest salinity and highest surface suspended loads. Over half of the stations both north and south of the intake spoil had maxima during this quarter. This quarter marked the resumption of rains after the dry season, and pulses of turbidity were observed coincident with salinity minima.

The storm (quarter) variable was highly significant. Station means for the quarter (with storm events removed) were calculated and subtracted from surface turbidities collected during storms. The increase in turbidity attributable to storm conditions is illustrated for the two most severe storms (Figures 6.1-27 and 6.1-28). Individual stations and the degree to which they were affected were obviously products of wind direction and strength. The small data base for storm conditions and the partial nature of the meteorological data, however, prevented a quantitative assessment of these contributions.

In general, surface turbidity distributions were inversely related to salinity isopleths for the discharges from the CFBC and the Withlacoochee River, decreasing with increasing salinity (Figure 6.1-29). Stations with the highest observed surface turbidities were 1, 4, 5, 6, and 8. A secondary group included 7, 9, and 17. Turbidity at these stations is most likely the result of precipitation of humic substances, export of salt marsh detritus, and erosion of CFBC spoil islands.

Stations lowest in surface turbidity included most of those south of the intake spoil. These were sheltered from the severest northerly winds and salinities were presumably controlled by the low humic waters of Crystal River. The marshes adjacent to Station 31 also appeared to have lower tidal exchange volumes and lower flows with less scouring. Finer grained material within the marsh itself and accumulated algal detritus also indicated more of a depositional environment than the area near Station 17. Less material appears to be exported from this southern marsh and sediment loads in the adjacent basins are correspondingly less (Cottrell 1974).

Suspended Solids

Suspended load analyses also included GLM procedures. Models were produced for surface and bottom total suspended load data as a function of quarter, storm (quarter), station, turbidity, temperature, and salinity. Storm dates were the same as those described in the analyses of extinction coefficients and turbidity.

Models generated were highly significant. ANOVA summaries indicated that turbidity values could account for a majority of the variation in the data. Quarter, storm (quarter), station and turbidity terms were all highly significant for both data sets. Salinity was only significant for surface turbidities. Temperature (beyond the effects accounted for by the quarter and station terms) was insignificant in accounting for suspended load data variation.

The spring quarter had the highest overall surface suspended load recorded. The lowest concentrations were recorded during the winter, Quarter III. This pattern, while compatible with the rainfall and salinity trends discussed earlier is much less clear cut than for turbidity. Bottom loadings were again more variable than surface and seasonal trends were slightly different from surface values. The lowest values recorded for turbidity and extinction coefficients were also during Quarter III. The effect of storms on suspended load was comparable to the effects on turbidity and the individual stations most affected were again dependent on wind strength and direction.

Similar to turbidity distributions, stations with highest overall values of total suspended load were concentrated along the southern side of the CFBC (Figure 6.1-30). Surface loads at Stations 1 and 6-9 were not significantly different from Station 5, which had the highest load over the course of the project. Those stations with the lowest observed surface values are those south of the intake dike and nearshore (Stations 31-33, 48-40) as well as Station 28.

Due to the variability of bottom TSS data, station to station comparisons produced fewer significant differences despite the wide spread in mean suspended load. Highest values were again observed at stations near the CFBC (1, 3-6, 8-10, and 15) and ranged from 29 to 17 mg/l. Those stations with the lowest suspended loads included stations south of the intake (35, 39, 40), offshore (24, 26), and some Level A and B thermal stations (27, 28, 29).

Volatile suspended solids were also analyzed by the GLM procedure. Independent variables of quarter, station, and chlorophyll were applied to surface and bottom data sets. The models produced were highly significant. Quarter and chlorophyll variables accounted for significant portions of data variability. The station term was significant for bottom values but not for surface.

Seasonal distributions of volatile suspended load were comparable to the trends shown by overall chlorophyll data. The lowest levels of suspended volatiles were recorded during the winter, Quarter III. This period coincided with the lowest quarterly means for turbidity, total suspended solids, and extinction coefficients.

Data variability permitted few significant differences to be observed between stations. Station 8 contained the highest average volatile solids (7 mg/l) for the project. This station also appeared to be a depositional area, as not only volatile but also total suspended solids were high here. Percent silt/clay, total organic carbon, and sulfide concentrations in the sediments at this station were among the highest of those observed in the study area, and the mean grain size was one of the smallest. Stations with volatile suspended loads not significantly different from 8 included those immediately south of the CFBC spoil islands and Level A and B thermal stations (13, 17, 20, 21, and 29). Values at Stations 3 and 33 were also high.

Barge Traffic

The effects of barge traffic on suspended load and turbidity were also investigated through GLM analyses. Surface and bottom data sets from Stations 17, 34, 35, 36, and 37 were selected as being those most likely to show any increases as a result of sediment resuspension. Station 17 was included as it receives the most direct exposure to waters that have passed through the plant condensor. Independent variables included quarter, storm (quarter), station, and barge (quarter-station). The degree of barge influence at these stations was selected based on the length of time since traffic had passed or, in the case of 17, the length of time in which a disturbed water mass could be expected to reach that station.

The models produced for surface and bottom turbidities were both highly significant. The quarter term accounted for most of the data variability in both models, and storm (quarter) was significant for the surface turbidities. No other variables were significant. Barge effects were either not apparent at the selected stations during the times sampled or were overridden by those due to wind or wave action. Other obscuring factors may be the transient nature of any disturbance. Velocities in the intake canal would act to rapidly disperse any elevated turbidities.

The model for bottom suspended load data was not significant. In that produced for the surface values, however, again only quarter and storm (quarter) accounted for any significant amount of variability. Barge influences were not apparent.

Chlorophyll

Surface and mid-depth chlorophyll concentrations were analyzed as a single data base by the GLM procedure, using quarter, station, extinction coefficient (KS), secchi depth, salinity, temperature, and volatile suspended solids as independent variables. Of these only temperature and salinity were insignificant and quarter, station, and KS were highly significant.

Highest overall chlorophyll levels were recorded during the second summer. Winter, Quarter III, levels were lowest. This is compatible with the expected seasonal growth patterns of phytoplankton and cold weather reductions in photosynthetic activity.

Station by station comparisons show few differences and data variability for some stations is quite large compared to stations with comparable means. Those stations with the highest levels are generally centered around the CFBC and the Withlacoochee River entrances to the study area (Stations 1, 3, 4, 5, 8, 9, and 15) (Figure 6.3-31). Lowest levels were observed at offshore and southerly stations.

As chlorophyll samples were collected from eight randomly selected stations per week and volatile suspended solids were only collected every other week, the data base for this statistical analysis was limited. The conjunction of these parameters was met for some stations only once during the entire project. When all weekly chlorophyll data was combined without regard to sampling depth, the seasonal and spatial patterns discussed above were confirmed.

6.1.3 Discussion

Water quality stations in the study area were statistically divided into five groups: four of decreasing thermal influence and those unaffected. The groupings were slightly different for surface and bottom waters, more stations being included for the affected surface waters. Stations 13, 17, 18, 19 and 29 in Basins 1, 2 and 3 were those most directly affected by thermal discharge. Little input of heat was observed from either the Cross Florida Barge Canal or the Withlacoochee River. The distribution of the thermal plume, as determined by station mean water temperatures, agreed well with that predicted by the numerical models.

Spatial salinity patterns were complex as the Crystal River, the Withlacoochee River and CFBC, and the plant (discharging offshore water nearshore) all act as inputs to the study area. Seasonal salinity trends were present but were not directly related to rainfall recorded either at the power plant or in the Crystal River/Inglis area. Minimum salinities were recorded during the spring quarter.

Dissolved oxygen levels were strongly and inversely related to temperature; summer minima and winter maxima were recorded. Percent saturation of dissolved oxygen was also lowest during the summer. The station with the lowest mean oxygen level was that with the highest mean temperature. Distribution of macrophytes affected both dissolved oxygen and percent saturation levels, and appeared to be one of the controlling variables in accounting for pH distributions. Chlorophyll levels displayed seasonal trends (winter minima) but did not control either DO or pH values.

Water clarity was most reduced at stations near the CFBC. High extinction coefficients were apparently the product of dissolved humics and particulate matter exported from the Withlacoochee River, the CFBC, and adjacent salt marshes. Erosion of the spoil islands is also indicated. These same factors also influenced the distributions of turbidity and total and volatile suspended loads. Waters of highest clarity were south of the intake spoil and offshore. Light was apparently not a limiting factor at those stations most affected by the thermal discharge.

Storms produced elevated values of extinction coefficients, turbidity, and suspended load. The stations and the degree to which each was affected were the product of wind directions and strengths. Wave and current resuspension of sediments also apparently contribute. The effect of barge traffic on these paramters was not apparent.

REFERENCES FOR 6.1

American Public Health Association (APHA). 1980. Standard Methods for the Examination of Water and Wastewater, 15th Edition.

Applied Biology, Inc. 1982. Crystal River Benthic Community Structure Survey. Report to Florida Power Corporation.

Carder, K.L. 1974. Technical Report #3 on Independent Environmental Study of Thermal Effects of Power Plant Discharge, Natural Heating of Salt Marsh Waters in the Area of Crystal River Power Plant, Dept. of Mar. Sci., Univ. of So. Fla.

CH2M Hill, Inc. 1983. Withlacoochee Marine Biology Study, 1982. Report to Withlacoochee Regional Planning Council.

Cottrell. 1974. Sediment Composition and Distribution at Crystal River Power Plant: Erosion vs. Deposition. Final Report to FPC. Report C. Univ. of Fla.

Cottrell. 1978. Analysis of Suspended and Surficial Sediment in the Discharge Basins of Crystal River Power Generating Facility, Crystal River, Florida, Rosenstiel School of Marine and Atmospheric Science, Miami, Florida.

Submitted to FPC, Nov. 1978, In: FPC, 1979, Special Surveillance Studies, Suppl. 1. Crystal River Unit 3, Docket No. 50-302.

Cox, R.A., F. Culkin, J.P. Riley. 1967. The electrical conductivity/chlorinity relationship in natural sea water. Deep Sea Research, Vol. 14, 203.

Environmental Protection Agency. 1979. Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020. Cincinnati, Ohio.

FPC. 1975. Summary Analysis and Supplemental Data. Report to Interagency Research Advisory Committee.

FPC. 1980. Post Operational Monitoring Program. Crystal River Units 1, 2, and 3, Annual Report, 1979. Two Volumes.

Grimes, C.B. 1971. Thermal Addition Studies of the Crystal River Steam Electric Station, Prof. Pap. Ser. No. 11, Fla. Dept. Nat. Resour.

Grimes, C.B. and J.A. Mountain. 1971. Effects of Thermal Effluent upon Marine Fishes near the Crystal River Steam Electric Station. Prof. Pap. Ser. No. 17. Fla. Dept. Nat. Resour.

Jaeger, J.E. 1973. The determination of salinity from conductivity, temperature and pressure measurements, In: Proceedings, Second S/T/D Conference and Workshop, San Diego, CA.

Klausewitz, R.H. 1973. Diffusion model for a shallow barricaded estuary. M.S. Thesis, Univ. of So. Fla.

Klausewitz, R.H. 1979. Thermal Plume Determination and Model Verification During Unit 3 Operation, In: FPC, 1979, Special Surveillance Studies, Suppl. 1. Crystal River Unit 3. Docket No. 50-302.

Knight, R.L. and W.F. Coggins. 1982. Record of estuaries and salt marsh metabolism at Crystal River, Florida, 1977-1981. Final Report to FPC. Systems Ecology and Energy Analysis Group, Univ. of Fla.

Mann, J.A. and R.N. Cherry. 1970. Large springs of Florida's "Sun Coast" Citrus and Hernando Counties. U.S. Geological Survey.

Riley, J.P. and G. Skirrow. 1975. Chemical Oceanography. 2nd edition, Academic Press, London, Appendix Table 6.

UNESCO. 1966. International Oceanographic Tables, UNESCO Office of Oceanography.

Table 6.1-1 Penetrant Light. Extinction coefficients KS, KB (ft^{-1}); station depths, D (ft); depth to which 1%, 5%, 10% of surface radiation penetrates, Z(1), Z(5), Z(10) (ft); percent surface radiation at bottom, %Io @ B (%).

Station	KS (ft^{-1})	KB (ft^{-1})	D (ft)	Z(1) (ft)	Z(5) (ft)	Z(10) (ft)	%Io @ B
1	0.54	0.53	2.6	8.7	5.7	4.3	25.2
2	0.49	0.48	4.0	9.6	6.2	4.8	14.7
3	0.40	0.42	7.5	11.0	7.1*	5.5*	4.2
4	0.51	0.63	5.8	7.3	4.8*	3.7*	2.6
5	0.47	0.76	5.1	6.1	3.9*	3.0*	2.1
6	0.53	0.54	5.0	8.5	5.5	4.3*	6.7
7	0.60	0.59	5.3	7.8	5.1*	3.9*	4.4
8	0.42	0.55	6.7	8.4	5.4*	4.2*	4.3
9	0.47	0.45	7.5	10.2	6.7*	5.1*	3.4
10	0.38	0.37	9.1	12.5	8.1*	6.2*	3.5
11	0.31	0.29	9.4	15.9	10.3	7.9*	6.5
12	0.23	0.20	14.4	23.0	15.0	11.5*	5.6
13	0.35	0.46	3.0	10.0	6.5	5.0	25.2
14	0.48	0.42	5.1	11.0	7.1	5.5	11.7
15	0.48	0.45	6.3	10.2	6.7	5.1*	5.9
16	0.37	0.39	7.2	11.8	7.7	5.9*	6.0
17	0.50	0.54	2.4	8.5	5.5	4.3	27.4
18	0.42	0.41	5.8	11.2	7.3	5.6*	9.3
19	0.45	0.41	4.8	11.2	7.3	5.6	14.0
20	0.36	0.41	7.4	11.2	7.3*	5.6*	4.8
21	0.43	0.43	8.5	10.7	7.0*	5.4*	2.6
22	0.45	0.39	8.4	11.8	7.7*	5.9*	3.8
23	0.39	0.34	10.6	13.5	8.8*	6.8*	2.7
24	0.29	0.29	9.8	15.9	10.3	7.9*	5.8
25	0.27	0.23	12.1	20.0	13.0	10.0*	6.2
26	0.24	0.23	14.4	20.0	13.0	10.0*	3.6
27	0.43	0.43	4.9	10.7	7.0	5.4	12.2
28	0.43	0.44	6.8	10.5	6.8	5.2*	5.0
29	0.36	0.36	6.2	12.8	8.3	6.4	10.7
30	0.41	0.40	6.4	11.5	7.5	5.8*	7.7
31	0.45	0.31	4.9	14.9	9.7	7.4	21.9
32	0.33	0.30	4.4	15.4	10.0	7.7	26.7
33	0.40	0.31	7.1	14.9	9.7	7.4	11.1
34	0.33	0.26	8.8	17.7	11.5	8.9	10.1
35	0.25	0.25	7.5	18.4	12.0	9.2	15.3
36	0.27	0.23	11.5	20.0	13.0	10.0*	7.1
37	0.21	0.25	13.3	18.4	12.0*	9.2*	3.6
38	0.26	0.34	4.0	13.5	8.8	6.8	25.7
39	0.27	0.27	7.4	17.1	11.1	8.5	13.6
40	0.22	0.20	13.3	23.0	15.0	11.5	7.0

*Calculated depth exceeded water column depth.

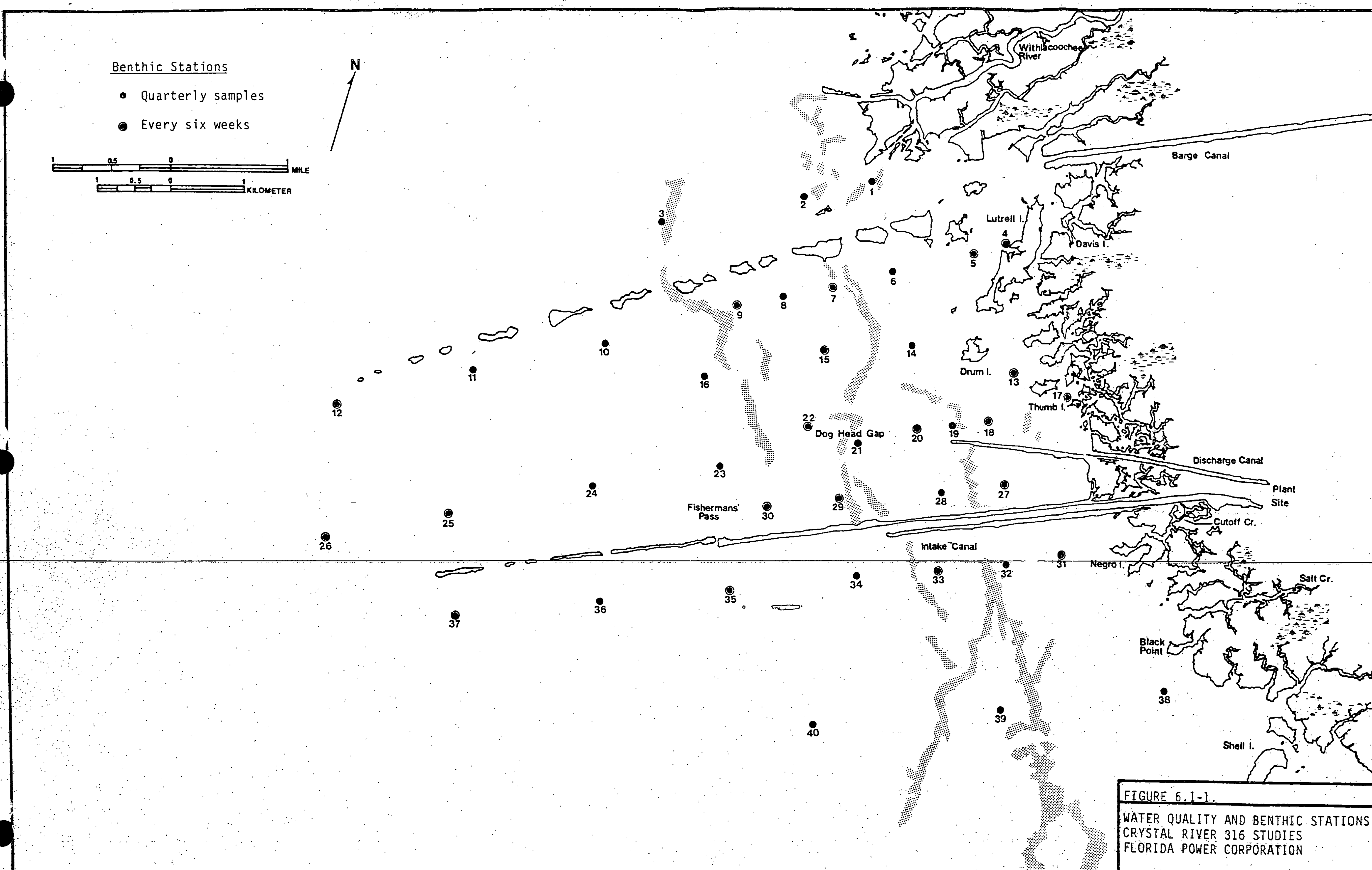


FIGURE 6.1-1.
WATER QUALITY AND BENTHIC STATIONS.
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

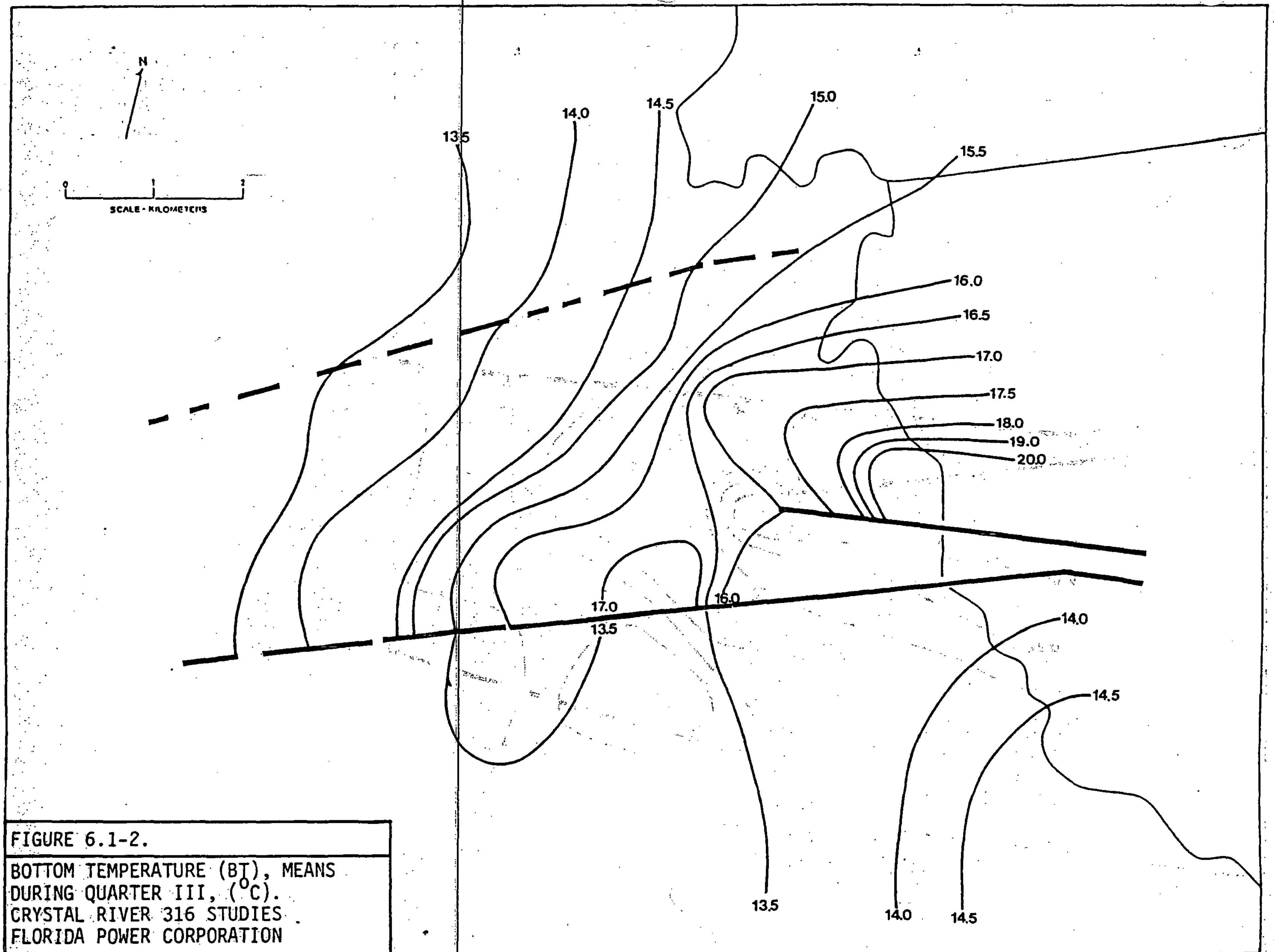


FIGURE 6.1-2.

BOTTOM TEMPERATURE (BT), MEANS DURING QUARTER III, (^{o}C). CRYSTAL RIVER 316 STUDIES FLORIDA POWER CORPORATION

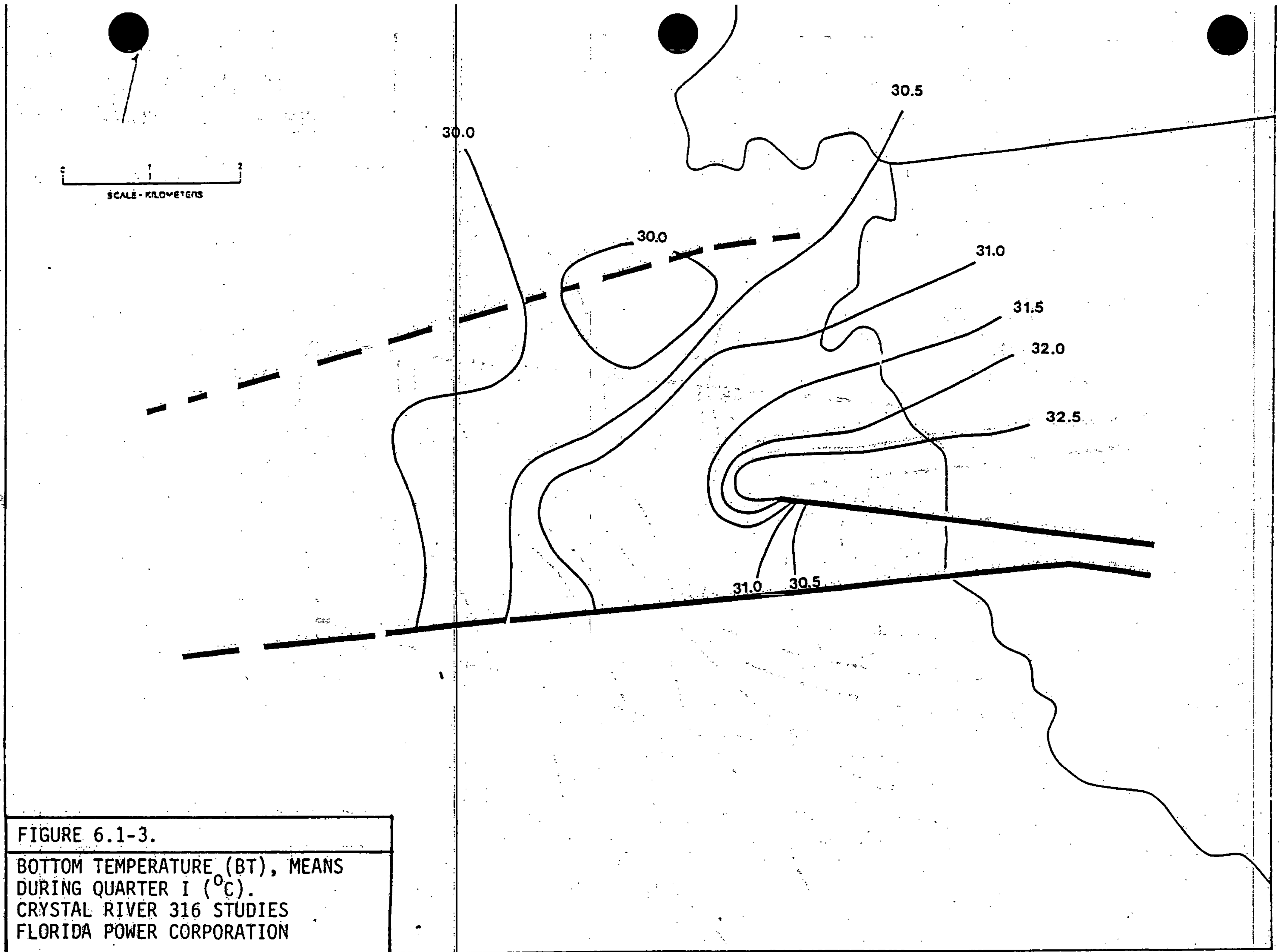


FIGURE 6.1-3.

BOTTOM TEMPERATURE (BT), MEANS DURING QUARTER I (^{o}C).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

	36	37	40	35	31	39	34	32	33	3	26	12	25	38	2	11	10	1	24	8	9	4	6	5	7	15	16	27	14	23	28	22	21	20	30	13	29	18	19	17		
17	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	0	0	0	0	0	17	LEVEL A
19	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	19	
18	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	18	
29	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	
13	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	
30	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	30	LEVEL B
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	20	
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	21	
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	22	
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	28	
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	23	
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	14	
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	27	
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	16	LEVEL C
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	15	
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	7	
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	5	
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	6	
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	4	LEVEL D
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	9	
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	8	
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	24	
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	1	
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	10	
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	11	
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	2	
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	38	
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	25	
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	12	
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	26	
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	3	
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	33	
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	32	
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	34	
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	39	
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	31	
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	35	
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	40	
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	37	
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	36	

FIGURE 6.1-4.

SURFACE TEMP. RESULTS OF TUKEY'S TESTS BETWEEN STA. MEANS (* = SIGNIFICANT DIFFERENCES).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

	37	40	36	35	34	39	26	31	33	32	12	25	3	11	10	24	2	38	9	1	8	7	16	6	15	27	23	4	5	22	30	28	21	14	20	29	13	19	18	17	
17	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	0	0	0	0	0	LEVEL A
18	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	
19	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	
13	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
29	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
20	*	*	*	*	*	*	*	*	*	*	*	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	LEVEL B
14	*	*	*	*	*	*	*	*	*	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	
21	*	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	LEVEL C
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	LEVEL D
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	*	
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	*	
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	*	

FIGURE 6.1-5.

BOTTOM TEMP. RESULTS OF TUKEY'S TESTS BETWEEN STA. MEANS (* = SIGNIFICANT DIFFERENCES).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

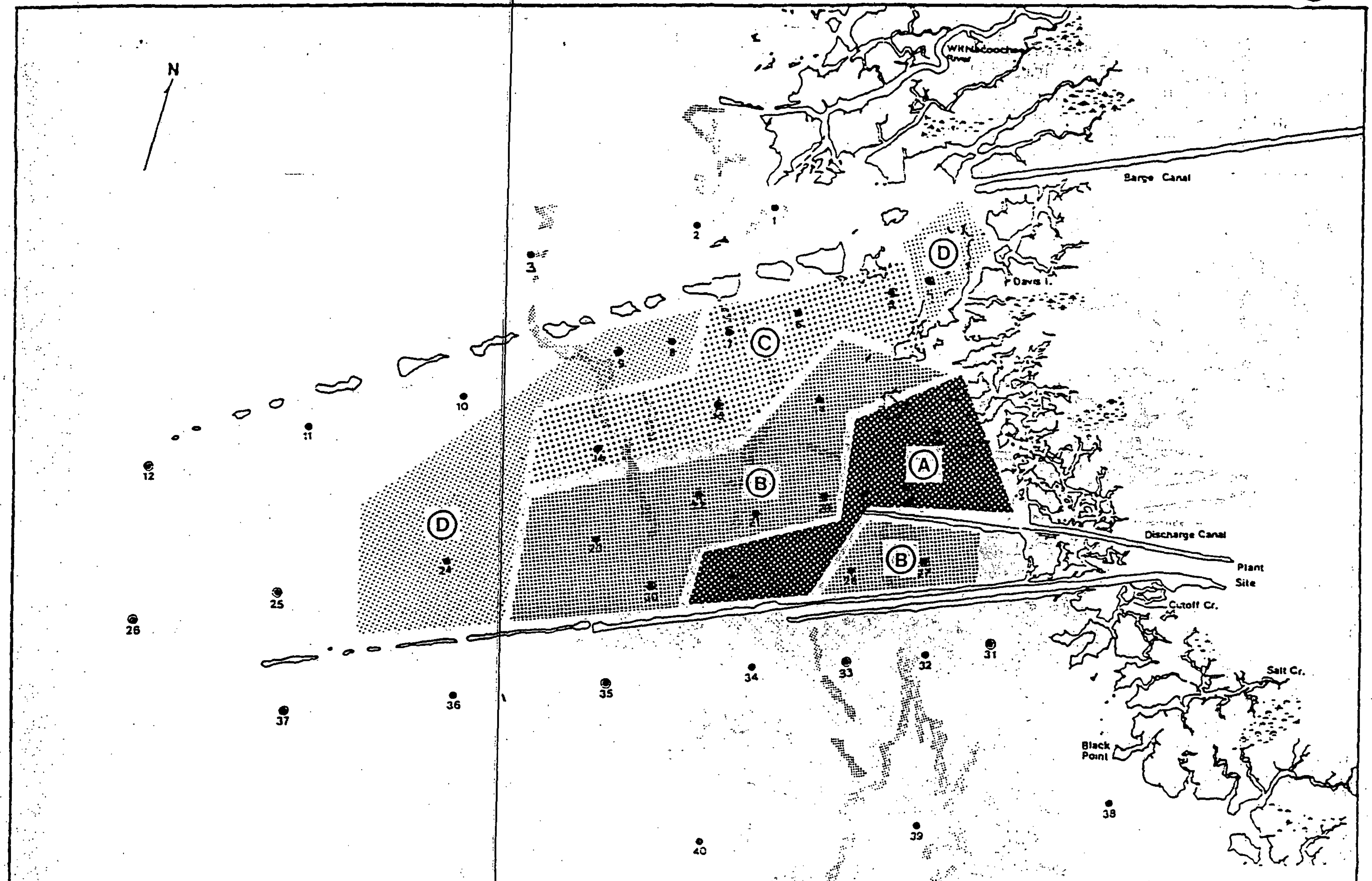


FIGURE 6.1-6.

THERMAL LEVEL CLASSIFICATIONS, SURFACE WATERS (A=HIGHEST). CRYSTAL RIVER 316 STUDIES FLORIDA POWER CORPORATION

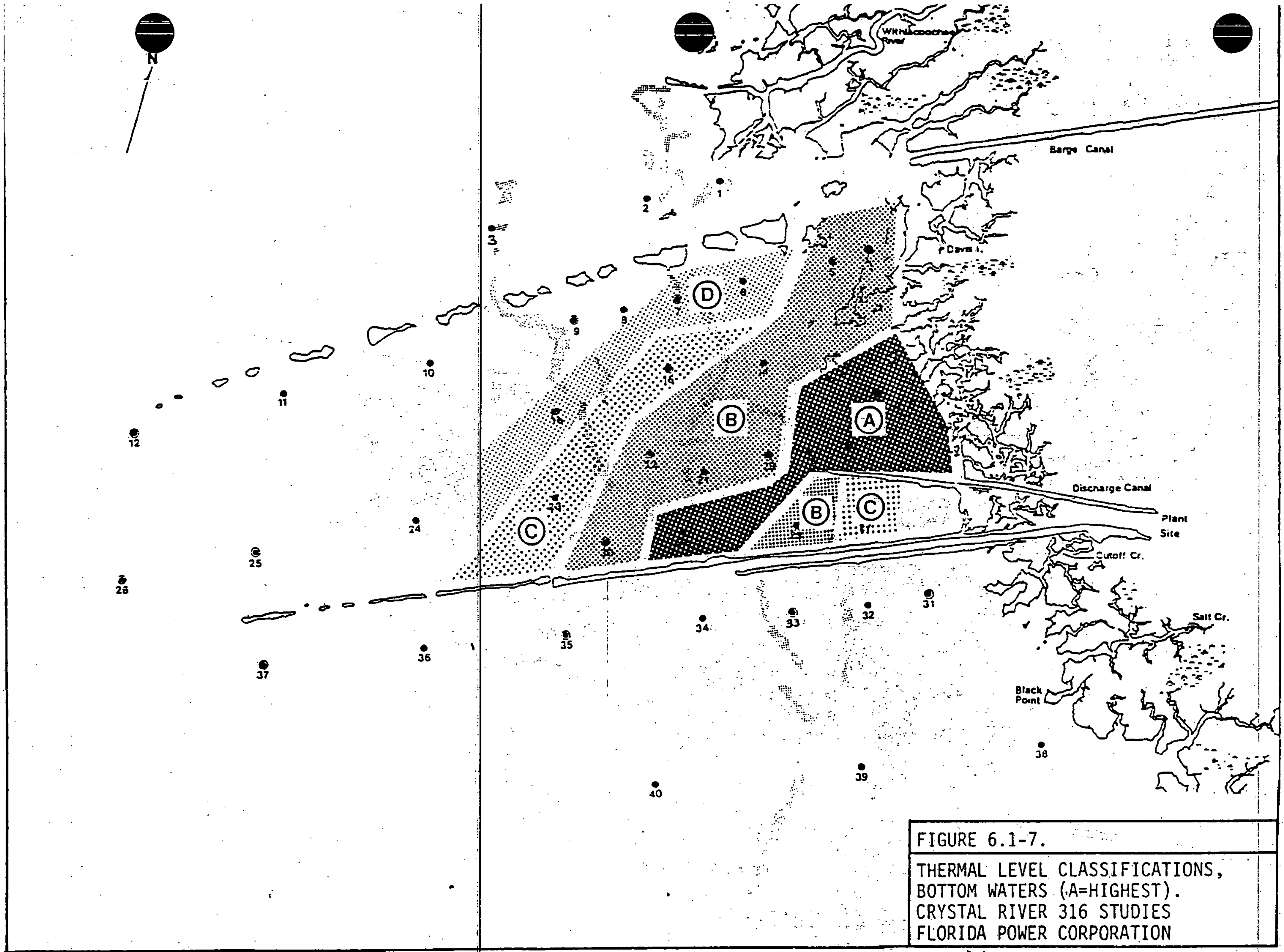


FIGURE 6.1-7.

THERMAL LEVEL CLASSIFICATIONS, BOTTOM WATERS (A=HIGHEST).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

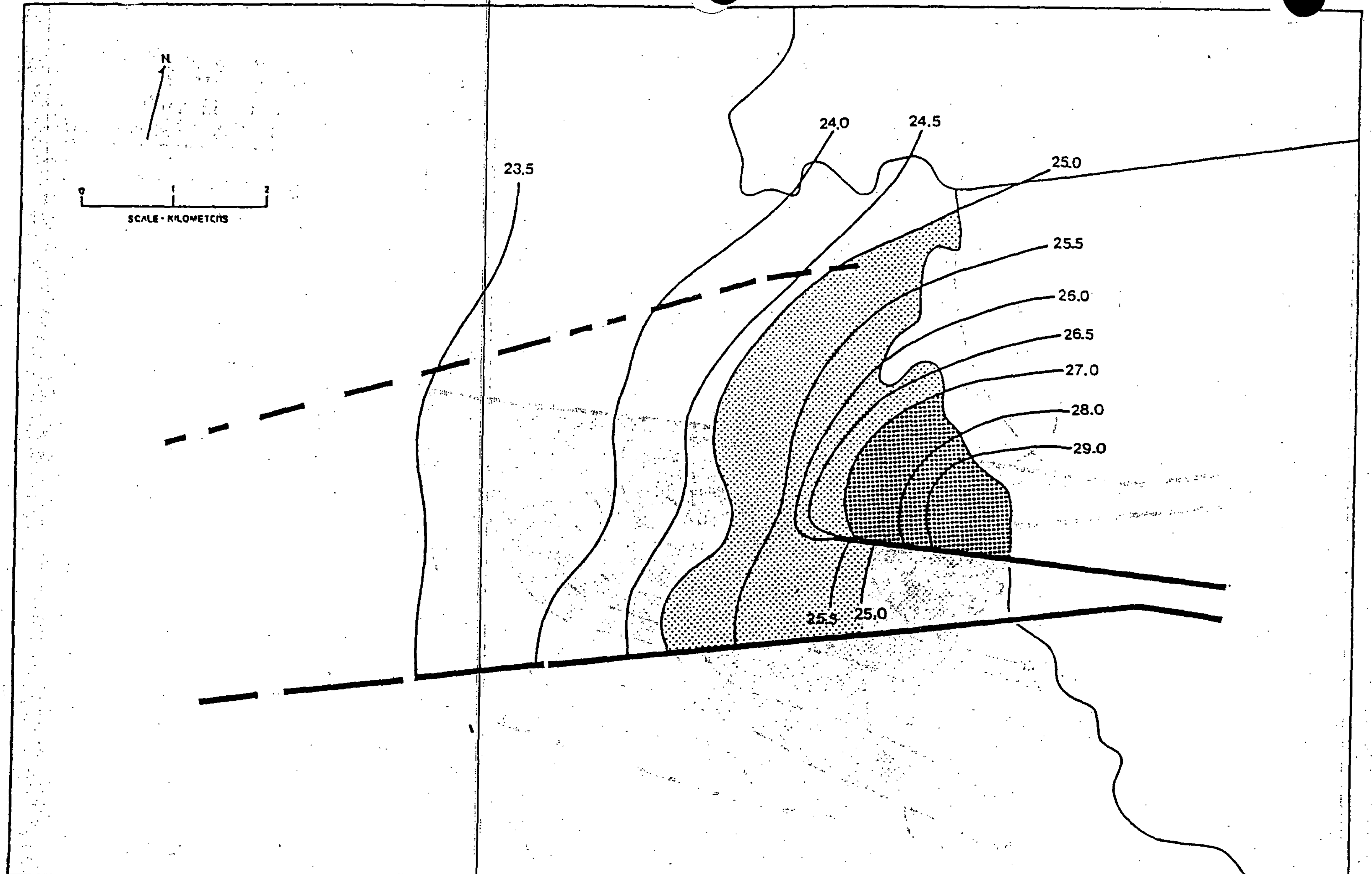


FIGURE 6.1-8.

BOTTOM TEMPERATURES (BT), MEANS AT HIGH TIDE, QUARTERS I-V, (°C).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

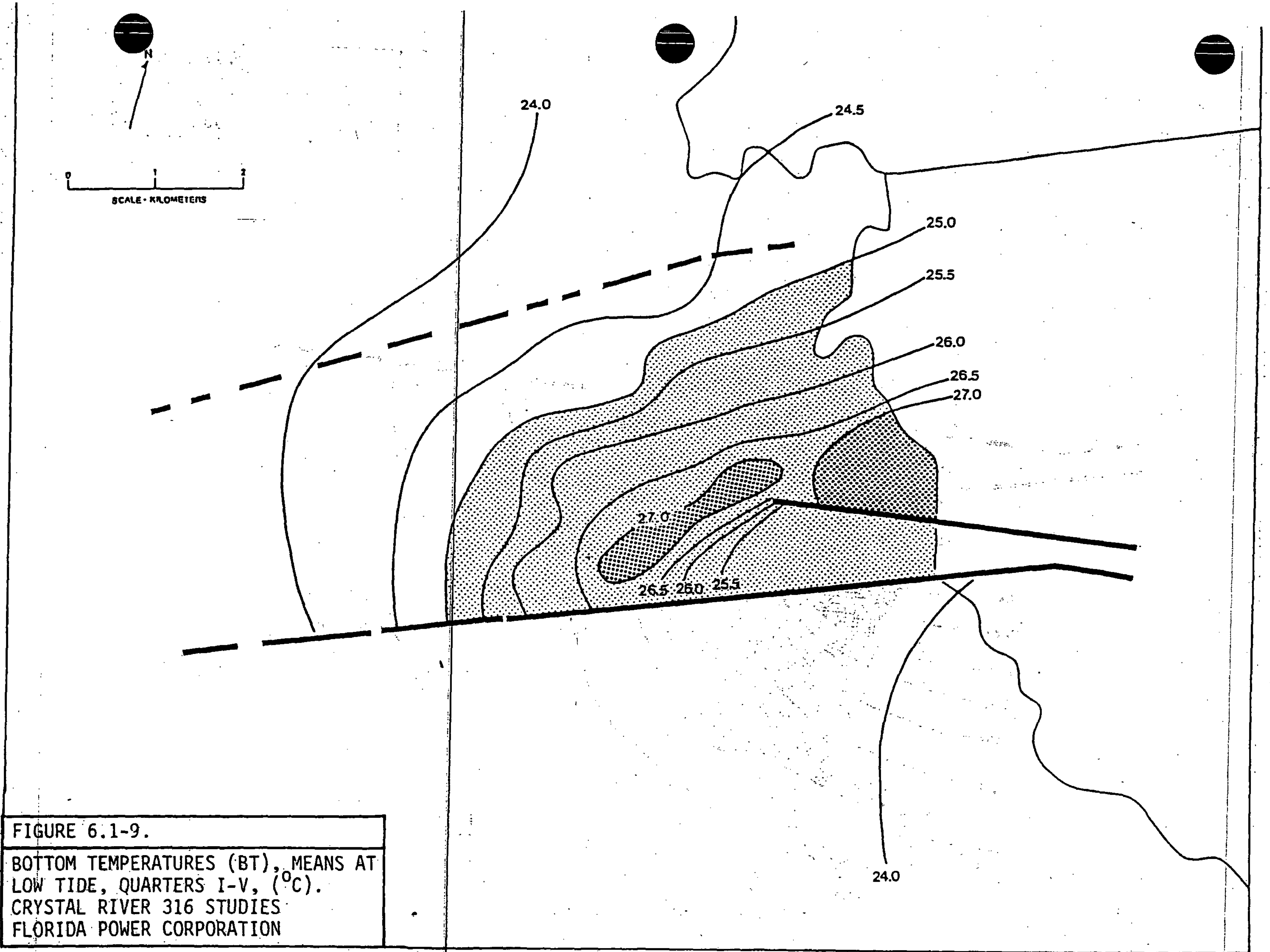


FIGURE 6.1-9.

BOTTOM TEMPERATURES (BT), MEANS AT LOW TIDE, QUARTERS I-V, (^{o}C).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

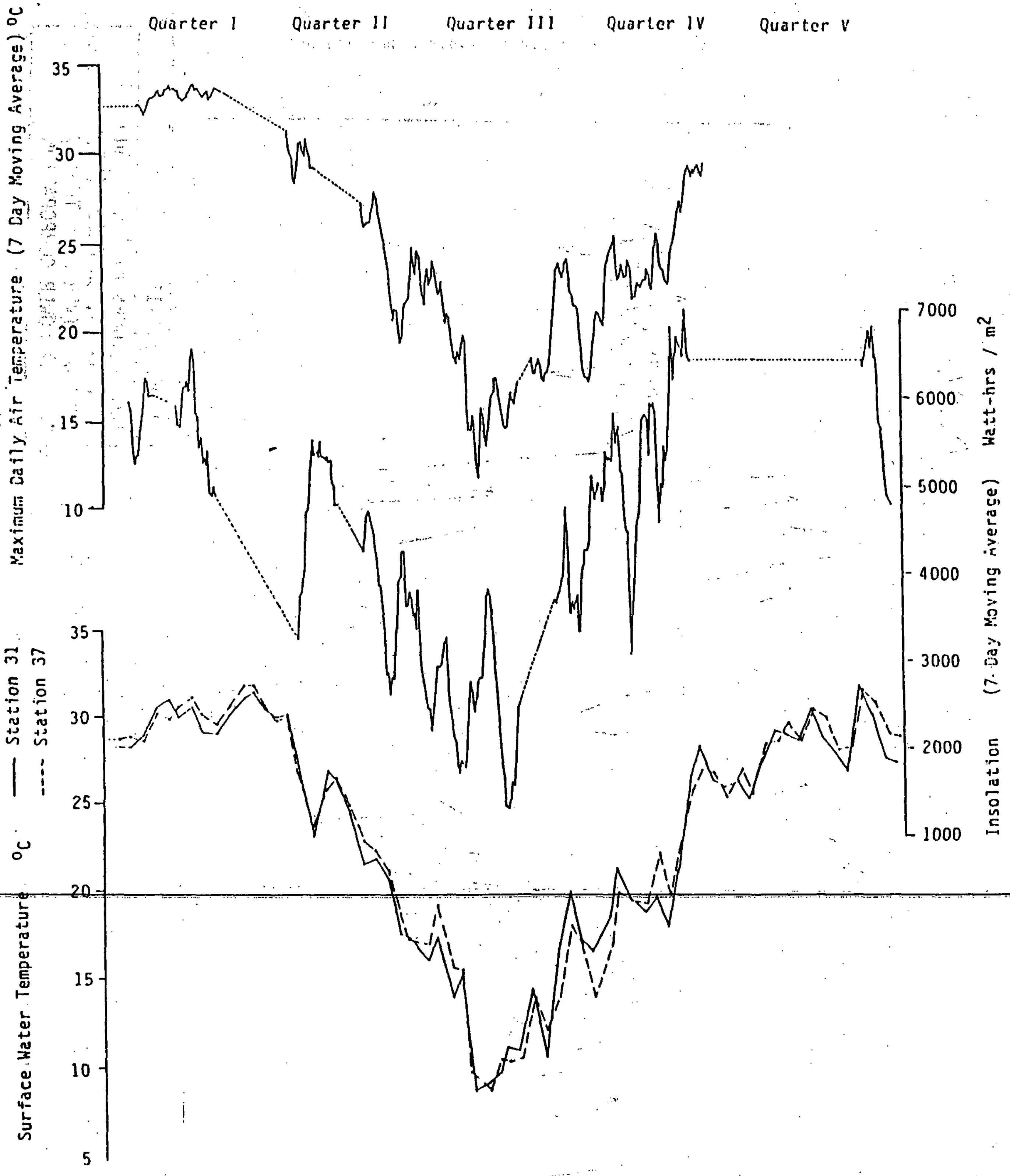


FIGURE 6.1-10.

MAXIMUM DAILY AIR TEMP. INSOLATION, SURFACE WATER TEMPERATURE. CRYSTAL RIVER 316 STUDIES FLORIDA POWER CORPORATION

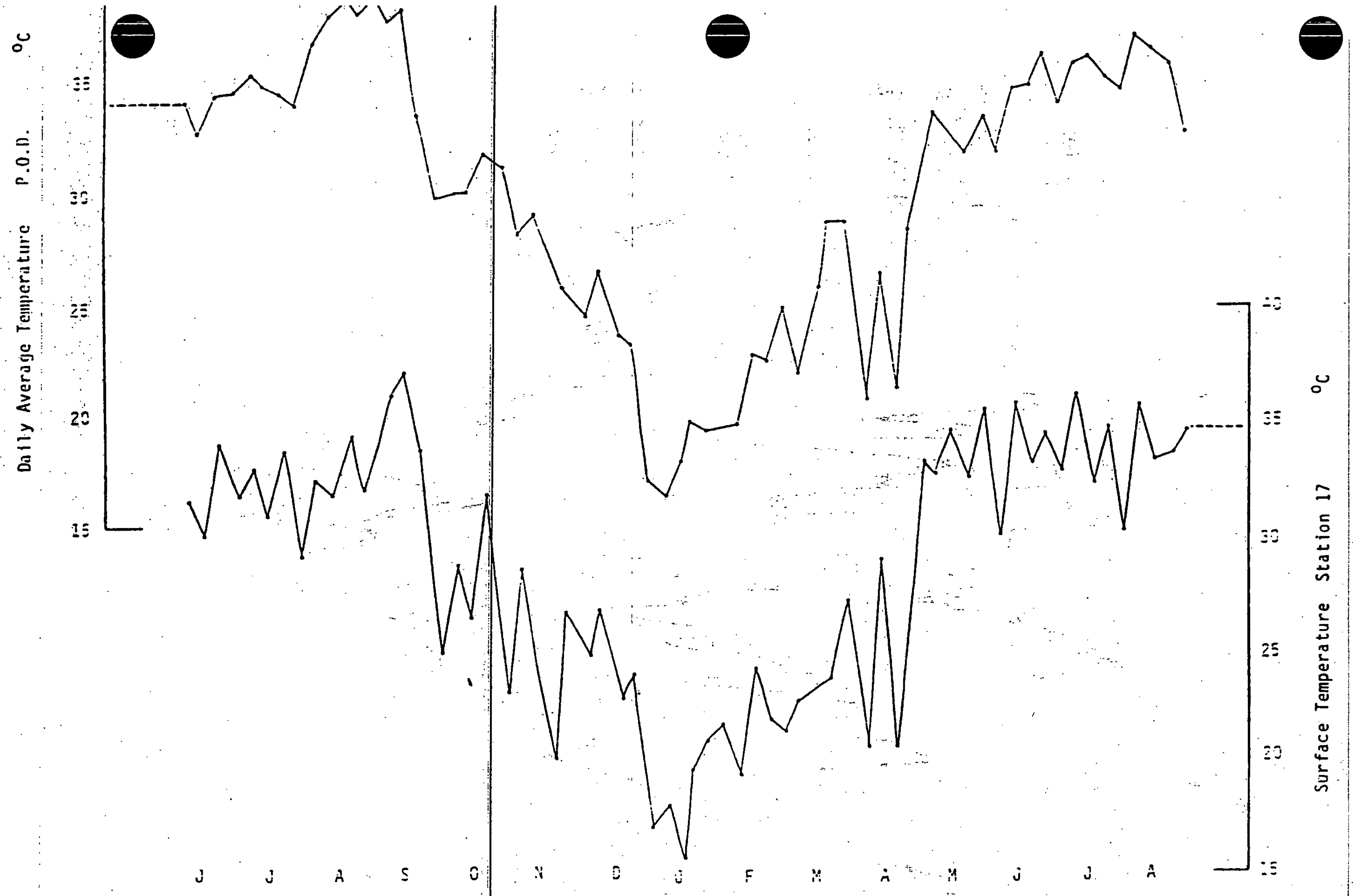


FIGURE 6.1-11.

TEMPERATURES AT P.O.D. AND STATION 17, SURFACE, (°C). CRYSTAL RIVER 316 STUDIES FLORIDA POWER CORPORATION

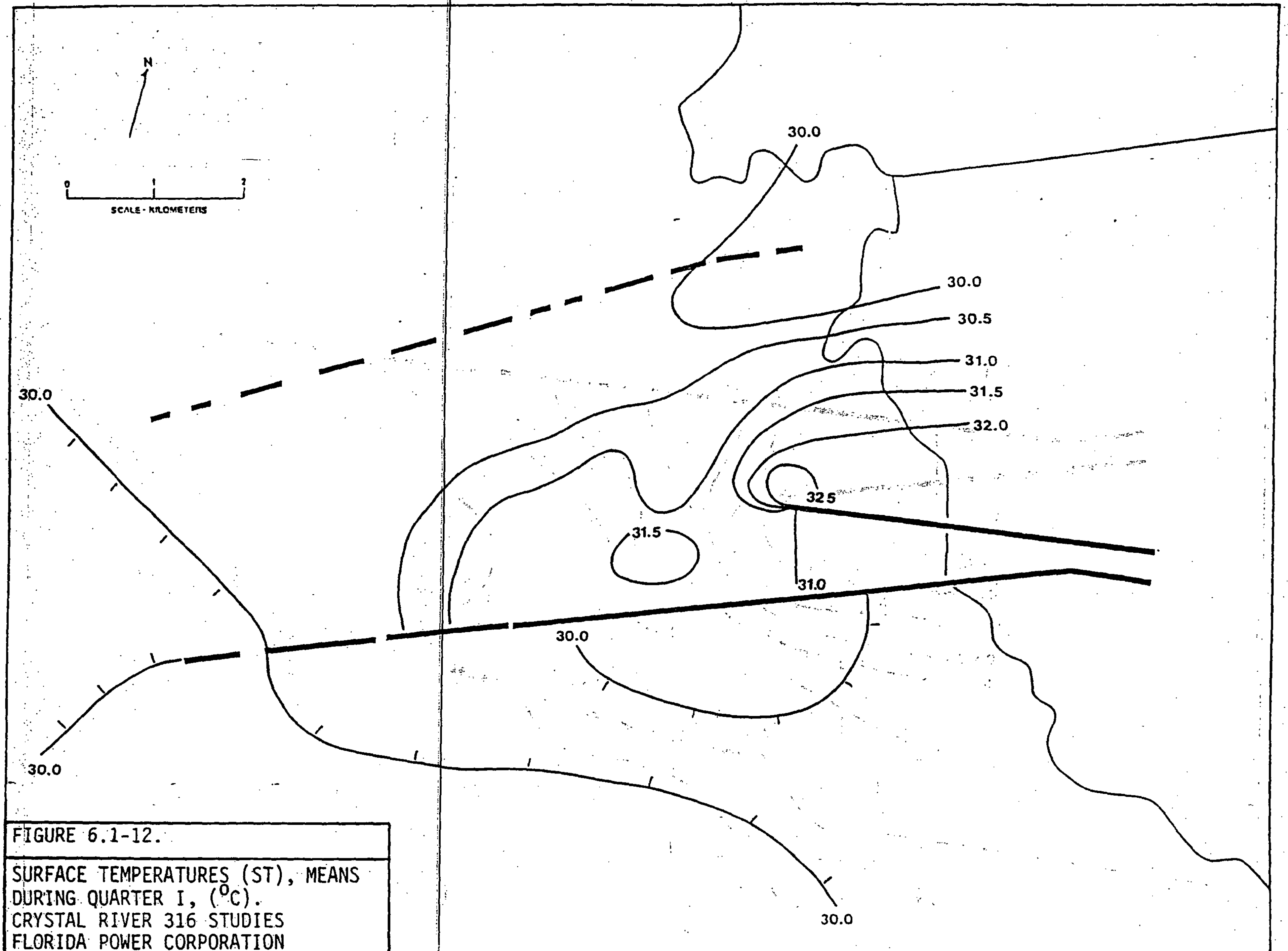


FIGURE 6.1-12.

SURFACE TEMPERATURES (ST), MEANS DURING QUARTER I, (^{O}C).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

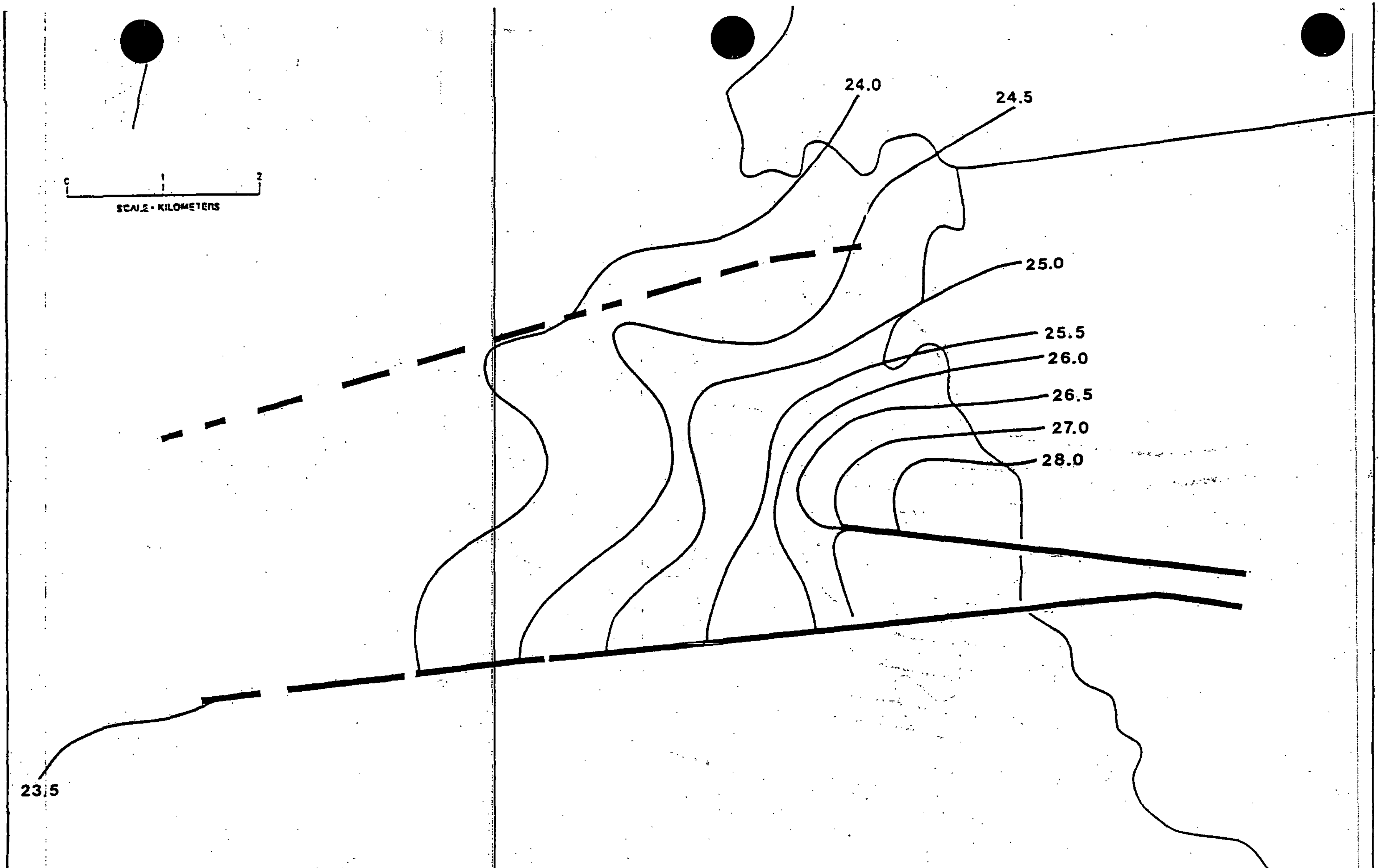


FIGURE 6.1-13.

SURFACE TEMPERATURES (ST) AT HIGH TIDE, QUARTERS I-V, (°C).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

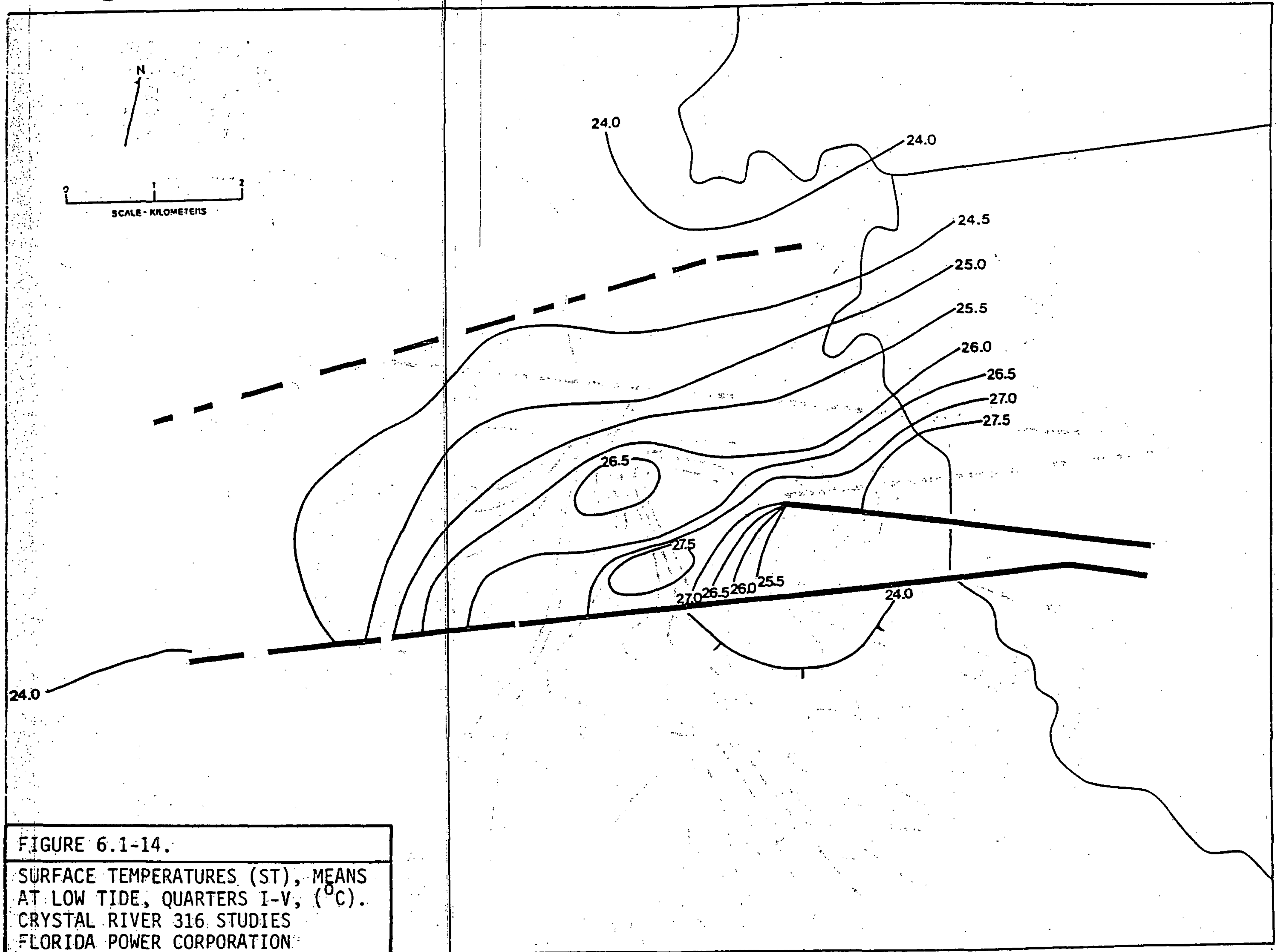


FIGURE 6.1-14.

SURFACE TEMPERATURES (ST), MEANS AT LOW TIDE, QUARTERS I-V, (°C).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

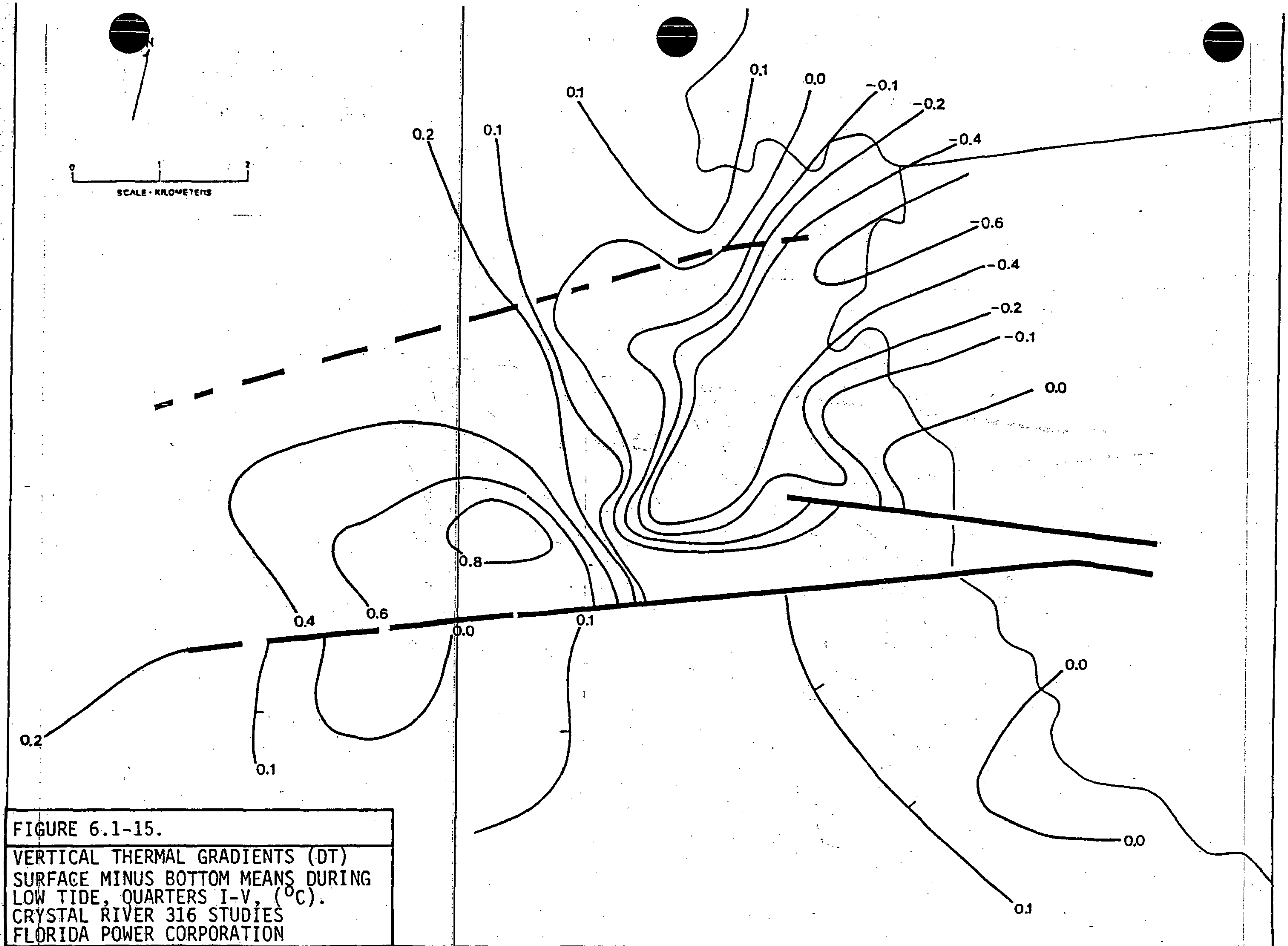


FIGURE 6.1-15.

VERTICAL THERMAL GRADIENTS (DT) SURFACE MINUS BOTTOM MEANS DURING LOW TIDE, QUARTERS I-V, (^{o}C).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

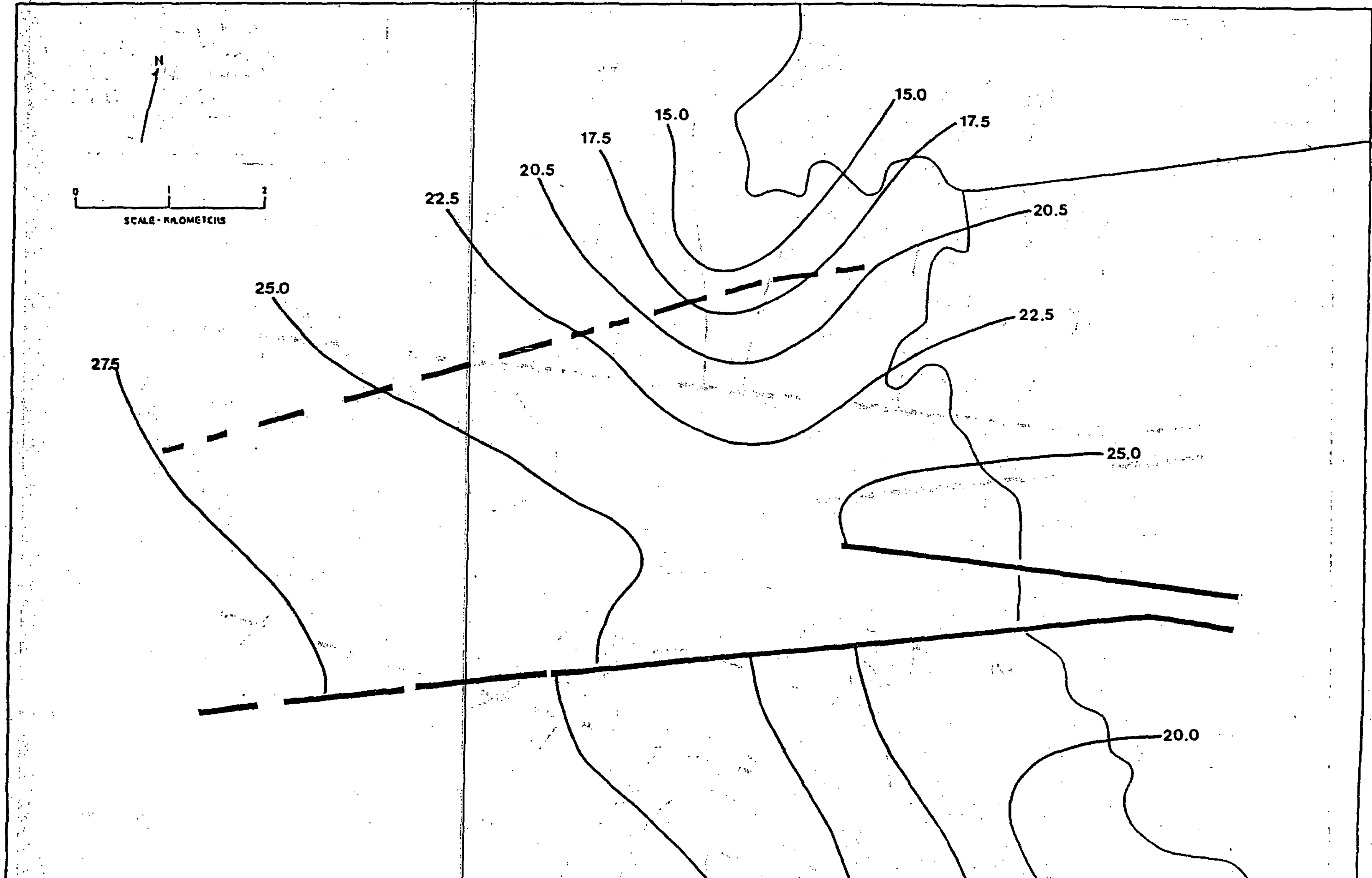


FIGURE 6.1-16.

BOTTOM SALINITY (BC), MEANS DURING QUARTER V, (o/oo).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

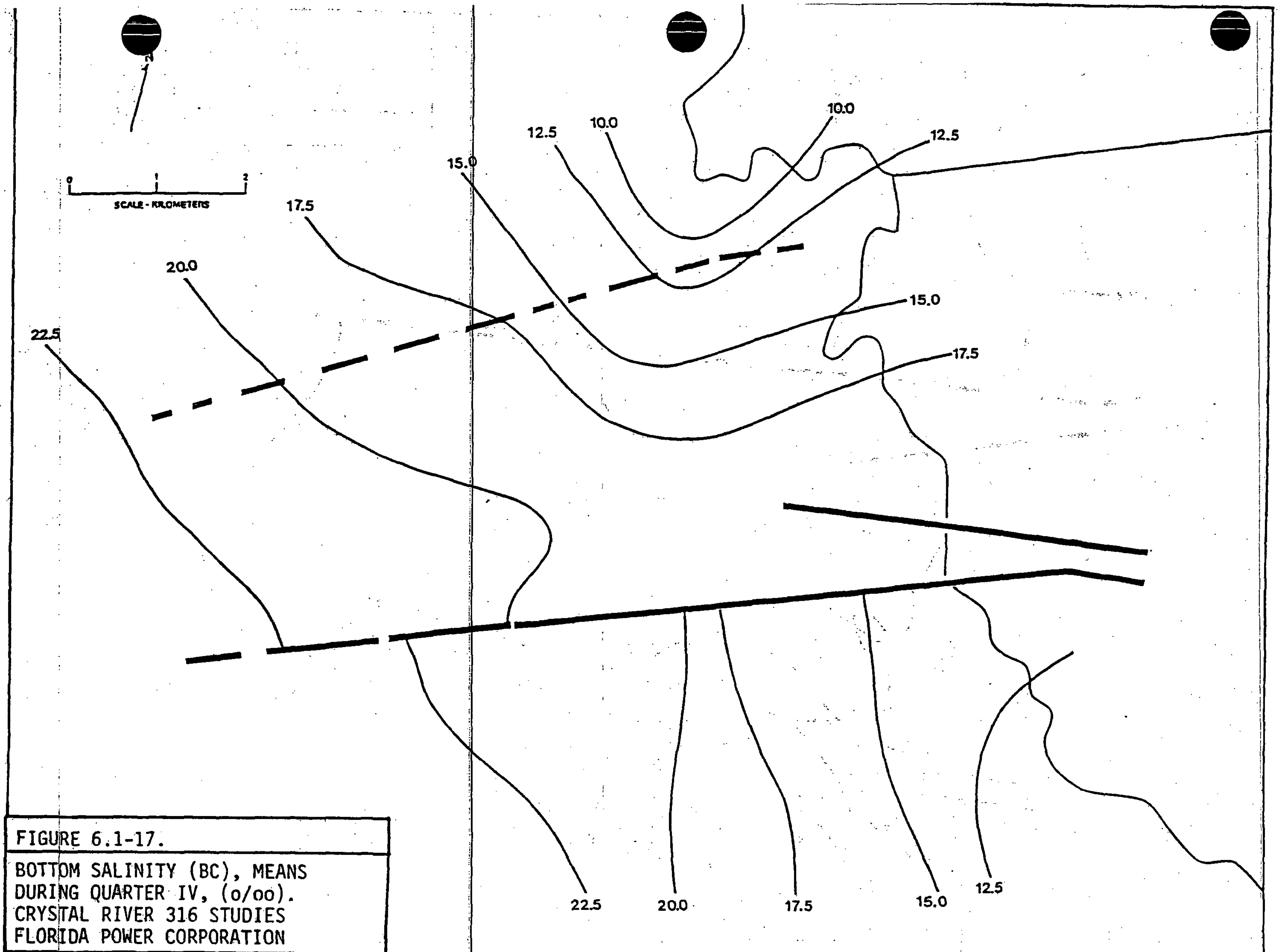


FIGURE 6.1-17.

BOTTOM SALINITY (BC), MEANS DURING QUARTER IV, (o/oo).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

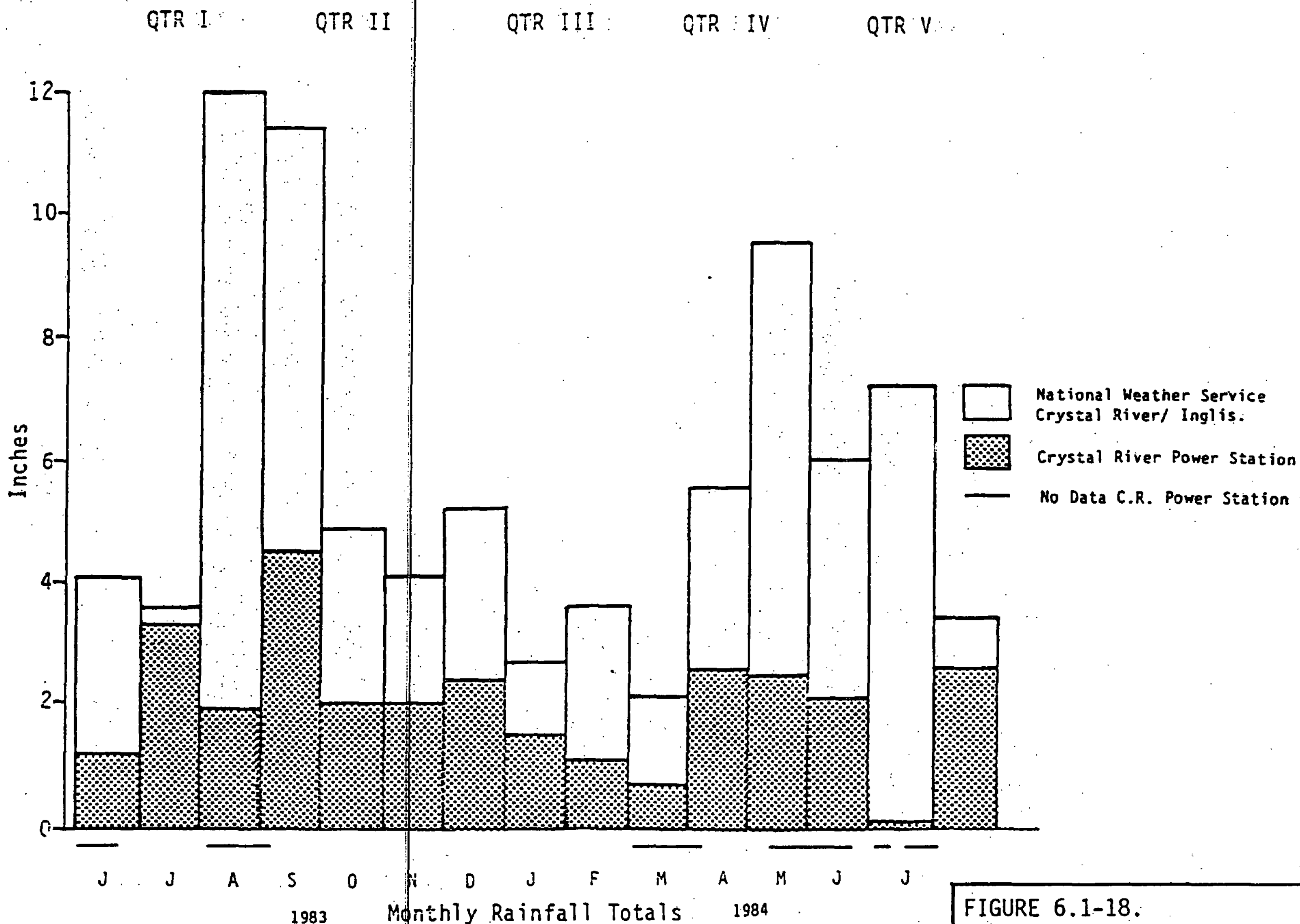


FIGURE 6.1-18.

MONTHLY RAINFALL TOTALS,
CRYSTAL RIVER AREA, (INCHES).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

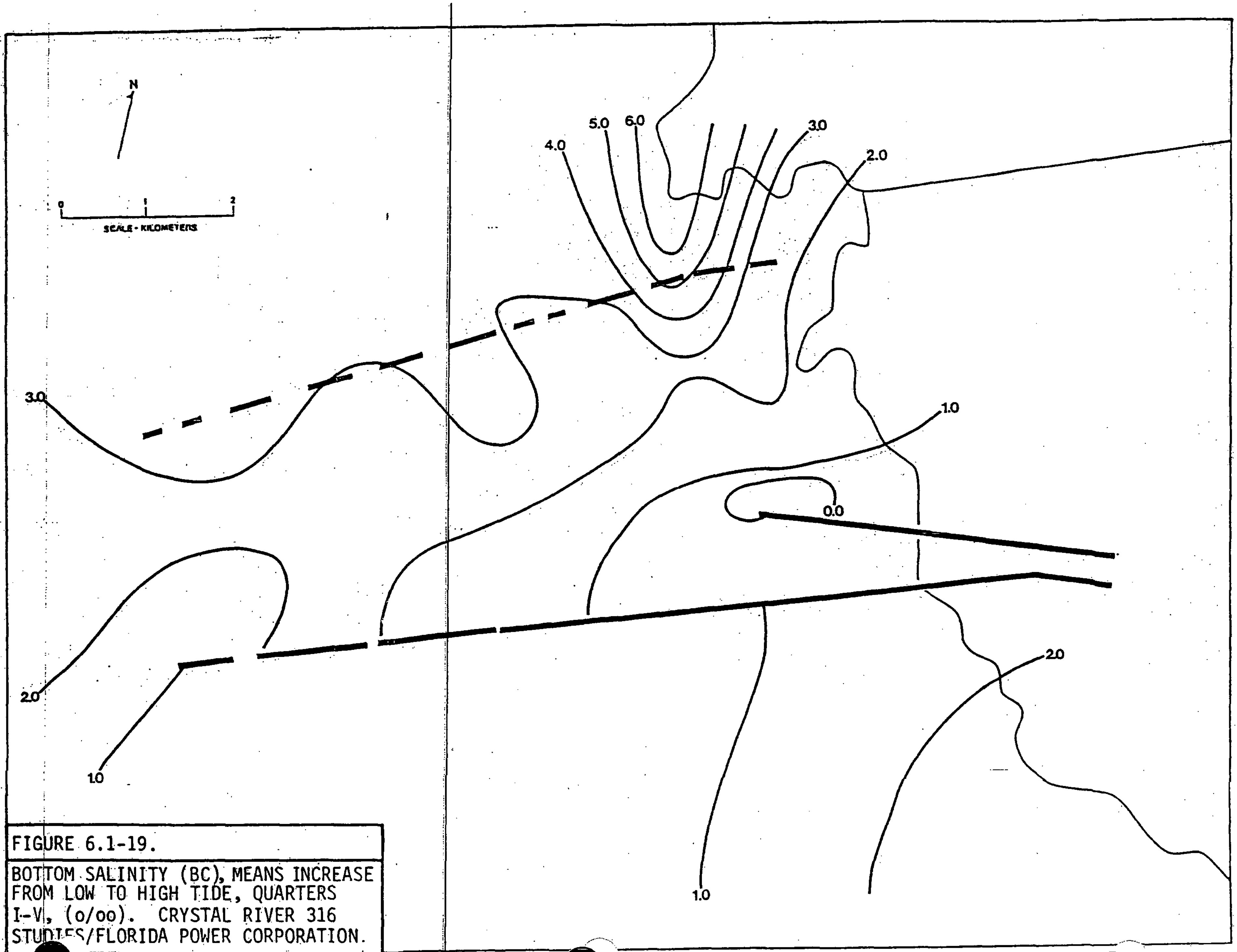


FIGURE 6.1-19.

BOTTOM SALINITY (BC), MEANS INCREASE FROM LOW TO HIGH TIDE, QUARTERS I-V, (o/oo). CRYSTAL RIVER 316 STUDIES/FLORIDA POWER CORPORATION.

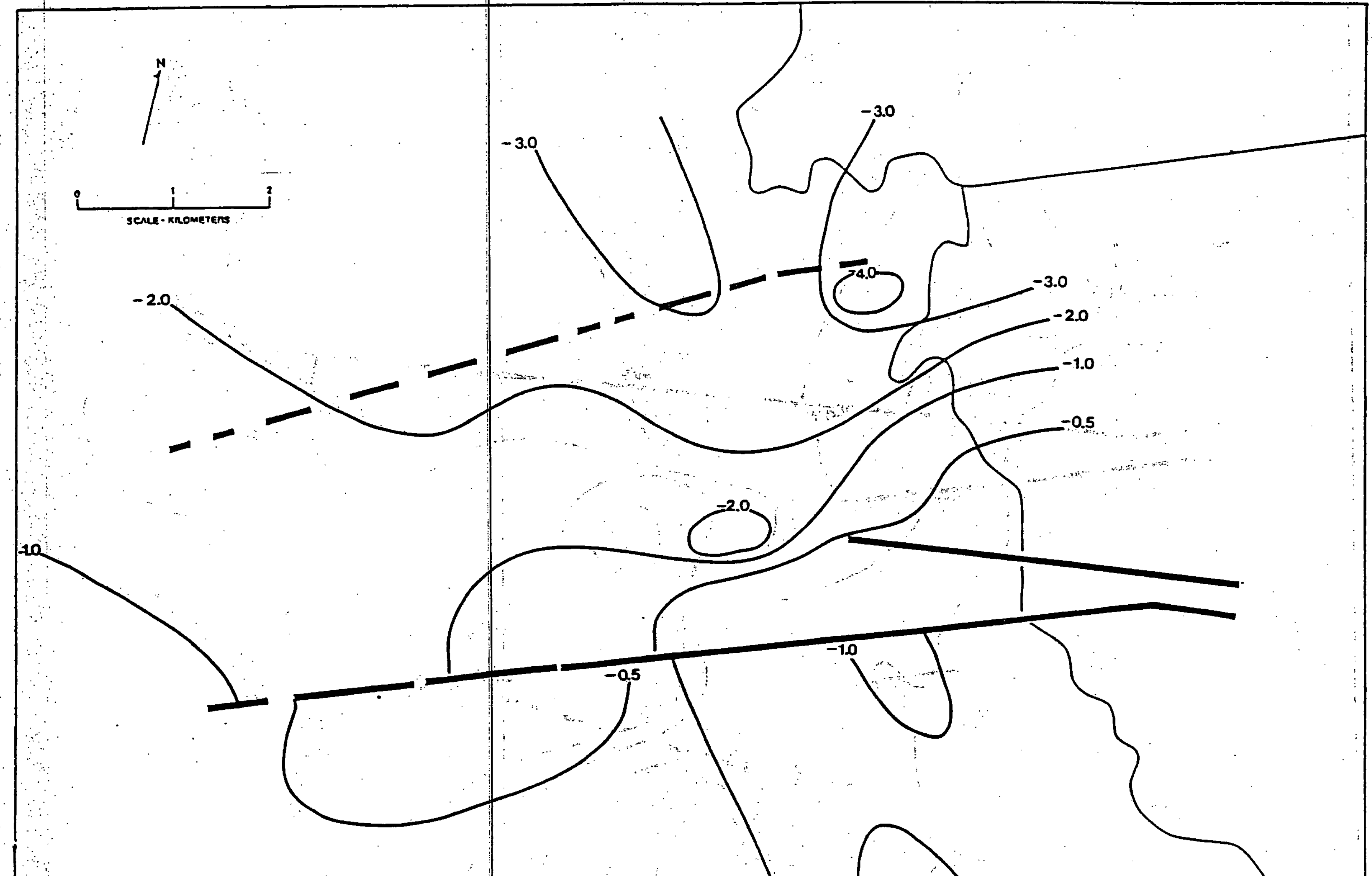


FIGURE 6.1-20.

VERTICAL SALINITY GRADIENTS (DC), SURFACE MINUS BOTTOM, QUARTERS I-V, (o/oo).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

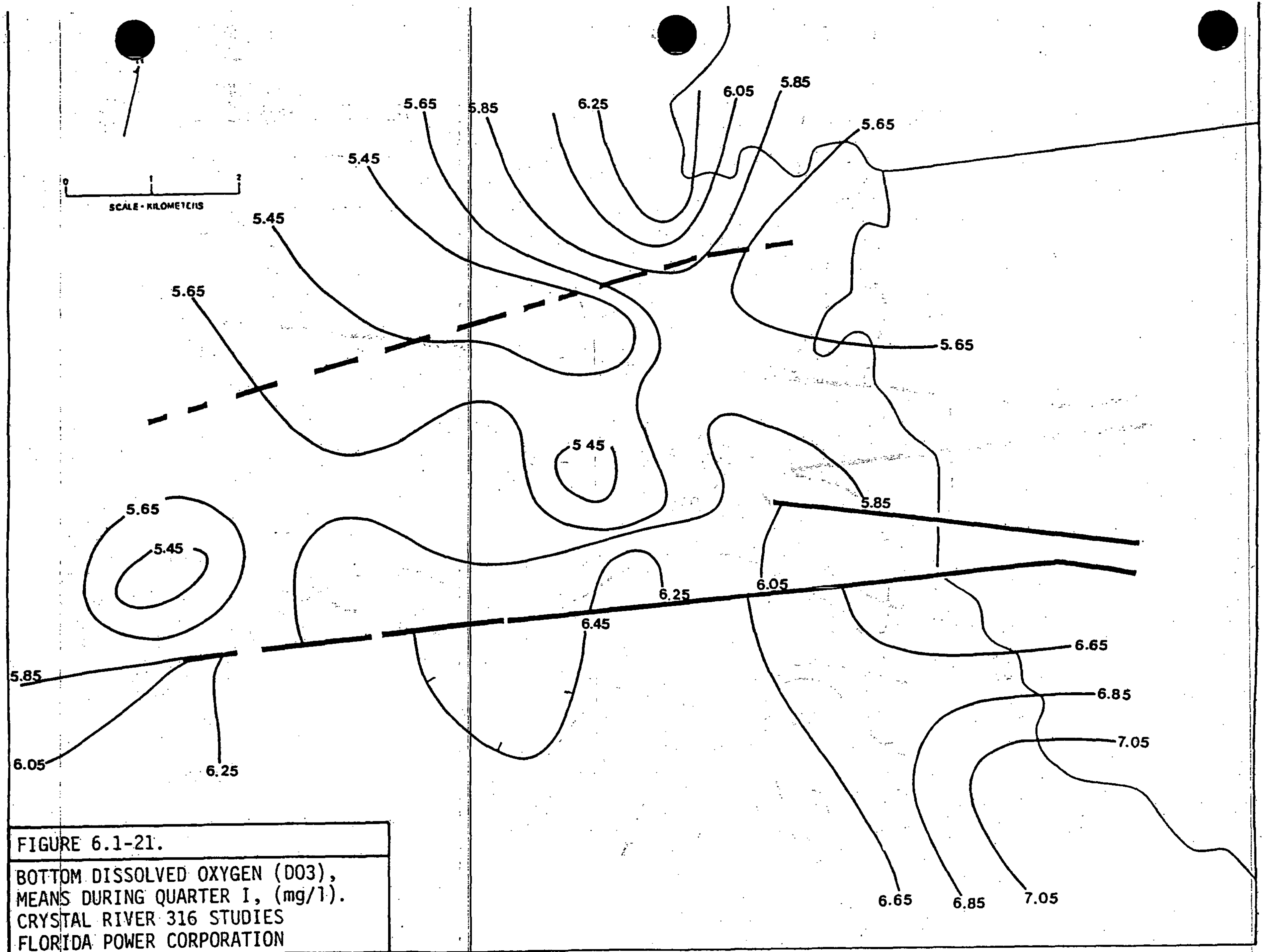


FIGURE 6.1-21.

BOTTOM DISSOLVED OXYGEN (DO3), MEANS DURING QUARTER I, (mg/l). CRYSTAL RIVER 316 STUDIES FLORIDA POWER CORPORATION

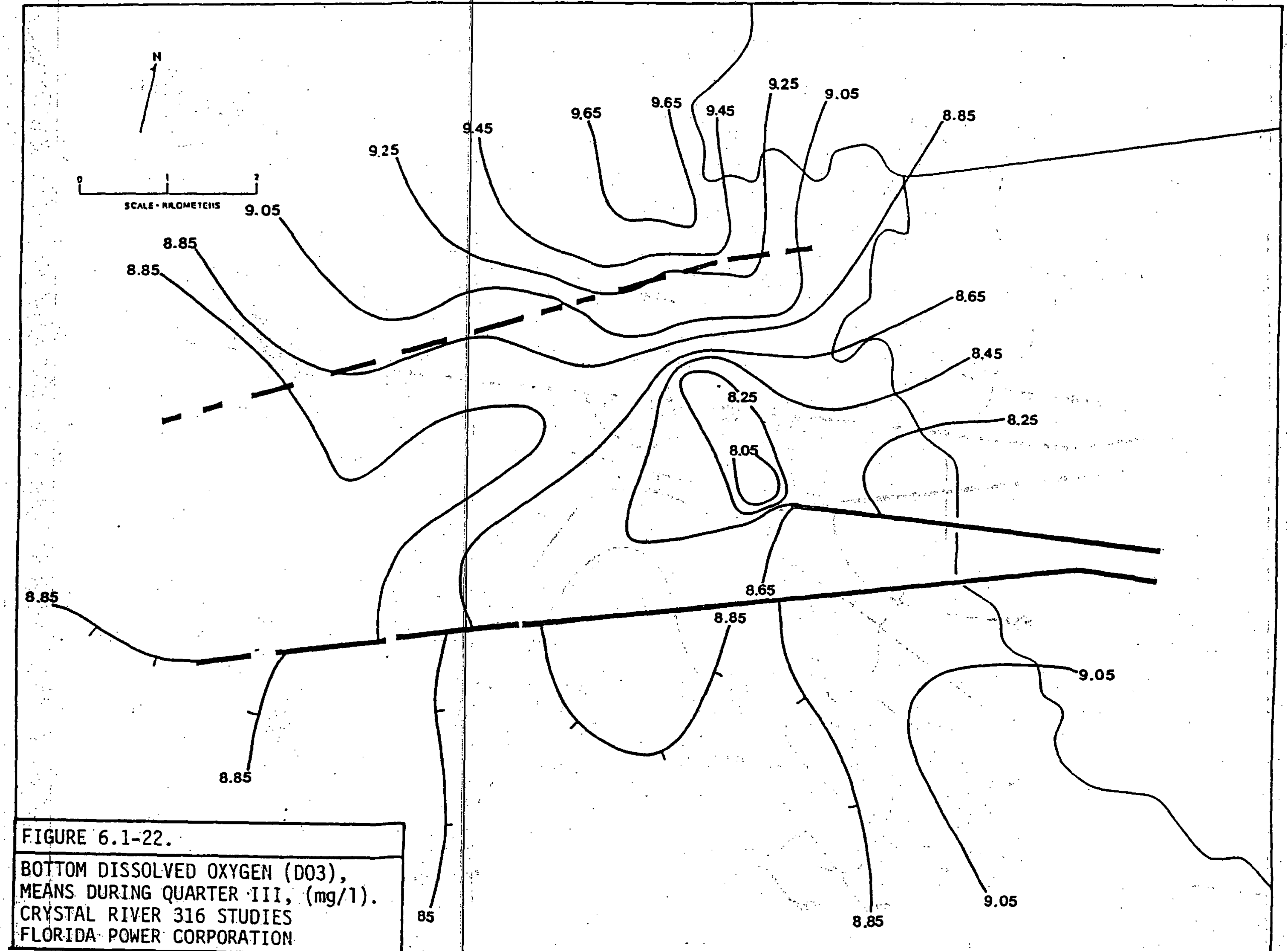


FIGURE 6.1-22.

BOTTOM DISSOLVED OXYGEN (DO3), MEANS DURING QUARTER III, (mg/l). CRYSTAL RIVER 316 STUDIES FLORIDA POWER CORPORATION

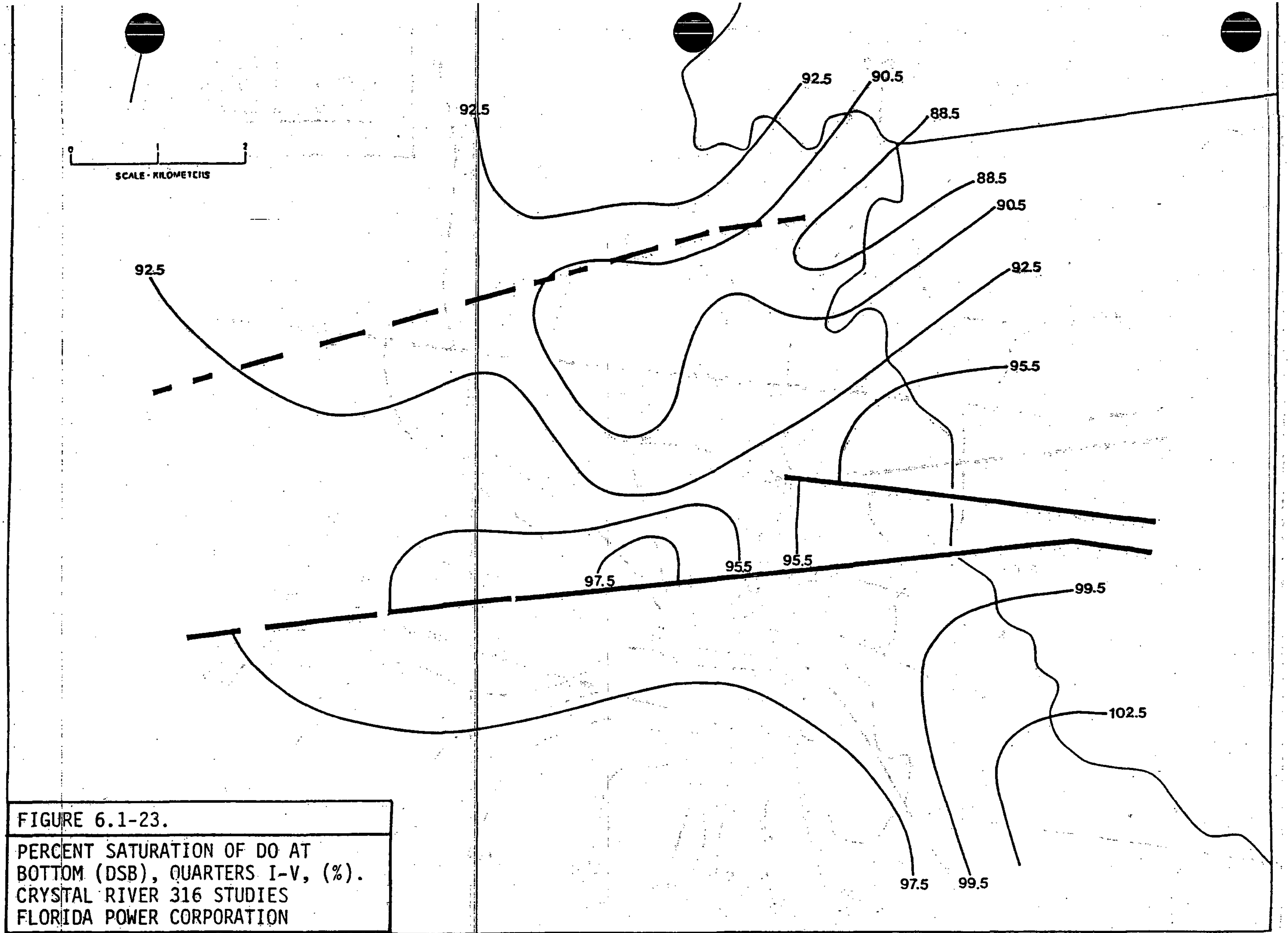


FIGURE 6.1-23.

PERCENT SATURATION OF DO AT BOTTOM (DSB), QUARTERS I-V, (%).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

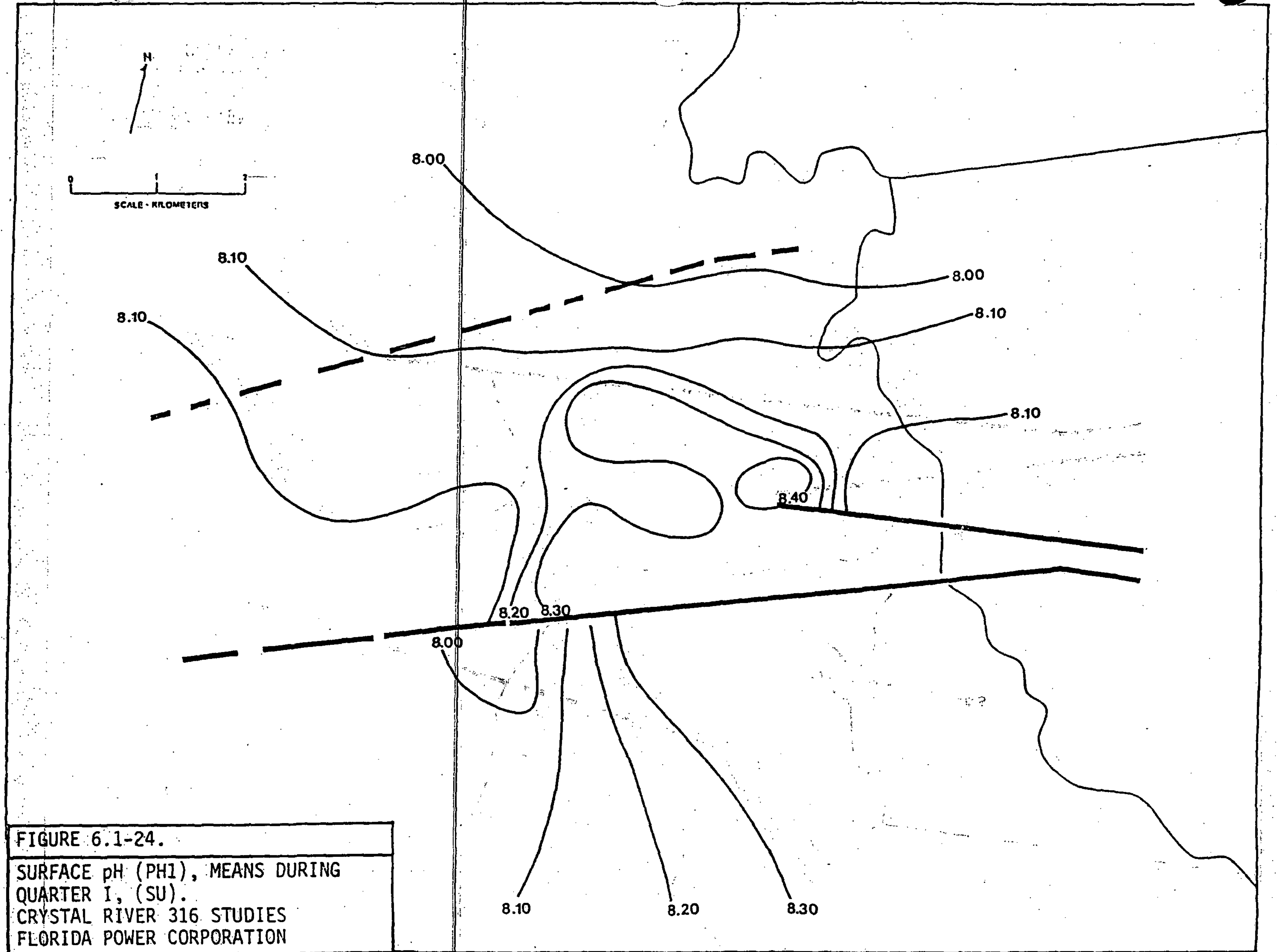


FIGURE 6.1-24.

SURFACE pH (PH1), MEANS DURING
QUARTER I, (SU).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

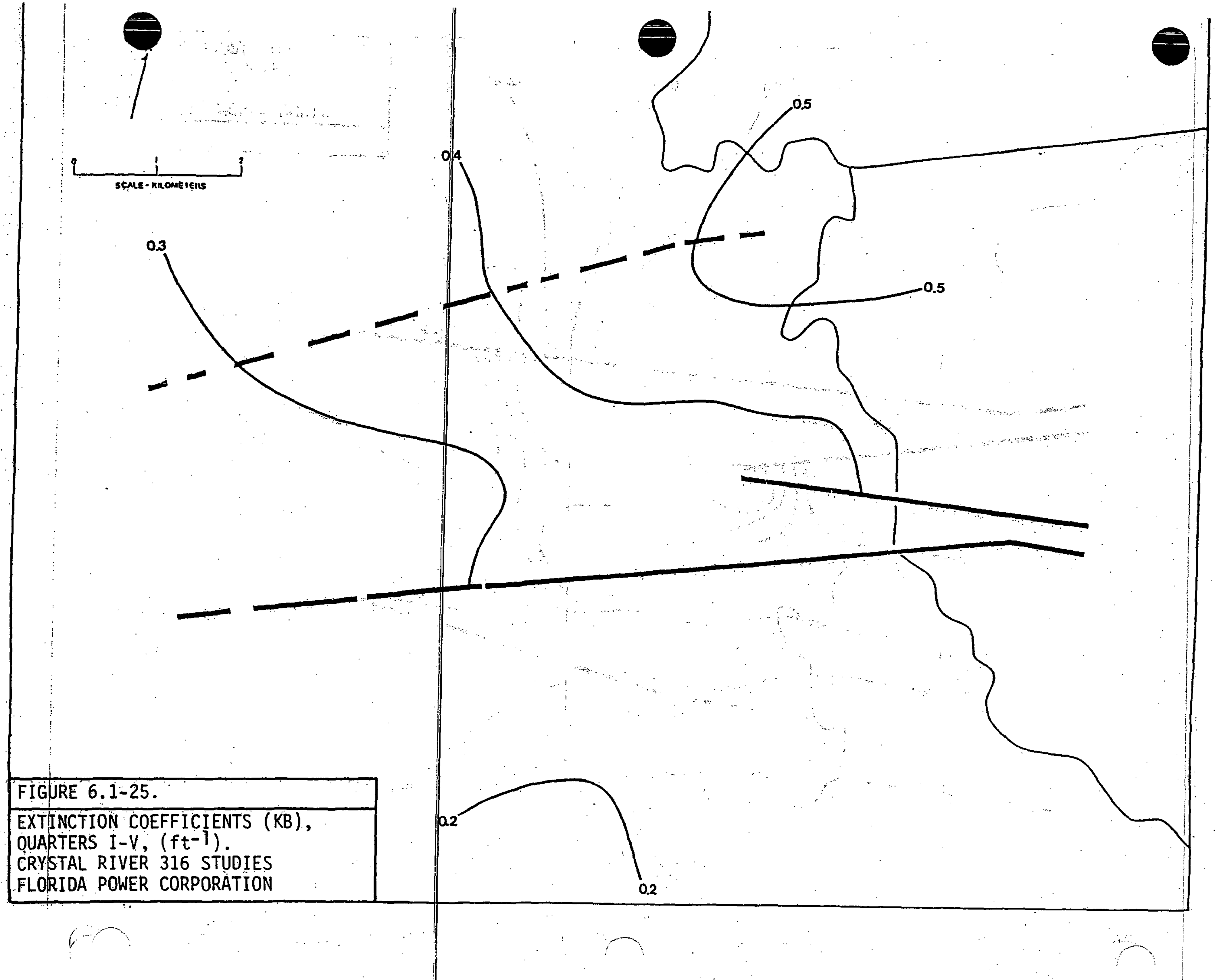


FIGURE 6.1-25.

EXTINCTION COEFFICIENTS (KB), QUARTERS I-V, (ft^{-1}).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

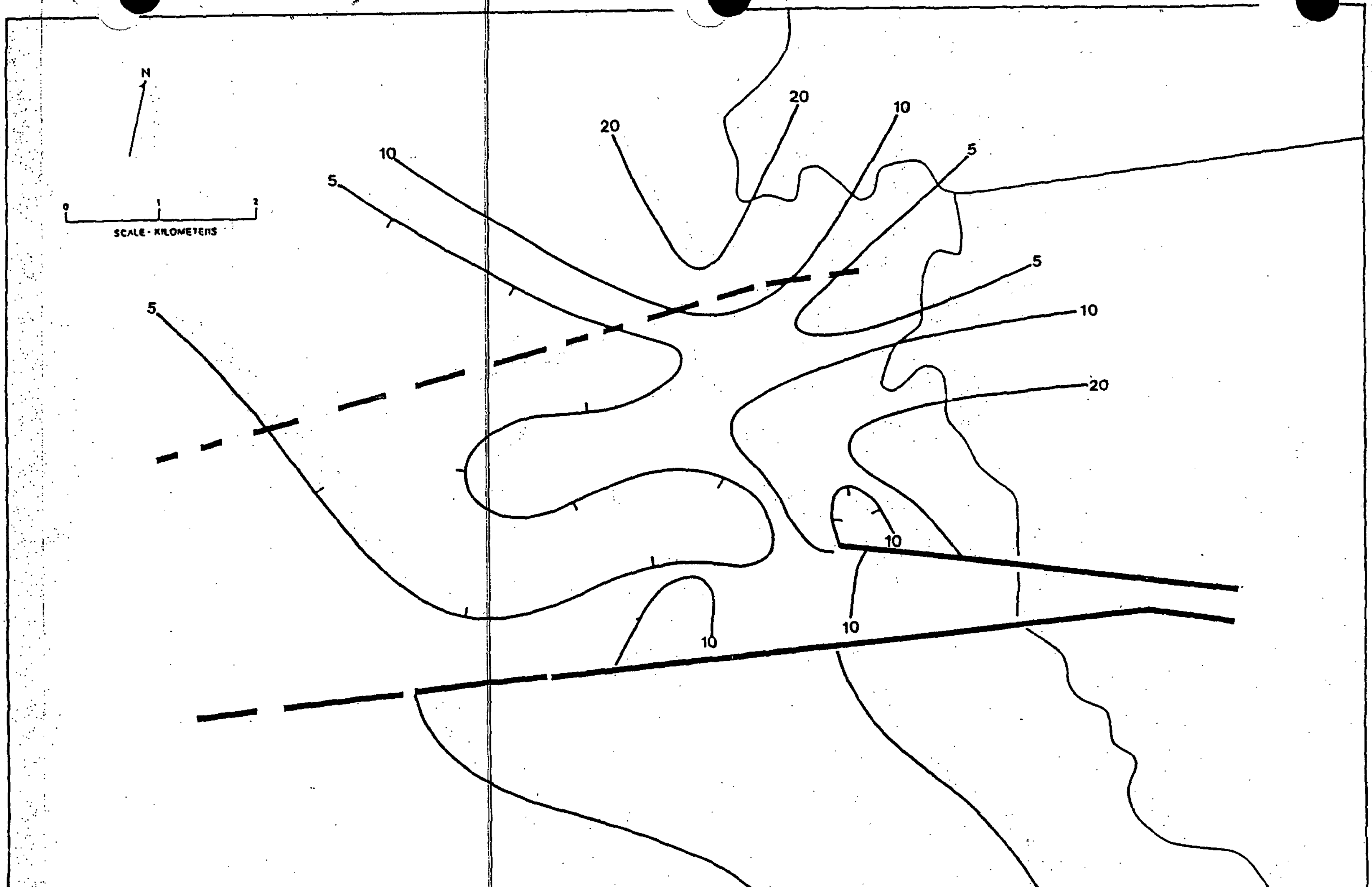


FIGURE 6.1-26.

PERCENT LIGHT AT BOTTOM,
QUARTERS I-V, (%).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

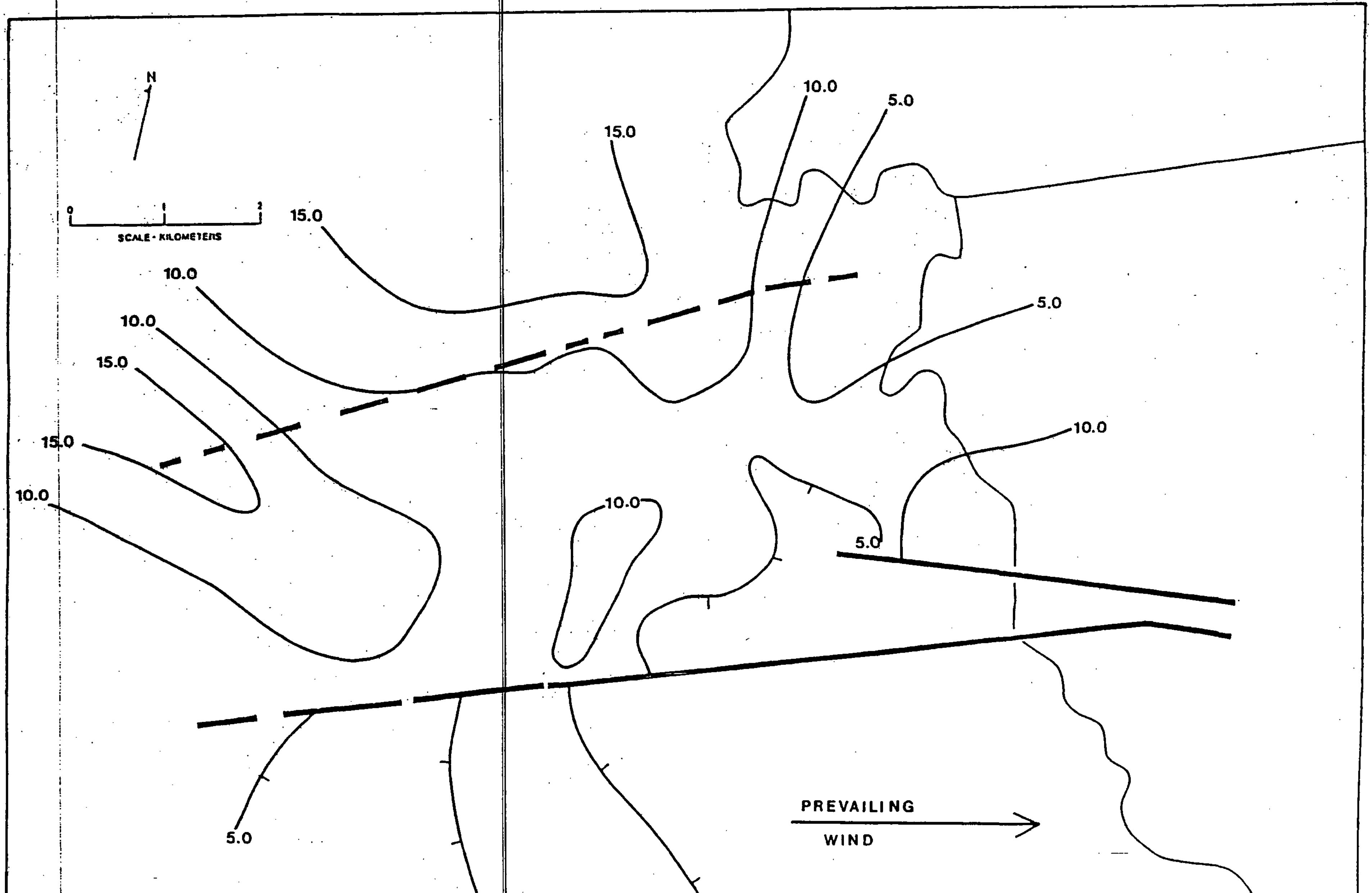


FIGURE 6.1-27.

ELEVATION OF TURBIDITY DUE TO STORM, 7/26/84, (NTU).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

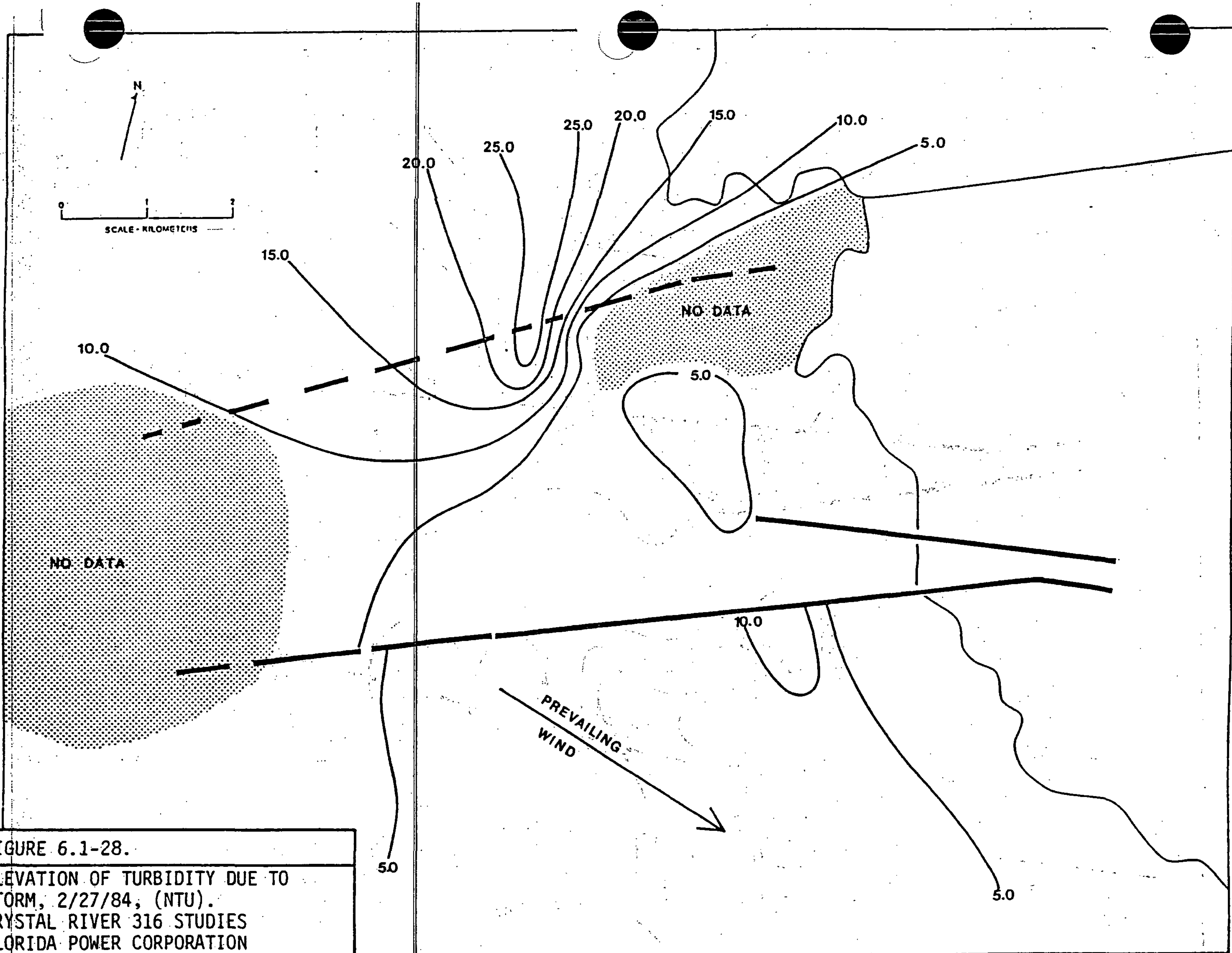


FIGURE 6.1-28.

ELEVATION OF TURBIDITY DUE TO STORM, 2/27/84, (NTU).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

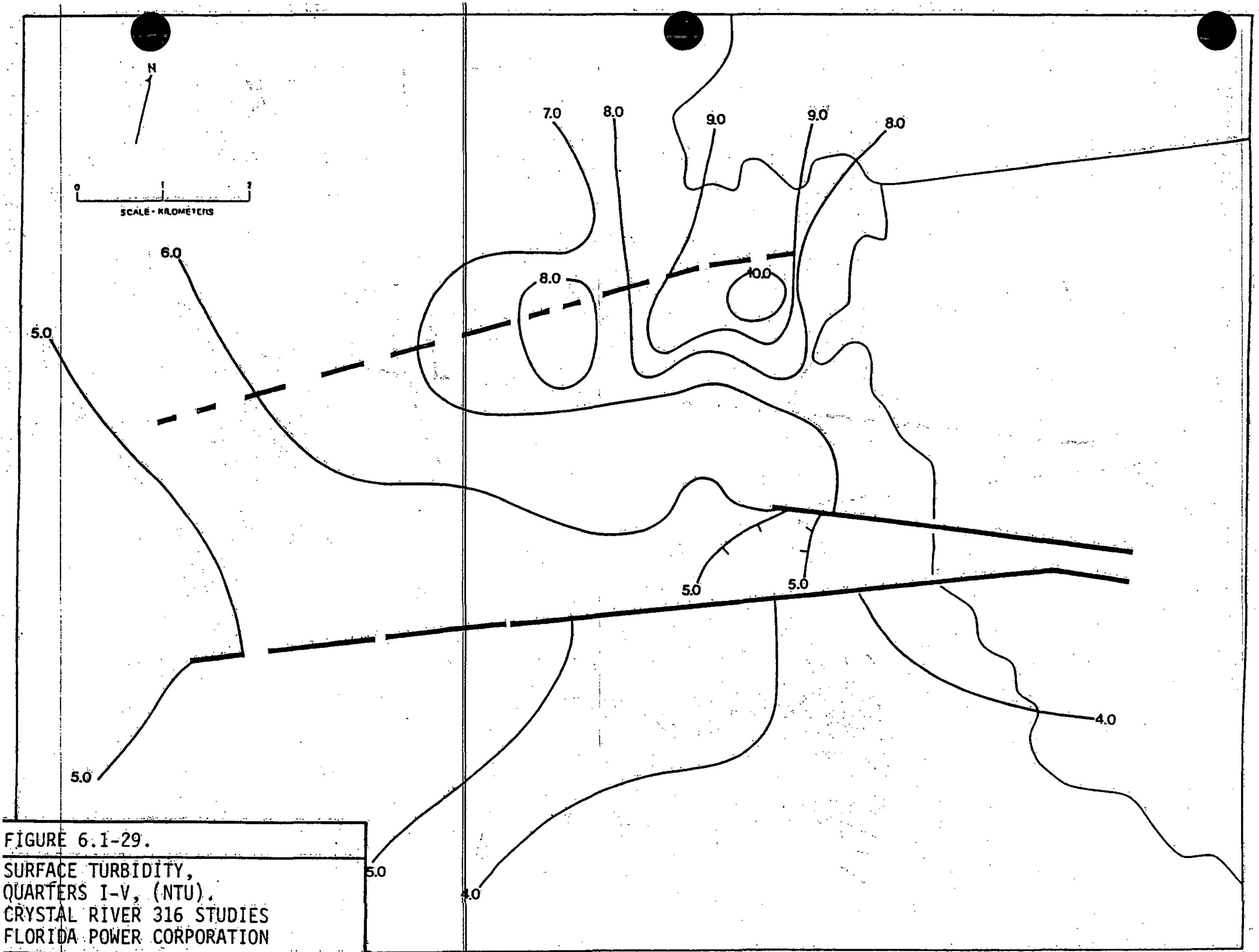


FIGURE 6.1-29.

SURFACE TURBIDITY,
QUARTERS I-V, (NTU).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

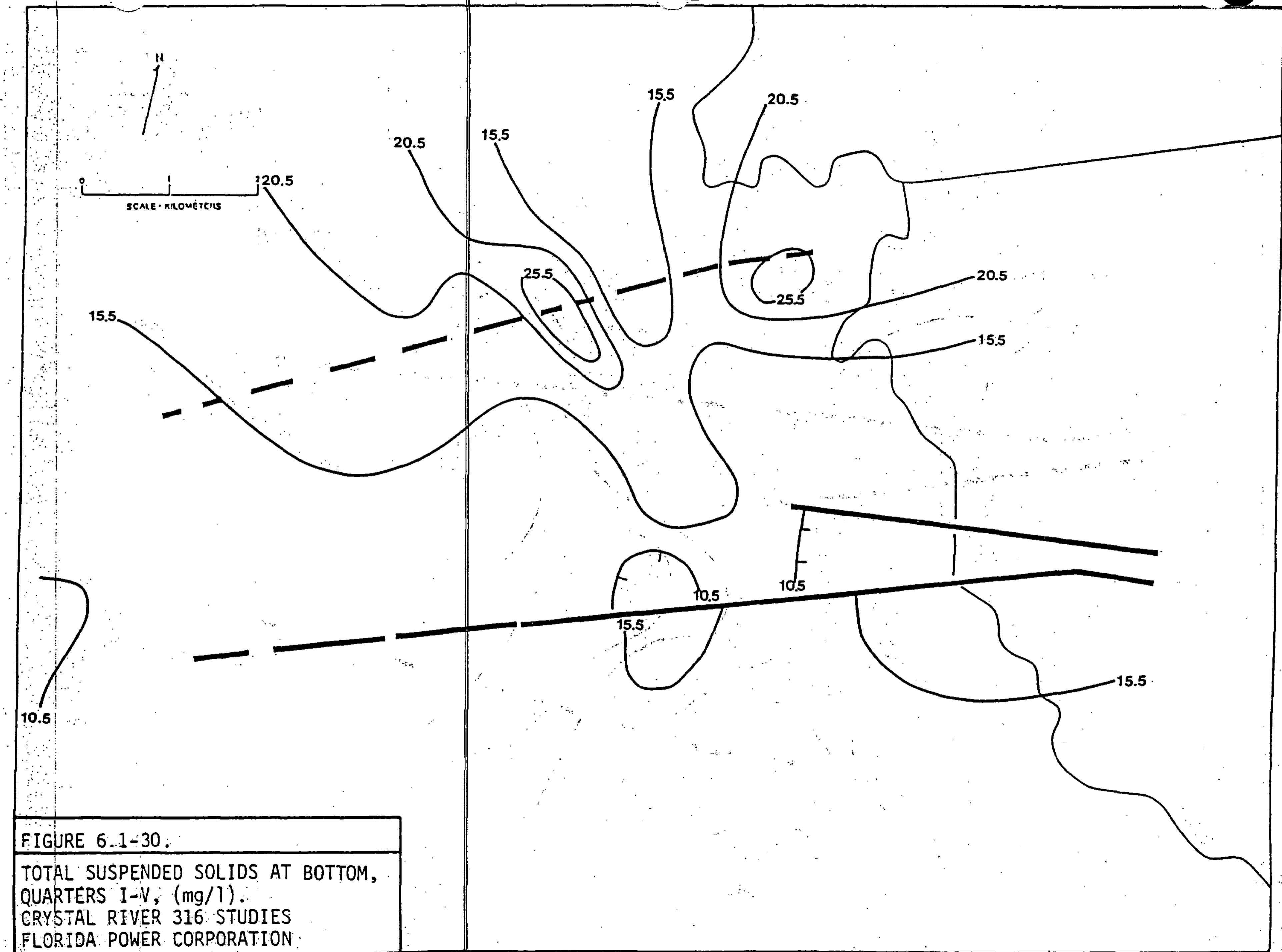


FIGURE 6.1-30.

TOTAL SUSPENDED SOLIDS AT BOTTOM, QUARTERS I-V, (mg/l).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

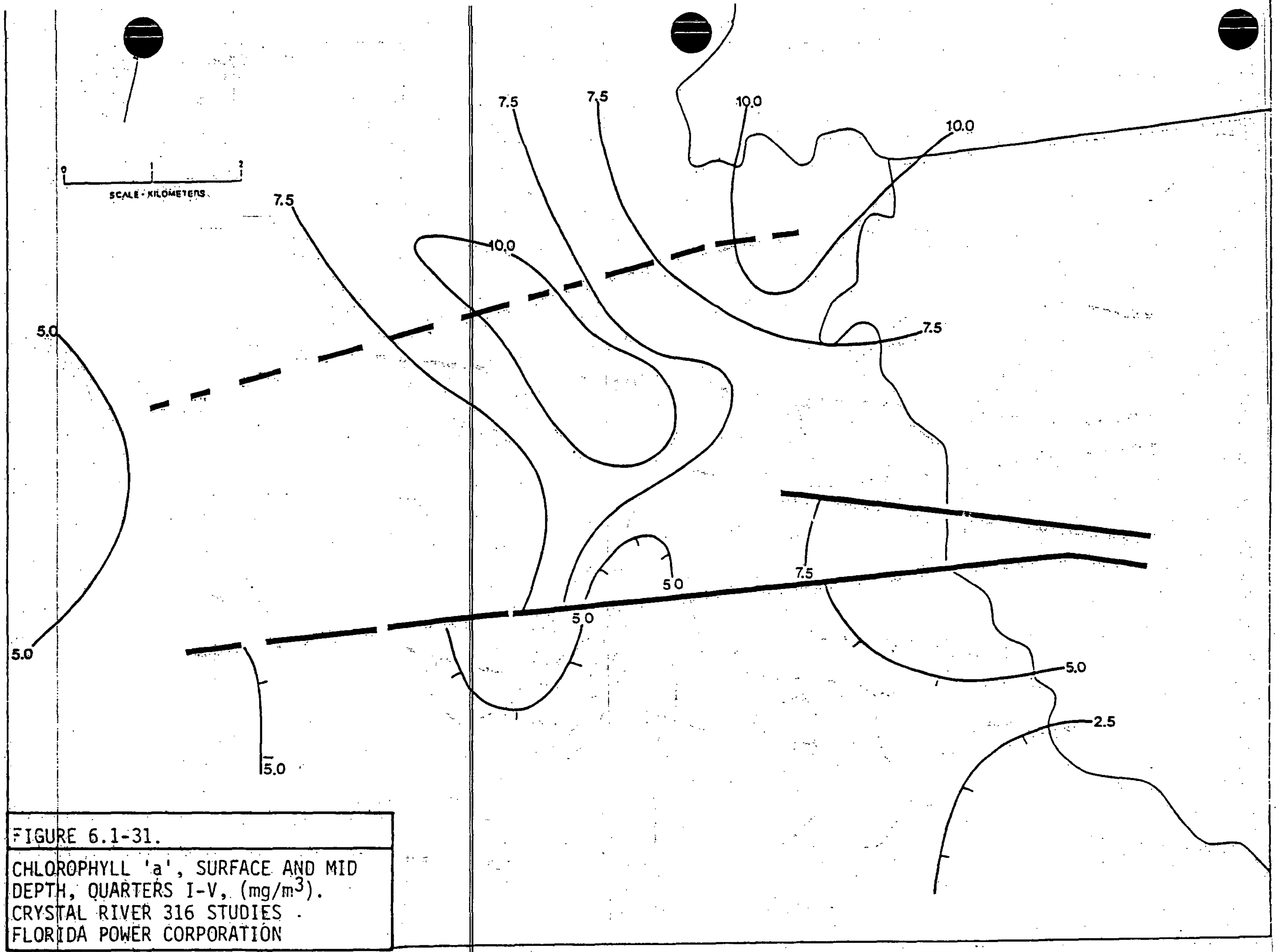


FIGURE 6.1-31.

CHLOROPHYLL 'a', SURFACE AND MID DEPTH, QUARTERS I-V, (mg/m^3).
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

6.2 BENTHIC INFAUNA

6.2.1 Sampling and Laboratory Analysis

6.2.1.1 Field Sampling Procedures

Benthic faunal samples were collected at 40 stations (Figure 6.1-1) once a quarter for five quarters, and at 20 of these stations once every 6 weeks for five samplings, to provide quantitative information on the soft bottom macro-infauna of the study area. Samples were collected using benthic faunal box cores constructed after a design originally used by Saloman (1976). Inside core dimensions were 12.5 x 12.5 x 15 cm deep.

Stations locations were established using Loran C. Cores were obtained at each station by divers. The cores were inserted vertically into the substrate. The diver would then remove the sediments on one side of the core and slide a hand across the open end. The core was then inverted and a close weave cotton bag placed over the entire core. A total of eight faunal cores were collected for each station. Six of the cores were processed and two were archived for use if needed. After emptying the core contents into the cotton bag, each bag was submerged in a solution of 15 percent magnesium sulfate solution in seawater for narcotization (Russell 1963).

After narcotization of core samples for a minimum of 30 minutes, samples were washed through a 0.5 mm mesh sieve to remove the finer sediments, preserved in 10 percent formalin seawater and stained with rose bengal stain to facilitate rapid and accurate sorting (Mason and Yevich 1967; Korinkova and Sigmund 1968; Hamilton 1969; Williams and Williams 1974).

Sediment samples were collected each quarter at the 40 benthic faunal stations and analyzed to determine granulometric distribution, total organic carbon (TOC), and free sulfide content. Sediment samples for sulfides were collected from ten stations each day for four consecutive days (40 stations). Samples were collected as early as possible each day and immediately returned to the laboratory for processing. Because sulfides are easily oxidized, the transporting container excluded atmospheric oxygen, was purged with nitrogen after each opening and the entire device was stored and transported on ice.

For collection of the sulfide samples at each station three 3.81 cm (ID) by 15 cm PVC cores were utilized. Cores were collected by a diver. An uncapped core was pushed into the substrate with one hand until the sediment within the core reached the top rim. Cores were then capped on the upper end, sediment was removed from around the outside of the core, the contents of the core were retained by hand, the core was removed from the substrate and the open end capped. Cores were then returned to the support vessel and stored.

Concurrently with the faunal core collection three sediment core samples were collected at each station for granulometry and total organic carbon (TOC). Cores were collected using the method described above. On the surface vessel, the sediment was extruded into a 500 ml plastic sample jar. Each jar was stored on ice until returned to the field facility, where samples were inventoried and frozen. Samples remained frozen until processed.

Also in conjuction with the benthic faunal sampling, sediment temperature and Eh were measured with a Martek Mark VII multiparameter instrument equipped with a specialized sediment probe. Eh readings were taken once every 3 minutes for 25 minutes, while temperature was read with the last Eh reading. Eh and temperature measurements were made once every 6 weeks at the stations sampled for fauna.

6.2.1.2 Laboratory Procedures

After a minimum of 48 hours in 10 percent formalin preservative, benthic faunal samples were transferred to 70 percent isopropyl alcohol. In preparation for rough sorting, faunal samples were decanted into light and heavy fractions. The light fraction contained the majority of fauna and was sorted under a Unitron ZSB stereozoom binocular microscope. The heavy fraction, containing primarily molluscs and larger animals, was sorted with the unaided eye in the white background pan. Each sample was rough sorted into four major groups: polychaetes; crustaceans; molluscs; and miscellaneous.

Taxonomic identifications were performed under various powers of the binocular stereozoom (.7-40X) or a Nikon or Unitron compound microscope (40-1000X). Identifications of taxa to the lowest practical level were accomplished with the use of descriptive literature, comparison to reference collections, and the use of external consultants for verification of problem identification.

Sulfide cores were analyzed according to procedures described in Method 3-243 (EPA 1981), Method No. 112-71W (Technicon 1973), and Method 427 (APHA 1980). The methods are capable of detecting sulfide levels of 0-0.32 mg/l. Three sulfide cores were analyzed from each benthic station. Sample cores were subsampled, placed onto a prepurged, distillation apparatus, and purged with nitrogen into a cadmium sulfate trapping solution using constant, predetermined purge times and rates and reagent volumes. Samples were analyzed using Technicon's Industrial Method 112.71W and a Technicon AutoAnalyzer II. Sample concentrations were computed based on original sediment weight.

Laboratory methods used for grain size analysis follow the procedures of Folk (1974). In the laboratory, sediment samples were stirred thoroughly and subsamples removed for TOC analysis. The remaining sample was then split into replicate samples. Each aliquot was then washed with distilled water through a 0.063 mm screen to remove as much of the silt/clay fraction as possible. This fraction was collected and dried. The material greater than 0.063 mm was dried and then placed into a Wentworth sieve series of 1 phi intervals (2.0 mm, 1.0 mm, 0.5 mm, 0.25 mm, 0.125 mm, 0.063 mm and less than 0.063 mm catch pan). The material retained on each sieve was weighed (to 0.001 gm). Sediment fraction raw weights were then analyzed to yield the following: size class percentage; cumulative percentage; median phi value, mean grain size (phi); sorting coefficient; graphic skewness and graphic kurtosis. The calculations use equations as cited in Folk (1974).

Total organic carbon analyses were conducted using Method 1 (EPA 1981) and Oceanography International (OI) Corporation's Dry Oxidation Procedure (OI undated). The effective range of this procedure is 0.2 to 40 mgC/g.

Subsamples were weighed and then dried to a constant weight at 70°C and weighed again to calculate percentage solids.

Inorganic carbon was removed from the samples by addition of HCl. Samples were then dried, treated with CuO, purged with O_2 and combusted. Samples were analyzed with an OI TOC analyzer (nondispersive infrared type) and quantified against standards and blanks prepared from known carbon concentrations.

6.2.1.3 Statistical Analyses

All of the benthic core summary statistics were calculated after the data set had been purged of species which were not representatively sampled by the core samplers. SAS procedures were used to calculate all summary statistics. The data were analyzed primarily with summary statistics which characterize the benthic community. Species richness, diversity (as measured by Shannon-Weaver, Pielou 1975), and evenness were calculated for each station and date of sampling. Morisita's index of faunal similarly was also calculated for each pairwise combination of station and sampling date. Faunal density (number per m^2) was the only non-community type metric calculated.

The hundreds of pairwise measures of Morisita's index were summarized using the EAP package (Eco Analysis 1984). The EAP package is a group of SAS style procedures which are serially compiled with the SAS package. This package provided a dendogram display of a group-averaged sorting, cluster analysis. The inverse of the Morisita's value was used as the distance metric. The dendograms were produced for each sampling period and with the species-station date collapsed over all sampling periods to assess spatial similarities among the stations. They were also produced for each station to assess temporal clustering of the community. Finally, cluster dendrograms were produced over all stations and periods to simultaneously assess spatial and temporal similarity clustering.

Abiotic parameters relevant to benthic core sampling were also analyzed using the SAS GLM procedures. Sulfide and Eh valves were analyzed relative to time, station, sediment temperature, and mean and median grain size of the sediments. The analysis of sulfide concentrations also included total organic carbon as a covariate.

6.2.2 Results

Introductory chapters to this report have described the general characteristics of the study site. In terms of the subtidal benthic habitats, the study area may be classified as shallow and heterogeneous. Sediment types range from mud to coarse sand and shell. The area contains limestone outcroppings and associated hard substrate, except in the discharge basin where the bottom consists primarily of fine sand and mud. Extensive oyster reefs and patchy seagrasses south of the intake canal add to the heterogeneity of the substrate in the study area. Depths ranged from less than one meter to slightly over four meters at the forty stations where benthic infauna were sampled (Table 6.2-1). Average depth at the stations was two meters. In general, depth increased gradually offshore.

In order to evaluate the effects of the thermal plume on the benthic communities of the study area, the influence of temperature and other abiotic parameters must be considered in evaluating the distribution of benthic infauna. Section 6.1 provides a detailed description of all water quality parameters (on a quarterly basis); the same data were utilized in this section but as six-week means of only bottom measurements to provide direct comparisons with the infauna.

Abiotic Parameters

Temperature

To compare with benthic infaunal data, distribution of bottom temperature at the site was analyzed from four types of information:

1. Weekly synoptic measurements at the 40 stations (collected in conjunction with photometry measurements);
2. Continuous thermograph measurements at or near the 40 stations;
3. Sediment temperature measurements at the time of benthic sampling;
4. Hydrodynamic model projections of the thermal plume under various tidal and seasonal conditions.

Since infaunal sampling was conducted once every six weeks, temperature data from synoptic sampling and thermographs were summarized as six-week averages at each station. In order to account for short-term fluctuations in temperature, the data were also examined as three-week means. The six-week and three-week averages included the week of benthic sampling. Synoptic data was generally collected on high and low tides during alternate weeks. Therefore, the averages mask tidal influence. Measurements of sediment temperature during the infaunal sampling were not synoptic; in light of the shallow nature of Crystal Bay and solar-induced temperature variations within a particular day, sediment temperature data can be used only to describe general trends.

Synoptic bottom temperature at the forty stations is summarized as six-week averages in Table 6.2-2. The three-week averages exhibited essentially the same trend as six-week averages. Lowest temperatures were during January-February and highest temperatures during July-September. Spatial and temporal trends were essentially similar between the three-week and six-week averages. Certain stations had consistently higher temperatures; those stations were 4 and 5 (northern Control Transect); 13-15 (Thermal Transect A); 17-23 (Thermal Transect B); and 23-30 (Thermal Transect C). Based on six-week averages, nine stations exceeded 32°C during September: 13, 14, 17, 18, 19, 20, 21, 28, and 29. The area enveloped by these stations is shown in Figure 6.2-1.

Utilizing plant intake temperatures as ambient temperature, bottom temperature variation from ambient for the six-week averages is presented in Table 6.2-3. The following groups of thermal stations (Figure 6.2-2) can be recognized from the data:

$1^{o}C - 2^{o}C$:	4, 5, 14, 22, 27, 28, and 30	(Group I)
$2^{o}C - 3^{o}C$:	13, 20, 21, and 29	(Group II)
Greater than $3^{o}C$:	17, 18, and 19	(Group III)

Group I stations may be considered marginally thermal stations (Stations 4 and 5 appear to be influenced by both the barge canal and the thermal effluent, as discussed in Section 6.1, and are not effective controls). Group II and Group III stations can be considered thermal stations which are directly influenced by the effluent. Group III stations can be considered maximally influenced by the effluent, since average temperatures at these stations are substantially higher than intake temperatures. It is interesting to note that Group II and Group III stations exceed $32^{o}C$ (average temperature) during the hottest period of the year (August-September). These groups were somewhat different from those identified with quarterly data in Section 6.1.

Six-week average temperature data from thermographs at or near the forty stations are presented in Table 6.2-4. Compared to the synoptic data, thermograph average temperatures were lower since they included night temperatures. However, the general trends related to bottom temperature distribution at the study site were similar to the trends exhibited by the synoptic data.

Sediment temperatures are summarized in Table 6.2-5. Consistently higher temperatures were measured at Stations 13, 14, 17, 18, 19, 20, 21, 27, 28 and 29. This grouping of highly thermal stations is similar to that derived through the analysis of synoptic and thermograph data.

Predicted thermal plume configurations are shown in Chapter 10.6. The $2^{o}C$ isotherm simulated under full plant load, worst case conditions closely approximates the offshore boundary of the thermal groups defined by the field temperature results (synoptic, thermograph, and sediment temperatures). This general agreement of the results obtained by different means confirms that the areas shown in Figures 6.2-1 and 6.2-2 are where thermal effects, if any, would most likely occur on the benthic communities.

Salinity

Bottom salinity information from the weekly synoptic surveys were analyzed as six-week means for each station, similar to the analysis of temperature data. Summary data are presented in Table 6.2-6. For a majority of the stations, temporal variation in salinity was minimal. In general, offshore stations and Stations 17 and 18 near the point of thermal discharge had a higher salinity, while stations near the two rivers (1, 2, 38) and the barge canal (4, 5, 6) had a much reduced salinity.

Turbidity

Bottom turbidity data from the weekly synoptic surveys were averaged as six-week means for each station; results are presented in Table 6.2-7. In general, turbidity values exhibited considerable variation both temporally and spatially. Offshore stations were less turbid and stations near the barge canal spoil islands (Stations 4, 5, 6, 8, 9, 10) and Stations 15 and 21 were most turbid.

Total Suspended Solids (TSS)

TSS information from the biweekly surveys were averaged as six-week means and results are presented in Table 6.2-8. TSS values varied substantially both in time and space, and as with turbidity, were lower at offshore stations and higher near the barge canal spoil islands.

Dissolved Oxygen (DO)

Bottom DO data from the weekly synoptic surveys were averaged as six-week means for each station; results are presented in Table 6.2-9. In general, DO values were high in the study area. Lowest values were observed during July-September. Anoxic conditions were not observed at any station. Lower DO values were observed at Stations 3, 5, 7, 8, 9, 15, 21, and 22 during August-September (1983).

Based on the results of the water quality parameters (six-week averages/bottom) presented above, thermal station groups identified in Figure 6.2-2 can be subdivided as follows:

Group I ($1^{o}C$-$2^{o}C$ increase):	A: Stations 4 and 5 (lower salinity and DO; higher turbidity and TSS)
	B: Stations 14, 22, 27, 28, and 30.
Group II ($2^{o}C$-$3^{o}C$ increase):	Stations 13, 20, 21, and 29.
Group III (greater than $3^{o}C$ increase):	A: Stations 17 and 18 (higher salinity)
	B: Station 19.

Sediment Characteristics

Granulometry

Mean grain size at the forty stations ranged from a low of -0.27 phi (coarse) at Station 29 to a high of 3.53 phi (very fine) at Station 8. Summarized data for all stations is presented in Table 6.2-10. Based on mean grain size, the following groups of similar stations can be discerned:

Group I	(coarse sand): Stations 19, 29, and 35.
Group II	(medium sand): Stations 2, 3, 11, 12, 15, 23, 25, 26, 30, 32, and 36.
Group III	(very fine sand): Stations 4, 5, 8, 21, and 40.
Group IV	(fine sand): all other stations.

Temporal variations in mean grain size were generally minimal except at Station 29 where sediments changed from coarse sand in June 1983 to fine sand in July 1984.

Silt/Clay Content

Percent of silt/clay content in the sediments at stations is summarized in Table 6.2-11. In general, silt/clay content was high at the study site. Except for Stations 1, 2, 19, 29, and 30, all other nearshore stations had a high content of silts and clays. This was especially true at Stations 4, 5, and 8. In general, offshore stations contained less than 5 percent silt/clay content (except Station 40), while nearshore stations frequently exceeded 15 percent silt/clay content.

Redox Potential (Eh)

Measured sediment Eh at the stations is summarized in Table 6.2-12. In general, high negative values of Eh (reducing environments) were very common in the study area, especially in the nearshore areas and areas near the barge canal and the two rivers. Temporal variability of Eh values were high and did not exhibit any specific seasonal trends.

Total Organic Carbon (TOC)

Sediment TOC values at the stations are summarized in Table 6.2-13. TOC values were generally high at the study area with considerable temporal variation. Lowest values were observed at Stations 1, 3, 11, 16, 24, 26, 29, and 35-37 and during July 1984. Only Station 29 is in the thermal area.

Sulfides

Sediment sulfide content at the stations is summarized in Table 6.2-14. In general, values were low at most stations. Extremely high sulfide content was evident at Stations 8, 17, and 38, followed by Stations 21 and 32. Moderately high values were observed at Stations 4, 5, 7, 37, and 39. Lowest sulfide values were observed at Stations 11, 12, 19, 25, and 26. Sulfide values were generally inconsistent from station to station.

Identification of Controls

Thermal groups identified in Figure 6.2-2 can be further subdivided as follows, based upon sediment characteristics:

Group I (1^oC-2^oC increase):	A: 4 and 5 (very fine sand)
	B: 14 and 27 (fine sand)
	C: 22 and 28 (medium to fine sand)
	D: 30 (medium sand)
Group II (2^oC-3^oC increase):	A: 21 (very fine sand)
	B: 13 and 20 (fine sand)
	C: 29 (coarse sand)
Group III (greater than 3^oC increase)	A: 17 and 18 (fine sand)
	B: 19 (coarse sand)

Stations 4 and 5 of Group I differ from similar sediment stations of other groups by exhibiting much lower salinities, DO content and higher turbidity and TSS. Stations 17 and 18 differ from Station 19 by exhibiting higher salinities also.

Based on the sediment type and selected water quality parameters, the most appropriate control station(s) for the sets of thermal stations (identified above) are:

IA:	Stations 4 and 5	Control: 1
IB:	Stations 14 and 27	Controls: 6, 7, 33, and 39
IC:	Stations 22 and 28	Controls: 2 and 38
ID:	Station 30	Controls: 2, 3, 12, 25, 26, 32, and 36
IIA:	Station 21	Controls: 8 and 40
IIB:	Stations 13 and 20	Controls: 6, 31, and 33
IIC:	Stations 29	Control: 35
IIIA:	Stations 17 and 18	Controls: 6, 31, and 33
IIIB:	Station 19	Control: 35

Faunal Parameters

Species Composition

A total of 918 taxa were identified from approximately 375,000 individuals collected during this study. Meiofaunal species such as ostracods, nematodes and copepods and species which were taxonomically lumped (oligochaetes, nemertines) and colonial species, although sorted and identified, were not included in the data analyses. Numerous species of polychaetes were frequently common and abundant. In terms of overall abundance, the following species contributed over fifty percent of the total fauna (in order of rank abundance): Fabricia sp. A; Streblospio benedicti; Aricidea philbinae; Tharyx cf. dorsobranchialis; Aricidea taylori; Mediomastus ambiseta; Axiothella mucosa; Mediomastus sp.; Myriochele oculata; Lumbrineris verrilli; Halmyrapseudes cf. cubanensis; and Haploscoloplos foliosus. All of these species with the exception of H. cf. cubanensis, a tanaid, were polychaetes.

Some spatial patterns of the abundant species were as follows: Fabricia sp. A occurred as a dominant species (in terms of temporally combined abundance) at over 50 percent of the stations. It was more abundant south and northwest of the intake dike (Figure 6.2-3). Numerical abundance of Streblospio benedicti was limited to the nearshore areas between the barge canal and the discharge canal (Figure 6.2-4). Aricidea philbinae was generally abundant nearshore (Figure 6.2-5). Tharyx cf. dorsobranchialis was abundant in the nearshore areas adjacent to the discharge spoil and Station 31 (Figure 6.2-6). Dominance of Aricidea taylori was limited to a few stations in Basins 3 and 4 and Station 17 (Figure 6.2-7). Mediomastus ambiseta had a patchy distribution south of the barge canal spoil islands and the intake spoil (Figure 6.2-8), while Mediomastus sp. was abundant mostly at offshore stations (Figure 6.2-9). Myriochele oculata was numerically abundant primarily at offshore stations (Figure 6.2-10). Lumbrineris verrilli was primarily abundant at mid depth stations (Figure 6.2-11). Axiothella mucosa was consistently abundant only at Stations 27, 28, 23, 30, and 35 (Figure 6.2-12). The tanaid, Halmyrapseudes cf. cubanensis was dominant only at Stations 1 and 4 (Figure 6.2-13). Haploscoloplos foliosus was numerically dominant at stations near the barge canal and the nearshore stations at the plant discharge (Figure 6.2-14).

Other dominant species which showed patchy distribution in the study area were as follows: Acteocina canaliculata was abundant in the thermal stations (18, 19, 20, 21, and 28) and Stations south of the intake spoil (31, 32). Ampelisca holmesi was abundant only at Stations 2 and 13. Paraprionospio pinnata, Haploscoloplos fragilis and Mysella planulata exhibited patchy distributions. Laonereis culveri and Neanthes succinea (Figures 6.2-15 and 6.2-16), both considered as thermally tolerant species (Logan and Maurer, 1975) occurred in the thermal areas. Polydora websteri and Heteromastus filiformis, also considered thermophilic, were abundant at nearshore thermal stations. Temporal variations in the abundance of the dominant species listed above were considerable.

The density and percent abundance of the ten most dominant species at each of the 40 stations during each sampling period are provided in Appendix III. Based on species dominance alone, the following four somewhat discrete communities can be recognized in the study area:

Stations 1 and 4:	Halmyrapseudes - Xenanthura - Streblospio community;
Station 3:	Brachidontes - Crepidula community;
Stations 2, 5-8, 13-15, 17-21, 27-33, 38, and 39:	Aricidea - Streblospio - Tharyx - Fabricia community;
Stations 9-12, 16, 23-26, 35-37 and 40:	Mediomastus - Myriochole - Goniadides community.

Each of these communities appears to intermix but still retain a distinct spatial pattern (Figure 6.4-17).

Species composition, especially the dominants, changed through the year. During the hottest period of the year (July-October), analyses of distributional patterns of the numerically abundant species (Appendix III) showed that Tharyx cf. dorsobranchialis, Mediomastus ambiseta, Aricidea philbinae and Aricidea taylori were abundant throughout the study area. Streblospio benedicti was abundant at all thermal and northern stations east of Fisherman's Pass and at Station 31 south of the intake spoil. Paraprionospio pinnata was abundant at all nearshore stations except in the area of thermal discharge (Figure 6.2-18). Myriochele oculata and Lumbrineris verrilli were abundant at all stations except stations nearshore. Haploscoloplos foliosus and H. fragilis were abundant in the summer only at Station 1 and Stations 4 through 9 near the barge canal spoil islands. Thermal indicators Laeonereis culveri and Neanthes succinea were both abundant only at Stations 13 and 17. In addition L. culveri was abundant at Stations 18 and N. succinea was abundant at Station 6 (Figures 6.2-19 and 20). Heteromastus filiformis, also considered a thermal indicator, was most abundant at only Station 17. Polydora websteri, a thermally tolerant species, was abundant at Stations 13, 19, and 29. Polydora websteri is associated with oyster reefs in the study area (see Section 6.5); Stations 19 and 29 were near oyster reefs.

Many of the species which were abundant at a few stations were present in small numbers at almost all of the sampled stations in the area. However, Halmyrapseudes cf. cubanensis did not occur at 17 of the 40 stations and Axiothella mucosa did not occur at 8 of the 40 stations. Also, Capitella capitata did not occur at 6 of the 40 stations (10, 11, 22, 25, 34, and 36). Other abundant species were ubiquitous and occurred at all or at a majority of the stations (Table 6.2-15). Rare or uncommon species were numerous in the southern and offshore areas; many of them did not occur in the thermal areas.

Oligomixity (dominance by one or two species) was generally high in the study area except at the following stations (Figure 6.2-21): 2, 11, 12, and 16 (Northern Control); 22, 24, 25, and 26 (Discharge transect - offshore); 31 through 40 (Southern Control). All stations within the area most probably enveloped by the thermal plume (Figures 6.2-1 and 6.2-2) exhibited a high degree of oligomixity.

In summary, results of the species composition of the infaunal communities in the study area show that:

1. Although the study area was extremely diverse in terms of the total number of species encountered, a few species dominated in terms of abundance.

2. Dominance distributional patterns of the species that were abundant ranged from cosmopolitan to very endemic at a few stations. Streblospio benedicti, an opportunistic species, appears to be most dominant in areas north of the intake dike, while Aricidea spp., Fabricia sp. A, and Tharyx cf. dorsobranchialis are widespread. Mediomastus sp. and Myriochele oculata exhibited highest dominance in the offshore areas. All other dominants were limited in their abundance to a few stations.

3. Four communities were defined from the area.

4. During the hottest period dominant species were abundant in both thermal and non-thermal areas. Neanthes succinea, Laonereis culveri, Heteromastus filiformis and Polydora websteri (thermal indicators) were most abundant at the nearshore thermal stations. Paraprionospio pinnata was least abundant at the thermal stations.

5. A majority of the dominants occurred at almost all stations; however, abundance of these species varied considerably spatially and temporally. Abundance and rank of dominant species changed at a majority of the stations between the common sampling periods (June-July) of the two years (1983-1984) indicating annual variations. Many of the rare species found in the southern area and offshore areas were not found in the thermal areas.

6. Oligomixity was generally high, especially in the nearshore areas north of the intake dike.

Faunal Density

Total faunal density (organisms/m^2) for all stations and sampling periods is summarized in Table 6.2-16. Overall, lowest densities occurred during July-

September and highest densities during April. Mean densities were considerably lower at Stations 5, 8, 18, and 24. Low densities were observed at Stations 2, 6, 7, 9, 14, and 15; high densities were observed at Stations 28, 29, 30, and 35. All other stations had moderate densities; no clear patterns in density related to the thermal areas were evident. Temporal variation in density was exceptionally high (over 200 percent change) at the following stations: 4, 5, 7, 8, 11, and 12 (Northern Transect); 13, 15, 16, 23, 26, 28, 29, and 30 (Thermal Transect); 33, 35, 36, and 37 (Southern Transect). Station 28 exhibited a dramatic increase in density between February and June, 1984 (34,059 to 113,387 organisms/m^2) mainly caused by a super abundance of Fabricia sp. A. Comparison of June/July data between 1983 and 1984 showed that considerable differences in density existed both in thermal and non-thermal areas. Overall, density was higher in June/July 1984 compared to June/July 1983.

Comparison of faunal density at thermal stations with control stations of similar sediment type with a 't' test (95 percent significance level) is shown in Table 6.2-17. In general, thermal stations were not significantly different in densities from corresponding southern stations. Thermal Station 17 was significantly higher in density compared to Control Stations 6 (north) and 31 (south) and was not different in density from Station 33 (south). Thermal Stations 21, 27, and 30 were significantly higher in density compared to northern control stations but were similar in density to southern stations.

When stations were grouped as Thermal (13, 17, 18, 19, 20, 21, and 29), South Control (31, 32, 33, 34, 35, 38, 39 and 40) and North Control (6, 7, 8, 9, 15, 16, and 23), density was significantly different between the North Control and South Control Stations. However, densities at both controls were not significantly different from density at the thermal stations.

Since polychaetes, molluscs and crustaceans were the major groups that dominated the study area, densities of these groups are summarized in Table 6.2-18 (Polychaeta); 6.2-19 (Mollusca); and 6.2-20 (Crustacea). Except for Stations 1 and 4 where crustaceans dominated, and Station 32 where molluscs and crustaceans co-dominated, polychaetes overwhelmingly dominated the faunal composition. Trends in total faunal density, therefore, were generally influenced by the patterns exhibited by the polychaete component.

Species Richness

The number of taxa collected at each station (species richness) during the various sampling periods is summarized in Table 6.2-21. Overall, highest species richness occurred during February and June 1984 and lowest during July and September 1983. Comparison of June/July data between 1983 and 1984 showed that considerable differences in species richness existed both in thermal and control areas. Overall, species richness was higher in 1984. Spatially, lowest species richness occurred at Stations 4 and 5 and highest at Stations 2, 11, 12, 16, 25, 30, 32-37, 39, and 40. In general, species richness increased offshore. Nearshore stations in the thermal area and near the barge canal had lower numbers of species than comparable nearshore stations south of the intake canal. Significant differences in species richness ('t'-test; 95% level) between comparable thermal and control stations are summarized in Table 6.2-22. Thermal Stations 13, 14, 17, 18, and 20 were not significantly different in species richness from corresponding northern control stations but contained a significantly lower number of species when compared to southern control stations. Thermal Stations 21, 22, 27, 28, and 30 were higher (or similar) in species richness compared to corresponding northern control stations but had a significantly lower numbers of species when compared to southern control stations. Thermal Stations 19 and 29 were significantly lower in species richness when compared to southern control Station 35. Thermal Stations 22, 28, and 30 were higher in species richness compared to northern stations but not significantly different from southern stations. Lower salinity thermal Stations 4 and 5 were not significantly different from northern control Station 1.

The Thermal, Northern and Southern station groupings (as for faunal density comparisons; see previous section), were significantly different from each other in species richness. Lowest species richness was encountered in thermal areas; slightly higher values in the northern transect; and highest values on the southern transect. In general, thermal stations were more comparable to the northern transect than to the southern transect (in terms of species numbers).

Species number for the three major components is summarized in Tables 6.2-23 (Polychaeta), 6.2-24 (Mollusca), and 6.2-25 (Crustacea). Unlike faunal density, molluscs contributed a much larger proportion to the total species richness; however, polychaetes provided the majority of the species. Numbers of molluscan species were particularly low at Stations 4, 5, 8, 13, 14, 15, 17, 18, 19, 20, 21, 28, and 29. A majority of these stations are in the thermal area. Lower numbers of crustacean taxa were found at Stations 4, 5, 8, 17, 18, and 20. All these stations, except 8, are in the thermal area. All of the southern stations were rich in crustacean and molluscan taxa.

Species Diversity and Equitability

Values of Shannon-Weaver diversity index and Pielou's equitability index are summarized in Tables 6.2-26 and 6.2-27, respectively. Lowest diversities (associated with both low equitability and species richness) were observed at Stations 1 and 4. Lower diversities were also observed at Stations 5, 6, 8, 14, 15, 17, 18, 19, 20, 21 and 29. A majority of these stations were in the thermal area. In general, diversity and equitability exhibited similar spatial and temporal trends as those exhibited by species richness; 't' tests of significance revealed the same dissimilarities between the compared stations, i.e., northern stations were generally more similar to the thermal stations. Both thermal and northern stations were different when compared to the southern stations.

Log-Normal Curves

Individuals in natural benthic communities are generally distributed in a log normal fashion among species. Variation from this distribution or from the slope of the straight line produced from a log-normal distribution has been reported to be indicative of stress (Gray and Mirza 1979). Polluted communities are purported to either show a break in the straight line or have angles to the x-axis lower than 35°. Log-normal distribution of individuals per species was fitted and curves drawn for each station and sampling period according to the method described by Gray and Mirza (1979). Angles to the x-axis were measured from these curves and data is summarized in Table 6.2-28.

Utilizing mean angles, the information is portrayed graphically in Figure 6.2-22. Stations in the thermal area and the nearshore northern area had the least log-normal angles (30-35°) indicating possible stress conditions. Offshore northern stations and the southern stations had higher log-normal angles (greater than 40°).

Faunal Similarity

Utilizing Morisita's index, faunal similarity between stations for each of the sampling periods was computed and results are presented as trellis diagrams. Also for each of the periods, a cluster analysis was conducted (Morisita's Index, group average sorting) and results are presented as dendrograms.

Faunal similarity trends during each of the sampling periods can be summarized as follows:

June, 1983 (Figures 6.2-23 and 24): Thermal stations 17, 18, 19, and 27 (Rocky Cove) and Station 6 were similar to each other. Also, Thermal Stations 20 and 21 and Stations 15, 22, 28, and 30 were similar to each other. These groups of stations were generally dissimilar to all other stations. Interestingly, Thermal Station 13 was similar to northern Stations 2 and 7, while Thermal Station 14 was similar to southern Stations 31 and 39. Offshore stations were generally similar to each other, while Station 29 (thermal area) was dissimilar from all other stations.

July, 1983 (Figures 6.2-25 and 26): Thermal Stations 17 and 18 were similar to northern Station 5. Also, Thermal Stations 20, 22, and 29 were similar to each other and to Stations 7 and 15. Thermal Station 13 was similar to Station 27 (Rocky Cove) and Station 31 (Southern). Offshore stations were similar to each other. Stations 9 (Northern) and 30 (Thermal) were similar to each other; Station 4 was dissimilar from all other stations.

September, 1983 (Figures 6.2-27 and 28): Thermal Stations 13, 14, and 17 and Stations 20 and 21 were similar to each other. All other thermal stations were similar to each other and to several stations in the northern area. Southern nearshore areas grouped together in similarity, while most offshore stations were similar to each other. Stations 1 and 29 were dissimilar from all stations.

October, 1983 (Figures 6.2-29 and 30): Most Thermal Stations (13, 17, 18, 20, and 27) grouped together in similarity with northern nearshore stations. Thermal Stations 15 and 22 were similar to each other and Station 7 (northern) and 33 (southern). Offshore stations were similar to each other, while Stations 29 and 4 were dissimilar from all stations.

November, 1983 (Figures 6.2-31 and 32): Thermal Stations 13, 14, and 18 were similar to each other and to several northern nearshore stations and the southern Station 38. Thermal Stations 17, 19, and 29 were similar to each other and to the northern Station 3 and southern Station 32. Thermal Stations 20, 21, 28, and 15 were similar to each other, while Thermal Station 22 was similar to offshore Stations 16 and 24 and to Stations 31 (southern) and 2 (northern). Generally, offshore stations were similar to each other. Station 1 was dissimilar from all other stations.

January, 1984 (Figures 6.2-33 and 34): Thermal Stations 13, 18, 20, and 27 were similar to each other and similar to several northern stations. Thermal Station 17 was generally dissimilar from all stations. Most northern and offshore stations grouped together in similarity. Thermal Station 22 was similar to offshore Stations 26 and 37, while Thermal Station 29 was similar to offshore Station 12.

February, 1984 (Figures 6.2-35 and 36): Thermal Stations 14, 18 and 21 were similar to each other and several nearshore northern stations. Thermal Station 17 was similar only to Station 13 (thermal) and 38 (southern nearshore). Thermal Stations 19, 20, 22, 28, and 29 were similar to each other and were similar to Stations 23 (offshore thermal) and 32 (southern nearshore). Thermal Station 27 was similar to northern Station 3. Stations 1 and 11 were dissimilar from all other stations. Offshore stations generally grouped together in similarity.

April, 1984 (Figures 6.2-37 and 38):Thermal Stations 17, 18, 20, 22, and 29 were similar to several northern and some offshore stations. Thermal Station 13 was similar to offshore Stations 30 (thermal) and 35 (southern). Offshore Stations 25, 26, and 37 grouped together in similarity. Station 12 was dissimilar from all other stations.

June, 1984 (Figures 6.2-39 and 40): Thermal Stations 17, 20, 21, 22, and 27 were similar to each other and to Stations 16 (offshore), 2 and 9 (northern). Thermal Station 18 was similar to Stations 5, 7, 8 (northern), and 15 (offshore thermal). Thermal Station 13 exhibited generally low similarity to all stations but grouped closer to Station 38 (southern nearshore). Offshore stations generally were similar to each other. Stations 1 and 4 were similar to each other but dissimilar from all other stations.

July, 1984 (Figures 6.2-41 and 42): Thermal Stations 17, 20, 22, 27, and 29 were similar to each other and to Station 31 (southern nearshore). Thermal Station 18 was similar to northern Station 5 and 7, while Thermal Station 13 was similar to Station 30 (thermal offshore). In general, offshore stations grouped together. Station 4 was dissimilar from all other stations.

Temporal changes in similarity were examined at each of the 40 stations. Mean faunal similarity between sampling periods at each station is summarized in Table 6.2-29. In general, temporal variability in similarity was high at both thermal and non-thermal areas. Greatest variability occurred at Stations 11 and 29. Comparison of faunal similarity between June/July 1983 and 1984 showed that spatial, faunal affinities of thermal and non-thermal stations were somewhat different between years indicating that annual fluctuations may have altered communities in the study area at both thermal and non-thermal stations. Although these changes caused by annual fluctuations were evident, the groupings of stations for 1983 and 1984 were similar in that thermal stations group together and were similar to several northern control stations.

A faunal similarity analysis combining all quarterly data at each station (Figures 6.2-43 and 44) showed that Thermal Stations 13, 14, 17, and 27 were similar to each other and similar to Station 2 (nearshore northern). Thermal Stations 18, 20, and 21 were similar to each other and to northern Stations 5, 6, 7, and 8 and to Station 15 (thermal offshore). Thermal Station 28 was similar to Stations 23, 30 (offshore thermal), 35 and 36 (offshore southern). Thermal Stations 19 and 29 were somewhat similar to northern Station 3. Northern Stations 9 and 22 were similar to southern Stations 31, 32, and 39. Station 1 and 4 near the barge canal were similar to each other but different from all other stations. Offshore stations generally grouped together in similarity.

Utilizing six-week sampling data at 20 stations, a similar analyses provided essentially the same results (Figures 6.2-45 and 46) except that Thermal Stations 17 and 29 exhibited much lower similarities with other thermal and non-thermal stations. Thermal Station 13 was similar to Stations 30 (offshore thermal) and 35 (southern offshore). Thermal Station 18 was similar to northern Stations 5 and 7 and offshore Thermal Station 15, while Thermal Station 20 was similar to offshore Thermal Station 22 and northern Station 9. In examining temporally uncombined data for all stations (i.e., all possible combinations of time and space) with a faunal similarity cluster analysis, the same trends exhibited by the temporally combined data presented above were evident.

In summary, faunal similarity analyses showed that thermal stations were more often similar to each other and to the northern control stations. Certain stations (e.g., 29, 1, and 4) were different than all other stations. Offshore stations were generally similar to each other. Thermal stations most often similar to each other were: 17, 18, 19, 20, 21, and 22.

Biotic/Abiotic Relationships

Potential correlations between various abiotic parameters and faunal density, species richness and species diversity were examined with the use of linear regressions. Faunal density appeared to be correlated with grain size and to a lesser degree with silt/clay and total organic carbon (significant F value at 95 percent level). Faunal density appeared unrelated to other abiotic factors (temperature, salinity, turbidity, TSS and sediment sulfides, sorting and Eh; Table 6.2-30). Species richness appeared to be correlated with temperature and salinity and to a lesser degree with sediment parameters (Table 6.2-31). Similarly, species diversity appeared to be correlated with temperature and salinity and to a lesser degree with sediment parameters (Table 6.2-32).

In terms of sediment preference of the dominant species in the study area, Fabricia sp. A was most abundant at stations with coarser sediments (11, 13, 23, 26, 28, 29, 30, 34, 35, 36, and 38) at least during some times of the year. Streblospio benedicti was most abundant at stations with silty sediments (4, 5, 6, 8, 15, 18, and 21). However, S. benedicti was most abundant at siltier stations offshore and in the southern transects. Aricidea philbinae was abundant in a variety of sediment types and was most abundant in the thermal areas. Other dominant species did not exhibit any clear cut preference for sediments or other abiotic parameters.

In summary, temperature appears to affect species richness and diversity while sediment parameters control faunal density in the study area.

Annual Faunal Fluctuations

Long-term annual fluctuations in benthic communities have been observed by several investigators (Pearson 1975, Santos and Simon 1980; Dugan and Livingston 1982; Mahoney and Livingston 1982). Between June/July of 1983 and 1984 considerable changes in species composition, faunal density and species richness occurred in the study area indicating that annual fluctuations may be extremely important. Thermal effects on various community parameters appear to be similar between the two years. Evaluation of the magnitude of differences in community parameters between thermal and control areas showed: 1) annual fluctuations were clearly evident and 2) thermal effects were exhibited in addition to the annual fluctuations.

6.2.3 Impact Assessment

Introduction

The benthic community is generally considered to be the best faunal group for assessing environmental stress due to its relative lack of mobility and varied sensitivity to physiological stresses (Dills and Rogers 1972). In addition, the relatively long life histories of benthic organisms make them valuable indicators of past and present water quality (Mackenthun 1966; McKee 1966; Cairns and Dickson 1971).

Temperature is a primary environmental factor in the distribution and survival of aquatic organisms. Sediment type is a specific factor affecting the zonation of benthic organisms, particularly the infauna (Peterson 1913; 1915; 1918; Thorson 1957; Sanders 1958; Bloom et al. 1972; Pearson 1975). Apart from other biological factors (such as competition, predation, etc.), temperature and sediment type seem to be the major factors in benthic faunal distribution. Since various species tolerate temperature increases to differing degrees and display temperature induced reproduction, increased temperature could have both "positive" and "negative" effects. In theory, when heated effluent is introduced into a benthic environment, the following species-specific processes would occur:

1. Some temperature "sensitive" (stenothermal) species would disappear.

2. Some new species would immigrate into the now warm environment.

3. Some species (eurythermal opportunists) would increase in abundance.

4. Some temperature "sensitive" species would decrease in abundance.

Depending on the balance of (1) and (2), diversity (species richness) of the heated environment would either increase or decrease. Dominance would probably be a prime factor in response to changes in (3) and (4). Seasonal changes would, of course, complicate the process.

In a natural eurythermal environment such as Crystal Bay, a shallow subtropical bay where there is a high incidence of eurythermal species, heated effluents (within lethal limits for individual species) may not have a pronounced or detectable effect on the benthic fauna. On the other hand, synergistic effects and biological changes in the other components of the ecosystem (e.g., plankton) would indirectly affect the composition and structure of benthos. This has been recognized by various authors in the past (Markowski 1960; Pearce 1969; Mackenthun 1969; Virnstein 1972; Davis 1972).

Rowe et al (1972) documented the effects of thermal pollution in the lower Mystic River. They identified zones of extreme stress characterized by low faunal density, biomass and species diversity. An interesting study by Logan and Maurer (1975) on the diversity of marine invertebrates in a thermally affected area of the Indian River (Delaware Bay), identified an extremely high diversity zone in the immediate vicinity of the thermal discharge caused by the existence of "pioneer" communities in a state of "non-active equilibrium" (i.e., a community with low dominance, high equitability and low faunal density). Similar zones were reported earlier by Warinner and Brehmer (1966) and Nauman and Cory (1969). A few opportunistic species (e.g., Nereis succinea, Heteromastus filiformis) have also been suggested by Logan and Maurer (1975) as indicators of thermal effects.

Temporally, the most severe effects of the thermal effluent on the benthic fauna would be expected in the summer (Naylor 1965; Warinner and Brehmer 1966; Pearce 1969; Nauman and Cory 1969). However, disruptions in communities due to "cold shock" in winter (due to variability of power plant operation) cannot be ruled out.

Bamber and Spencer (1984) in a recent study of thermal effects on benthic communities in River Medway Estuary showed that areas most influenced by the discharge are: (1) significantly depressed in species richness; (2) higher in densities caused by a few species, i.e., oligomixity; and (3) dominated by opportunistic species that were tolerant of thermal stress (and not organic stress, such as Capitella capitata). Overall, they concluded that thermal effects were limited to the discharge canal and where the thermal discharge impinged on the bottom.

Previous benthic faunal studies at Crystal River are not directly comparable to the present study because of significant differences in methodology and areas of investigation. Historical benthic information from the study area appears to indicate that thermal effects in the form of depressed species richness and abundance occur in the discharge basin. However, drawbacks in the methods used and the limited area of investigation inhibits any conclusion that can be comprehensive in terms of spatial and temporal thermal effects.

From studies described in literature, some of the expected thermal effects on the benthic infaunal communities in the vicinity of the power plant at Crystal River can be summarized as follows.

1. Reduced species richness;

2. Increased or decreased total abundance (faunal density);

3. Increase in the abundance of some eurythermal and opportunistic species;

4. Immigration and abundance of thermal pollution indicator species;

5. Emigration and/or decrease in the abundance of some stenothermal species;

6. Decreased diversity and equitability;

7. Increased dominance (i.e., oligomixity) of a few species;

8. Alteration of basic community structure;

9. Faunal dissimilarity compared to adjacent natural or undisturbed communities.

To evaluate thermal effects in the study area the nine characteristics listed above are tested as hypotheses statements (below) leading to an impact assessment of benthic communities in the vicinity of the power plant.

Species Richness

In general, all thermal stations were lower in species richness than corresponding southern control stations, but not the northern control stations. Therefore, it appears that the thermal effluent in concert with silty conditions found in the northern areas reduces total species richness in an area bounded by Stations 17, 13, 14, 21, and 27. However, no statistically significant differences in species richness between thermal stations and northern control stations were noted.

Examination of molluscan and crustacean species richness provides stronger evidence of thermal effects. Molluscan species richness was considerably lower at Thermal Stations 13, 14, 17-21, 28, and 29 and Stations 4, 5 (low salinity-thermal regime), 15 (slight thermal), and 8 (northern Control Station). Similarly, crustacean species richness was lower at Thermal Stations 17-20 and Stations 4, 5, and 8. Stations 8 and 15 have slightly higher temperatures than plant intake temperatures (Table 6.2-3). Stations 4, 5, and 8 had a high silt/clay content probably causing the reduced molluscan and crustacean species richness. Therefore, it appears that the thermal effluent reduces the species richness of molluscs and crustaceans primarily in an area bounded by Stations 13, 14, 17, 21, and 29 (Figure 6.2-47). The cause of depressed species richness at Station 15 is unknown.

Faunal Density

In general, faunal density at the thermal stations was not statistically different from densities at both southern and northern control stations. Thermal Stations 17, 21, and 27 were higher in densities when compared with northern control stations, while Station 18 was lower in density compared to its corresponding southern control station. Using either increased or decreased abundance as criteria of adverse thermal effects, it appears that the area bounded by Stations 17, 21, and 27 is adversely affected in terms of abundance (Figure 6.2-48). The change in density does not encompass all stations within this area, and therefore the extent of the thermal effect is not clear.

Eurythermal and Opportunistic Species

Streblospio benedicti, a eurythermal and opportunistic species, was most dominant in the northern nearshore areas, especially at the stations with silty conditions. Thermal Stations 18 and 20 had a greater abundance of *S.*

benedicti than other thermal and southern control stations. Aricidea philbinae was most abundant at Thermal Stations 13, 17, and 27. Tharyx cf. dorsobranchialis was most abundant at Thermal Stations 13, 14, 17, 20, 22, 27, 28, and 29, and appears to prefer areas with a higher temperature regime. Aricidea taylori exhibited increased abundance at Thermal Stations 17, 20, 22, and 27. The species abundance patterns discussed above appear to indicate that the area bounded by Stations 13, 14, 17, 22, and 29 is affected by the thermal effluent in the form of increased abundance of selected eurythermal opportunists (Figure 6.2-49).

Thermal Pollution Indicators

Greatest abundance of thermophilic opportunistic species, Laoenereis culveri and Neanthes succinea were at Stations 13, 17, 18, and 27. N. succinea was abundant also at northern control Stations 2, 3, and 6, Thermal Stations 19 and 29 and southern control Station 32. Heteromastus filiformis, also considered a thermophilic opportunist, was most abundant at Station 17. Polydora websteri was most abundant at Stations 13, 19, and 29. Based on the abundance of indicator species, the area bounded by Stations 17, 13, 19, and 29 appears to be adversely affected by the thermal effluent (Figure 6.2-50).

Stenothermal Species

Higher dominance and lower species richness at the thermal stations and northern control stations appears to have excluded several "rare" species found in the southern control areas. This exclusion of several species may be a response to higher temperatures in the thermal zone, especially during the summer. However, habitat heterogeneity in the southern areas (presence of seagrass beds and less silty conditions) probably plays a much larger role than temperature in determining presence or absence of rare species. In terms of dominant species, Paraprionospio pinnata, was the only species that was widespread among nearshore different habitat types but was least abundant at Thermal Stations (especially during the summer) 13, 14, 17, 18, 19, 27, 28, and 29 (Figure 6.2-18). Mediomastus ambiseta was most abundant at nearshore northern and southern controls but not at the thermal stations (Figure 6.2-8). Haploscoloplos foliosus and H. fragilis similarly appeared to avoid thermal areas, but were also not abundant in southern control areas. The thermal effluent, therefore, appears to adversely affect the distribution of P. pinnata and M. ambiseta and probably the distribution of H. foliosus, H. fragilis, and several rare species. Species which were more abundant offshore, such as Mediomastus sp., Myriochele oculata and Goniadides carolinae are probably stenothermal but do not occur in abundance in either of the nearshore control areas. Since many of the other dominant species (e.g., Fabricia sp. A) remained unaffected, and since the study area is expected to primarily contain eurythermal species (subtropical and shallow), exclusion and reduction in abundance of stenothermal species can be considered minimal.

Species Diversity and Equitability

In general, species diversity and equitability values were lower at Thermal Stations 14, 17-21, and 29 and at Stations 5 (low salinity-thermal), 8, 15 (slightly thermal), and 6 (northern control). Southern control stations were much higher in these parameters than the northern and thermal areas. Therefore, it appears that the area bounded by Stations 17, 14, 21, and 29 is adversely affected in diversity and equitability by the thermal effluent (Figure 6.2-51). Similar low values were found at the northern control stations.

Oligomixity

Dominance of few species (oligomixity) was a common phenomenon in the study area. This phenomenon was especially accentuated in the thermal areas and the northern nearshore control areas (Figure 6.2-21). The striking dissimilarity in oligomixity between the southern/offshore stations and the northern/thermal stations may be indicative of stress conditions imposed by a combination of temperature and silty conditions in the northern and thermal stations.

Community Structure

The study area appears to be composed of four types of communities (Figure 6.2-17). Areas dominated by *Halmyrapseudes* and *Brachidontes* were small. The offshore community dominated by *Mediomastus*, *Myriochele*, and *Goniadides* was distinct and widespread in both northern and southern areas. The nearshore community dominated by *Aricidea*, *Tharyx*, *Streblospio*, and *Fabricia* spanned thermal, northern and southern areas. Therefore, it appears that the basic components of the community remain unchanged by the effects of the thermal effluent. Evaluation of the log-normal distribution (Figure 6.2-22) among the communities at each station, however, shows that thermal areas bounded by Stations 17, 13, 21, and 29, the nearshore northern control stations (6 and 7), and the low salinity/high temperature stations (4 and 5) have an altered intrinsic structure indicating stress conditions (Sensu, Gray and Mirza, 1979). It can be surmised that environmental stress in different forms (silty conditions and/or temperature increases) change the basic log-normal distribution of communities. It appears, therefore, that while stations in the thermal regime are adversely affected by the effluent, stations in the north are adversely affected by silty conditions. The absence of such a change in the southern stations and the apparent gradient (Figure 6.2-22) in log-normal distribution with distance from the point of thermal discharge strengthens this conclusion. Other community structure parameters, such as faunal density, abundance of dominant species, diversity and equitability have been discussed earlier and tend to confirm the alterations to structure caused by the thermal effluent (as shown by the evaluation of log-normal distributions).

Faunal Similarity

Detailed descriptions of faunal similarities between stations are provided in the results section. In general, the area bounded by Stations 17, 13, 14, 21, and 28 exhibited faunal homogeneity (Figure 6.2-52) with some similarities to the northern control stations but was dissimilar from the southern control stations. During September (1983), Station 17 contained a unique species composition: over 75 percent of the total abundance was contributed by three species, *Aricidea taylori*, *A. philbinae*, and *Laeonereis culveri*, probably as a response to elevated temperatures during the summer period. Similar dominance of few species occurred at Stations 18, 19, 20, 21, and to a lesser extent at Stations 13, 14, 15, 27, 28, and 29. *Aricides taylori*, *A. philbinae*, *L. culveri*, *Tharyx* cf. *dorsobranchialis*, and *Streblospio benedicti* were dominant at these stations. In the winter (January 1984), Thermal Station 17 was dissimilar to all stations by having a super abundance of A. philbinae, probably as a response to elevated temperatures that were optimal for A. philbinae. Overall, the faunal similarity analyses indicated that thermal effects are limited to the area shown in Figure 6.2-52. However, similarity of many of the thermal stations to northern control stations indicate that although changes have occurred in the thermal areas, the significance of the change is questionable.

General Considerations/Summary

As expected, two factors appear to play a major role in the distribution of benthic infauna in the study area: sediment type and temperature. While sediment type seems to control density of organisms, temperature controls species richness and diversity (see Results). Therefore, in examining the effects of the thermal effluent, sediment type is the most important element to keep constant. Salinity plays a controlling role only at a few stations near the Withlacoochee River and the Barge Canal. To discern thermal effects, comparisons were made only between stations which were similar in sediment type. Utilizing this strategy, the examination of various community parameters and hypotheses in relation to the thermal effluent suggests that adverse effects caused by the discharge are generally minimal, because they have not encompassed large areas or caused catastrophic changes. However, there is strong evidence (as discussed earlier) to indicate that subtle adverse changes have occurred in the communities bounded by Stations 17, 13, 14, 21, and 29 (Figure 6.2-47). A lesser degree of change seems to have occurred at Stations 4, 5, 22, and 30. The greatest degree of adverse thermal effects appears to be limited to the area bounded by Stations 13, 17, and 18 (Figure 6.2-53).

Overall, the study area (especially the northern areas) can be classified as a stressed habitat for benthic infaunal communities. Natural perturbations in the form of storms appear to affect bottom conditions because of the shallow nature of the study area. Presence of seagrasses in the southern areas probably limits the perturbation caused by storms. Considering the effect of the storms, and the silty conditions associated with the barge canal spoil islands, benthic infaunal communities in the study area are probably resilient and adapted to disturbances. Characteristic of such communities is a preponderance of opportunists and species which have short lives and high reproductive rates, i.e., an 'r' selected community (sensu MacArthur and Wilson 1967; Pianka 1971). The effect of the thermal effluent on such a community is to further modify its structure toward an even more opportunistic and resilient state until survival is affected. This shift is evident only at Stations 13, 17, and 18; survivability does not seem to be affected.

REFERENCES FOR 6.2

American Public Health Association (APHA). 1980. Standard methods for the examination of water and wastewater, 15th edition.

Bamber, R. N. and J. F. Spencer. 1984. The benthos of a coastal power station thermal discharge canal. J. Mar. Biol. Ass. U.K. 64:603-623.

Blooom, S. A., J. L. Simon, and V. D. Hunter. 1972. Animal-sediment relations and community analysis of a Forida estuary. Mar. Biol. 13(1):43-56.

Cairns, J. and K. L. Dickson. 1971. A simple method for the biological assessment of the affects of waste discharge on the aquatic bottom-dwelling organisms. J. Water Poll. Ctr. Fed. 43(5):755-772.

Davis, C. C. 1972. The effects of pollutants on the reproduction of marine organisms. In: M. Ruivo (ed.), Marine Pollution and Sea Life - Fishing News (Books). London, p. 305-311.

Dills, G. G. and D. T. Rogers. 1972. Aquatic-biotic community structure as an indicator of pollution. Geol. Surv. Alabama Circ. 80, 21 p.

Dugan, P. G. and R. J. Livingston. 1982. Long-term variation of macro-invertebrate assemblages in Apalachee Bay, Florida. Estuar. Coast. Shelf Sci. 14:391-403.

EcoAnalysis, Inc. 1984. Ecological Analysis Package. Ojai, California, Ecoanalysis, Inc.

Environmental Protection Agency (EPA). 1981. Procedure for Handling and Chemical Analysis of Sediments and Water Samples, Technical Report EPA/CE-81-1, Buffalo, NY.

Folk, R. L. 1974. Petrology of Sedimentary Rocks. Hemphill Publishing Co., Austin, Texas. 182 p.

Gray, J. S. and F. B. Mizra. 1979. A possible method for the detection of pollution-induced disturbances on marine benthic communities. Mar. Poll. Bull. 10(5):142-146.

Hamilton, A. L. 1969. A method of separating invertebrates from sediments using long wave ultraviolet light and fluorescent dyes. J. Fish. Res. Bd. Can. 26:1667-1672.

Korinkova, J. and Sigmund. 1968. The coloring of bottom fauna samples before sorting. Vestn. Cesk. Spol. Zool. 32:300.

Logan, D. T. and D. Maurer. 1975. Diversity of marine invertebrates in a thermal effluent. J. Water Poll. Ctr. Fed. 47(3):515-523.

MacArthur, R. H. and E. O. Wilson. 1967. The theory of island biogeography. Princeton Univ. Press. Princeton, NJ, 203 p.

Mackenthun, K. M. 1966. Biological evaluation of polluted streams. J. Water Poll. Ctr. Fed. 38(2):241-247.

Mackenthun, K. M. 1969. Temperature and aquatic life. Public Works 100:88-90.

Mahoney, B. M. S. and R. J. Livingston. 1982. Seasonal fluctuations of benthic macrofauna in the Apalachicola Estuary, Florida, USA: The role of predation. Mar. Biol. 69:207-214.

Markowski, S. 1960. Observations on the responses of some benthonic organisms to power station cooling. J. Animal Ecol. 29:249-257.

Mason, W. T. and R. O. Yevich. 1967. The use of phloxine B and rose bengal stains to facilitate sorting benthic samples. Trans. Am. Microsc. Soc. 86:221-223.

McKee, J. E. 1966. Parameters of marine pollution - an overall evaluation. In: T. A. Olson and F. J. Burgess (eds.), Pollution and Marine Ecology, p. 259-266. Interscience.

Nauman, J. W. and R. L. Cory. 1969. Thermal additions and epifaunal organisms at Chalk Point, Maryland. Ches. Sci. 10:218-226.

Oceanography International (OI). Undated mimeo. Manufacturer's operating procedure. Model 524, Total carbon system. Dry oxidation procedures.

Pearce, J. B. 1969. Thermal addition and the benthos, Cape Cod Canal. Ches. Sci. 10:227-233.

Pearson, T. H.. 1975. The benthic ecology of Loch Linnhe and Loch Eil, a sea-loch system on the west coast of Scotland. IV. Changes in the benthic fauna attributable to organic enrichment. J. Exp. Mar. Biol. Ecol. 20:1-41.

Peterson, C. G. J. 1913. Evaluation of the sea II. The animal communities of the sea bottom and their importance for marine zoogeography. Rep. Danish Biol. Sta. 21:110.

Petersen, C. G. 1915. On the animal communities of the sea bottom in the Stagerrak, the Christianna Fjord and the Danish waters. Rep. Danish Biol. Sta. 23:3-28.

Petersen, C.G. 1918. The sea bottom and its production of fish food. A survey of the work done in connection with the valuation of the Danish waters from 1883-1917. Rep. Danish Biol. Sta. 25:62 p.

Pianka, E. 1971. On R and K Selection. American Naturalist 100:592-597.

Pielou, E. C. 1975. Ecological Diversity. John Wiley and Sons, New York. 165 pp.

Rowe, G. T., P. T. Pollani and J. I. Rowe. 1972. Benthic community parameters in lower Mystic River. Int. Rev. Ges. Hydrobiol. 57(4):573-584.

Russell, W. D. 1963. Notes on methods for the narcotization, killing, fixing, and preservation of marine organisms. Mar. Biol. Lab., Woods Hole, Mass. 70 p.

Saloman, C. N. 1976. The benthic fauna and sediments of the nearshore zone off Panama City Beach, Florida. MR76-10, U.S. Army, Corps of Engineers, Coastal Engineering Res. Ctr., Fort Belvoir, VA 22060. August.

Sanders. H. L. 1958. Benthic studies in Buzzards's Bay. I. Animal-sediment relationships. Limnol. Oceanogr. 3(3):245-258.

Santos, S. L. and J. L. Simon. 1980. Marine Soft-bottom community establishment following annual defaunation: larval or adult recruitment? Mar. Ecol. Prog. Ser. 2:235-241.

Technicon. 1973. Industrial Method No. 112-71 w/Tentative Hydrogen Sulfide in Water and Seawater. Tarrytown, NY.

Thorson, G. 1957. Bottom communities. Chpt. 17, In: Treatise on Marine Ecology and Paleoecology. J. W. Hedgepeth (ed.) Vol. 1, p. 461-534.

Virnstein, R. W. 1972. Effects of heated effluent on density and diversity of benthic infauna at Big Bend, Tampa Bay, Florida. M. A. Thesis, Univ. of So. Fla., Tampa. 59 p.

Warinner, J. E. and M. L. Brehmer. 1966. The effects of thermal effluents on marine organisms. Air Water Poll. Int. J. 10:277-289.

Williams, D. D. and N. E. Williams. 1974. A counterstainding technique for use in sorting benthic samples. Limnol. Oceanogr. 19(1):154-156.

9.0 FISHERIES

Samples of juvenile and adult fish were collected by using four different gear types at various locations throughout the study area. The data are intended to provide information on the local fish community and to support evaluation of thermal, impingement and entrainment effects on fish populations. As in the impingement and entrainment evaluations, selected species are emphasized.

The fisheries program included a short-term effort to collect blue and stone crabs and to tag and recapture blue crabs. These data were intended primarily to identify patterns of local movement and coastal migration.

9.1 SAMPLING AND LABORATORY ANALYSIS

9.1.1 Sampling Procedures

Fisheries samples were collected in the vicinity of the Crystal River Power Station at monthly intervals from June 1983 through May 1984. Several gear types, including otter trawls, beach seines and a drop net, were used. Open water otter trawls were collected at night. Tidal creek trawls and all other fisheries samples were collected during the day. Station locations are shown in Figure 9.1-1.

A 3.05 meter otter trawl constructed of 3.8 cm mesh in the body, 1.3 cm mesh in the cod end and a 6.5 mm mesh nylon cod end liner was used for the open water trawling. Seven samples were collected at each station. The net was released from a moving boat and dragged along the bottom for 2 minutes (per haul).

Duplicate beach seine collections were made at each station using a 22.9 meter long by 1.8 meter deep seine constructed of 6.5 mm mesh. The seine was deployed in the following manner: an anchor attached to the end of the seine was placed on the beach. The seine was payed out as the other end was walked perpendicular to the beach. When approximately three-quarters of the length of the seine had been deployed, the net was walked in a semicircular formation. After the distal wing was on the beach, the two ends of the net were drawn together and the net was hauled onto the beach.

The drop net apparatus consisted of a portable frame from which a 1.6 mm mesh net was suspended and then remotely triggered to enclose a 16 m^2 water column. The trigger line was pulled after an acclimation period of approximately 2 hr. After the net was dropped, the enclosed area was swept five times with a 6.5 mm mesh seine. This was followed with a series of three sweeps with a 1.0 mm mesh seine. Two replicates were collected on each sampling date.

Four creeks were sampled with a 3.05 meter otter trawl constructed of 3.8 cm mesh in the body, 1.3 cm mesh in the cod end, with a cod end liner of 3.2 mm mesh nylon. Seven samples were collected at each site. The net was released from a moving boat, and dragged along the bottom for 2 minutes (per haul).

A blue crab tagging/recapture study was conducted during a 16 week period from September through December 1983. A total of 120 plastic coated standard wire mesh crab traps were set and retrieved weekly along four transects, designated A through D, within the study area. Each transect consisted of 30 individual traps, which were evenly spaced into six groups containing five traps each. Each group of five traps along a transect was designated as an individual station (Figure 9.1-2).

Each individual crab trap was baited with shad. Traps were retrieved, emptied, and reset every 7 days, at which time all healthy viable blue crabs were tagged and released. To avoid tag loss due to molting or death, only mature healthy female crabs and healthy male crabs larger than 127 mm carapace width were tagged. Tags were fastened to the carapace of the blue crab with 40 pound test monel. The tags were sequentially numbered and contained information pertinent to how the tag was to be returned. The tag number, date, and location of capture, carapace width to the nearest millimeter, sex, and general appearance of each tagged crab were recorded. Crabs were released approximately 200 m from the point of capture. When previously tagged crabs were recaptured, the tag number, sex, carapace width, date, time, and location of recapture were recorded and the crab was then released.

In addition to tagged blue crabs, any stone crabs (Menippe mercenaria) which were captured, as well as any blue crabs which could not be tagged, were measured for carapace width, sex was noted, and the specimens released.

To supplement the number of blue crabs tagged, all blue crabs impinged on the travelling screens during a 24 hr period were collected once weekly during the tagging study. The dates and times of collection were designated to correspond with the regular impingement sampling schedule. During this time, all viable blue crabs were placed in a divided water table. At the end of a minimum 24 hr holding period, each healthy crab was removed and tagged in the same manner as described previously. All blue crabs, dead or alive, were also measured for carapace width and total weight for the impingement study. The total number of crabs held, as well as percent mortality, were recorded. Tagged impinged crabs were then divided randomly into three equal groups and transported to three predetermined release points within the study area. These release points were designated as Stations E, F, and G (Figure 9.1-2).

Along with the field work, an extensive public notification program was initiated in cooperation with the Florida Department of Natural Resources (FDNR). Notices of the tagging project were sent to local licensed commercial crabbers, bait shops, docks, and processing houses in an attempt to enhance the number of tag returns. Included in this notification was a description of the study and the tags used, and the announcement of a nominal reward for tag returns with desired information. FDNR coordinated the tag returns to provide consistency with their statewide program.

9.1.2 Laboratory Analysis

All fish and macroinvertebrates were identified, counted, and weighed by species. Identifications were made utilizing standard literature sources and MML's reference collection. Nomenclature of fishes followed that established by the American Fisheries Society. Taxonomy was based on external characteristics as given in major taxonomic keys. A voucher specimen for each species was retained. The identifications of any questionable specimens were verified by external taxonomic specialists. A reference collection of all taxonomically confirmed species was maintained.

In addition to the general analyses, selected important organisms were examined in detail and analyzed for length-weight relationships, overt parasites, and disease. Additionally, certain species were analyzed for sex, reproductive condition, fecundity, and age as shown in Table 9.1-1.

Twenty-five individuals from each of the nine selected important species obtained by beach seining and trawling in each experimental (north of the intake canal) or control (south of the canal) area during each month were examined for obvious instances of parasitism and disease. External sexual characteristics were noted. Each species was also sexed internally, their stages of maturity recorded, and their reproductive condition examined. The latter was reported following standard classifications: immature, mature, ripe/gravid, or spent. Fecundity of ripe or gravid fish was determined by the gravimetric method. Age was determined using otoliths or scales for fish species subjected to fecundity analyses. Analyses were performed for each month of the study. Sex and reproductive state (e.g., gravid, egg-bearing) of important macroinvertebrates were recorded where possible.

TABLE 9.1-1

DETAILED STUDIES OF SELECTED IMPORTANT ORGANISMS

Species	Sex	Reproductive Condition	Fecundity	Age	Length-Width	Disease and Parasites
Polka-dot batfish	X	X			X	X
Pigfish	X	X	X	X	X	X
Pinfish	X	X	X	X	X	X
Silver perch	X	X	X	X	X	X
Spotted seatrout	X	X	X	X	X	X
Spot	X	X	X	X	X	X
Red drum	X	X	X	X	X	X
Striped mullet	X	X	X	X	X	X
Bay anchovy	X	X	X	X	X	X
Blue crab	X	X				
Stone crab	X	X				
Pink shrimp		X				

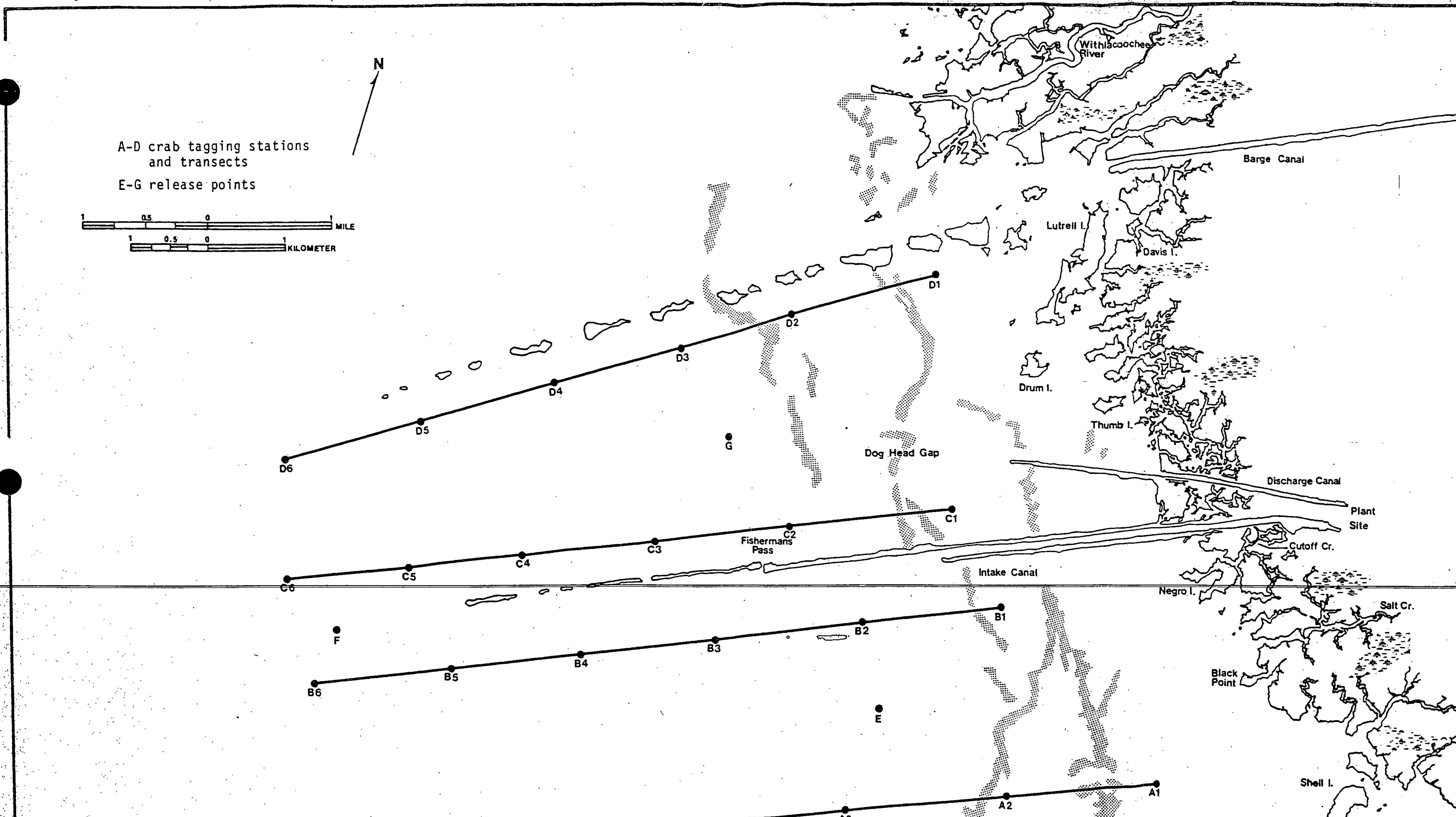


FIGURE 9.1-2.

CRAB TAG TRANSECTS.
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

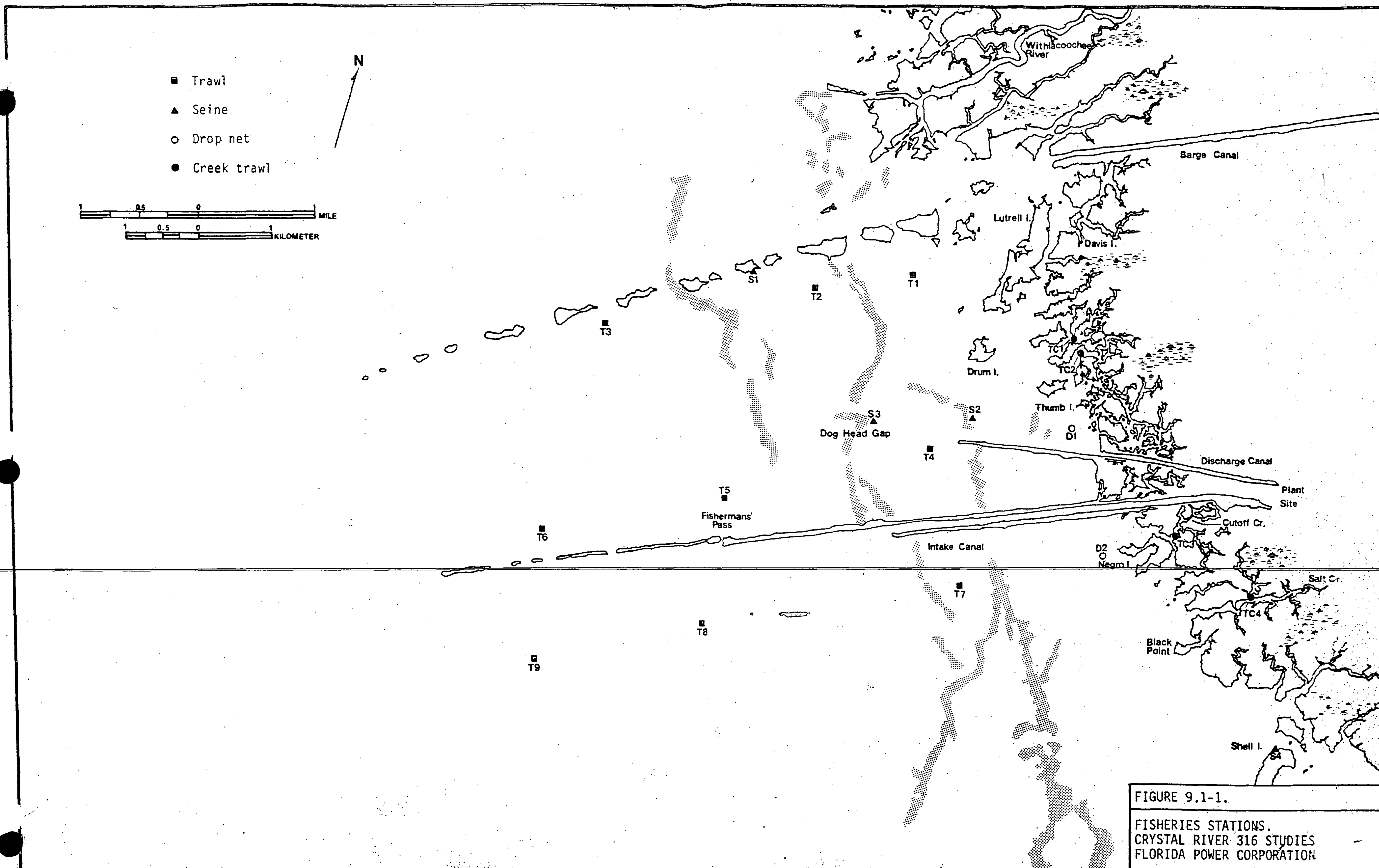


FIGURE 9.1-1.

FISHERIES STATIONS.
CRYSTAL RIVER 316 STUDIES
FLORIDA POWER CORPORATION

9.2 RESULTS

Fish and invertebrate numbers and biomass have been provided in quarterly reports by gear type, month, and station. Summary tables for SIO are provided in Appendix VII. In general, numbers were small, although occasional large collections did occur. As a result, one or two samples have a large effect on total values. Quantitative analyses which can be performed are limited. The following sections report the results of fisheries sampling by gear type.

9.2.1 Trawl

The trawls captured a total of 98 species of fish and 108 species of invertebrates. The total catch of fish varied seasonally with lowest numbers in January and February (see Figure 9.2-1). The peak number at any one station occurred in May (Station T9), but similarly high densities occurred in April, June, July, and August (Table 9.2-1). Highest densities at all stations occurred in late spring and summer (May, August, September, June). Invertebrate densities followed a similar seasonal pattern although low densities found in December and January continued through June, and then increased to a peak in July and August.

Fish biomass followed the same general seasonal pattern seen in the density data (see Figure 9.2-2). Invertebrate biomass was lowest from December through February, however, peak values occurred from March through May rather than in summer.

The variability in the data associated with capturing a school of fish can efffectively mask patterns of distribution. For example, trawling in April at Station T4 yielded 502 spot which was 91 percent of the catch at the station and 38 percent of the catch at all stations. At the same time, some general patterns do appear consistently from month to month. Comparisons among transects (northern, T1-3, central, T4-6, southern, T7-9) indicate the lowest densities of both fish and invertebrates along the central transect (see Tables 9.2-2 and 3). The transects to the north and south had similar numbers overall. Highest numbers of fish were collected to the north in 1983 and to the south in 1984. Numbers of invertebrates were consistently higher to the south. Fish biomass was highest to the south except in the fall. Based on average fish weights, the larger fish were collected along the central or southern transects.

Within transects, distributional trends vary from month to month, but to the north, Stations T1 or T2 generally had the highest numbers and T3 the lowest. On the central transect, the variation was similar with highest densities inshore at Station T4 and lowest offshore at Station T6. To the south, the offshore station (T9) frequently had the highest numbers and the central station (T8) had the lowest.

Diversity (Shannon-Weaver) evenness (after Pielou 1975) and richness (number of species) were calculated for each trawl station in each sampling month. A summary table is included in Appendix VII (Table VII-23). Comparing across transects, richness was often lower along the central transect and was considerably higher along the southern transect in 1984. Evenness was slightly higher on the central transect in the winter and spring. Diversity was generally similar on all three transects. During 1983, diversity within transects increased with distance offshore along the north and central transects. Evenness and richness also increased offshore. Along the southern transect, diversity was highest inshore until April 1984 at which time the offshore station was most diverse. Evenness was frequently highest at T8 and richness was highest at T7 or T9.

In addition to evaluating population parameters for trawl data, total density and biomass, the data for each SIO were summarized (see Appendix VII, Tables VII-1 to 22). Several species were captured in very low numbers precluding detailed evaluation of their distributions; these included squid, stone crab, and polka-dot batfish. Blue crab occurred in low numbers but peaked in April and May; they were most consistently found at T1 and T2. Spotted seatrout numbers were also low, peaked in May and concentrated at T1-3 and T5. Bay anchovy were rarely collected in trawls; numbers peaked in the summer with most anchovies taken at Stations T1-4.

Other SIO were collected in greater numbers. Spot was present throughout the year with highest numbers in spring and summer at Stations T1-4. Based on biomass values, the smaller specimens were inshore at Station T1 and T4 and the largest spot were at Station T3. Pigfish were collected primarily in spring and summer, but their concentration was to the south. Pinfish occurred at about the same time, and they were also collected primarily at the southern stations. Moderate numbers of pinfish were also taken at Stations T1 and T2.

Silver perch were most common in summer and fall with the highest densities inshore at Stations T1, T2, and T7. Based on average weight comparisons, the smaller specimens were found at these stations. Pink shrimp were taken throughout the program with highest densities occurring in the summer. Numbers were higher inshore at that time but showed considerable variation at other times.

9.2.2 Seine

Seine collections yielded 49 species of fish and 15 species of invertebrates. Figure 9.2-1 provides a summary by month of the total number of fish collected. In general, the seines sampled a limited number of species, and of the species collected, many occurred in small numbers. Invertebrates were rare except at Station S1 in February when several species of shrimp common in grassbed habitats were collected (see Table 9.2-1). Fish captured in large numbers were usually juveniles of schooling species. Large numbers were taken in March at Station S1 (clupeids, spot) and S2 (clupeids), in February at Station S1 (spot), and in September at Station S2 (bay anchovy). Excluding these particularly large catches, lowest densities occurred from November through April and the highest in June and July. No clear pattern of distribution emerged. Station S2 did have the lowest density and biomass seen at the site in any given month over half of the time, but values at other stations were rarely much higher. The highest density per sampling date occurs most frequently at Station S1.

Diversity, evenness, and richness (see Appendix VII, Table VII-46) were very variable, both across stations and month to month. Diversity remained relatively high at S4 and tended to be highest at Station S1 or S4. Lowest values in winter were at Station S2. Richness was highest in winter at Station S4 and in spring at Station S1.

SIO information from seines is very limited (Tables VII-24 to 45). Stone crab, pink shrimp, red drum, and pigfish were collected only on one date. Silver perch were collected twice. Small numbers of batfish were collected over 5 months; all but one occurred at Station S1. Low numbers of blue crabs were found at all stations over 8 months.

Spot were collected mostly in February and March with highest numbers at Station S1. Pinfish were also collected in highest numbers in February and March at Station S1. Bay anchovy were collected in all months except January, February, and April. The station at which the maximum density occurred varied over time but was most often S2. Striped mullet occurred in varying numbers, mostly from August through February. Only four specimens were collected at Station S2.

9.2.3 Drop Net

Drop nets sample primarily small, shallow water inhabitants and species which move into shallow areas with the tide. Drop net collections contained 42 species of fish and 24 species of invertebrates. Numbers of organisms were generally low and variable (see Figure 9.2-1). Highest numbers were collected in February, November, October, and September (see Table 9.2-1). Lowest numbers occurred in December and January. The number of fish caught at Station D1 generally exceeded the number at Station D2, except in June, August, January, and December. Fish biomass was also usually higher at Station D1; exceptions were in July, April, and March when biomass was greater at Station D2. In contrast, more invertebrates were consistently taken at D2. Biomass of invertebrates was also generally higher at Station D2.

Diversity at drop net stations was highest at D2 in 10 of 12 months (Table VII-67). Diversity was lower at Station D1 in the spring despite higher richness. Evenness was correspondingly lower. Richness was generally higher at D2.

Selected species were uncommon in drop net collections (see Tables VII-47 to 66). Seatrout and bay anchovy were taken only at Station D1. Mullet, ~~batfish, and silver perch were collected only at Station D2. Of the species~~ collected at both stations, spot occurred in larger numbers at Station D1 and pigfish and pink shrimp were mostly at Station D2. Pinfish and blue crabs were about evenly distributed.

9.2.4 Creek Trawl

Given the locations and conditions sampled, this gear sampled organisms moving in and out of the creeks on a relatively high tide. Forty-three species of fish and 27 species of invertebrates were collected. Juvenile fish predominated. The largest numbers of fish were collected from January through May with the peak in March (see Figure 9.2-1). Invertebrate numbers were highest from November through March (Table 9.2-1). Fish biomass was highest in the spring; a secondary peak occurred in November.

Fish densities tended to be lowest at Station TC4 and at Station TC1. Peak densities tended to be at Station TC2. The same pattern was observed for the invertebrates collected.

Diversity in creek trawl samples was almost always higher at TC4 or TC1 and lowest at TC2 (see Table VII-86). Evenness tended to be lowest at TC2 or TC3. Richness increased at TC2 in the fall and early winter; in the spring, highest richness was at TC1 or TC2.

Mullet, spotted seatrout, pigfish, and bay anchovy were collected in small numbers (see Tables VII-68 to 85). Silver perch were generally rare but a large number were collected in May at Station TC1. Pink shrimp were taken at all stations over all months with the largest numbers collected at Station TC2. Blue crabs showed similar seasonal and spatial patterns; numbers were slightly higher at TC1. Spot were collected in only 5 months but in relatively high numbers. Peak numbers were in February and March at Stations TC1 and TC2. Pinfish was the most commonly collected SIO with highest numbers from February through May, at Station TC2. These peak values were made up of small fish which began to appear in January. Average weight continued to increase through May.

9.2.5 Crab Traps

During the 4 months of trapping, 7294 blue crabs and 6251 stone crabs were captured (Table 9.2-4). Of the blue crabs, 6123 were collected in crab traps, tagged, and released. An additional 220 crabs were impinged, tagged, and released. These results and subsequent analyses utilize collection data without correction for Catch Per Unit Effort (CPUE). CPUE by station and week of sampling was reviewed and evaluated statistically, but the results and conclusions described below and displayed in subsequent tables were unchanged.

Only about 17 percent of the blue crab captures occurred in September and October. At the same time, 43 percent of the stone crabs were caught (Table 9.2-5). In general, blue crabs were captured in larger numbers inshore on all four transects. In September and October, Stations A1, B1, C1, D1, and D2 accounted for about 73 percent of the catch. Numbers generally decreased at stations toward the offshore end of each transect. Stone crabs were concentrated toward the offshore end and center of the transects. Densities along Transect B were somewhat more homogeneous in having comparable numbers of stone crabs at B1-3 and B6, but the largest numbers were at B4 and B5.

In November and December, stone crabs maintained the pattern of largest numbers offshore and in the center of the transects (see Table 9.2-6). Blue crabs continued to be caught in large numbers at the inshore stations, but similar numbers were taken at the first four stations on each transect indicating an increase in densities 4-7 kms offshore.

Highest numbers of blue crabs were trapped at Transect D throughout the study. Transect A yielded the next highest number. Transects B and C had similar numbers, with B yielding slightly more overall. Stone crabs were most abundant at Transect B and least abundant at Transect D.

Data from crab traps were also evaluated in terms of sex and carapace size. Overall, stone crabs were 65 percent males, the percentage lower in November and December (61 percent) compared to September and October (70 percent) (see Tables 9.2-7 to 9.2-10). The distribution along a transect is similar for both sexes; male stone crabs were collected in higher numbers along Transects A and B while females were least dense on Transect A. At almost all stations, females were smaller than males.

The blue crabs collected were about 74 percent females. In September and October, however, only about 48 percent were females. The population in November and December was about 79 percent females. Both males and females were most dense inshore in September and October. Later, the males contined to be most dense inshore while females occurred in larger numbers toward the center of the transects. Highest numbers of both males and females were at Transect D, lowest numbers were at Transects B and C. Female blue crabs were generally larger than males, but no pattern of distribution based on size was apparent.

Immature blue crabs were not collected in September but then appeared in increasing numbers through December. They made up less than 4 percent of the catch. Parasitized specimens were also taken in increasing numbers each month and represented 3 percent of the blue crabs collected. Parasitized specimens averaged 110.5 mm.

A total of 3422 tagged blue crabs were recaptured. One hundred thirty-three crabs were recaptured initially by MML; of these, 68 were recaptured more than once. Most of these multiple captures involve only a second recapture although one crab was taken four times. The number of crabs recaptured represented 54 percent of the tagged crabs; 96 percent of the recaptures were from fishermen while 4 percent were taken by MML crab traps. Of all the recaptures, about 67 percent came from Crystal Bay. Of the Crystal Bay recaptures, about 79 percent were females.

Numbers of crabs recaptured in Crystal Bay are shown by release location in Table 9.2-11. The table records multiple recaptures in terms of both the original release station and the secondary release point for each recapture. The recapture location numbers refer to grid elements as shown in Figure 9.2-3. For recaptures reported by fishermen, locations are approximated based on information reported with the tag return, conversations with fishermen, and field observations. Data on recaptures are also presented by sex, (Tables 9.2-12 and 9.2-13) but males are relatively few in number and the pattern of recaptures is similar for both sexes. Thus results are discussed in terms of total numbers. Comparing recaptures by transects provides the best indication of local north-south movement. Crabs released on Transect A are recaptured primarily on Transect A (39 percent) or Transect B (44 percent). Recaptures after release on Transect B were mostly (71 percent) on Transect B, recaptures from Transect C were either on Transect C (38 percent) or Transect D (54 percent), and those from Transect D were recaptured along Transect D (80 percent). The latter value is biased by the lack of traps further north. The data do indicate a movement of crabs to the north from all transects but particularly from A and C with more limited numbers released on Transect B being recaptured on C or D. There is also some movement to the south from Transects B, C, and D.

Within each transect, there was some east-west movement indicated. Crabs released at inshore stations, e.g., A1, B1, B2, D1, and D2, were often found further offshore. Crabs released at central stations, e.g., A4, B4, D3, and D4, tended to be recaptured inshore.

In Table 9.2-14, the release and recapture data is presented in terms of the average time between the two events in order to consider rate of movement. The times are highly variable, and the variation in number of crabs recaptured requires careful interpretation. For crabs released at a point on a given transect, recaptures occur more quickly on the same transect than on other transects. On Transect A, recaptures on Transects C or D occur over the same range of average times as recaptures on Transect B. It is possible, using weighted averages for recaptures on the four transects, to define the time from release along Transect A until recapture as increasing with distance north: Transect A (22.5 days), Transect B (29.1 days), Transect C (34.1 days), and Transect D (36.8 days).

In addition to recaptures in Crystal Bay, recaptures were recorded north and south. Table 9.2-15 provides a summary of the numbers of crabs recaptured at various locations. The southern section of Crystal Bay accounted for only 0.5 percent of the recaptures. About 27 percent of the total recaptures were from Waccasassa Bay and less than 6 percent from further north. As would be expected, releases from northern transects in Crystal Bay accounted for higher numbers of recaptures to the north. Recaptures to the south came mostly from Transects A and B. Males accounted for all but one of the crabs recaptured to the south but only about 5 percent of the crabs moving north.

Average time between release and recapture is provided in Table 9.2-16. In general, crabs were recaptured most quickly in Crystal Bay with the time span increasing with distance from Crystal Bay. Maximum times occurred with crabs recaptured near Apalachicola River (about 225 km NW). Crabs recaptured to the south (10 km) had unexpectedly high times, similar to times seen about 200 km northwest.

Over 900 crabs were recaptured in Waccasassa Bay. A comparison was made of recapture times in Waccasassa Bay and release stations along Transects B and C. For each comparably located station, the time to recapture is less from Transect B than Transect C. Comparing Transects D and B, three of the comparable stations on B have shorter times until recapture in Waccasassa Bay. Crabs from Transect A take longer than crabs from B but sometimes more and sometimes less time than crabs from C and D. Comparing weighted average times by transect indicates the shortest recapture time from Transect B (43.8 days) and the longest time from Transect C (52 days). The average time from Transect D (45 days) is similar to that from Transect B but lower than from Transect A (49.7 days).

9.2.6 Special Studies of SIO

Evidence of disease or parasitism was encountered in only two species. Fifty-seven batfish, all with an intestinal nematode, were collected and sacculinid parasites were found on 76 blue crabs of 422 collected. All but one batfish was from trawl collections, the largest number occurred at Station T7, and parasitized fish were taken in 10 of the 12 collections. Almost 72 percent of the parasitized batfish were collected in the control area. All but two of the blue crabs reported were also from trawl collections, the largest number were taken at Station T9, and they occurred in all months with higher numbers in April and May. In other gear, only 2 of 115 crabs were parasitized. In the trawls, a significantly greater percentage of parasitized crabs occurred in the thermal area (56 percent) compared to the control area (44 percent). This pattern was reversed only in the spring (control, 63 percent; thermal, 37 percent).

Gravid females of only three species were collected and analyzed; all were less than 1 year old. Three pigfish were collected in March 1984 at Stations T7 and T9. Fecundity ranged from 17302 to 28160 (average 21660) eggs per female. Nine bay anchovies were found to have 1173 to 4387 (average 2290) eggs per female. One specimen was taken in June 1983 at Station T4, three were collected in March 1984 at Stations T1 and T2, and the remainder were at Stations T7 and T8 in April. Eleven silver perch ranged from 17920-147050 (average 48140) eggs per female. All were collected in March at Stations T1 and T4 or in April at Stations T1, T4, T8. While the numbers involved are too small to warrant quantitative analysis, it can be noted that the March occurrence of silver perch and bay anchovy was at stations closest to the thermal discharge.

The SIO collected for special studies were analyzed for several other parameters to identify possible differences between thermal and control areas. For these analyses, thermal stations were defined as T1, T2, T4, S2, S3, D1, TC1, and TC2. These were compared to fish collected at Stations T7, T8, T9, S4, D2, TC3, and TC4.

Age

Each SIO was evaluated by age class in each month of the study. The number of specimens was generally small and variable. Bay anchovy were all first year fish. In all months when they were found only in one area (July, September, November, January, February), the fish were in the thermal area. In March and April higher numbers occurred at control stations while in May, August, and October, numbers were higher at thermal stations. Pigfish were 0-3 year classes; older fish were generally found at the control stations. Young-of-the-year were also most commonly at control stations.

Pinfish were of the 0 or 1 year classes. Numbers of young fish were highest at control stations except in early summer when comparable numbers were collected in both areas. Older specimens were more common at control stations. Silver perch were 0, 1, or 2 year classes; young fish occurred in higher numbers at the thermal stations throughout the year. Spotted seatrout were 0, 1, or 3 year classes but fish for which age was determined were too uncommon to consider distribution. One spot was in its second year; all others were young-of-the- year. Numbers were either equal in both areas (November, February, March, April, May) or higher at thermal stations. Mullet were 0, 1, or 2 year classes, but generally occurred in low numbers in one area or the other. Only two red drum were collected; both were age 1.

Sex

Each SIO for which sex was determined was considered in terms of total numbers at thermal or at control stations. Results are shown in Table 9.2-17. The ratio of females to males was higher in the thermal area compared to the control area for bay anchovy, batfish, silver perch, and pink shrimp. The ratio was lower for pigfish, pinfish, seatrout, mullet, and blue crab.

Reproductive Condition

The reproductive condition of specimens analyzed for each SIO was considered in terms of total numbers in control and thermal areas. Most species were either not collected in comparable conditions in both areas or were collected in similar numbers in both areas. Immature specimens found in larger numbers at thermal stations included bay anchovy, silver perch, spotted seatrout, spot, pink shrimp, and blue crabs. Immature batfish, pigfish, and pinfish were more common in control areas. Numbers of mature pinfish were higher in the control area. Mature bay anchovies had higher numbers in the thermal area.

Only bay anchovies, pigfish, pinfish, and silver perch were found in significant numbers for any condition other than immature. More mature silver perch tended to be collected in the thermal area; pinfish and pigfish were the reverse. Anchovies in all conditions were either in similar numbers in both areas or in higher numbers in the thermal area.

Length-Weight

The length-weight and condition index data were available in sufficient abundance for analysis of six species: bay anchovy, batfish, pigfish, pinfish, silver perch, and spot. The analysis examined differences in length-weight and condition factor by sex, season, and location (thermal vs control). The analysis is a regression of log of weight on log of length using one of the above factors as a covariate.

The analysis of the effect of sex on the length-weight relationship indicated that significant differences existed only for silver perch. Silver perch females have a greater rate of increase in weight by length (slope) than male silver perch.

In the analysis of the effects of season on the length-weight relationship a separate seasonal analysis was conducted for each sex for silver perch and for all specimens of the other five species. These tests revealed differences in log weight vs log length slopes for four species. For bay anchovy, the fall and spring specimens had a lower slope than summer and winter collected specimens. Mean size also differs with season with the smaller specimens being collected in the summer. Summer collected pinfish were large in size and had a weight-length slope greater than all other seasons. Fall collected pinfish were also large in size and had significantly greater slope than winter and spring collected specimens. Silver perch females were significantly smaller in the summer, but the larger spring specimens had a lower weight-length slope than specimens collected at other times of the year. Spot collected in the spring, while moderate in size, had weight-length slope significantly greater than specimens collected at other times of the year.

In the analysis of the effects of thermal vs control areas, four species displayed significant differences. In spring and fall, bay anchovy in the thermal area had a significantly lower weight-length slope than those collected in the control area. Spot collected in summer, fall, and winter showed the same pattern, but significantly larger specimens were collected in the thermal area. Female silver perch collected in summer, fall, and winter in the thermal area had a significantly greater weight-length slope than specimens collected in the control area. Pigfish showed the same pattern and were significantly smaller in size in the thermal area.

Reference for 9.2

Pielou, E. C. 1975. Ecological Diversity. John Wiley and Sons, New York. 165 pp.

TABLE 9.2-1

FISHERIES SAMPLING DATA
NUMBERS OF FISH (F) AND INVERTEBRATES (I)

Month	Trawl F	Trawl I	Seine F	Seine I	Creek Trawl F	Creek Trawl I	Drop Net F	Drop Net I
June	1742	625	1342	4	-	-	190	379
July	1277	2005	1084	-	444	172	151	501
August	2130	1834	559	13	334	129	42	79
September	1912	989	2047	1	314	117	410	-
October	1004	455	576	3	233	79	449	122
November	679	392	108	3	555	354	533	1021
December	554	269	36	26	80	807	28	292
January	121	605	67	2	788	2865	40	42
February	435	855	2898	147	1644	889	1418	6
March	1033	890	9846	7	3575	386	76	1
April	1304	774	75	13	636	125	136	-
May	2448	449	1028	10	1489	326	56	-

TABLE 9.2-2

NUMBER OF FISH COLLECTED BY TRAWL

Location	J	J	A	S	O	N	D	J	F	M	A	M	
	Month												
Northern Transect:													
T1	540	375	362	369	83	60	74	8	96	335	96	318	
T2	327	226	475	377	201	139	112	25	52	41	68	311	
T3	62	121	139	191	86	109	17	7	25	24	33	280	
Transect Total	929	722	976	937	370	308	203	40	173	400	197	909	6164
Central Transect:													
T4	82	28	67	197	105	92	169	15	25	40	551	103	
T5	49	61	158	144	59	29	58	8	13	23	20	154	
T6	19	24	68	41	26	21	24	6	18	19	37	107	
Transect Total	150	113	293	382	190	142	251	29	56	82	608	364	2660
Southern Transect:													
T7	145	97	215	155	111	99	12	17	89	152	358	249	
T8	46	31	231	49	140	59	72	16	56	64	61	156	
T9	472	314	415	389	193	71	16	19	61	335	80	770	
Transect Total	663	442	861	593	444	229	100	52	206	551	499	1175	5815

TABLE 9.2-3

NUMBER OF INVERTEBRATES COLLECTED BY TRAWL

Location	Month J	J	A	S	O	N	D	J	F	M	A	M	
:hern Transect:													
l	72	489	217	166	25	30	31	45	127	50	36	36	
2	88	186	264	85	28	24	18	73	92	129	132	74	
3	40	409	120	40	28	16	13	28	41	89	79	48	
ısect Total	200	1084	601	291	81	70	62	146	260	268	247	158	3468
:ral Transect:													
4	30	214	108	75	39	28	4	4	20	92	102	20	
5	47	164	73	25	23	15	25	17	27	26	41	42	
6	13	99	76	30	29	16	33	22	27	13	22	12	
ısect Total	90	477	257	130	91	59	62	43	74	131	165	74	1653
thern Transect:													
7	77	165	248	145	86	137	13	83	249	216	204	45	
8	40	41	218	56	67	19	56	99	92	69	54	25	
9	218	238	510	367	130	107	76	234	180	206	104	147	
ısect Total	335	444	976	568	283	263	145	416	521	491	362	217	5021

TABLE 9.2-5

NUMBER AND AVERAGE WIDTH OF CRABS TRAPPED

THROUGH OCTOBER 31, 1983

STATION	BLUE CRAB NUMBER	BLUE CRAB WIDTH (MM)	STONE CRAB NUMBER	STONE CRAB WIDTH (MM)
A1	228	141.6	2	84.5
A2	56	138.9	97	79.7
A3	23	142.3	131	80.7
A4	25	140.2	123	82.2
A5	3	141.7	127	85.6
A6	0	.	92	87.4
B1	147	149.8	115	82.3
B2	28	148.7	115	77.7
B3	14	148.0	144	78.7
B4	15	154.0	223	81.5
B5	4	150.8	240	83.1
B6	0		105	81.8
C1	119	137.2	74	78.0
C2	23	146.7	56	77.5
C3	30	151.1	107	79.3
C4	26	148.2	161	80.4
C5	13	150.7	117	79.8
C6	5	147.6	164	83.6
D1	211	153.8	1	70.0
D2	182	146.0	9	82.4
D3	38	145.1	107	78.8
D4	13	160.9	122	80.9
D5	5	163.8	132	80.4
D6	4	148.8	106	80.6

TABLE 9.2-4

NUMBER AND AVERAGE WIDTH OF CRABS TRAPPED

FROM SEPTEMBER 1983 THROUGH JANUARY 2, 1984

STATION	BLUE CRAB NUMBER	BLUE CRAB WIDTH (MM)	STONE CRAB NUMBER	STONE CRAB WIDTH (MM)
A1	742	142.9	11	79.8
A2	333	144.2	252	80.7
A3	325	148.5	368	80.3
A4	462	149.7	271	82.2
A5	63	153.2	362	82.8
A6	58	149.9	295	84.5
B1	533	146.1	238	81.9
B2	370	149.8	287	79.1
B3	312	147.6	288	79.3
B4	209	149.1	409	81.1
B5	100	147.8	464	81.6
B6	0		382	80.6
C1	351	140.5	144	78.3
C2	174	148.3	175	76.5
C3	435	149.4	185	78.3
C4	224	151.3	276	79.7
C5	111	145.5	332	79.4
C6	50	153.2	340	81.3
D1	574	152.8	6	82.7
D2	765	152.5	17	81.1
D3	605	148.2	148	79.2
D4	378	148.3	246	79.9
D5	95	148.2	344	80.1
D6	25	153.3	411	79.7

TABLE 9.2-6

NUMBER AND AVERAGE WIDTH OF CRABS TRAPPED

FROM NOVEMBER 1, 1983 THROUGH JANUARY 2, 1984

STATION	BLUE CRAB NUMBER	BLUE CRAB WIDTH (MM)	STONE CRAB NUMBER	STONE CRAB WIDTH (MM)
A1	514	143.4	9	78.8
A2	277	145.2	155	81.3
A3	302	148.9	237	80.1
A4	437	150.2	148	82.3
A5	60	153.8	235	81.3
A6	58	149.9	203	83.2
B1	386	144.8	123	81.6
B2	342	149.9	172	80.0
B3	298	147.6	144	80.0
B4	194	148.7	186	80.7
B5	96	147.6	224	79.9
B6	0	.	277	80.1
C1	232	142.1	70	78.6
C2	151	148.6	119	76.0
C3	405	149.3	78	76.9
C4	198	151.7	115	78.8
C5	98	144.9	215	79.1
C6	45	153.9	176	79.2
D1	363	152.3	5	85.2
D2	583	154.5	8	79.6
D3	567	148.4	41	80.2
D4	365	147.8	124	79.0
D5	90	147.3	212	79.9
D6	21	154.1	305	79.4

TABLE 9.2-7

NUMBER AND AVERAGE WIDTH OF FEMALE CRABS TRAPPED

THROUGH OCTOBER 31, 1983

STATION	BLUE CRAB NUMBER	BLUE CRAB WIDTH (MM)	STONE CRAB NUMBER	STONE CRAB WIDTH (MM)
A1	105	145.6	1	90.0
A2	31	144.9	4	74.8
A3	16	143.1	18	74.7
A4	13	150.5	21	75.0
A5	2	154.0	12	76.9
A6	0	.	3	75.0
B1	67	159.8	8	78.3
B2	12	161.6	46	73.7
B3	9	156.6	64	77.3
B4	14	154.8	52	74.1
B5	4	150.8	63	77.3
B6	0	.	7	81.4
C1	40	142.8	19	75.5
C2	15	142.7	27	78.1
C3	18	156.4	51	76.5
C4	24	149.5	66	75.9
C5	11	156.1	41	75.4
C6	5	147.6	28	78.2
D1	29	146.3	0	.
D2	86	157.7	2	86.0
D3	23	154.0	73	77.2
D4	8	159.1	61	78.0
D5	4	165.3	61	77.0
D6	4	148.8	46	77.1

TABLE 9.2-8

NUMBER AND AVERAGE WIDTH OF MALE CRABS TRAPPED

THROUGH OCTOBER 31, 1983

STATION	BLUE CRAB NUMBER	BLUE CRAB WIDTH (MM)	STONE CRAB NUMBER	STONE CRAB WIDTH (MM)
A1	107	141.4	1	79.0
A2	23	133.6	93	79.9
A3	7	140.4	113	81.6
A4	11	130.5	102	83.7
A5	1	117.0	115	86.5
A6	0	.	89	87.8
B1	71	143.5	99	82.6
B2	14	142.7	69	80.4
B3	5	132.6	80	79.8
B4	1	143.0	171	83.8
B5	0		177	85.2
B6	0		98	81.8
C1	58	143.1	52	79.3
C2	8	154.0	26	77.5
C3	11	144.2	45	83.7
C4	2	132.5	77	84.1
C5	2	121.0	63	83.0
C6	0		111	85.0
D1	181	155.3	1	70.0
D2	70	144.7	7	81.4
D3	10	141.6	34	82.2
D4	4	166.8	61	83.8
D5	1	158.0	71	83.2
D6	0		60	83.3

TABLE 9.2-9

NUMBER AND AVERAGE WIDTH OF FEMALE CRABS TRAPPED

FROM NOVEMBER 1, 1983 THROUGH JANUARY 2, 1984

STATION	BLUE CRAB NUMBER	BLUE CRAB WIDTH (MM)	STONE CRAB NUMBER	STONE CRAB WIDTH (MM)
A1	212	157.6	1	89.0
A2	185	153.8	25	79.7
A3	251	152.4	58	76.8
A4	409	151.0	56	76.9
A5	57	155.5	84	76.1
A6	54	151.4	60	77.1
B1	192	155.8	15	81.9
B2	273	155.4	49	76.2
B3	264	150.3	59	78.2
B4	186	149.7	72	76.8
B5	88	151.0	113	77.7
B6	0	.	92	76.7
C1	95	151.9	8	79.6
C2	104	152.4	46	74.3
C3	365	151.6	43	75.7
C4	184	153.2	56	76.1
C5	78	149.1	117	77.0
C6	40	157.8	86	75.4
D1	64	162.6	0	.
D2	411	160.6	6	77.5
D3	496	151.2	26	81.5
D4	335	149.8	64	75.7
D5	84	148.8	98	75.6
D6	19	155.0	147	78.4

TABLE 9.2-10

NUMBER AND AVERAGE WIDTH OF MALE CRABS TRAPPED

FROM NOVEMBER 1, 1983 THROUGH JANUARY 2, 1984

STATION	BLUE CRAB NUMBER	BLUE CRAB WIDTH (MM)	STONE CRAB NUMBER	STONE CRAB WIDTH (MM)
A1	228	137.1	8	77.5
A2	49	141.4	130	81.7
A3	30	143.5	179	81.2
A4	20	146.8	92	85.5
A5	1	132.0	151	84.2
A6	1	128.0	143	85.7
B1	149	137.6	108	81.5
B2	33	139.3	123	81.6
B3	17	144.9	85	81.2
B4	4	138.8	101	83.6
B5	3	125.3	111	82.2
B6	0		185	81.8
C1	118	139.7	62	78.5
C2	40	145.0	73	77.0
C3	21	138.2	35	78.3
C4	6	147.2	59	81.4
C5	8	145.5	98	81.7
C6	3	126.0	90	82.9
D1	288	151.3	5	85.2
D2	129	148.1	2	86.0
D3	35	139.8	15	77.9
D4	14	142.7	60	82.6
D5	4	132.3	114	83.6
D6	2	146.0	158	80.4

TABLE 9.2-11

TOTAL NUMBER OF CRABS RECAPTURED

RELEASE LOCATION

RECAPTURE LOCATION	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D1	D2	D3	D4	D5	D6	E	F	G
01	.	.	2	3	.	.	.	1	1	2	.	.	2	.	7	.	4	.	1	6	2	8	.	1	.	.	.
03	.	.	1	.	.	.	.	.	1	.	.	.	1	.	2	.	.	.	.	.	.	1	.	.	.	.	.
04	.	3	.	1	.	.	.	.	3	1	.	.	.	.	1	2	.	.	.	1	4	6	.	.	.	.	.
05	6	2	6	3	1	3	5	7	5	4	4	.	14	10	43	12	6	2	19	63	86	16	8	3	2	2	.
06	4	1	.	6	.	.	3	6	2	2	1	.	9	6	12	2	4	3	7	48	23	14	1	.	.	3	6
07	.	.	.	1	.	.	.	2	2	.	.	.	1	1	2	.	1	.	1	14	3	1	.	1	.	.	.
08	.	.	.	1	.	.	1	.	.	1	.	.	5	2	5	.	.	.	67	10	.	1	1	.	1	1	1
09	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.
11	14	9	14	25	1	3	27	10	18	18	2	.	6	1	2	4	2	1	3	5	2	5	.	.	1	2	.
12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
13	.	.	1	.	.	.	.	.	1	1	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
14	.	.	.	.	1	.	.	1	1	.	.	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.	1
15	.	.	.	.	.	.	2	.	1	.	.	.	.	.	3	1	.	.	.	1	.	.	1	1	.	.	.
16	1	.	6	8	.	2	2	.	1	2	3	.	10	8	2	.	1	.	.	.	.	.	.	.	.	1	.
17	1	1	1	3	.	.	.	.	.	.	1	.	12	11	.	2	2	1	37	5	2	1	1	1	.	.	.
18	.	.	.	.	.	.	.	.	.	1	.	.	21	6	5	4	2	.	8	8	2	3	1	.	.	1	.
19	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
21	3	4	2	6	1	2	.	.	6	1	.	.	.	.	.	.	.	.	.	1	1	.	.	.	2	.	.
22	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
23	3	3	3	8	2	6	11	10	3	.	8	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.
24	13	15	17	33	9	6	37	65	38	42	13	.	3	.	1	.	1	.	.	1	.	.	.	.	4	1	.
25	15	7	16	25	2	3	15	25	18	9	5	.	.	.	2	3	.	.	.	.	1	.	.	.	1	.	.
26	5	9	6	7	.	2	10	4	12	4	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
27	27	9	11	20	6	1	37	33	9	2	3	.	.	1	1	2	.	.	1	.	.	1	.	.	3	4	.
28	13	8	2	6	1	.	37	7	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.
29	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.
30	3	.	.	.	.	.	7	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
34	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
35	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
36	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
37	18	14	25	15	.	1	.	8	11	5	1	.	.	.	2	1	1	.	1	.	.	2	.	.	2	.	.
38	73	26	4	4	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	2	.
39	28	10	1	4	.	1	3	2	2	1	.	.	.	.	.	.	1	.	.	.	2	.	.	.	.	1	.
40	44	12	10	6	1	1	10	6	3	1	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.

TABLE 9.2-12

NUMBER OF FEMALE CRABS RECAPTURED

RECAPTURE LOCATION	RELEASE LOCATION																										
	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D1	D2	D3	D4	D5	D6	E	F	G
01	.	.	1	3	.	.	.	1	1	2	.	.	2	.	7	.	4	.	1	5	2	8	.	1	.	.	.
03	.	.	1	.	.	.	.	.	1	.	.	.	1	.	2	.	.	.	.	.	.	1	.	.	.	.	.
04	.	3	.	1	.	.	.	.	3	1	.	.	.	.	1	2	.	.	.	1	4	5	.	.	.	.	.
05	5	2	6	3	1	3	4	5	5	4	3	.	11	9	40	12	5	2	11	52	78	16	8	2	2	2	.
06	3	1	.	6	.	.	2	6	2	2	1	.	7	6	11	2	4	3	4	39	23	12	1	.	.	1	4
07	.	.	.	1	.	.	.	2	1	.	.	.	.	1	2	.	1	.	.	3	3	1	.	1	.	.	.
08	.	.	.	1	.	.	1	.	.	1	.	.	1	.	4	.	.	.	1	.	.	1	1	.	.	.	.
09	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
11	14	9	14	25	1	3	24	10	16	18	2	.	5	1	2	4	2	1	.	5	2	5	.	.	1	1	.
12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
13	.	.	1	.	.	.	.	.	1	1	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
14	.	.	.	.	1	.	.	1	1	.	.	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.
15	.	.	.	.	.	.	1	.	1	.	.	.	.	.	3	1	.	.	.	1	.	.	1	1	.	.	.
16	1	.	6	8	.	2	2	.	1	2	3	.	7	7	1	.	.	.	.	.	.	.	.	.	.	1	.
17	1	.	1	3	.	.	.	.	.	.	1	.	6	6	.	2	2	1	3	2	2	1	1	1	.	.	.
18	.	.	.	.	.	.	.	.	.	1	.	.	14	4	5	3	2	.	1	3	2	3	.	.	.	1	.
19	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
21	.	3	2	6	1	2	.	.	6	1	.	.	.	.	.	.	.	.	.	1	1	.	.	.	2	.	.
22	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
23	3	3	3	8	2	6	8	10	3	.	8	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.
24	10	12	17	31	9	6	34	56	36	42	13	.	1	.	1	.	1	.	.	1	.	.	.	.	3	1	.
25	12	7	14	25	2	3	11	25	17	9	5	.	.	.	2	3	.	.	.	.	1	.	.	.	1	.	.
26	3	6	6	7	.	2	8	4	12	4	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
27	18	8	11	18	6	1	27	30	6	2	3	.	.	.	.	2	.	.	.	.	.	1	.	.	2	2	.
28	7	8	2	6	1	.	8	5	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
29	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
30	1	.	.	.	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
34	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
35	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
36	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
37	12	12	24	12	.	1	.	7	10	4	1	.	.	.	2	1	.	.	1	.	.	1	.	.	2	.	.
38	53	22	2	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	1	.
39	10	8	.	3	.	1	2	2	2	1	.	.	.	.	.	.	1	.	.	.	2	.	.	.	.	.	.
40	18	10	10	6	1	1	8	4	3	1	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.

TABLE 9.2-13

NUMBER OF MALE CRABS RECAPTURED

RECAPTURE LOCATION	RELEASE LOCATION A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D1	D2	D3	D4	D5	D6	E	F	G
01	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
03	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
04	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
05	1	.	.	.	.	.	1	2	.	.	1	.	3	1	3	.	1	.	8	11	8	.	.	1	.	.	.
06	1	.	.	.	.	.	1	.	.	.	.	.	2	.	1	.	.	.	3	9	.	2	.	.	.	2	2
07	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	1	11	.	.	.	.	.	.	.
08	.	.	.	.	.	.	.	.	.	.	.	.	4	2	1	.	.	.	66	10	.	.	.	.	1	1	1
09	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.
11	.	.	.	.	.	.	3	.	2	.	.	.	1	.	.	.	.	.	3	.	.	.	.	.	.	1	.
12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
15	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
16	.	.	.	.	.	.	.	.	.	.	.	.	3	1	1	.	1	.	.	.	.	.	.	.	.	.	.
17	.	1	.	.	.	.	.	.	.	.	.	.	6	5	.	.	.	.	34	3	.	.	.	.	.	.	.
18	.	.	.	.	.	.	.	.	.	.	.	.	7	2	.	1	.	.	7	5	.	.	1	.	.	.	.
19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
21	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
22	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
23	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
24	3	3	.	2	.	.	3	9	2	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	1	.	.
25	3	.	2	.	.	.	4	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
26	2	3	.	.	.	.	2	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
27	9	1	.	2	.	.	10	3	3	.	.	.	.	1	1	.	.	.	1	.	.	.	.	.	1	2	.
28	6	.	.	.	.	.	29	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
29	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.
30	2	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
34	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
35	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
36	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
37	6	2	1	3	.	.	.	1	1	1	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.
38	20	4	2	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
39	18	2	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
40	26	2	.	.	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

TABLE 9.2-14

AVERAGE TIME BETWEEN RELEASE AND RECAPTURE IN DAYS

RECAPTURE LOCATION	RELEASE LOCATION A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D1	D2	D3	D4	D5	D6	E	F	G
01	.	.	40	42	.	.	.	40	35	24	.	.	78	.	36	.	43	.	39	40	39	28	.	49	.	.	.
03	.	.	102	.	.	.	.	.	8	.	.	.	45	.	21	.	.	.	.	.	.	16	.	.	.	.	.
04	.	36	.	14	.	.	.	.	14	46	.	.	.	.	4	15	.	.	.	11	6	8	.	.	.	.	.
05	26	63	10	26	69	39	30	16	22	17	50	.	37	24	22	23	27	20	29	25	22	19	30	60	10	18	.
06	45	14	.	46	.	.	26	16	37	23	18	.	54	34	22	20	20	34	46	26	21	28	17	.	.	18	34
07	.	.	.	98	.	.	.	45	58	.	.	.	21	36	32	.	63	.	25	22	24	33	.	16	.	.	.
08	.	.	.	14	.	.	36	.	.	15	.	.	22	8	17	.	.	.	18	24	.	22	7	.	14	5	9
09	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11	7	.	.	.	.	.	.	.
11	21	21	19	18	18	20	22	22	17	18	26	.	57	28	33	24	19	26	99	49	40	29	.	.	11	18	.
12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.
13	.	.	34	.	.	.	.	.	28	28	16	.	.	.	.	28	.	.	.	.	.	.	.	.	.	.	.
14	.	.	.	.	46	.	.	28	14	.	.	.	.	35	.	7	.	.	.	.	.	.	.	.	.	.	24
15	.	.	.	.	.	.	16	.	14	.	.	.	.	.	7	7	.	.	.	64	.	.	6	6	.	.	.
16	111	.	89	87	.	84	131	.	92	84	74	.	18	7	25	.	79	.	.	.	.	.	.	.	.	89	.
17	5	52	52	52	.	.	.	.	.	.	48	.	26	15	.	53	47	47	50	49	52	52	83	47	.	.	.
18	.	.	.	.	.	.	.	.	.	81	.	.	24	48	67	49	78	.	48	38	63	46	6	.	.	105	.
19	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13	.	.	.	.	.	.	.
21	30	45	27	47	54	42	.	.	19	23	.	.	.	.	.	.	.	.	.	103	41	.	.	.	22	.	.
22	.	.	101	.	.	.	.	.	.	.	.	.	140	.	.	.	.	.	.	.	.	.	.	.	.	.	.
23	55	13	54	32	6	30	10	19	16	.	11	.	.	.	.	8	.	.	.	.	.	.	9	.	.	.	.
24	29	27	25	27	17	34	15	11	17	26	21	.	23	.	11	.	9	.	.	63	.	.	.	.	39	24	.
25	22	10	27	25	3	17	28	17	12	14	17	.	.	.	32	49	.	.	.	.	4	.	.	.	25	.	.
26	21	18	24	21	.	17	31	13	9	14	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
27	23	36	37	21	12	20	22	15	41	32	24	.	.	92	58	40	.	.	71	.	.	28	.	.	26	44	.
28	46	69	25	60	149	.	69	49	.	128	128	.	.	51	.	.	.	.	.	.	.	.	.	.	203	.	.
29	64	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	80	24	.
30	8	.	.	.	.	.	13	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
34	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
35	.	.	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
36	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
37	19	27	25	31	.	24	.	30	22	26	24	.	.	.	43	82	36	.	107	.	.	44	.	.	11	.	.
38	17	10	15	16	10	.	12	.	.	.	.	.	.	.	.	.	.	.	.	15	.	.	.	.	27	19	.
39	20	25	104	4	.	23	31	20	6	19	.	.	.	.	.	.	3	.	.	.	6	.	.	.	.	12	.
40	25	33	37	66	25	92	24	16	13	36	.	.	.	.	.	.	.	.	119	59	.	.	.	.	.	.	.

TABLE 9.2-15

TOTAL NUMBER OF CRABS RECAPTURED

RECAPTURE LOCATION	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D1	D2	D3	D4	D5	D6	E	F	G
	RELEASE LOCATION																										
SOUTH CRYSTAL BAY	5	1	1	1	.	.	8	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.
CRYSTAL BAY	274	133	130	188	27	31	208	188	138	98	51	.	85	48	90	37	26	7	148	167	128	59	14	7	20	19	8
WACCASASSA BAY	16	14	21	38	9	7	25	37	37	21	14	.	21	40	85	45	21	17	37	133	136	104	31	10	7	11	16
SUWANEE SOUND	1	1	2	4	1	.	.	.	2	1	.	.	.	1	8	1	.	1	1	15	12	7	2	.	.	2	1
HORSESHOE COVE	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3	1	.	.	.	.	.	1
DEADMAN BAY	.	.	.	.	1	.	.	1	1	.	.	.	1	.	2	1	.	.	1	3	6	1	2	.	.	2	.
FENHOLLOWAY RIVER AREA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	4	3	.	.	.	1	1
APALACHEE BAY	2	1	1	7	.	.	1	1	5	1	.	.	3	1	9	7	4	3	.	8	7	7	5	.	4	.	3
DOG SOUND	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	1	2	1	.	.	.	.	.
APALACHICOLA RIVER AREA	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.
WEST OF CAPE SAN BLAS	.	.	.	1	.	.	.	1	.	1	.	.	.	.	1	.	.	.	.	3	1	.	.	.	.	.	.

TABLE 9.2-16

AVERAGE TIME BETWEEN RELEASE AND RECAPTURE IN DAYS

RECAPTURE LOCATION	RELEASE LOCATION																										
	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D1	D2	D3	D4	D5	D6	E	F	G
SOUTH CRYSTAL BAY	134	150	157	177	.	.	148	.	.	.	.	.	.	.	.	.	.	.	.	157	.	.	.	.	.	15	.
CRYSTAL BAY	24	26	31	31	23	34	31	17	19	26	26	.	34	25	26	30	35	31	34	28	23	25	26	42	38	32	30
WACCASASSA BAY	33	57	43	58	45	55	54	46	45	35	30	.	59	52	47	52	76	40	38	49	44	39	67	28	82	46	81
SUWANEE SOUND	22	18	70	60	78	.	.	.	69	40	.	.	.	121	82	81	.	63	70	54	87	71	69	.	.	82	27
HORSESHOE COVE	.	.	125	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	31	100	93	.	.	.	.	.	59
DEADMAN BAY	.	.	.	.	96	.	.	104	107	.	.	.	158	.	68	101	.	.	83	60	83	79	80	.	.	70	.
FENHOLLOWAY RIVER AREA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	119	.	.	.	.	78	101	61	.	.	.	115	73
APALACHEE BAY	100	181	147	175	.	.	102	131	109	108	.	.	133	133	116	118	125	98	.	138	142	105	84	.	173	.	79
DOG SOUND	.	.	.	.	.	.	126	103	.	.	.	.	.	.	.	.	.	.	.	108	123	100	.	.	.	.	.
APALACHICOLA RIVER AREA	.	.	.	189	.	.	.	.	.	187	.	.	.	.	.	.	.	.	.	181	198	.	.	.	.	.	.
WEST OF CAPE SAN BLAS	.	.	.	141	.	.	.	130	.	108	.	.	.	.	180	.	.	.	.	147	135	.	.	.	.	.	.

TABLE 9.2-17

NUMBERS OF SIO IN THERMAL AND CONTROL AREAS

Species	Male		Female	
	Thermal	Control	Thermal	Control
Bay anchovy	45	34	142	83
Polka-dot batfish	1	14	15	26
Pigfish	30	141	36	220
Pinfish	124	253	100	262
Silver perch	98	105	217	115
Spotted seatrout	6	4	5	4
Spot	239	69	213	61
Red drum		1	1	
Striped mullet	20	1	34	8
Pink shrimp	339	284	369	276
Blue crab	85	37	132	89
Stone crab		9	2	5

9.3 IMPACT ASSESSMENT

The fish and invertebrate populations sampled by fisheries gear are subject to direct impacts of station operation in the form of impingement and entrainment. These subjects have been dealt with previously in Sections 7.3 and 8.3. Indirect effects associated with the thermal discharge and the intake spoil will be discussed in this section.

9.3.1 Thermal Discharge

The fisheries' samples contain juveniles and adults of species which either inhabit Crystal Bay all year or migrate to and from the area. Both short-distance, onshore-offshore movements and wider ranging migrations occur. Given the ability of these species to move and the continuing operation of Units 1, 2, and 3 over several years, the sampling results are indicative of established patterns of movement and other activities in response to the local environment. Comparisons of SIO distributions sampled in the area of the thermal discharge to their distribution in areas unaffected by the discharge can provide an indication of the ability of each species to adapt to the conditions of the discharge. Additional information can be gained by considering thermal-control differences in disease or parasitism, age, sex ratio, reproductive condition, and the weight-length relationship.

The interpretation of sampling results is limited by two key factors: 1) the relatively low numbers of several of the SIO in all or some of the sampling gear and 2) the complex nature of Crystal Bay which confounds possible thermal effects with other environmental parameters. The low numbers of some species, such as red drum or squid preclude statements on effects of the thermal discharge. Higher but limited numbers of species like batfish or striped mullet force reliance on trends in the existing data and limit the value of conclusions.

Habitat differences within Crystal Bay complicate interpretation of results by providing other factors to which the SIO respond and modify their distributions. Freshwater inflows from Crystal River to the southeast and the Withlacoochee River to the northeast appear, based on water quality data, to create strong localized influences and broader areas of steep salinity gradients. Such gradients could be a stronger influence on distribution than the plant discharge. Squid, for example, have been reported to migrate in response to temperature and salinity (Laughlin and Livingston 1982). Another important factor may be the presence or absence of attached submerged vegetation which can provide cover and food. While the absence or limited amount of vegetation in the present discharge area could have been directly influenced by the plant discharge (see Section 6.3), its present distribution has a secondary influence on fish and inverterate species which seek out such areas. Such species in Crystal Bay would be found offshore of the thermal discharge, assuming depth is not a controlling factor, or south of the intake where attached vegetation is widely distributed over all depths. A variety of other factors such as depth, substrate type, use of deeper channels for onshore-offshore movement or exposure of shallow areas at low tide could also influence a given species' distribution.

Each SIO for which fisheries information are available to address thermal discharge effects will be considered separately. Overall distribution of fish and invertebrates in Crystal Bay has been noted in Section 9.2 and will not be addressed further, since the SIO are considered representative and individual species preferences and avoidances are the ultimate influence on total species distribution.

Evidence, primarily from seine and drop net collections, indicate that bay anchovy occur primarily in the thermal area, potentiallly experiencing ΔT's of 4-7°C. Summer conditions did not eliminate the species from the discharge area. Females occurred in relatively higher abundance in the discharge area. Gravid females were found inshore in the spring and were in both thermal and control areas. Young-of-the-year, both immature and mature, were more common in the thermal area, except in the spring. Of specimens analyzed, those in the thermal area did not weigh as much at the same length as specimens in the control area. Overall, bay anchovy appear to prefer the thermal area and may grow (length) faster there than elsewhere.

Batfish were rare offshore but more were found north or south of the discharge area than in the thermal area. The ratio of females to males was higher in the thermal area and immature specimens were most common in the control area. Parasitism occurred in all specimens. Preference for or avoidance of the thermal area is not clearly indicated.

Data on pigfish distribution comes primarily from trawl collections in which larger numbers were taken in the spring and summer at the southern stations. At other times, a more uniform distribution existed. Females, including gravid ones, predominated at stations to the south. Older specimens, young-of-the-year, immature and mature individuals were more common to the south. Smaller specimens occurred in the thermal area but their weights by length were higher than in control areas in all seasons except spring. Thus, pigfish appear to avoid the thermal area in the spring and summer. Reproduction at the site probably occurs to the south and is not limited by the discharge. At other times of the year, pigfish do utilize the discharge area.

Pinfish are similar in distribution to pigfish. In trawls they were most common to the south and at T1 and T2 in the spring and summer. Numbers were higher inshore on the north and central transects and offshore to the south. In seines, lowest numbers were at the thermal stations. In the drop net, numbers at D2 were generally higher than in the thermal area; the exception was in February. In the creek trawls, highest numbers occurred in February through May at TC2; these were primarily small fish. Young-of-the-year, 1 year old, immature and mature fish were all more abundant in the control areas. Based on weight-length analyses, growth occurs most rapidly in summer and fall when fish are concentrated to the south, with samller numbers at T1 and T2. Pinfish generally tend to avoid the thermal area where ΔT's are in excess of about 2°C, but small specimens appear to utilize the creek habitat adjacent to the thermal area in the spring.

Silver perch were collected in largest numbers by trawl inshore to the north and south. These were generally smaller specimens. Few were collected in other gear except in May at TC1. Both mature and immature fish were most common in the thermal area (T1, T2). Females were more common than males in the thermal area, they were smaller than males, and grew more rapidly in the thermal area. The latter was not the case, however, over the entire study area. Gravid females were primarily at T1 and T4 in the spring. Young-of-the-year were most abundant in the thermal area. Generally, the species utilizes inshore areas to the north and south. The fish avoid the higher temperature areas of the discharge but utilize areas subject to 2-3°C ΔT. This appears to be particularly true for activities relating to reproduction.

Trawl collections provided the greatest number of spotted seatrout and the fish were primarily to the north (May at T1-3 and T5). All seatrout taken by drop net were in the discharge area (June, July, May). The few specimens taken by creek trawl were from TC1 or TC2. Immature seatrout were more common in the thermal area; of the mature specimens, males predominated in the thermal area. Overall, the species occurs primarily at the northern end of Crystal Bay. It is not excluded from the thermal area, but like the silver perch, the fish appear to utilize only the lower ΔT areas of discharge.

Spot were relatively common in all four gear types. The pattern of distribution from all gears is similar to that indicated for spotted seatrout and silver perch. Numbers were highest to the north and in the center of Crystal Bay and lower to the south. Smaller fish were inshore (T1) and the largest were offshore (T3). The analysis of immature fish indicated more in the thermal area. Growth (W-L) was lower in thermal than control areas in summer, fall, and winter. Thus, this species also appears to be using outer portions of the discharge area. Based on drop net collections, it may also be using higher T sections in early spring.

Data for red drum do not support any conclusions concerning thermal discharge impacts. Data on striped mullet is also limited and suggest only that the species may be more common in the northern section of Crystal Bay.

Pink shrimp data indicate a wide distribution in Crystal Bay with the location of peak numbers changing over time. Numbers at thermal trawl stations, even in the summer, do not indicate avoidance of this area. However, August drop net collections which sampled higher temperature water did not contain shrimp and more shrimp were generally collected at D2. This probably indicates avoidance of the warmest discharge temperatures. Creek trawls collected most shrimp at TC1 and TC2 indicating utilization of creeks adjacent to the discharge area.

Few blue crabs were taken by trawl or seine, but trawl, drop net and creek trawl collections, like the crab trapping, indicated peak abundance inshore. Numbers at the thermal drop net station were higher in the winter but lower in the summer than at the southern station. Comparisons of crab trap data indicate some reduction in numbers at thermally affected stations on Transect C. This was more apparent in September-October than in November-December. Thus, blue crabs appear to avoid the warmer parts of the discharge area, particularly during the summer, but they are not excluded from the discharge area and the population is probably not adversely affected.

Stone crabs were rarely taken in fisheries gear other than crab traps. Data from the traps indicate an offshore distribution which limits any thermal discharge effects. Comparison of inshore numbers by transect showed fewer stone crabs inshore on the northern transect and more inshore on the two southern transects. Numbers on Transect C, however, suggest that some factor other than the thermal discharge may be affecting the stone crab distribution, particularly on Transect D.

Brief squid were collected only in the trawls in low numbers. The numbers, distribution, and occurrence by month do not support conclusions on thermal discharge effects.

9.3.2 Intake Spoil

Questions have been raised concerning the effect of the intake spoil at Crystal River on longshore migration of female blue crabs. The present study was designed to address local and longer distance movements of the crabs and to consider adverse impacts associated with the presence of the spoil. The excellent return rate of tagged crabs should permit answers to these questions.

Local crab movements, as determined from tag returns from commercial crabbers, is strongly influenced by the location of crabbers' traps. Oesterling (1976) noted, and it is still the case, that traps are most concentrated along the southern side of the intake spoil and on the southern side of spoil islands bordering the CFBC. This results in: 1) large numbers of recaptures being reported in these locations and 2) a potential reduction in time to recapture from certain release points where crabs quickly encounter and are captured in the high density of fishermen's traps. The former did occur but the latter was not particularly evident.

The patterns of recaptures in Crystal Bay indicates a general west and north movement from the release points. This is most evident from releases on Transects A and C. Releases on Transect B are often recaptured to the west along the same transect. Releases from Transect B are often recaptured to the west along the same transect. Releases from Transect B were also common in grid element 11 (Figure 9.2-1), which is farthest offshore, and along Transect D. A similar pattern occurs for releases from Transect A. Thus, it appears that crabs to the south of the spoil move offshore and around the spoil. Subsequent movement is then north and northeast.

The pattern of movement noted indicates that the intake spoil does represent a structure to be bypassed and the original capture and recapture data indicate that the spoil could influence the number of crabs occurring in the area of Transect C and perhaps D. However, if crabs in the area of Transect A are considered representative of longshore migrants, data on time to recapture after release on Transect A show that the time to recapture on Transect C is about 6 days more than for recapture on Trasect B. At the same time, recapture on Transect B takes about 6 days more than recapture on Transect A. Based on distance between transects, it is clear that some delay is taking place, on the order of 2.5 days, but the delay is relatively short. In addition, movement is taking place past the intake spoil in spite of the concentration of traps.

Longer distance migrations are represented in recaptures of Crystal Bay releases north of Crystal Bay. About 33 percent of the recaptures by crabbers took place north of Crystal Bay indicating significant movement from the area. Larger numbers of recaptures resulted from the release at Transects A and B than from Transects C and D. In addition, as noted in Section 9.2, recaptures in Waccasassa Bay occurred more quickly from Transect B than from any other transect and more quickly from Transect A than from Transect C. Therefore, it can be concluded that the intake dike is little if any obstacle to movement to the north beyond Crystal Bay. It is also suggested that the local movements which result in blue crabs moving out and around the intake spoil may result in migration further offshore and perhaps more directly to areas north than the route available to crabs north of the intake spoil but still south of the CFBC spoil islands.

REFERENCE FOR 9.3

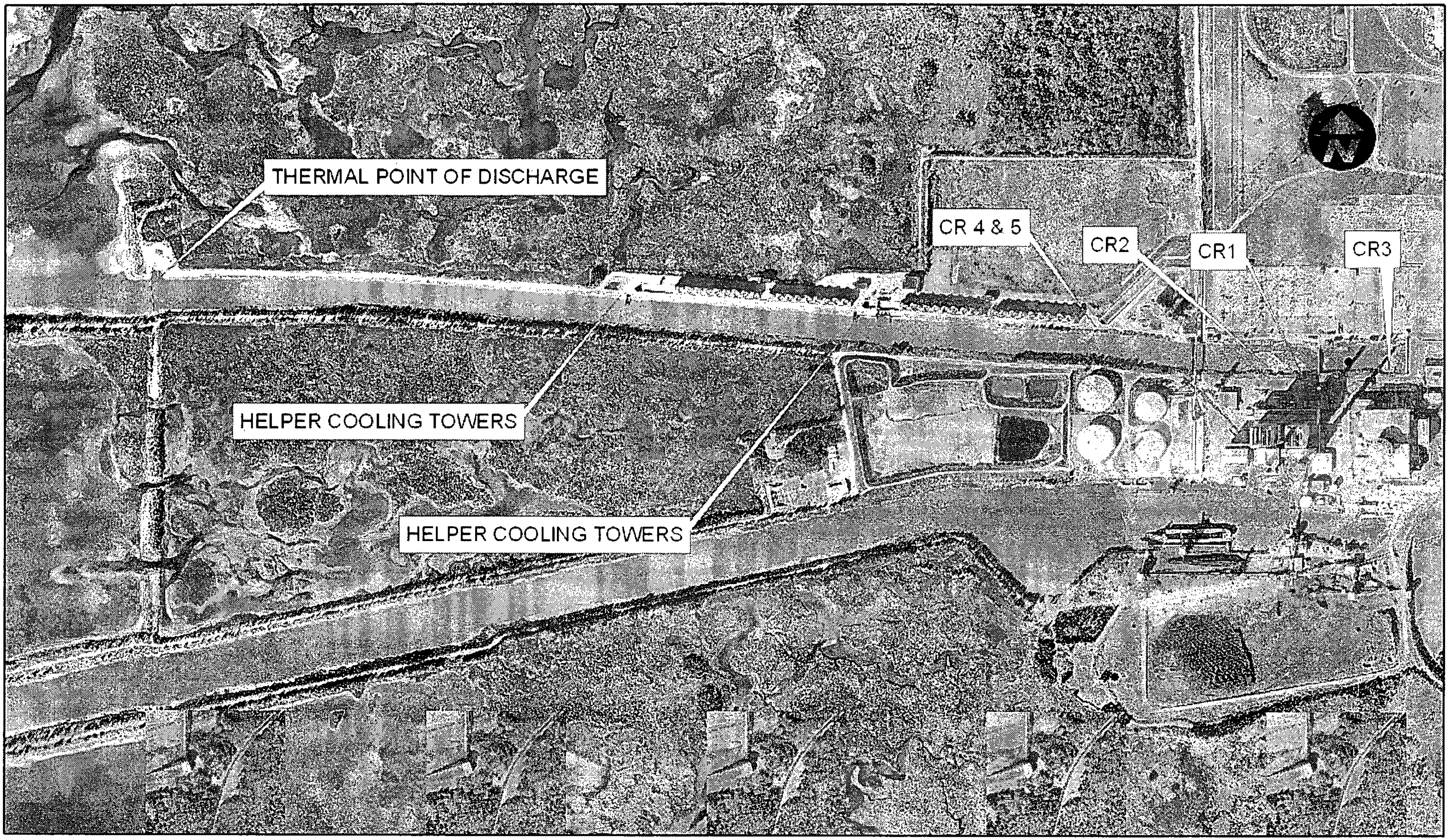
Laughlin, R. Q. and R. J. Livingston. 1982. Environmental and Trophic determinants of the spatial/temporal distribution of the brief squid (Lolliguncula brevis) in the Apalachicola estuary (North Florida, USA). Bull. Mar. Sci. 32(2): 489-497 pp.

Oesterling, M. 1976. Population structure, dynamics, and movement of the blue crab (Callinectes sapidus Rathbun) at Crystal River, Florida. Thesis, Univ. of Florida. 88 p.

Aquatic Ecology

AQ-8

1. Thermal Discharge Locations
2. CRN Flow Data – D074-D075
3. CRN Makeup-Blowdown



THERMAL POINT OF DISCHARGE
CR 4 & 5
CR2
CR1
CR3
HELPER COOLING TOWERS
HELPER COOLING TOWERS
N

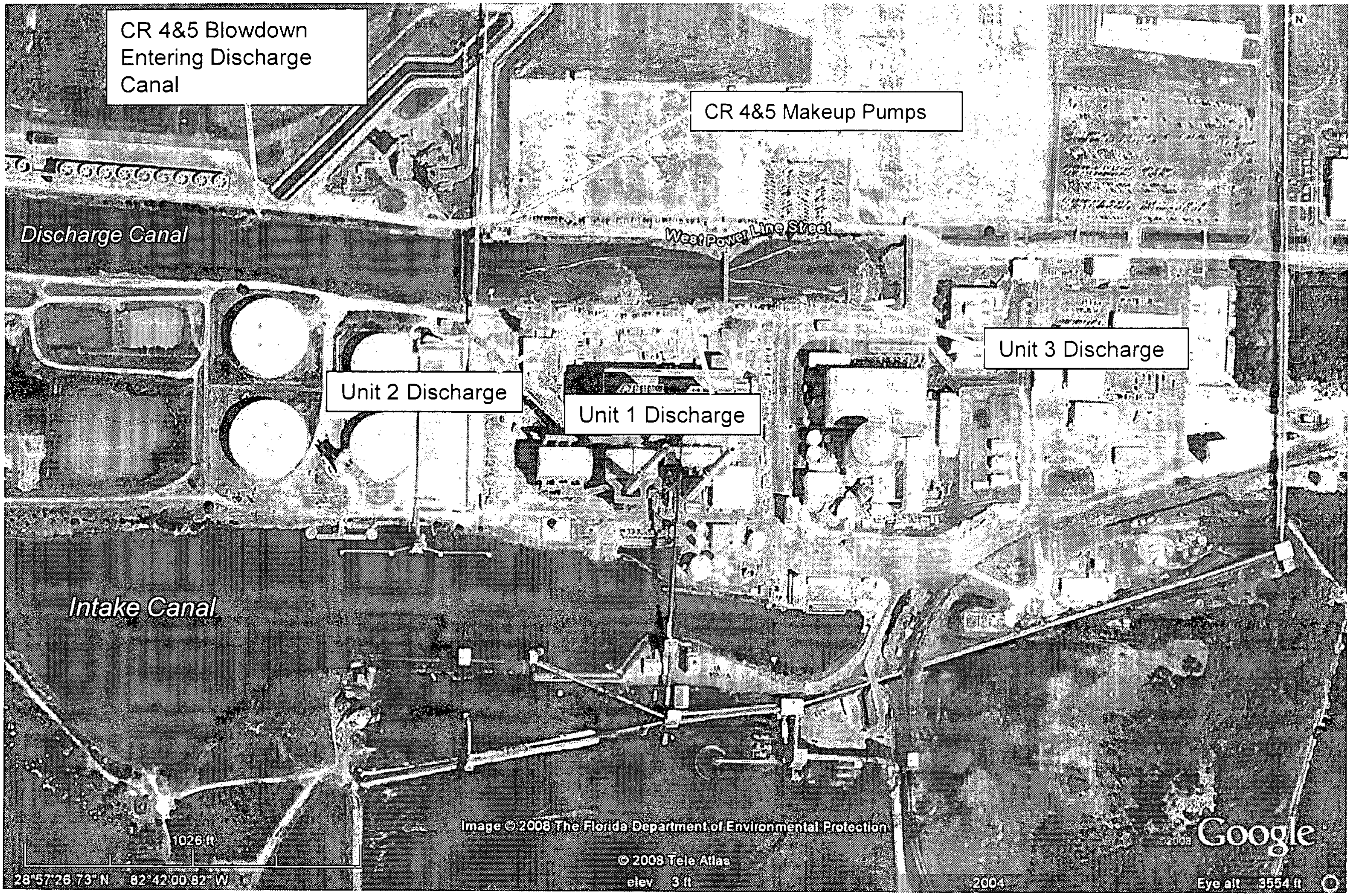
Crystal River 4&5 Flow Data

Date	Makeup Flow (max mgd)	Unit 4 Blowdown (avg mgd)	Unit 5 Blowdown (avg mgd)	Total BD Flow (avg mgd)
Oct-05	89.8	44.83	40.75	85.58
Nov-05	91.8	45.29	41.3	86.59
Dec-05	93.8	45.94	41.3	87.24
Jan-06	97.9	45.94	41.3	87.24
Feb-06	97.9	45.76	41.88	87.64
Mar-06	97.9	45.76	41.88	87.64
Apr-06	97.9	45.89	41.88	87.77
May-06	93.8	45.89	41.88	87.77
Jun-06	93.8	45.89	41.88	87.77
Jul-06	93.8	45.89	41.88	87.77
Aug-06	93.8	45.89	41.88	87.77
Sep-06	97.9	54.03	34.69	88.72
Oct-06	93.8	45.5	34.69	80.19
Nov-06	93.8	45.5	34.69	80.19
Dec-06	97.9	35.63	34.69	70.32
Jan-07	97.9	35.63	34.69	70.32
Feb-07	93.8	35.63	34.69	70.32
Mar-07	95.8	35.63	34.69	70.32
Apr-07	91.8	42.58	34.69	77.27
May-07	97.92	62.78	34.69	97.47
Jun-07	93.84	49.26	39.97	89.23
Jul-07	97.92	40.3	40.63	80.93
Aug-07	97.92	39.79	40.87	80.66
Sep-07	97.92	40.33	41.6	81.93
Oct-07	97.92	40.18	36.99	77.17
Nov-07	97.92	40.48	42.03	82.51
Dec-07	97.92	40.53	41.71	82.24
Jan-08	97.92	40.71	41.74	82.45
Feb-08	97.92	40.77	41.73	82.5
Mar-08	97.92	*42.86*	41.57	84.43
Apr-08	97.92	*42.86*	41.57	84.43
May-08	97.92	40.15	41.49	81.64
Jun-08	97.92	40.01	41.47	81.48
Jul-08	97.92	40.15	41.9	82.05
Aug-08	97.92	40.13	41.89	82.02
Sep-08	97.92	40.06	40.95	81.01
Oct-08	97.92	42.32	41.25	83.57
Nov-08	97.92	0	39.92	39.92
Dec-08	97.92	40.88	38.75	79.63
Jan-09	97.92	47.07	40.56	87.63
Feb-09	102	40.77	41.35	82.12
Mar-09	51	49.85	0	49.85
Apr-09	51	54.86	0	54.86
May-09	97.92	55.59	20.24	75.83

long-term avg.=	**94.52**	**80.36**
long-term max.=	**102**	**97.47**

= estimated values due to flow meter malfucntion

Crystal River Units Makeup & Blowdown Locations



Aquatic Ecology

AQ-10

1. Excerpt from CRS procedure OP-CWB-4
2. CR 1 & 2 Number of Events due to POD Limits
3. CR 1 & 2 Equivalent Derated Hours Due to POD Limits
4. CR 1 & 2 Equivalent Derated MW-Hours Due to POD Limits

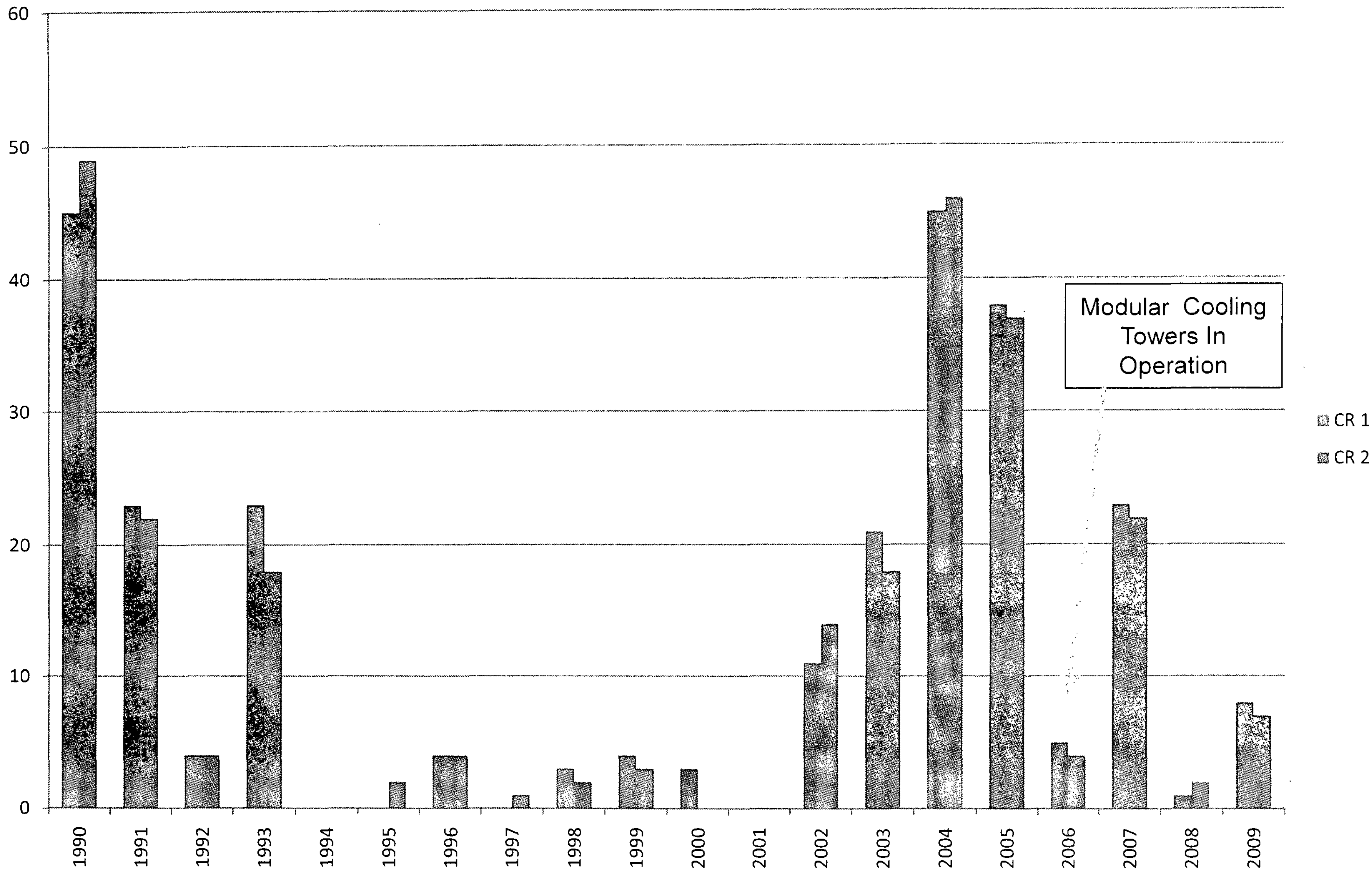
Here is an excerpt from the CRS procedure OP-CWB-4 that is specifically related to the MCT installation...

2.2 The Modular Cooling Tower (MCT) system was added in the spring of 2006. These modular towers are intended to supplement the existing Helper Cooling Towers (HCT) for control of the Point of Discharge (POD) temperature from the site discharge canal.

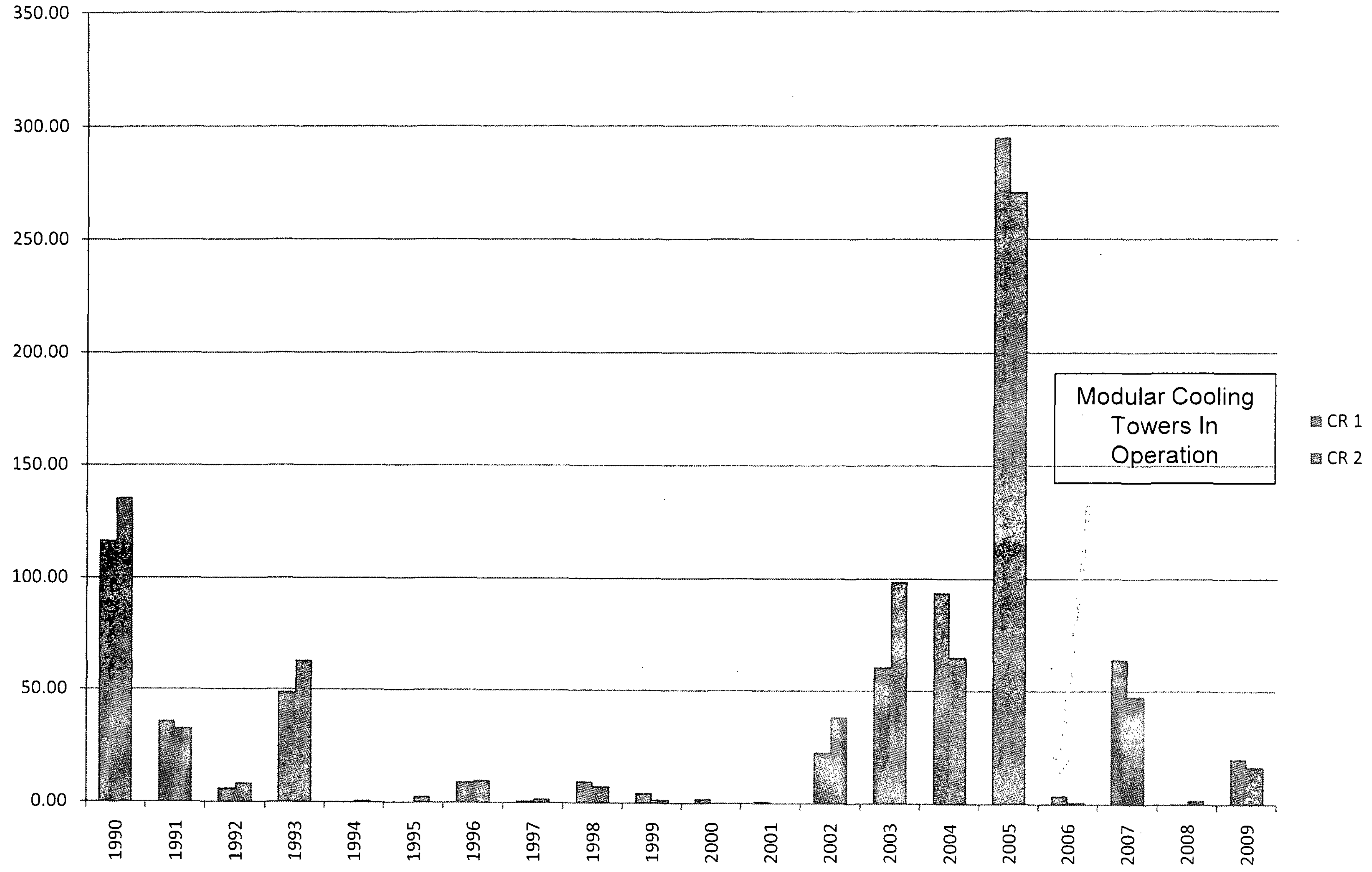
2.2.1 The modular towers shall normally be used after all Helper Cooling Towers have been placed in service when POD temperature limits may otherwise be exceeded without load reduction on the CRS generating units. **When comparing HCT operation to MCT operation, the MCTs should be "last-on, first-off". If not operated in this manner, valid justification must exist and shall be documented in the Shift Supervisor's log.** Refer to section 4.0.

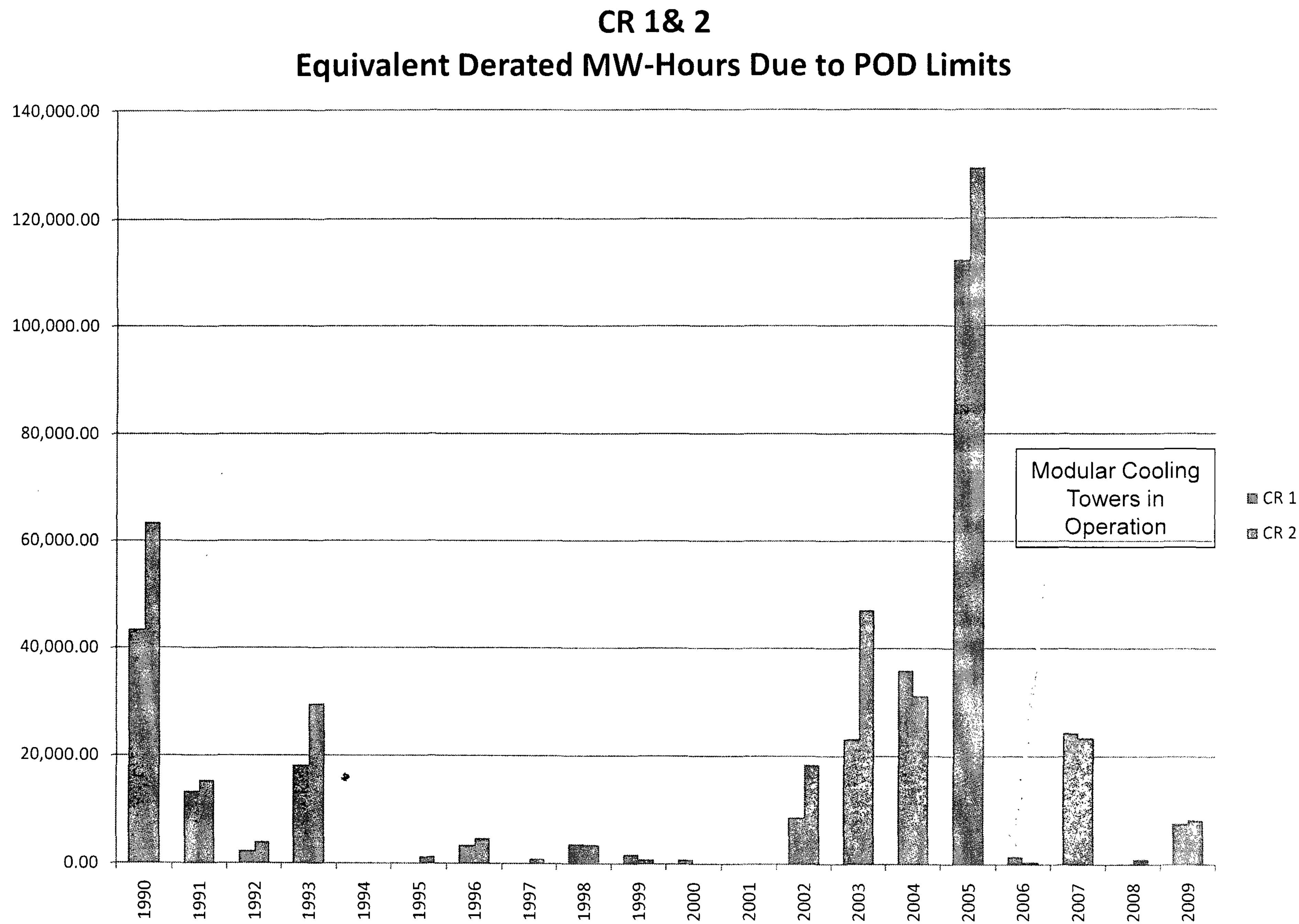
2.2.2 The modular towers should reduce the need for load reduction of the CRS generating units during hot weather when load demand and circulating water inlet temperature is high.

CR 1& 2
Number of Events Due to POD Limits



CR 1& 2
Equivalent Derated Hours Due to POD Limits




CR 1& 2
Equivalent Derated MW-Hours Due to POD Limits
140,000.00
120,000.00
100,000.00
80,000.00
60,000.00
40,000.00
20,000.00
0.00
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
Modular Cooling Towers in Operation
CR 1
CR 2

Aquatic Ecology

AQ-12

1. Florida Power (2005), FSAR Chapter 8, Electrical Systems
2. Golder Associates (2006), Crystal River Energy Complex Proposal for Information Collection NPDES Permit No. FL0000159

TABLE OF CONTENTS

8. ELECTRICAL SYSTEMS

8.1 DESIGN BASES

The design of the Electrical Systems for Crystal River Unit 3, is in compliance with the requirements of General Design Criteria 11, 24, and 39, (see Section 1.4) and provides required power sources and equipment to ensure continued operation of essential reactor and station auxiliary equipment under all conditions. The design satisfies the IEEE 308 proposed criteria for Class 1E Electrical Systems, dated June, 1969. In addition, the Electrical Systems for Crystal River Unit 3 are in compliance with the intent of 10 CFR 50, Appendix A, General Design Criterion 17.

8.2 ELECTRICAL SYSTEM DESIGN

8.2.1 NETWORK INTERCONNECTIONS

The unit generates electric power at 22 kV which is fed through an isolated phase bus to the unit main transformers where it is stepped up to 500 kV transmission voltage and delivered to the 500 kV substation. The 230 kV substation, which serves as the preferred source of reactor plant ES bus power and can serve as the preferred source of plant auxiliary power during all modes of operation, incorporates the breaker-and-a-half scheme, except for breakers 4900 and 4902 which feed the offsite power transformer. The 500 kV substation is a ring bus. The 230 kV substation is connected to the existing Florida Power Corporation transmission network by five lines which leave the site on three independent rights-of-way and terminate in three separate substations. A line is considered to have terminated when it reaches a substation with more than two 230 kV lines or a transformation to a higher voltage.

The 500 kV substation is connected to the existing FPC transmission network by two full capacity lines (each line is physically capable of handling full output of Units 3 and 5 generation) which leave the site in independent rights-of-way and terminate in separate substations. There is no transformation tie for power transportation between the 500 kV and the 230 kV substations at the Crystal River plant site. There is a momentary tie between the substations internally at Unit 3 while switching power sources when the 500 kV substation is used as an offsite power source.

8.2.1.1 Single Line Diagrams

Figure 8-1 presents single line diagrams of the 500 kV and 230 kV substation Electrical Systems.

Figure 8-2 presents an "Electrical One Line Diagram Composite" of the CR3 electrical distribution system.

8.2.1.2 Reliability Considerations

Reliability considerations to minimize the probability of power failure due to faults in the network interconnections and the associated switching are as follows:

a. The double-circuit 230 kV transmission lines are separated by a distance sufficient to prevent a falling tower from damaging adjacent 230 kV towers or lines.

b. Each of the five 230 kV lines is capable of carrying in excess of 100% of the full output of Unit 1 or Unit 2 or Unit 4 except that the Fort White line is limited to 93% of the Unit 4 rating.

c. The single-circuit 500 kV transmission lines are separated by a distance which is sufficient to protect against contact from another 500 kV conductor blowout condition under hurricane winds of 135 miles per hour.

d. Each of the two 500 kV lines is capable of carrying in excess of 100% of the full output of Crystal River Unit 3 and Unit 5. The substation can therefore tolerate a fault on either outgoing line, or on the bus to which it is connected, without resulting in significant loss of generator load.

e. The breaker-and-a-half switching arrangement in the 230 kV substation includes two full capacity main buses, where each bus is individually capable of supplying all the load required for the 230 kV system. Primary and backup relaying is provided for each circuit along with local circuit breaker failure backup switching. These provisions permit the following:

   1. Any circuit can be switched under normal or fault conditions without affecting another circuit.
   2. Any single circuit breaker can be isolated for maintenance without interrupting the power or protection to any circuit.
   3. Short circuit of a single main bus will be isolated without interrupting service to any outgoing line or to the plant.
   4. Short circuit failure of the tie breaker will result in the loss of its two adjacent circuits until it is isolated by disconnect switches.
   5. Short circuit failure of a bus side breaker will result in the loss of only one circuit until it is isolated.
   6. Circuit protection will be ensured from failure of the primary protective relaying by backup relaying.

With the above protective features, the probability of loss of more than one source of 230 kV power from faults is low; however, in the event of an occurrence causing loss of the 230 kV remote connections, the Engineered Safeguards (ES) will be supplied from one or more of the two remaining sources of power (see Sections 8.2.3.1.2 and 8.2.3.1.3).

8.2.1.3 System Stability

Florida Power Corporation participates in Florida Reliability Coordinating Council (FRCC) Stability Studies for the State of Florida and Southern Company (SOU) interconnected systems, to determine system performance during transient disturbances. These study results are used to:

a. Establish transfer limits and operating criteria for coal-by-wire imports to minimize the possibility of a system disturbance.

b. Assure the planned system meets FRCC planning criteria for probable and improbable disturbances.

c. Develop coordinated statewide load shedding programs to insure recovery from severe system disturbances.

Florida Power Corporation also performs more detailed stability studies of the FPC and neighboring systems to assure adherence to planning criteria. Additionally, joint studies are performed with neighboring utilities to investigate problems at the interface of the systems.

These extensive planning and operating studies are used to develop operating criteria and limits that will help to reduce system disturbances and ensure grid stability.

8.2.2 PLANT DISTRIBUTION SYSTEM

The Plant Distribution System consists of the various Auxiliary Electrical Systems designed to provide reliable electrical power during all modes of plant operation and shutdown conditions. The systems have been designed with sufficient power sources, redundant buses, and required switching to accomplish this.

ES equipment is arranged so that loss of an emergency generator or of a single ES bus for any reason will still leave sufficient auxiliaries to safely perform the required functions. In general, the auxiliaries related to functions other than ES will be connected to any of the two unit auxiliary buses. ES loads have been divided between the two Class 1E Auxiliary Power Systems in observance of the single failure criteria.

8.2.2.1 Single Line Diagrams

Figure 8-3 through Figure 8-8a are single line diagrams of the Crystal River Unit 3 Distribution System.

8.2.2.2 Auxiliary Transformers

Crystal River Unit 3 is provided with one full capacity unit auxiliary transformer and one full capacity start-up transformer. The unit auxiliary transformer is connected to the generator and can supply power to the unit auxiliary buses. The start-up transformer is connected to the 230 kV substation and can serve as the normal source of non-1E power during all modes.

Each of the aforementioned transformers have two isolated secondary windings, one at 6900 volts and one at 4160 volts, for the purposes outlined in the following paragraphs. Each transformer is capable of supplying the normal full non-1E load requirements of Crystal River Unit 3.

8.2.2.3 6900 Volt Auxiliary System

The 6900 Volt Auxiliary System is designed to power the 9000 hp Reactor Coolant Pump (RCP) motors. This system is arranged into two bus sections, Bus 3A and Bus 3B, each feeding two RCP motors. In addition, Bus 3A feeds the 6900-4160V Reactor Auxiliary Transformer 3, which in turn feeds the 4160V Reactor Auxiliary Bus 3 switchgear. During normal operation, both 6900V auxiliary buses are fed from the startup transformer or the unit auxiliary transformer. The capability exists to automatically transfer the 6900V buses from the unit auxiliary transformer to the start-up transformer.

Normal bus transfers initiated at the discretion of the operator for test or maintenance purposes are "live bus" transfers, i.e., the incoming source feeder circuit breaker will be closed onto the running bus section. The operator will, at his discretion, trip the outgoing source feeder circuit breaker which will result in transfers without power interruption. Manual paralleling of sources which are out of phase is prevented by the use of synchronism check relays which continuously monitor the two sources.

8.2.2.4 4160 Volt Auxiliary System

The 4160 Volt Auxiliary System has six bus sections. Two of these bus sections, ES Buses 3A and 3B, comprise the 4160 volt switchgear of the two redundant Class 1E electrical systems. Another two bus sections, designated as Unit Buses 3A and 3B, have the turbine-generator and other non-safety oriented loads divided between them in order to provide increased plant reliability. One other bus section, designated Reactor Auxiliary Bus 3, provides power for the Auxiliary Feedwater Pump (FWP-7), through Reactor Auxiliary Transformer 3 (MTTR-5) or a Standby Diesel Generator (MTDG-1). Lastly, there is the Backup ES Transformer Auxiliary Bus 3 which can be used to connect the future Alternate AC Diesel Generator to ES Bus 3A or ES Bus 3B.

The two 4160V unit auxiliary buses, Unit Buses 3A and 3B, can be fed from the startup transformer. During normal operation, and following separation from the system due to external disturbances, these two 4160V unit buses can also be fed from the unit auxiliary transformer. Use of the unit auxiliary transformer presumes the unit generator is available, or time is available to establish 500 kV backfeed. The 4160V Reactor Auxiliary Bus 3 can be fed from the unit auxiliary transformer or the startup transformer, since it is powered via a transformer directly from the 6900V Auxiliary System (refer to Section 8.2.2.3).

Manual transfers of 4160V buses using synchronism check relays are as described for the 6900 Volt System in Section 8.2.2.3. Manual transfers are permitted only when the incoming source is in synchronism with the bus at the time transfer is initiated. Emergency automatic transfers from the auxiliary transformers to the startup transformer will be rapid bus (i.e., "dead bus") transfers. The outgoing source feeder circuit breaker will trip and the incoming source feeder circuit breaker will close.

ES Buses 3A and 3B of the 4160 Volt Auxiliary System are normally fed from the Unit 3 offsite power transformer through a direct cable connection or the Unit 3 backup ES transformer through the Backup ES Transformer Auxiliary Bus 3 and a cable/bus duct connection. There are no fast automatic transfers of these buses. Transfers of either bus to the alternate preferred source are manual. Transfers to the emergency diesel generator sources are manual if bus voltage has not failed, and automatic if bus voltage fails or is degraded. Automatic transfer to the Emergency diesel generator is via a two-out-of-three relay scheme for loss of voltage event and a three-out-of-three scheme for a degraded voltage event.

Automatic closure of diesel-generator breakers is supervised by auxiliary contacts of the other bus feeder breakers to ensure that all other sources have been cleared by the voltage relays and that the associated bus is dead. Interlocks are provided to prevent paralleling of the two diesel generators at any time and also to prevent paralleling of the 4160 volt ES buses when offsite power is unavailable during accident conditions.

8.2.2.5 480 Volt Auxiliary System

The 480 Volt non-safety related Auxiliary System has seven power centers, six consisting of a 4160/480 volt transformer and its associated 480 volt switchgear (bus), and one consisting of two 4160/480 volt transformers and associated 480 volt buses (split bus).

Six of the power centers are normally powered from the 4160 volt Unit Buses 3A and 3B. The 480V Plant Auxiliary Bus 3 provides power to certain non-safety related essential loads.

The 480 volt non-safety related auxiliary system also has one power center, consisting of a 12,470 / 480 volt transformer and its associated 480 volt bus powered from the Crystal River site 12 kV distribution line.

The 480 volt safety related electrical system consists of two redundant power centers that are identified as 480V ES Bus 3A and 480V ES Bus 3B. The 480V ES Buses 3A and 3B are normally powered from 4160V ES Buses 3A and 3B, respectively, in accordance with standards noted in Section 8.1. Because of this, the transfer of power sources for 480V ES Bus 3A and 3B is normally inherent with the transfer of 4160V ES buses 3A and 3B, as discussed in Section 8.2.2.4.

Under administrative controls, 480V ES Bus 3A and 3B can be connected together during shutdown conditions using two independent safety related tie breakers. Interlocks are provided in the tie breaker controls to prevent paralleling 4160V ES Buses 3A and 3B.

Under administrative controls, 480V ES Bus 3A may provide an alternate power feed, using a safety related tie breaker, to 480V Reactor Auxiliary Bus 3A. Under administrative controls, 480V Plant Auxiliary Bus 3 may provide alternate power feed to four of the other non-safety related power centers (including 480V Reactor Auxiliary Bus 3B) using a tie breaker. The 480V Reactor Auxiliary Buses 3A and 3B supply power to Pressurizer Heater Motor Control Centers 3A and 3B, respectively. The alternate power feeds to 480V Reactor Auxiliary Buses 3A and 3B provide the emergency power sources to the pressurizer heaters (Section 4.2.4.4).

Safety related breakers provide automatic isolation of the non-safety related 480V buses from the safety related buses, and provide isolation between 480V ES Buses 3A and 3B under the following conditions:

1. Loss of offsite power
2. ES actuation coincident with a loss of offsite power
3. ES Actuation coincident with an Emergency Diesel Generator powering the associated 4160V bus

Conditions 2 and 3 above actuate the 480V ES bus lockout relay(s). Each lockout relay trips and prevents closing the associated safety related isolation breakers until the operator resets the ES actuation and the lockout relay.

Safety related ES Motor Control Centers, ES 3A-1, 3A-2, 3A-3, 3AB, 3B-1, 3B-2 and 3B-3 provide power and control for associated safeguards equipment. The 3A and 3B Motor Control Centers are powered from 480V ES Buses 3A and 3B, respectively. The 3AB Motor Control Center is powered from either the 480V ES Bus 3A or 3B, using a non-automatic transfer switch. The transfer switch has controls located locally and in the main control room.

Motor Control Center 3AB also provides 480 volt power to the Diesel Driven Emergency Feedwater (EFW) Pump Building safety related Motor Control Center MTMC-25. The Diesel Driven EFW Pump Building safety related Motor Control Center feeds safety related building equipment, diesel auxiliary equipment and battery charger for the safety related 125 VDC battery required to support the diesel during standby, start and operating modes.

Auxiliary contacts from the ES Motor Control Center 3AB transfer switch are used in permissive logic for the ES slow speed start of Reactor Building Recirculation System fan AHF-1C. The AHF-1C Engineered Safeguards "A" train auto start signal will be enabled only when AHF-1C is ES-selected as the "A" train fan, with ES-MCC-3AB supplied from the "A" train source. Conversely, the AHF-1C Engineered Safeguards "B" train auto start signal will be enabled only when AHF-1C is ES-selected as the "B" train fan, with ES-MCC-3AB supplied from the "B" train source.

Motor Control Center MTMC-24 (via ACDP-164 which is located in MTMC-24) provides 480 volt power to the Diesel Driven EFW Pump Building non-safety related Motor Control Center MTMC-26. The Diesel Driven EFW Pump Building safety related Motor Control Center feeds non-safety related building equipment and loads that support the Diesel Driven EFW Pump facility.

8.2.2.6 250/125 Volt DC System

The 250/125 Volt DC System provides a source of reliable continuous power for DC pump motors, control, and instrumentation. In general, DC motors are rated 240 volts and control circuits 125 volts DC.

The 250/125 Volt DC System consists of a Class 1E portion and a non-1E portion. The Class 1E portion of the 250/125 Volt DC System consists of two isolated bus sections, each supplied by a battery and battery chargers. A spare 125 volt DC battery charger is provided for each battery for backup.

The battery chargers normally supply the DC System load and the float charge to the batteries. The chargers are also capable of supplying a 24 hour equalize charge. The chargers are supplied with a high/low voltage alarm relay to monitor the DC System. A high voltage alarm is provided to protect against battery overcharging during normal operation.

Hydrogen evolution from all batteries located in the Control Complex (including the Battery Rooms), and the subsequent hydrogen buildup in the Control Complex and in the Battery Rooms, was determined for various modes and operating conditions. Many factors influence the hydrogen generation rate and concentration of hydrogen (e.g., ambient temperature, cell voltage, air dilution flow rates, room/building volumes, system operating mode, etc.).

Hydrogen reaches flammable levels at 4% by volume in air. NFPA69 recommends that concentrations of flammable gasses be limited to 25% of their flammable limit in air. This corresponds to 1% for hydrogen.

During normal recirculation mode, with batteries fully charged and on the float, Control Complex hydrogen concentration lags hydrogen concentration at the primary source (in the Battery Rooms). Assuming zero in-leakage of fresh dilution air, the Control Complex could remain in the emergency recirculation mode, as described in section 9.7.2.7.h, for at least 30 days before the 1% limit is reached in the Battery Rooms. The Control Complex as a whole could reach 1% over a somewhat longer period.

A worst case scenario permits hydrogen to reach 1% in the Battery Rooms in approximately 15 hours. This requires: (1) worst case post-SBO room temperature [106.65°F], (2) cell voltage just below the alarm setpoint [2.34 VPC], and (3) a total loss of Battery Room HVAC. This worst case scenario envelops less challenging conditions, such as, a loss of Battery Room HVAC during normal or emergency recirculation.

Battery discharge is monitored by contact making ammeters mounted in the main DC panels. This provides a remote alarm when the battery is supplying power to the system.

The electrolyte level, specific gravity, and cell voltage of each battery pilot cell is checked on a weekly basis for the Class 1E batteries and monthly for the non-1E battery. The electrolyte level, specific gravity, and cell voltage of each battery cell is checked on a quarterly basis.

The arrangement and number of batteries, chargers, and DC distribution panel boards are as shown on Figure 8-7, Figure 8-8 and Figure 8-8a. The output of spare battery chargers may be fed to either half of their corresponding 250/125 Volt DC System. The entire system satisfies the IEEE proposed criteria referred to in Section 8.1.

The capacity of each of the two batteries is sufficient to feed its connected load for two hours continuously, and is capable of performing three complete cycles of safeguards breaker closures and subsequent tripping.

In addition, a calculation has been done to demonstrate that, with appropriate and timely load shedding by the operator, the batteries can supply all necessary components for a four hour station blackout. This includes diesel generator field flashing and breaker closure at the end of the period.

Each Class 1E battery has been sized to have an 8 hour rating of 1708 ampere hours, based on the use of 116 cell batteries and discharge to 1.81 volts per cell, 210/105 volts across the battery at 77°F.

Each battery system is provided with sufficient battery charger capacity (not including the spare battery charger of the system) to fully recharge the associated battery in less than 24 hours while supplying the maximum steady state DC load connected to the system.

Each battery charger in the Class 1E DC system has been sized at 200 amperes continuous capacity.

A single line diagram of the Class 1E DC System showing essential loads is given in Figure 8-8 and Figure 8-8a.

The 250/125 VDC distribution panels are provided with loss of voltage relays and status lights that indicate "POWER AVAIL" at the COF panel for the operator.

The non-1E DC system provides power to various non-safety related loads during normal operations and is not required to remain operable during accident conditions. The main components of the non-1E DC system are located on the 95' elevation of the Turbine Building. The non-1E system consists of a single 250 VDC battery supplying loads distributed from a single 250/125 VDC main distribution switchboard. Three 125 VDC battery chargers (two in continuous service and one standby) provide power to the non-safety related loads and maintain the battery in a charged state during periods when AC input power is available.

Each battery charger has been sized at 300 amperes continuous capacity and is provided with problem detection circuitry which provides local indication and initiates a remote alarm.

8.2.2.6.1 125 Volt Diesel Driven EFW Pump Building DC System

The DC system is safety related and provides a reliable source of power for diesel driven EFW pump DC instrumentation and equipment and the diesel air start valve(s). The safety related DC system consists of a battery, battery charger and a DC distribution panel.

The battery charger normally supplies the DC system load and maintains a float charge on the battery. The charger is capable of supplying a 24 hour equalizing charge, and is supplied with a high/low voltage alarm relay to monitor the DC system.

A safety related AC ventilation fan maintains Battery Room hydrogen concentration below the explosive level of 4% by volume of air. During the diesel standby mode, the battery is fully charged and on float. The capacity of the battery is sufficient to feed its connected load for a four hour station blackout.

The battery has been sized to have an 8 hour rating of 231 ampere hours, based on the use of 58 cells and discharge to 1.81 volts per cell, with 105 volts across the battery at 77°F. The battery charger has been sized for 50 amps, which is sufficient capacity to fully recharge the battery in less than 24 hours while supplying the maximum steady state DC load connected to the system.

8.2.2.7 120 Volt AC Vital Power System

The 120 Volt Vital Power System provides reliable UPS (Uninterruptible Power Supply) and non-UPS sources for essential power, instrumentation, and control loads under operating conditions. The system contains both Class 1E components powered from ES buses and non-Class 1E components powered from reactor auxiliary buses. Backup power supplies are provided for UPS loads from the safety related and non-safety related station batteries, respectively. The non-UPS part of the Vital Power System is discussed in the next section under the Regulated Power System.

The Class 1E UPS part of the system consists of four UPS bus sections supplying eight distribution panels through automatic, high speed static/manual transfer switches from either a static inverter (normal source) or a 480 Volt ES motor control center through a regulating transformer (alternate source). The static inverters are the normal source for the UPS bus sections and are normally supplied from a 480 Volt ES Motor Control Center with an uninterrupted transfer to a 125 Volt Class 1E DC system battery source on loss of normal supply. Indicating lights provide the status of each circuit fed from these two vital bus sources.

The non-Class 1E UPS part of the system consists of one distribution panel supplied through a manual transfer switch from either a static inverter (normal source), or a 480 Volt motor control center through a regulating transformer (alternate source). The static inverter is the normal source for the UPS bus section and is normally supplied from a non-Class 1E 480 Volt Reactor Motor Control Center with an uninterrupted transfer to a 125 Volt non-Class 1E DC system battery source on loss of normal supply.

The entire 120 Volt AC Power System satisfies the proposed IEEE-308, June 1969 "Criteria for Class 1E Electrical Systems."

8.2.2.8 120 Volt AC Regulated Power System

The 120 Volt AC Regulated Power System is the non-UPS part of the Vital AC system discussed in the previous section. The 120 Volt AC Regulated Power System supplies instrumentation, control, and power loads requiring regulated 120 volts AC power. It consists of six distribution panels and regulating transformers fed from motor control centers. Four Class 1E distribution panels distribute 120 VAC power received from ES motor control centers via regulating transformers. Two non-Class 1E distribution panels distribute 120 VAC power received from reactor auxiliary motor control centers via regulating transformers.

8.2.2.9 120Y208 Volt AC Power System

A low voltage 120Y208 Volt AC Power System supplies instrumentation, control, and power loads requiring unregulated 120Y208 volt AC power. It consists of distribution panels and transformers fed from motor control centers.

8.2.2.10 Evaluation of the Physical Layout - Electrical Distribution System Equipment

The Electrical Distribution System equipment has been located to minimize the vulnerability of vital circuits to physical damage. The locations are as follows:

a. The unit auxiliary, start-up, and backup ES transformers are located outdoors, physically separated from each other. Lightning arrestors have been provided, where applicable, for lightning protection. The transformers are protected by automatic water spray systems to extinguish oil fires quickly and prevent the spread of fire. The unit auxiliary, startup and backup ES transformers are separated from the main step-up transformers and from each other by fire walls. A water curtain is actuated in the event of a fire in any of the transformers to protect the Turbine building from the fire. The Unit 3 offsite power transformer is located in the 230 kV switchyard.

b. The unit auxiliary 6900 volt switchgear, 4160 volt switchgear, and 480 volt switchgear are located to minimize exposure to mechanical, fire and water damage. This equipment is coordinated electrically to permit safe operation under normal and short circuit conditions.

c. The ES 4160 volt switchgear and 480 volt switchgear are physically separated from each other and from unit auxiliary switchgear and located in a Class I structure to further minimize exposure to mechanical, fire, and water damage. This equipment is coordinated electrically to permit safe operation under normal and short circuit conditions.

d. The 480 volt motor control centers are located in the areas of electrical load concentration. Those associated with the Turbine Generator Auxiliary Systems, in general, are located below the turbine generator operating floor level. ES motor control centers are located in Seismic Class I areas. Separation of redundant power systems has been maintained throughout.

e. The plant Class 1E DC system batteries, associated chargers, and inverters are located in separate rooms within the control complex, (a Class I structure), to minimize vulnerability to damage. Each Class 1E DC system battery room has a separate supply air duct and both rooms are exhausted by a common duct. The supply and exhaust ducts in each battery room can be automatically isolated by activating isolation dampers in the ducts. The isolation dampers are activated by temperature switches located in each room. Isolation of one battery room does not affect the supply and/or exhaust of the other room. In addition, each room has a smoke detector which actuates an annunciator alarm on the main control board.

f. Non-segregated, metal-enclosed 6900 volt and 4160 volt buses are used for major bus runs where large blocks of current are to be carried. The routing of this metal-enclosed bus is such as to minimize its exposure to mechanical, fire, and water damage.

g. Cables, trays, conduit, and electrical equipment which are safeguards are color coded to help ensure the complete maintaining of power, control, and instrument channel integrity. Non-safeguards cable may run through a safeguard tray, but does not run subsequently in any other safeguards tray.

    1. Power, control, and instrument cables run in trays are color coded to identify their channel association. Conduit and trays are also color coded to identify their channel association. The color code scheme is as follows:

Red or black with red stripe	Engineered Safeguards channel A or RPS channel 1
Green or black with green stripe	Engineered Safeguards channel B or RPS channel 2
Yellow or black with yellow stripe	Engineered Safeguards channel AB or RPS channel 3
Blue or black with blue stripe	RPS channel 4

    2. In addition to being color coded, all cable trays have their own unique number affixed to them.

    3. All cables have their circuit identifying number permanently affixed to each end and wherever they leave their assigned cable tray.

h. The 480 volt Diesel Driven EFW Pump Building safety related Motor Control Center is located in the Diesel Driven EFW Pump Building, which is a seismic Class I structure. Separation of power systems has been maintained throughout.

i. The Diesel Driven EFW Pump Building safety related DC system is located in the Diesel Driven EFW Pump Building. The battery room ventilation intake and exhaust ducts are direct to the building outside environment and do not have isolation dampers.

8.2.2.11 General Cable Considerations

a. The application and routing of control, instrumentation, and power cables are such as to minimize their vulnerability to damage from any source. All cables, including interlocked armor and rubber insulated, are designed using conservative margins with respect to their current carrying capacities, insulation properties, and mechanical construction. Power and control cable insulation rating is 90°C. Appropriate instrumentation cables are shielded to minimize induced voltage and magnetic interference. Wire and cables related to ES and reactor protective systems are routed and installed to maintain the integrity of their respective redundant channels and protect them from physical damage.

b. Environmental qualification testing used to assure safety related cables located inside containment will operate under the worst conditions of combined temperature, pressure, humidity, and radiation is described in Section 8.2.2.14.

c. Power circuit cables are sized on the basis of the maximum ambient temperature expected, the current requirements of the respective equipment, and the designed cable tray loading. The reference used for cable selection is the CR-3 Electrical Design Criteria - Cable Ampacity Sizing.

d. An ambient temperature of 50°C within the reactor, auxiliary, and intermediate buildings, and an ambient temperature of 40°C in other plant areas was the original design basis ambient for all power cable ratings. Alternatively, actual or greater than ambient temperatures may be used.

e. In general, motor and transformer feeder cables are rated at 125% of full load current. In some cases, the 125% of full load current rating is not met. However, as a minimum, the cable will have a rating of 115% of full load current. This provides for motor and equipment operation at service factor ratings.

f. A small number of existing power cables have been found that have ratings in specific locations which do not meet the CR-3 Electrical Design Criteria – Cable Ampacity Sizing. These cables are evaluated individually to determine if they are suitable for continued use. The identification of these cables and the evaluations for continued use are documented in Engineering Calculations.

g. Fire seals are used at cable trays and cable runs where they enter or leave Class I areas, enter or leave the control and auxiliary buildings, and where vertical trays pass through floor openings.

h. When trays containing power cables are enclosed with fire rated material to comply with Appendix R, Section III.G.2 requirements, ampacity derating factors are applied in accordance with the CR-3 Electrical Design Criteria – Cable Ampacity Sizing. The derating factors in these Design Criteria are in accordance with the NRC Safety Evaluation Report, "Crystal River Unit 3 – Revision 1 to Safety Evaluation Report Addressing Thermo-Lag Related Ampacity Derating Issues," dated January 21, 2000 (3N0100-07).

i. Power and control cable trays are ladder type. Where there are horizontal trays passing under grating or hatches, the top tray has a solid cover which is spaced above the tray for ventilation. Where a tray has a vertical rise near a walkway, through or above the floor, covers are installed for protection.

j. The general purpose power and control cable used for the original construction was determined to be flame retardant using a draft of the test defined in IEEE Standard 383. Specifically, these cables were found not to propagate a fire while ignited by a burlap igniter. The general purpose instrument cables were exposed to the vertical flame test described in Section 6.19.6 of IPCEA S-19-81 and, in all cases, there was not significant flame travel and no continued burning after the fifth application of flame. General purpose power, control and instrument cable installed subsequent to the original construction has been purchased as flame retardant, in accordance with the requirements of IEEE Standard 383 or equivalent.

   Some special purpose cable, used for non-safety related circuit functions such as alarms and indications is not certified as flame retardant, and has been installed in non-safety related cable trays. The amount of this cable that is not certified as flame retardant has a total insulation weight of less than 0.2% of the total weight of all cable insulation that contributes to the fire loading. Therefore, this amount is considered to be not significant.

8.2.2.12 Separation of Redundant Circuits

a. The electrical supply, control, and instrumentation cable for mutually redundant or backup equipment have physical separation to assure that no single credible event will prevent operation of the associated function because of electrical conductor damage. Critical circuits and functions include power, control, and instrumentation associated with reactor protection, ES, and reactor shutdown. Credible events include, but are not limited to, the effects of short circuits, pipe ruptures, fires, and missiles. The minimum electrical separation required for protection against Design Basis Accidents (DBAs) is included in the basic plant design (CR3 Electrical Design Criteria manual).

b. General Separation Requirements:

   1. Cables for mutually redundant or backup equipment are run in separate conduits, cable trays, ducts, and penetrations in accordance with FPC's Design Criteria, "Electrical Circuit Physical Separation and Cable Tray Loading."
   2. Where it is impractical for reasons of terminal equipment arrangement to provide separate wireways, cables for mutually redundant or backup equipment are separated from each other by physical barriers or metallic conduit.
   3. Power and control cable rated at 600 volts or below are not placed in wireways with cable rated above 600 volts.
   4. Low level analog signal cables are not routed in wireways containing power or control cables.
   5. Wireways are identified using permanent markings. The purpose of such markings is to facilitate cable routing identification for future modifications or additions.
   6. Permanent identification of cables and conductors is made at all terminal points.
   7. Cable splices in conduits and trays are not allowed.

c. Specific Separation Requirements:

   1. There is four channel separation for the reactor protection and a three channel separation for the safeguards circuits. Where wiring in two or more cables is joined for a common alarm or events recorder point, the cables concerned are not routed in more than one safeguards channel tray where routing through the safeguards tray is used for necessity.
   2. Power cables and logic output control cables for mutually redundant components in safety or safeguards systems are routed separately.

3. Separation of station battery DC control power is maintained for each safeguards redundant bus.
4. The design objectives for the minimum physical dimensions between a safeguard channel's power, control, and instrument cable trays have 9 inches vertical separation between the bottom of the top tray and top of lower tray, and 6 inches horizontal separation between adjacent sides. However, in certain areas where physical limitations govern, the separation is less than 9 inches and 6 inches, respectively.
5. Deleted
6. There are three different locations on the reactor building where electrical penetrations are made. The physical separation of the penetration cartridges within the particular area is determined by the reactor building tendon spacing. The 12 inch diameter penetration sleeves are on minimum vertical spacing between centers of 3 feet. Minimum horizontal spacing of redundant safeguards penetrations is 5 feet outside containment.
7. Non-safeguards cable from redundant safety buses (AC or DC) is not run together in the same tray.
8. Missile producing areas are avoided for locating redundant safeguards raceway wherever possible. However, where such a location is unavoidable, either protective shielding is provided for redundant safeguards raceway or only one safeguard channel raceway is allowed to occupy the area.
9. The design objective for the minimum physical dimensions horizontally and vertically, between redundant safeguard channel trays is given in Table 8-3. Where this minimum spatial separation cannot be maintained a physical barrier is provided.

8.2.2.13 Cable Tray Loading and Separation

a. 6900 Volt Power Tray:

   1. No other cable is routed in the same tray with 6900 volt power cable.
   2. There is only one layer of cable in a tray.
   3. Deleted

b. 4160 Volt Power Tray:

   1. No other type of cable is routed in the same tray with 4160 volt power cable.
   2. There is only one layer of cable in a tray.
   3. For fire rated material applications refer to Section 8.2.2.11.h.

c. 480 Volt and DC Power Tray:

   1. No other type of cable other than 600V or 1 kV rated cable are mixed in the same tray carrying 480 Volt, 125 Volt AC, and 250/125 Volt DC power circuit cables.
   2. Tray loading of 50% physical fill is the design objective. However, in certain areas where physical limitations govern, the tray fill exceeds 50%. For fire rated material applications refer to Section 8.2.2.11.h.

d. Control Tray:

   1. In general, control tray 120 VAC or 125 VDC is reserved for those cables providing control paths for electrically controlled plant equipment. The most common control wire size used at CR-3 is #14 AWG insulated to a minimum of 600 Volts. In some instances,

480 Volt, 120 Volt AC, and 125 Volt DC power cables size #8 AWG and smaller are allowed to be routed in the control cable trays to facilitate installation.

2. In general, control cable tray loading of 50% physical fill is the design objective. However, in certain areas where physical limitations govern, the cable fill may exceed 50%. In all cases, however, thermal loading has been considered. Certain power cable with conductor sizes larger than #8 AWG are installed in control trays. These exceptions have been evaluated and approved for physical compatibility by analysis/calculation, in accordance with CR-3 Nuclear Engineering procedures.

e. Instrument Tray:

1. In general, instrument cable tray loading of 50% physical fill is the design objective. However, in certain areas where physical limitations govern, the cable fill may exceed 50%.
2. There are no other types of cables mixed with instrumentation cabling except alarm, telephone, and low level paging circuits. Certain control cables are installed in non-safety related instrumentation trays, and certain non-safety related instrument circuits are installed in control trays. These exceptions have been evaluated and approved for resistance to electrical noise by an analysis/calculation, in accordance with CR-3 Nuclear Engineering procedures.

f. Dual Use Tray:

1. Dual use trays contain non-safety related control and instrument cables routed to the Main Control Board from individual control and instrument trays in the Cable Spreading Room. Due to physical limitations preventing the use of separate raceways, trays with a dual classification are utilized for both control and instrument circuits in this location. Instrument circuits routed in dual use trays consist of cable that is noise-resistant (such as shielded twisted pairs) and has been evaluated and approved for resistance to electrical noise by analysis/calculation, per CR-3 Nuclear Engineering procedures. Any future installation of circuits in these trays will be evaluated and approved per CR-3 Electrical Design Criteria Manual (EDCM).
2. No power circuits are routed in dual use trays.

8.2.2.14 Safety Related Cable Environmental Testing

There are safety related power, control and instrumentation cables that must perform their safety function during accident environments, which include conditions of high temperature, pressure, radiation and humidity. As required by 10 CFR 50.49, these cables have been environmentally qualified for these conditions as defined in FPC's Environmental and Seismic Qualification Program Manual. Manufacturer's qualification testing, in accordance with IEEE Standard 323-1974 or DOR Guideline, has been evaluated in FPC's Vendor Qualification Packages. These evaluations provide documented auditable evidence that the manufacturer's testing properly envelopes the postulated accident environmental conditions and assures that the cable integrity will be maintained for its installed life, including a postulated Design Basis Accident.

8.2.3 SOURCES OF AUXILIARY POWER

8.2.3.1 Description of Power Sources

Each source has various degrees of redundancy and reliability as outlined below:

8.2.3.1.1 Offsite Power Transformer and Backup ES Transformer

The Crystal River Unit 3 Offsite Power Transformer and Backup ES Transformer serve as the normal sources for ES auxiliaries.

Power to these transformers is provided from any one of five 230 kV transmission circuits or from any one of the fossil Units 1, 2, and 4.

Both the Unit 3 Offsite Power Transformer and Backup ES Transformer are sized to carry Unit 3 full load ES auxiliaries. Through appropriate ES 4160V circuit breaker alignments, either transformer can supply one or both ES 4160V buses (3A and 3B). Both transformers are designed to be available as dedicated Unit 3 ES sources except when:

1. There is a 230 kV system blackout, and neither of Units 1, 2 nor Unit 4 is running.
2. A catastrophic occurrence destroys both buses in the substation.
3. Both transformers fail.
4. Both transformer connections to the 230 kV substation fail.
5. The cable/bus duct connections fail.

8.2.3.1.2 Unit Auxiliary Transformer

As described in Section 8.2.2.2, one power supply to unit auxiliary loads other than safeguards is available through the unit auxiliary transformer connected to the main generator bus. This transformer is sized to carry unit non-safeguards full load auxiliaries. The unit can serve as a power source for safeguards loads during shutdown conditions (backfed from the 500 kV switchyard), subject to the loading and voltage restraints and administrative controls. Transfer of any loads to the unit auxiliary transformer is accomplished manually only.

8.2.3.1.3 Emergency Diesel Generators

Upon loss of the sources of power described in Sections 8.2.3.1.1 and 8.2.3.1.2 above, power will be supplied from two automatic, fast start-up diesel engine generator units. These are sized so that either one can carry the required ES load. Each Emergency Diesel Generator (EDG) unit will feed one of the ES 4160 volt buses.

Each emergency generator is nameplate rated for 3750 kVA at 0.8 power factor (3000 kW). This rating has been extended to 4083 kVA at 0.857 power factor (3500 kW). The following power restrictions apply:

1. 0 - 2850 kW - continuous.
2. 2851 - 3200 kW - cumulative 2000 hour rating.
3. 3201 - 3400 kW - cumulative 200 hour rating.
4. 3401 - 3500 kW - cumulative 30 minute rating.

Emergency Diesel Generator calculated kW load values, based on field test kW data and brake horsepower (BHP) data, remain within the ratings during worst case loading scenarios.

Emergency Diesel Generator steady state auto-connected load is within the 2000 hour rating during the worst case loading scenario. The worst case EDG scenario is a Loss of Offsite Power coincident with an ES actuation resulting from the worst case design basis event and failure of the other EDG to start. The latest worse case EDG loading information for various scenarios is contained in EDG loading calculations supplemented by loading information contained in EDG loading logs which maintain updated loading changes information.

For both EDGs, steady state auto-connected load occurs during the first 60 minutes into the scenario and does not include loads imposed by the starting of motors such as during block loading, and short duration loads such as motor operated valves, battery charger surges, and short duration pump surge flows. Loads imposed by the starting of motors are not included in the service ratings and are less than the EDG manufacturer limits of 3910 kW for such loading.

The worst case EDG steady state auto-connected load including momentary short duration loading is less than the upper limit of the 200 hour rating.

The worst case EDG steady state auto-connected load plus essential manual loads is less than 3300 kW, the minimum bounding load applied during the EDG refueling interval load test.

The worst case EDG steady state loading including manually applied loads during the 7 day accident loading scenario, when the Operator manually performs EDG load management in accordance with EDG load management procedures, is less than the upper limit of the 200 hour rating.

The worst case EDG dynamic voltage and frequency dips resulting from motor starting during block loading and manual loading are less than 25% and 5% respectively and voltage and frequency recover, within 60% (3 seconds) of all load-sequence time intervals for step load increases, to within 10% and 2% respectively. These values are supportive of the recommended limits established by Regulatory Guide 1.9 for dynamic engine/generator analyses.

The worst case EDG dynamic load imposed by the starting of motors during block loading and manual loading is less than the manufacturer limit of 3910 kW.

The EDGs are capable of synchronizing and accepting loads greater than or equal to the maximum expected steady state accident loads, which are the automatically connected accident loads and the required manually applied accident loads. However, the upper limit of the 200 hour service rating is also available for flexibility in post accident load management as needed, including short duration loads. The cumulative time weighted load ratings of the EDGs will not be exceeded.

Sufficient fuel is stored in underground storage tanks (DFT-1A and DFT-1B) combined to supply a single Emergency Diesel Generator for seven days at the upper limit of the 200 hour rating.

Sufficient fuel is stored in each Emergency Diesel Generator day tank (DFT-3A or DFT-3B) to supply the associated EDG for one hour at all actual event-specific profiles.

Each diesel generator unit consists of a diesel generator and its subsystems as described below. The subsystems are unique to their associated diesel generator to ensure that a single failure of any part thereof will not disable onsite emergency AC power:

a. A Fuel Oil System (see Figure 8-10) consisting of components located both off the unit and on the unit. Off unit components are a 30,000 gallon storage tank, a 550 gallon day tank, pump control switches, and pumps to transfer the fuel from the storage tank to the day tank. On unit components are filters, fuel injection pumps, and pumps to provide header pressure.

The off unit pumps consist of one AC motor driven pump and one DC motor driven pump and are provided to move fuel from the storage tank to the day tank as required. Each pump has ample capacity to supply the engine and the DC pump serves as a backup to the AC pump.

The on unit pumps consist of one engine driven pump and one backup DC motor driven pump.

b. A Starting Air System (see Figure 8-11) consisting of a dual drive air compressor, two air reservoirs, relief valves, check valves, and local gauges to provide starting air at 225 to 250 psi. On the unit, the air is directed through a manual shutoff valve and two air start solenoid valves to the engine. Sufficient air is stored in the air reservoirs for six successive start attempts. Additional manual valving is provided to transfer air between the A and B starting air systems to provide additional starting air if required. Starting air provides control air (reduced to 20 psig) to the HVAC control cabinets, 19 & 20, for the EDG ventilating fan controls.

c. A Jacket Coolant System (as shown in Figure 8-12) consisting of a self-contained Cooling System with air-cooled radiators mounted at a slight angle from vertical. The cooling water temperature during operation is controlled by a bypass temperature control valve.

d. An Air Cooler Coolant System (see Figure 8-14) designed to remove the heat from the turbocharger discharge line.

e. A Standby Heater System to provide heat to the jacket water circuits and the lube oil in the engine sump. This thermostatically controlled electrically heated system is energized whenever the engine is not running or speed is below 250 rpm.

f. A Lube Oil System (see Figure 8-13) consisting of an engine driven lube oil pump, a lube oil filter, two lube oil coolers in series, a full flow strainer, a motor driven pre-lube pump, a standby circulating pump, a 15 kW electrical heater, a thermostat, a hand priming pump, and a local pressure gauge to provide engine lubrication.

Diesel building intake air is used for radiator cooling, diesel room ventilation and combustion purposes. An L-shaped structural wall (EGX-2) extends some 20 feet above the diesel building roof for the purpose of deflecting exhaust air away from the intake, minimizing any preheating effect that recirculation could cause under certain wind and weather conditions. Without this wall, a significant amount of hot air recirculation would have the potential to occur during warm ambient temperature/wind combinations and could detrimentally affect engine performance and power output capability. Diesel room ventilation and combustion air are described in Sections 9.7.2.e.2 and 9.7.2.1.h.2.

Only the following three subsystem ties are provided between the two diesel generator units:

a. A double valved connection between the two 30,000 gallon fuel oil storage tanks to provide additional fuel capacity to either diesel generator unit. Both valves are manually operated and remain closed during normal plant operations.

b. A double valved connection to interconnect the air reservoirs in the Air Start System to provide additional air to either diesel generator unit. Both valves are manually operated and remain closed during normal plant operations.

c. A double valved connection to interconnect fuel oil Day Tanks A and B to provide the capability to access fuel supply via Fuel Transfer Pumps A and B to either day tank. Both valves are manually operated and remain closed during normal plant operations.

Control power for each emergency diesel generator is supplied from the appropriate 125/250 volt Class 1E DC plant battery, e.g., emergency diesel generator "A" control power is supplied from battery "A".

Circuits supplying control power to the diesel generator units are separated in accordance with Section 8.2.2.12, e.g., circuits for control and power for the diesel generator "A" unit are routed only via an ES "A" raceway.

Emergency diesel generator protection and control features are shown in Figure 8-9. Each EDG is provided with the following local and remote alarms:

	Local	Remote
Crankcase Pressure High	X	*
Jacket Cooling Pressure Low	X	*
Engine Overspeed	X	*
Fuel Oil Pressure Low	X	*
Lube Oil Pressure Low	X	*
Lube Oil or Jacket Coolant Temperature Low	X	*
Lube Oil Level Low	X	*
Jacket Coolant or Intercooler Coolant Level Low	X	*
Jacket Coolant Temperature High	X	*
Air Start Isolation Valve Not Fully Open	X	*
Day Tank Fuel Oil Level Low	X	*
Day Tank Fuel Oil Level High	X	*
DC Fuel Oil Transfer Pump Running	X	*
Loss of Field	X	*
Generator Stator Temperature High	X	*
Generator Field Ground	X	*
Diesel Start Failure	X	X
Air Start Pressure Low	X	X
Any Switch Not in Auto Position	X	X
Generator Differential	X	X
Loss of Control Voltage	X	*
Generator Field Excitation Lost	X	*

* Common Control Room Alarms

An additional alarm is provided in the Main Control Room when an emergency diesel generator is operating within its 30 minute load rating.

Emergency diesel generator constants based on rated 3750 kVA are as follows:

X_d	=	1.189 Per Unit
$X_{d'}$	=	0.227 Per Unit
$X_{d''}$	=	0.12 Per Unit
SCR	=	0.923
WK^2	=	38,930 pound $(feet)^2$

The diesel generator exciter is a static control device which provides and controls the current to the field winding of the generator to maintain the generator voltage within the regulator band from no load to full load. The exciter regulator derives its operating power from the vector summation of the generator terminal voltage and current and can, therefore, sustain any symmetrical or non-symmetrical short circuit or overload of the generator.

The response time of the exciter-voltage regulator to various load changes is less than 30 milliseconds which is nearly instantaneous when compared to the generator response time of two seconds.

Reliability tests have been conducted on a prototype diesel generator unit to assure that the engine generator is capable of performing the following starting, running, loading, and stopping sequence at least 99 times out of 100 times consecutively, without adjustment to the engine generator:

a. Start unit and accelerate it to rated speed and load.
b. Maintain 3000 kW load for five minutes.
c. Shut the unit down without an idling or cooling off period and allow it to stand until temperatures drop to the keep-warm system level. (This was determined to be a two hour complete cycle).
d. Repeat items a, b, and c above through 100 consecutive cycles.

The units, with the exception of the 30,000 gallon underground fuel storage tanks, are located in an annex on the southeast corner of the auxiliary building, and are separately enclosed to minimize the likelihood of mechanical, fire, or water damage. The interior dividing wall between the diesel generator rooms precludes the transfer between the rooms of environmental effects such as fire, Fire System actuation, internally generated missiles or excessive temperature and is designed to the same criteria as the exterior walls as described in Sections 5.1.1.1 and 5.4.1. The dividing wall contains 2 three-hour rated fire doors.

The fuel storage tanks are located underground outside the annex and are provided with cathodic protection consisting of underground anodes powered through rectifiers to preclude long term corrosion. The tanks are maintained in a full condition thus preventing appreciable condensation.

Protection from water damage such as the flooding of surrounding structures and the fuel oil storage tanks is as described in GAI Report No. 1807, Crystal River Unit No. 3 Hurricane Study and Section 2.4.2.4.

The diesel generator rooms are provided with a Drainage System consisting of two 20 gpm sump pumps (1 per diesel room) feeding into a 6 inch drain line and a separate 6 inch drain line for floor drains in the area. A high level alarm warns the operator of liquid in the sump. The Drainage System is designed to be capable of handling water from the Fire Protection System or any rainfall or water spray created from high winds and conducting it away from the area. Operational capability of the diesel generator units during actuation of the Fire Protection System is inherent in the units design.

The permeability of the compacted fill surrounding the underground fuel oil storage tank is 1 x 10^{-5} cm/sec which will preclude water contamination of the nearest open water supply (the intake canal and structure located approximately 340 feet away) resulting from tank leakage. There is no other safety related equipment that could be affected by tank leakage.

Each diesel-engine will be automatically started upon the occurrence of any of the following incidents:

a. Initiation of safety injection operation.
b. Overpressure in the reactor building.
c. Degraded voltage or loss of voltage on the 4160 volt ES bus with which the emergency generator is associated. In addition, upon loss of the 4160 volt bus voltage, the diesel-generator unit will be automatically connected to its bus. The sequence to accomplish this will be as follows:

Step 1 Automatic tripping of all breakers on the bus with the exception of the block 1 feeder load breakers described in Section 7.1.3.2.3 , and the 4160 volt/480 volt ES auxiliary transformer feeder breaker.

Step 2 After the unit comes up to speed and voltage, the emergency generator breaker will automatically close.

Step 3 Manual starting additional equipment as required for safe plant operation.

If there is a requirement for ES System operation coincident with the loss of voltage on the 4160 volt bus, Step 2 will be followed by the automatic sequential starting of safeguards equipment listed on Table 8-1 and Table 8-2 described in Section 7.1.3.2.3. These tables represent the worst case steady state auto-connected loading anticipated for each diesel generator.

In the event that one emergency generator does not come on the line when called for, the automatic starting sequence of components associated with this generator and bus will be blocked.

The automatic sequential loading of each diesel-generator unit with safeguards auxiliaries will be accomplished in six load blocks as described in Section 7.1.3.2.3. These blocks have been selected to limit system voltage dips.

Safeguards control center starters have been specified to hold in at 65% of rated voltage for a period of 2 seconds. Therefore, the voltage dips of blocks 2 through 6 do not cause the safeguard control center starters to drop out. The block 1 voltage dip causes a pick up delay of the safeguard control center starters. This delay was conservatively assumed to be 1 second which is the time taken by diesel generator voltage to recover to starter pick up level during block 1. The second level undervoltage relaying delay time of 5 seconds takes the assumed 1 second starter pick up delay into account allowing the plant to meet technical specification response time requirements.

Starting of a diesel-engine generator unit takes less than 10 seconds. From a dead start, the High Pressure Injection (HPI) and Low Pressure Injection (LPI) Systems will be available for operation within 35 seconds. The six block load sequence for these systems is shown in Section 7.1.3.2.3.a.

If the system, rather than the emergency generator units, supplies power to the safeguards buses at the time of actuation, safeguards loads will be started in the same six load blocks.

As a result of low transformer impedance for the Unit 3 offsite power transformer and the Unit 3 backup ES transformer, respectively, system voltage dips are minimized.

In this event, core injection systems will be in operation in less than 15 seconds, since diesel starting time would not then be a factor. Each emergency diesel generator is equipped with protective relaying to prevent or limit damage resulting from an unacceptable operating condition such as a generator or 4160 volt ES bus fault. Upon detection of an unacceptable operating condition, the emergency diesel generator differential relaying will trip and lock-out the emergency diesel generator engine (reference Figure 8-9) and the associated output breaker. Upon detection of an unacceptable operating condition, other protective relaying will trip and lock-out the emergency diesel generator output breaker (and generator exciter in the case of generator field overcurrent relaying). The protective trip relaying affecting each emergency diesel generator and its associated breaker is single-channel and not bypassed during an accident condition.

8.2.3.2 Power to Vital Loads

All power sources except the start-up transformer supply power to the 4160 volt bus sections which serve the ES auxiliaries and reactor protective systems. The ES auxiliaries and reactor protective systems have been arranged so that a failure of any single bus section will not prevent the respective systems from fulfilling their protective functions.

Logic and control circuitry will be fed without interruption from Class 1E DC system sources and inverter buses.

ES buses will only be tied together manually. During both normal and emergency modes of operation, these buses are normally fed from either the offsite power transformer or the backup ES transformer with the capability of individual feeds from different diesel generators.

8.2.3.3 Reliability Considerations

Independent sources of DC control power are provided for the protective relaying schemes described in Section 8.2.1.2.e and the 230 kV breakers as follows:

a. Independent DC batteries for primary functions and for backup functions, provide control power for protective relaying schemes and breaker switching for the 230 kV substation.

b. Primary and backup relaying protection is provided for the 230 kV buses, transmission lines, plant lines, the Unit 3 offsite power transformer, the Unit 3 backup ES transformer, and associated power cable/bus duct ties to the Unit 3 4160 volt ES buses. In each type of protection the primary and backup schemes are operated from separate DC supplies and employ separate master trip relays for the required tripping and blocking functions. Redundant, but not physically separate, current transformers are utilized for the redundant relay schemes. However, potential transformers used for the redundant schemes are not redundant.

   The primary and backup relay schemes are taken out of service for testing, repair or maintenance periodically. However, both schemes are never taken out of service simultaneously without the associated equipment being isolated from the 230 kV substation.

c. Each 230 kV breaker is provided with two electrically independent sets of tripping coils designated as primary and backup and supplied from separate DC supplies.

d. Power and control cables for six bays of the 230 kV substation (including the plant line to the Unit 3 backup ES transformer) are routed through Unit 1 and the 230 kV substation. Power and control cables for the Unit 3 offsite power transformer bay are routed from Unit 3 through the 500 kV substation. Except for within the 230 kV and 500 kV substations, cable transmitting DC power for the above features is installed in accordance with Section 8.2.2.12.a. Physical independence for cable installed between Unit 3 and the 500 kV substation and the cable installed within the cable tunnel between Unit 1 and the 230 kV substation is provided by the use of cable tray and conduit.

The plant lines to the Unit 3 offsite power transformer and backup ES transformer and associated cable/bus duct connection are the preferred offsite power sources for Crystal River Unit 3 ES buses.

The protection schemes for these power sources, the other plant lines, the 230 kV substation and the transmission lines connected to it are designed so that no single failure of any relay scheme will result in the loss of both sources of offsite power to Unit 3 should a fault occur. These design features ensure power supply reliability and minimize the possibility of failure. These features assure adequate fault sensing and clearing capability to assure both offsite power sources will not be lost considering any single relay scheme is unavailable due to equipment failure, maintenance or testing.

The 500 kV substation is not considered as an offsite power source for Unit 3 during normal operation. This source can be made available within 8 hours of plant shutdown (Modes 5 and 6) subject to certain voltage and loading constraints and administrative controls.

The emergency diesel generator reliability is monitored in accordance with a program which meets the recommendations of NUMARC 87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," Appendix D, EDG Reliability Program.

8.3 TESTS AND INSPECTIONS

The diesel-engine generators are normally controlled from a control board located in the control room. Provision has been made on the control board to manually initiate a fast start of either of the generators with closure of the associated air circuit breakers connecting the generator to its 4160 volt Engineered Safeguards (ES) equipment bus with the bus de-energized. Testing of this system may be done by the control room operator at his convenience any time the units are not otherwise running, with due regard for reactor auxiliaries in use.

The 230 kV and 500 kV circuit breakers can be inspected, maintained, and tested as follows:

a. Transmission line circuit breakers are tested on a routine basis. This can be accomplished on the breaker and a half scheme and the ring bus scheme without removing the transmission line from service.
b. Generator circuit breakers can be tested with the generator in service.

Transmission line protective relaying can be tested on a routine basis. Generator protective relaying is tested when the generator is off-line. The 4160 volt circuit breakers, motor starters, and associated equipment can be tested while the unit is in service.

Testing is performed on the Class 1E power systems as required by Improved Technical Specifications.

The ungrounded DC System has detectors to indicate when there is a ground existing on any leg of the system. A ground on one leg of the DC System will not cause any equipment to malfunction.

Grounds can be located by a logical isolation of individual circuits connected to the faulted system, while taking the necessary precautions to maintain the integrity of the vital bus supplies.

8.4 QUALITY CONTROL

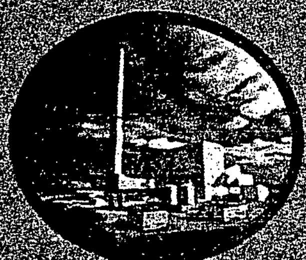
Assurance that the electrical systems meet their design bases, insofar as the integrity of the systems is concerned, is obtained by analysis, inspection, and testing. The quality program (preoperational) for Crystal River Unit 3 is described in Section 1.6. The quality program (operational) for Crystal River 3 is described in Section 1.7. The quality program for Class 1E electrical systems complies with NRC Regulatory Guide 1.30 (8/72) with clarifications as described in Table 1-3. The offsite power circuits from the transmission system up to, but not including, the supply breakers on the Class 1E switchgear units are not a Class 1E electrical system, and are maintained in accordance with normal utility maintenance procedures and practices. The supply breakers on the Class 1E switchgear units provide the Class 1E separation from the non-Class 1E offsite power circuits.

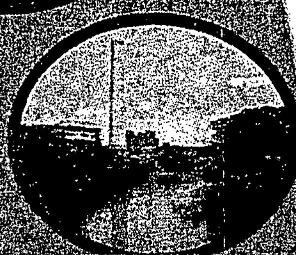
END-OF-CHAPTER

Golder Associates 2006

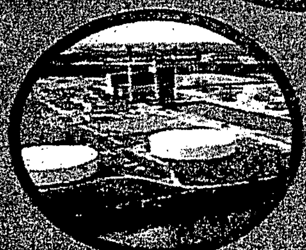
Progress Energy

"CR-3 PIC"





Crystal River Energy Complex
Proposal for Information Collection
NPDES Permit No. FL0000159



Golder Associates

5100 West Lemon Street, Suite 114
Tampa, Florida 33609

January 2006 043-9513

Energy. http://www.progress-energy.com

Golder Associates Inc.

5100 West Lemon Street, Suite 114
Tampa, FL USA 33609
Telephone (813) 287-1717
Fax (813) 287-1716
www.golder.com

REPORT ON

PROPOSAL FOR INFORMATION COLLECTION FOR PROGRESS ENERGY CRYSTAL RIVER ENERGY COMPLEX CITRUS COUNTY, FLORIDA NPDES PERMIT NUMBER FL000159

Submitted to:

Progress Energy
410 S. Wilmington Street
PEB C-7
Raleigh, North Carolina 27602-1551

Submitted by:

Golder Associates Inc.
5100 West Lemon Street
Suite 114
Tampa, Florida 33609

Distribution:

4 Copies - Progress Energy – North Carolina
2 Copies - Progress Energy – St. Petersburg
3 Copies - Golder Associates Inc.

October 2005

043-9513

Golder Associates Inc.

5100 West Lemon Street, Suite 114
Tampa, FL USA 33609
Telephone (813) 287-1717
Fax (813) 287-1716
www.golder.com

Golder Associates

October 12, 2005

Our Ref.: 043-9513

Progress Energy
410 S. Wilmington Street
PEB C-7
Raleigh, North Carolina 27602-1551

Attention: Mr. Fred Holt

RE: DRAFT REPORT ON PROPOSAL FOR INFORMATION COLLECTION CRYSTAL RIVER ENERGY COMPLEX

Dear Mr. Holt:

Golder Associates Inc. (Golder Associates) is pleased to submit the above referenced draft Proposal for Information Collection (PIC) for the Crystal River Energy Complex.

Golder appreciates the opportunity to work with you on this project. If you have any questions regarding this report or if you need additional assistance please contact us.

Sincerely,

GOLDER ASSOCIATES INC.

Manitia Moultrie
Permitting and Compliance Group Leader
and Associate

Stephen Friant
Stephen Friant, Ph.D.
Senior Scientist

Gregory Powell, Ph.D., P.E.
Water Resource Engineer

MM/GP/SF/dcg

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

The Clean Water Act (CWA) Section 316(b) Phase II rule requires the submittal of a Proposal for Information Collection (PIC) and applicable portions of a Comprehensive Demonstration Study (CDS) for the Crystal River Energy Complex.

The following report (PIC) provides a description of the information that will be used to support the CDS for the Crystal River Energy Complex. Section 2 provides a brief overview of the Section 316(b) Phase II regulatory requirements associated with the PIC and CDS process. Section 3 of the report provides a description of the Crystal River facility, cooling water intake structure(s) (CWIS), source waterbody, hydraulic zone of influence and CWIS operations. A description of the current and proposed technologies, operational measures, and/or restoration measures that will be considered during the CDS process is provided in Section 4. Section 5 provides a description of historical studies that were conducted to characterize impingement mortality and entrainment in the vicinity of the facility. Section 6 provides a description of the historical and planned consultations with the appropriate fish and wildlife agencies that are relevant to the proposed field sampling plan and Section 7 provides the proposed impingement mortality sampling plan for the Crystal River Energy Complex. Section 8 provides the preliminary 316(b) implementation schedule and finally, Section 9 provides a list of the references that are applicable to the PIC and CDS.

2.0 316(b) REGULATORY REQUIREMENTS

The U.S. Environmental Protection Agency (EPA) has promulgated regulations under Section 316(b) of the CWA that require that the location, design, construction and capacity of CWIS reflect the best technology available (BTA) for minimizing adverse environmental impacts to aquatic organisms. The 316(b) Phase II rule establishes minimum performance standards for applicable electric generating facilities based on the type of waterbody in which the intake structure is located, the volume of water withdrawn and the facility's capacity utilization rate.

For those facilities that withdraw cooling water from one of the Great Lakes, the ocean, an estuary, tidal river or a freshwater river (withdrawal greater than 5% of the annual mean river flow), the performance standards require reduction in impingement mortality by 80 to 95 percent, and reduction in entrainment by 60 to 90 percent. For facilities that withdraw cooling water from a river (withdrawal 5% or less of the annual mean river flow), lake, or reservoir, only the impingement mortality performance standard applies.

Applicable facilities may choose one of five alternatives for meeting BTA requirements. These options are:

1) Demonstration that the facility has reduced flow commensurate with closed-cycle recirculating cooling, and/or reduced maximum design intake velocity to 0.5 foot/second (ft/s) or lower; or

2) Demonstration that the facility's existing design and construction technology, operational measures, and/or restoration currently meets performance standards; or

3) Selection and implementation of design and construction technologies, operational measures, or restoration measures, that will, in combination with existing technologies, operational or restoration measures meet the specified performance standards; or

4) Demonstration that a facility has installed and properly operates and maintains EPA approved technology; or

5) Demonstration that a facility qualifies for a site-specific determination of BTA because the costs of compliance (i.e., new technology) are either significantly greater than those considered by the EPA during the development of the rule, or the facility's costs of compliance would be significantly greater than the environmental benefits of compliance with the performance standards. The rule also provides that facilities may use restoration

measures in combination with or in lieu of technology to meet performance standards or in establishing BTA on a site-specific basis.

The 316(b) Phase II rule requires the submittal of applicable portions of the CDS. The purpose of the CDS is to provide a determination of whether the facility meets the performance standards and recommend a basis for determining BTA for minimizing adverse environmental impact. The information from the CDS is required to characterize impingement mortality and entrainment impacts, describe the operation of cooling water intake structures, and to confirm that the technology (ies), operational measures, and/or restoration measures meet the applicable performance standards. Prior to the start of information collection activities, a PIC must be submitted to the Florida Department of Environmental Protection (FDEP) for review and comment. The PIC provides a description of the information that will be used to support the CDS. As required, this PIC for the Crystal River Energy Complex provides the following information:

a) A description of the proposed and/or implemented technologies, operational measures, and/or restoration measures to be evaluated in the CDS (Section 4);

b) A list and description of any historical studies characterizing impingement mortality and entrainment and/or the physical and biological conditions in the vicinity of the cooling water intake structures and their relevance (Section 5);

c) A summary of any past or ongoing consultations with appropriate fish and wildlife agencies that are relevant and a copy of written comments received as a result of such consultations (Section 6); and

d) A sampling plan of study for any new field studies proposed to be conducted in order to ensure that the permittee has sufficient data to develop a scientifically valid estimate of impingement mortality and entrainment at the site. The sampling plan outlines methods and quality assurance/quality control procedures for sampling and data analysis (Section 7).

For completeness, and to provide the setting for the PIC, Section 3 describes the facility, source waterbody, CWIS configuration and operation, CWIS area of influence, and the regulatory requirement applicable to the Crystal River Energy Complex.

3.0 CRYSTAL RIVER ENERGY COMPLEX

The Crystal River Energy Complex (Complex) is located on an approximate 5,000-acre site near the Gulf of Mexico in Citrus County, Florida. The Complex is approximately 7.5 miles northwest of the City of Crystal River, within the coastal salt marsh area of west central Florida (Figures 3-1 and 3-2). The Complex contains five electric generating units.

3.1 Facility Description

Units 1 and 2 are coal fired and Unit 3 is a nuclear fueled electric generating plant located within the Complex. These three units utilize once-through condenser cooling and are authorized to discharge cooling water by NPDES Permit No. FL0000159. Units 4 and 5 are coal fired units and utilize closed cycle cooling using natural draft cooling towers. Units 4 and 5 withdraw water for cooling tower makeup from the discharge (canal) from Units 1, 2, and 3. During certain times of the year (May 1 through October 31), once-through helper cooling towers are operated to reduce the thermal discharge from Units 1, 2 and 3 and to reduce impingement and entrainment. The helper cooling towers cool a portion of the heated water which has passed through the condensers from Units 1, 2, and 3 (as well as Units 4 and 5), then discharges back to the discharge canal. The helper cooling towers are operated as necessary to ensure that the discharge temperature does not exceed 96.5°F as a three-hour rolling average at the point of discharge into the Gulf of Mexico.

3.2 Source Waterbody Description

Source water for Units 1, 2 and 3 is withdrawn from a common canal located south of the units which extends into the Gulf of Mexico, a Class III marine water. The intake canal is a dredged canal approximately 14 miles long with an average depth of 20 feet (the area of the intake canal has a natural rock bottom under the initial layer of sand and sediment that extends the length of the canal). The dredged canal is confined between two dikes for about 2.9 miles, at which point the southern dike terminates. The northern dike parallels the channel for another 4.5 miles with the first opening at Fisherman's Pass occurring 1.2 miles past the southern dike. Additional openings occur at irregular intervals. Water flows eastward in the canal. Historical velocities at the mouth of the canal are tidally influenced and ranged from 0.6 to 2.6 feet/second (1983-1984). Spoil from offshore construction

(1979-1980) was used to create dikes adjacent to the intake and discharge canals. The canal is also used to bring coal barges into the facility (Figure 3-1).

3.3 Cooling Water Intake Structure

The cooling water intake structure for Units 1, 2, and 3 consists of concrete structures with bar racks, traveling screens, and seawater pump components.

3.3.1 CWIS Configuration

Units 1 and 2

The intakes for Units 1 and 2 are similarly constructed and are located on the northern bank of the canal. They are located at the head of a slight embayment with the Unit 1 screenwall located to the east (Figure 3-3). A floating barrier and a coarse mesh wire fence extend across the embayment of the intake canal to prevent floating or partially submerged debris from the intakes. The combined intakes are approximately 141 ft across with external bar racks. Cooling water is withdrawn from the intake canal through external 4-inch bar racks which prevent trash and large debris from entering the intake structure. Each intake has four bays with a circulating water pump and traveling screen in each bay. The traveling screens are identical in Units 1 and 2. The traveling screen system is operated approximately three times a day (once every 8 hours) in order to remove floating or suspended debris and marine life. The screen trays are 9 ft wide and are equipped with standard 3/8 inch, square, wire mesh. The screens are conveyed upwards to an overlapping water spray system which washes the debris and impinged organisms off the screens into a common trough which is directed to sumps located adjacent to the intakes. The Unit 1 trough is approximately 1 foot in depth and slopes to the east; the Unit 2 trough is approximately 2 ft in depth and slopes to the west.

Unit 3

The intake structure for Unit 3 is separate from the intakes of Units 1 and 2. A chain link fence extends across the entire width of the intake canal downstream of the intakes for Units 1 and 2. The fence restricts access to Unit 3 and also collects floating or partially submerged debris.

The intake is approximately 118 feet across and has external bar racks with 4-inch spacing between bars. The racks are continuous from above the surface of the water to the slab. There are 4 pump bays and seven traveling screen bays separated from the pump bays by a common plenum. An eighth traveling screen bay provides service water. Similar to Units 1 and 2, the traveling screen trays are 9 feet wide and have 3/8-inch mesh screen. They are operated once every 8 hours and cleaned by a front spray wash system. The screenwash trough slopes to the west were material is collected in a sump prior to discharge to the intake canal. The trough receives combined wash water from all screens.

3.3.2 CWIS Operations

Units 1, 2, and 3

Cooling water for Units 1, 2, and 3 is withdrawn from a common canal located south of the units which extends into the Gulf of Mexico. Cooling water is pumped through large circulating water pumps from the intake canal. The water is then pumped through the condensers and out to the discharge canal.

Unit 1 has four circulating water pumps each rated at 77,500 gpm; the four pumps at Unit 2 are each rated at 82,000 gpm. The units operate with three to four pumps in operation. In rare instances, pumps may operate without heat rejection. The design intake flow for Units 1 and 2 is 638,000 gpm/919 million gallons per day (MGD). Unit 3 operates with four circulating water pumps , two being rated at 167,000 gpm and the other two rated at 179,000 gpm. The overall design intake flow for Unit 3 is limited to 680,000 gpm/979 MGD. The three units have a combined flow of ~ 1898 MGD. Additionally, Unit 3 has a nuclear services water pumping system with a normal flow rate of approximately 10,000 gpm. During emergency conditions, additional pumps can increase this flow up to approximately 20,000 gpm. Combined condenser flow from Units 1, 2 and 3 is limited by the NPDES permit to 1897.9 MGD during the period of May 1 through October 31, and 1613.2 MGD during the remainder of the year.

The discharge from Units 1, 2 and 3 is used to provide make-up to the Units 4 and 5 closed-cycle cooling towers.

3.4 Regulatory Requirements and Performance Standard

3.4.1 Units 1, 2, and 3

Units 1, 2, and 3 withdraw water for cooling purposes from an intake canal which extends into the Gulf of Mexico, as such; the source water body is classified as an "estuary". A facility which withdraws cooling water from a tidal river, estuary, or ocean must meet the performance standards for both the impingement mortality reduction (80 to 95% reduction) and entrainment (60 to 90% reduction) from the calculated baseline.

4.0 EXISTING AND PROPOSED TECHNOLOGY, OPERATIONAL AND/OR RESTORATION MEASURES

4.1 Applicable Performance Standards

Crystal River Units 1, 2 and 3 are required to reduce impingement mortality by 80 – 95% and entrainment by 60 to 90% from the calculated baseline. The definition of a calculation baseline "means an estimate of impingement mortality and entrainment that would occur at your site assuming that: the cooling system has been designed as a once-through system." In the preamble to the final rule (FR Vol. 69, No. 131, page 41595, July 9, 2004) EPA states that the definition of calculation baseline "recognizes and provides credit for any structural or operational controls, including flow or velocity reductions, a facility had adopted that reduce impingement mortality or entrainment." In regard to the Crystal River facility the baseline flow of a once-through system absent "structural or operational controls including flow or velocity reductions" is discussed below.

4.2 Existing Technology, Operational and Restoration Measures

It is stated in the definition of calculation baseline that "the baseline practices, procedures, and structural configuration are those that your facility would maintain in the absence of any structural or operational controls, including flow or velocity reductions, ..." It is apparent that the baseline conditions can be related to flow.

The calculation baseline serves at least two main purposes. One is to establish a basis from which to formulate a compliance strategy for the applicable performance standard (s). The second is to properly credit facilities that have compliance measures already in place (69 Fed. Reg. 41612).

The calculation baseline definition provides for the assumption that the site cooling water system has been designed as a once-through system (obviously related to flow as one major aspect) and that this baseline operation is absent of impingement and entrainment reduction measures such as structural or operational controls including flow or velocity reductions. This is again related to flow. The record has established that the baseline can be related to flow and that credits can be related to flow. The question is what is this relationship? The following references support a direct relationship:

- In the same citation mentioned above (69 Fed. Reg. 41612), it is stated " EPA agrees that reducing intake [flow] by installing flow reduction technologies will result in a similarly high reduction of impinged and entrained organisms; . . ."

- In Response to Comment 316bEFR.034.022 – EPA states "EPA believes that assuming a uniform distribution is a conservative [emphasis added] and appropriate approach to estimating impingement and entrainment rates."

- In Response to Comment 316(b)EFR.041.037 – EPA states "EPA notes that the assumption that I&E is proportional to flow is not unusual or inconsistent with other predictive studies, including those by industry." Additionally in the same response it is stated that EPA's 1976 Development Document for the Best Technology Available for the Location, Design, Construction and Capacity of Cooling Water Intake Structures for Minimizing Adverse Environmental Impact (DCN 1-1056-TC) concluded that "reduction of cooling water intake volume (capacity) should, in most cases, reduce the number of organisms that are subject to entrainment in direct proportion to the fractional flow reduction."

- Response to Comment 316(b) EFR.062.003 and several others – It is stated "EPA believes it has presented ample evidence demonstrating a significant decrease in the level of entrainment when intake flow is minimized in relation to the flow of the source waterbody. The documents DCN# 2-013L-R15 and 2-013J support the propositions that flow is related to entrainment and organisms are distributed somewhat uniformly throughout the waterbody."

- 67 Fed. Reg. 17141 and 69 Fed. Reg. 41599– It is stated "EPA believes that, absent entrainment control technologies, entrainment at a particular site is proportional to intake flow at that site."

- 69 Fed. Reg. 41601 states "Reducing the cooling water intake structure's capacity is one of the most effective means of reducing entrainment (and impingement)."

- 69 Fed. Reg. 41637 it is stated "Additionally, if a portion of the total design intake flow is water withdrawn for a closed-cycle, recirculating cooling system (but flow is not sufficiently reduced to satisfy the compliance option in § 125.94(a)(1)(i)), such facilities may use the reduction in impingement mortality and entrainment that is attributed to the reduction in flow in meeting the performance standards in § 125.94(b)."

It is evident that EPA supports a direct relationship between a percentage reduction in flow (or a credit for a percentage of reduction in flow) and compliance with the percentage reduction that the performance standards prescribe. An example of this concept follows. Consider a two unit facility with a hypothetical baseline once-through cooling water design of 1000 MGD (500 MGD/Unit). If this facility currently has a cooling tower in place for one unit and this cooling tower has a make-up from a sourcewater body of 25 MGD then this facility should received credit for a percentage reduction in I & E of 48 %. (1000 MGD – 475 MGD net reduction = 475 / 1000 = 48 % reduction credit).

Units 1, 2 and 3 currently use helper cooling towers and seasonal flow reduction in order to meet permit requirements and reduce impingement and entrainment. Natural draft closed-cycle cooling towers are in operation at Crystal River Units 4 and 5 which withdraw water from the discharge of Units 1, 2 and 3 to further minimize entrainment and impingement. Table 4-1 demonstrates that without the above mentioned measures the baseline flow for the facility would be approximately 4,718 MGD. Recognizing the flow reduction credits and associated reduction in impingement and entrainment the facility realizes a reduction of 66% from the baseline flow. This 66% in turn falls within the range of 60 – 90 % for entrainment compliance.

4.3 Implemented Technology, Operational and Restoration Measures

As part of a negotiated permit settlement, Progress Energy agreed to construct and operate a multi-species marine hatchery to mitigate entrainment and impingement as a result of the operation of Units 1, 2, and 3. Utilizing the expertise of a Technical Advisory Committee, it was recommended that the facility culture red drum, spotted seatrout, pink shrimp, and striped mullet as the first four species to culture. Pigfish and silver perch were later added to the list. During 2003, blue crab and stone crab were added to the list for a total of eight species. To date, the center has raised and released 932,394 red drum fingerlings (125,064 in 2003), 791,665 spotted seatrout fingerlings (163,200 in 2003), 241,898 pink shrimp (49,755 in 2003), 500,000 first feeding larvae of striped mullet in 2003, and 40,000 silver perch larvae in 2003. Stone crab and blue crab larvae were cultured in 2003 and released in 2004.

The hatchery produces a credit for the biomass that is impinged at the facility. This credit can currently be demonstrated to be 17% which is founded on a baseline derived from past studies. This credit may be more or less depending on an updated baseline. However adding the 17% credit to the 66% credit for flow reduction measures provides a reduction credit of 83% for impingement mortality reduction. This 83% reduction falls into the impingement mortality performance standard range of 80 – 95%.

The Crystal River Energy Complex intends to pursue credit for the impingement and entrainment reduction provided by 1) the operation of the Units 4 and 5 cooling towers 2) the operation of the Helper Cooling Towers 3) seasonal flow reduction and 4) an impingement credit provided by the operation of the Mariculture Center.

4.4 Proposed Technology, Operational and/or Restoration Measures

4.4.1 Feasible Technology, Operational and/or Restoration Measures

The Crystal River Energy Complex can potentially demonstrate that the existing technology, operational and restoration measures currently meet the impingement mortality and entrainment reduction performance standards, or Compliance Alternative 2.

Credit for the operation of the helper cooling towers, flow reduction, operation of the closed-cycle cooling towers and the Mariculture Center can be used to offset impingement mortality and entrainment losses (in lieu of technology modifications).

Alternatively, should adequate credit not be available to meet the performance standards, Compliance Alternative 3 (selection and implementation of design and construction technologies, operational measures and/or restoration measures) will be considered (in combination with existing technology, operational and restoration measures) as described below:

- Selection/implementation of design technology (impingement mortality reduction only);
    - Installation of fish return system(s) on Units 1, 2, and/or Units 3;
- Operational modification (impingement mortality reduction only);
    - Continuous operation of the traveling screens
- Restoration measures (impingement mortality and/or entrainment reduction);
    - Operation of the Mariculture Center;
        - Historical production exceeds required compensation; or
        - Modify production to meet required performance standard.

If the cost of the proposed technologies, operational and/or restoration measures are significantly greater relative to EPA's model technology cost for the facility, and/or relative to the environmental benefits of compliance with the performance standards, a site-specific performance standard may be proposed as provided in Compliance Alternative 5.

A summary of this flow path is provided in Figure 4-1.

5.0 HISTORICAL IMPINGEMENT MORTALITY AND ENTRAINMENT DATA

This section provides a description of historical studies which characterized impingement mortality and entrainment and/or the physical and biological conditions in the vicinity of the CWIS and their relevance to the proposed Sampling Plan of Study.

5.1 Historical Impingement and Entrainment Data

316(a) and (b) demonstration studies were conducted in the 1970s and again in 1983-1984 to evaluate the impact of the CWIS on regional fisheries (*Crystal River Units 1, 2, and 3, 316 Demonstration Final Report, Florida Power Corporation, 1985*). The sampling program was conducted in 1983 and 1984 to evaluate the 1) thermal impacts on water quality, benthos, macrophytes, salt marsh and fisheries and 2) intake effects from entrainment and impingement.

5.1.1 Impingement

Impingement sampling was conducted for one, randomly selected, 24 hour period once a week for 12 months at Units 1, 2, and 3 starting in June 1983. Each unit was sampled every 6 hours. Raw impingement numbers collected weekly from the traveling screens were converted to numbers collected per volume of water passing through the screens. Selected important organisms (SIO) were used as the metric to describe the species that were determined to be ecological, recreational and commercial important species in the vicinity of the Crystal River CWIS. The list of SIO used during the historical study is provided in Table 5-1 for historical reference.

The results indicated that impingement was a function of the time of the year, species present and generating unit. In general, the maximum impingement rate occurred during spring, and for selected organisms, during a second pulse in late summer. Of the SIO, bay anchovy were impinged with the greatest numbers at Unit 3, and during March. The second most abundant SIO was the polka-dot batfish which also occurred at Unit 3 and peaked in March. Spot was the third most abundant species and peaked in later April and early May. A summary of total fish impinged by unit by species is presented in Table 5-2 for historical reference. The total impinged by unit is summarized in Table 5-3. As shown, the highest impingement rate was at Unit 3, followed by Unit 2 and then Unit 1. Total weight in kilograms (kg) is also given and follows a similar trend as numbers impinged, except that polka dot batfish had the largest biomass for fish impinged during the study.

The demonstration study indicated that 87,978 bay anchovy, 74,483 bat fish, 3,697 pigfish, 15,235 pinfish, 12,000 silver perch, 2,804 spotted seatrout, 28,094 spot, 8 red drum, and 1,120 striped mullet were estimated to be impinged.

Invertebrates were impinged in greater numbers than fish. The SIO invertebrates represented less than 83 percent of the total SIO impinged annually and less than 42 percent of the total organisms impinged. The annual number of pink shrimp and blue crab impinged was estimated to be 640,887 and 383,560, respectively. Brief squid and stone crab impingement was estimated to be 86,954 and 1,535 per year. Impingement for pink shrimp and blue crabs occurred in high numbers throughout spring.

5.1.2 <u>Entrainment</u>

Entrainment sampling was conducted every two weeks during the study period from late June 1983 to late September 1984. Entrainment samples were collected from 15 stations in the vicinity of Units 1, 2, and 3 once during the day and night. Samples were not actually taken at the screens; therefore, stations within the intake canal close to the screens were used to estimate entrainment rates through the plant. The station with the highest density was used to estimate entrainment in order to provide a conservative assessment. These densities were multiplied by plant flow and adjusted to age 1 equivalents through the Equivalent Adult Model (EAM). The EAM model uses species specific natural mortality rates to simulate the growth of eggs and larvae to one year old adults.

Bay anchovy was the most abundant entrained organism. The equivalent adults for eggs, prolarvae, and postlarvae were 10.4, 0.75, and 6.7 million bay anchovies, respectively. The loss of juveniles was estimated to be 3.8 million equivalent adult anchovies. For polka-dot batfish, only juveniles were entrained and the equivalent adults were 190,000. The equivalent adults lost for postlarvae were 37,000 and for juveniles 47,000. The entrained prolarvae, postlarvae and juveniles were 26,000, and 600 equivalent adults, respectively. For seatrout the estimated equivalent adults were 900 based on eggs and larvae. The entrainment of spot postlarvae and juveniles resulted in 280,000 and 410,000 equivalent adults, respectively. For striped mullet the corresponding lifestage equivalent adults were 95 and 5,800. Pink shrimp equivalent adult loss was 22, 18,830, and 10,230 for mysis, postlarvae and juveniles, respectively. Only two stone crabs as equivalent adults were estimated lost from entrainment. For squid, the estimated loss of equivalent adults was 3,600.

5.1.3 Summary of Historical Data

In January 1985, FPC submitted the final 316(b) report to the EPA as required by their July 23, 1979, modified NPDES permit. Results of the studies indicated that impacts to fish and shellfish were observed. The level of entrainment and impingement demonstrated by the 316(b) study constituted an "adverse impact to the biota of Crystal Bay and environs." As a result of these findings FPC instituted certain compliance measures. It is stated "*...it was concluded that a reduction of plant flow by 15 percent during the months of November through April, in conjunction with the construction and operation of a fish hatchery over the remaining operating life of the three units constituted minimization of the environmental impacts of the cooling water intake.*" (EPA Fact Sheet, NPDES FL0000159).

5.1.4 Applicability to the Calculated Baseline

These historical data, which were collected using appropriate QA/QC provides a strong base to design a field study and additional data collection efforts. The worse case condition for calculated baseline is to assume 100% impingement and entrainment mortality at applicable design flows. The 1983-84 study used the representative species (RS) approach, referred to as SIO, and reported both numbers and total weight impinged and absolute density and equivalent adults entrained. Although the applicability of the historical SIO data to current conditions may be limited, in order to provide maximum flexibility and consistency, it is recommended to use a similar approach for any new data collection efforts for impingement. The metric (RS) that will be used to calculate the baseline will be the one that provides the least data variability and uncertainty while also serving the purpose of RS. This will be particularly important when comparing the baseline data to the verification data in order to demonstrate compliance with the performance standards.

6.0 AGENCY CONSULTATIONS

This section provides a summary of past or ongoing consultations with appropriate Federal, State, and Tribal fish and wildlife agencies that are relevant to the CDS.

6.1 National Marine Fisheries Service Consultation

The National Marine Fisheries Service (NOAA Fisheries) previously issued a Biological Opinion on August 8, 2002 subsequent to a June 1999 opinion. The Opinion was issued as a result of a request by the Nuclear Regulatory Commission to reinitiate the ESA section 7 consultation for the operation of the Crystal River cooling water intake system(s).

The following endangered and threatened marine mammal, sea turtle, and marine plant species under the jurisdiction of NOAA Fisheries are know to occur in or near the intake system(s):

Common Name	*Scientific Name*
Green sea turtle (E)	*Chelonia mydas*
Kemp's ridley sea turtle (E)	*Lepidochelys kempii*
Hawksbill sea turtle (E)	*Eretmochelys imbricata*
Leatherback sea turtle (E)	*Dermochelys coriacea*
Right whale(E)	*Eubalaena glacialis*
Humpback whale (E)	*Megaptera novaeangliae*
Sperm whale (E)	*Physeter macrocephalus*
Loggerhead sea turtle (T)	*Caretta caretta*
Gulf sturgeon (T)	*Acipenser oxyrinchus desotoi*

The Opinion concluded the following:

1) The NOAA Fisheries "does not believe that there are resident stocks of (whales) in the Gulf of Mexico; therefore, these species are not likely to be adversely affected by the operation of the CWIS; and

2) It is unlikely that the Gulf sturgeon will stray from mud and sand bottoms marine foraging areas in the Gulf to enter the rocky bottomed intake canal and substantially be affected by the CWIS.

The NOAA Fisheries believes that the level of live take sea turtles in the intake canal may reach 75 sea turtles rescued alive from the bar racks annually and 3 lethal takes annually that are causually related to operation of the CWIS. The majority of these turtles are expected to be Kemp's ridleys, followed by green and loggerhead sea turtles. Hawksbills and leatherbacks are expected to make up a very small portion of this (less than 1 percent). This level of anticipated annual take, over the next five years, is not likely to appreciably reduce the survival and recovery of Kemp's ridley, green, loggerhead, hawksbill, or leatherback sea turtles.

The Opinion established terms and conditions governing the reporting thresholds and rescue of sea turtles. These terms and conditions were incorporated into NRC License Amendment No. 190, CR-3 Operating License, Appendix B, Environmental Protection Plan, Section 4.2, Endangered or Threatened Sea Turtles.

6.1.1 FDEP/EPA Consultation

As discussed in Section 4.0, as part of a negotiated permit settlement, Progress Energy agreed to construct and operate a multi-species marine hatchery to mitigate entrainment and impingement as a result of the operation of Units 1, 2, and 3. A copy of the 2000 Annual Report for the Crystal River Mariculture Center is provided in Appendix B.

Additionally, an excerpt from the EPA Fact Sheet, NPDES FL0000159, 1993) follows:

> *In January 1985, FPC submitted its final report of the 316(a) and 316(b) studies which were conducted from June 1983 to August 1984. Results of the studies showed adverse biological effects were associated with the siting and operating of Crystal River Units 1, 2, and 3.... The level of entrainment and impingement demonstrated by the 316(b) study constituted an adverse impact to the biota of Crystal Bay and environs.*
>
> *FPC submitted a proposal for certain mitigation measures which included: creation of marshes, planting of seagrasses, construction and operation of a hatchery, and implementation of a monitoring program. On January 23, 1987, FPC submitted an alternative proposal to extend the existing discharge canal. Additional information regarding that proposal was provided on April 17, 1987, comprising the installation of helper cooling towers (i.e., only a portion of the plant's heated effluent is cooled and returned to the discharge canal where it mixes with the remainder of un-cooled effluent), reduction of intake flow, and hatchery construction and operation. The proposal was modified on March 1, 1988, to include a seagrass monitoring and planting program, and a limitation on plant operations to maintain a three-hour average temperature not to exceed 96.5°F and an instantaneous maximum temperature not to exceed 97.0°F.*
>
> *<u>Regarding EPA's Previous 316(a) determination</u>: The FPC proposal to install helper cooling towers are expected to return the discharge area to the approximate thermal levels in*

existence prior to the operation of Unit 3 (beginning in 1977). It should be noted that the determination also stated that the helper cooling towers would not reduce the present intake flow or the entrainment of aquatic organisms associated with the flow. However, the proposed reduction in plant intake flow during the months of November through April would proportionately reduce entrainment during that period. (Installation of closed cycle cooling towers could reduce entrainment damage by about 85%, however, the increased cost was considered to be wholly disproportionate to the environmental benefits to be derived).

<u>Regarding EPA's Previous 316(b) determination</u>: The intakes of the Crystal River Power Plant are located in an estuarine nursery area. The capacity of Units 1, 2 and 3, based on a once-through cooling mode is 1898 MGD. There are no design features incorporated in the facility which would minimize impact of the large volume of flow and poor location. The location, capacity, and design of Crystal River Units 1, 2, and 3 do not reflect the best technology available for minimizing adverse impacts as required by 316(b) of the CWA. To minimize the adverse impact of the plant intake structures, installation of fine mesh screen and a return mechanism would constitute best available technology. However, such a modification was not considered to be technically feasible, due to the use of the intake canal for coal delivery. Ambient silt from the Gulf of Mexico, which settles in the intake canal is re-suspended by coal barges, would collect on the intake screens (0.5 mm mesh would be necessary to remove fish eggs and larvae). Even if the silt did not clog the screens and render them inoperable, return of the removed solids to Salt Creek (necessary for return of aquatic organisms in Crystal River site) would cause unacceptable siltation in the small creek. No other practical technological modification of the cooling water intake structures is available which would minimize the environmental impacts to an acceptable level. Therefore, it was concluded that a reduction of plant flow by 15 percent during the months of November through April, in conjunction with the construction and operation of a fish hatchery over the remaining operating life of the three units constituted minimization of the environmental impacts of the cooling water intake.

Progress Energy Florida is not currently involved with consultations with federal, state and wildlife agencies, however, the following agencies will be contacted in order to coordinate sampling and field activities and acquire the reference permits and licenses to support the field sampling effort:

<u>Florida Fish and Wildlife Conservation Commission (FFWCC)</u>

The scientific, educational, and exhibitional collection of marine species is authorized by the FFWCC under a Scientific Research Special Activity License (SAL). The FFWCC has the authority to regulate freshwater and marine species within the waters of the State of Florida.

<u>United States Fish and Wildlife Service (USFWS)</u>

The USFWS issues the Native Endangered and Threatened Species Scientific Purposes Permit which allows the permittee to "take" threatened or endangered species. The permit is needed because threatened and endangered species may be harassed, captured, or collected in the course of trawling and pulling plankton nets.

National Marine Fisheries Service (NMFS)

The NMFS may issue a Scientific Purpose Permit for scientific research purposes or to enhance the propagation or survival of species listed as threatened or endangered species. The NMFS regulatory authority only extends to threatened and endangered marine and anadromous species, other threatened and endangered species are handled by the USFWS.

7.0 IMPINGEMENT SAMPLING PLAN

Since the current operational measures can produce an entrainment reduction credit within the performance standard range of 60 to 90 percent reduction from the baseline, an entrainment sampling plan is not being proposed. Also taking into account these operational measures and the credits realized by the Mariculture Center the impingement reduction performance standard is potentially met. However, due to the compliance margin for potential impingement mortality reduction, a sampling plan for impingement monitoring is being proposed to better assess the baseline.

The sampling plan must document all methods and quality assurance/quality control procedures for sampling and data analysis. The sampling and data analysis methods proposed must be appropriate and provide a quantitative survey and include consideration of the methods used in other studies performed in the source waterbody. The sampling plan must include a description of the study area [including the area of influence of the cooling water intake structure(s)], and provide a taxonomic identification of the sampled or evaluated biological assemblages (including all life stages of fish and shellfish).

7.1 Area of Influence

The Hydraulic Zone of Influence (HZI), sometimes called the "area of influence" (40 CFR 122.21(r)(2)(ii)), the "zone of potential involvement" (EPA, 1977) or simply the "zone of influence", is that portion of the source waterbody hydraulically affected by the cooling water intake structure withdrawal of water. The HZI defines the source area for small, weakly motile or planktonic organisms that are possibly influenced by the induced flow. It has little or no meaning for larger organisms that can swim away from the induced flow. Conceptually, the HZI-line is the dividing line between water that is influenced primarily by ambient wind-induced currents and water that is primarily influenced by flow to the intake. Inside the HZI (i.e., on the intake side of the line) the probability of hydraulically influencing weakly motile or planktonic (i.e., non-motile) organisms is high; outside the HZI the probability is less.

The radial distance of the HZI-line within the Gulf of Mexico (i.e., the "R_{HZI}" dimension in the table and in the definition sketch, which is part of Appendix A) is determined by continuity, using the formulas provided in Appendix A. The maximum radial distance to the stagnation point limit or dividing line of the HZI within the Gulf of Mexico (i.e., the "R_{HZI}" dimension in the table and the definition sketch) is determined using the potential flow theory by equating the mean ambient velocity to the velocity that would be induced by the intake in still water. In the case of the Crystal River Energy Complex, flow to the intake canal is influenced by dredge spoils which extend from the intake canal entrance westward and impede water flow from the north. Also, an old dredge spoil island extends southward from the intake canal entrance impeding flow from the east to the intake. As such, most water that is drawn into the intake originates southwest of the intake canal entrance.

The input values and the calculated dimensions of the HZI for the cooling water intake structure (and canal) located on the Gulf of Mexico estuary are shown in Table 3-1. This table provides information for three design intake flow conditions (scenarios) and two mean ambient velocity conditions. The mean depth within the HZI of the Gulf of Mexico estuary is 8 ft in all scenarios (See Figure 3-4 and Table 7-1).

The three scenarios are:

Scenario 1 assumes that all units at the Crystal River Energy Complex are operating and the maximum flow is 4,718 MGD (this value is the baseline intake flow that would be required for the facility to meet the state thermal water quality standards (if the Helper Cooling Towers (HCTs) and Units 4 & 5 cooling towers were not in operation. See Table 4-1).

Scenario 2 assumes that the design intake flow from the operation of Crystal River Units 1, 2 and 3 is 1,898 MGD and is representative of operations annually during May 1 through October 31.

Scenario 3 assumes that the design intake flow from the operation of Crystal River Units 1, 2 and 3 is 1613.2 MGD and incorporates the reduction in flow which occurs annually during November 1 through April 30.

The two mean ambient velocity conditions are:

a) Mean ambient velocity (Vma) = 0.1 feet/second (ft/s)

b) Mean ambient velocity (Vma) = 0.3 feet/second (ft/s)

Scenario 1 is provided as a comparison to Scenarios 2 and 3 to demonstrate the reduced HZI and proportional reduction in entrainment and impingement mortality that occurs as a result of facility operations. Scenario 3 further demonstrates the reduction in entrainment and impingement that occurs during the flow reduction season which contributes to a reduction in entrainment and impingement mortality.

The location of the HZI-line within the Gulf of Mexico will change with varying withdrawal amounts, water levels and changes in bottom elevations (associated with sediment deposition and dredging activities), and therefore, will vary with time. At certain times of the year, during normal operations (May 1 through October 31), the maximum design intake flows will increase, the HZI will increase and the HZI-line will move away from the shoreline ("R_{HZI}" will increase). As discussed above, the maximum R_{HZI} value associated with the maximum design intake flows of Units 1, 2 and 3 (as shown in Table 7-1) is 5,813 ft at a mean ambient velocity of 0.1 ft/s. The minimum R_{HZI} value associated with maximum design intake flows of Units 1, 2 and 3 during flow reduction (Nov 1 through April 30) at a mean ambient velocity of 0.3 ft/s. is 662 ft. Consequently, at a given intake flow condition, inside the HZI-line defined by a mean ambient velocity of 0.3 ft/s, the probability of hydraulically influencing non-motile organisms is high most of the time. Furthermore, at a given intake flow condition, outside the HZI-line defined by a mean ambient velocity of 0.1 ft/s, the probability of hydraulically influencing non-motile organisms is low. Between these boundaries the probability of hydraulically influencing non-motile organisms is moderate and variable.

7.2 Impingement Sampling Plan

The objective of the Crystal River Energy Complex sampling plan is to identify and quantify the current levels of fish and shellfish that are impinged on the traveling screens during normal operation. The 316(b) rule allows the use of various metrics (i.e., representative species [RS] or all species and total count for fish and shellfish or total biomass) to characterize impingement mortality and to measure success in meeting the performance standards. During the impingement mortality characterization stage, the proposed metric will remain undefined in order to provide maximum flexibility during the preliminary data collection effort. The metric(s) that will ultimately be used to characterize impingement mortality will be the one(s) that provides the least data variability and uncertainty and will also be used to demonstrate compliance with the performance standards. This will be particularly important when comparing the baseline data to the verification monitoring data in order to demonstrate compliance with the performance standards. Sampling will be conducted using methods similar to those used in the previous study (Florida Power Corporation, 1985) to allow for data comparison between the previous study and the proposed study.

7.2.1 <u>Sampling Frequency and Methodology</u>

Impingement samples will be collected from the traveling screens biweekly, over a 24-hour period. Sampling days will be selected according to plant operations. Impingement samples will be collected every 6 hours, during the 24-hour period, at each of the three units unless operational restrictions or other circumstances dictate otherwise. Two samples will be collected during the day and two samples will be collected during the night.

Sampling will proceed for a 12 month period. Data will be reviewed periodically (at least quarterly) to determine if modifications should be made to the sampling program or if sufficient data has been collected to support the calculation baseline. Sampling is summarized in Table 7-2 and is scheduled to begin in 2006.

Samples will tentatively be collected at all 3 units (Unit 1, 2, and 3) using 3/8 inch mesh wire baskets which fit into the screen wash collection sumps of each unit. The screens will be operated under normal conditions. The wire baskets will be placed in the sump at the beginning of the sampling period, and at the end of two hours if the screens are not rotating at that time, the screens will be rotated and washed for 30 minutes to collect all fish and shellfish impinged. The fish and shellfish will be separated from the seagrass and other debris for identification. The two hour sample will be extrapolated to represent the number of fish and shellfish impinged during the previous 6-hour period.

Fish and shellfish will be identified in the field to the lowest practicable taxonomic level, sorted (typically by species) and enumerated. If there are two distinct size groups of a particular species (e.g. young-of-the-year and older) then each size group will be treated as a separate species. The batch weight (gm or kg, depending on the number of organisms) will be obtained for each species (or size group). Up to 25 fish or shellfish per species or size group will be individually measured for length (total length, mm) and weight. For sample sizes greater than 25, a subsample of 25 specimens of each species will be selected for measurements that are representative of the size distribution in the sample. At times of the year when samples contain excessive numbers of organisms, a random splitter will be used to obtain an appropriate subsample that can be analyzed within a 1 to 2-hour period.

All data will be recorded on the field data sheets for accurate data transfer into the Crystal River 316(b)-Data Management System (DMS). Additionally, if sample size and debris load permits, the initial condition of the fish will be recorded, e.g. 1) live or 2) dead. Live organisms will be returned to the Gulf and dead organisms will be appropriately disposed. A representative sample will be collected from every sampling event. This sample will consist of one to two specimens of each species caught during the sampling event and will be used confirm the accuracy of field identification. Fish and shellfish that could not be identified in the field will be placed in a plastic sample bag, stored on ice, and taken to the laboratory for taxonomic identification. If necessary, fish and shellfish specimens will be sent to a recognized expert on taxonomic identification. A voucher collection of all species collected will be maintained for identification confirmation.

The following information will be obtained and recorded for each sampling event on field data sheets and transferred to the Crystal River 316(b)-DMS:

- Fish and shellfish taxonomic identification, numbers, measurements and observations;
- Identification of the circulating water pumps in operation at the start and end of the sampling event;
- Volume of circulating water or flow rate (based on the number of circulating water pumps in operation and the pumping rates);
- Identification of the screens in operation during the sampling event and the Units sampled;
- Date and time of day at initiation and completion of the sampling event;
- Intake water temperature, dissolved oxygen, salinity, conductivity, pH, and environmental variables will be measured and recorded at the beginning and end of each 6-hour sample period.
- Names of field staff.

7.2.2 Treatment of Data

The raw data will be summarized by lifestage as discussed below and transformed to allow relative comparisons between species, by week, month, year and unit. To normalize the abundance data to account for differences in sample volumes, the densities of the collected fish and shellfish will be calculated. Sample densities (presented as # per 100 m^3) will be calculated by dividing the number of fish and shellfish collected in each sample by the volume of water filtered through the unit during the collection of that sample and extrapolated to represent the 6-hour sample period.

7.2.3 Calculation of Base Densities

The raw data will be adjusted to account for:

- Lifestage ; and
- Sample volumes.

Each impingement sample represents the accumulation of fish on the screens for that sampling period. The date and hour that each sample is collected will be matched with the hourly intake volume of the appropriate unit. The duration (hours) of each impingement sample will be multiplied by the hourly intake flow rate to estimate the volume of water drawn through that screen and sampled. To calculate the base density of impinged organisms, the number impinged during the sampling period will be divided by the corresponding volume through the unit. This is expressed as:

$$\rho_{i-base} = \frac{N_i}{V_i}$$

where:

$\rho_{i\text{-}base}$ = Base impingement density (# / m^3)

N_i = Number impinged

V_i = Volume of impingement sample (m^3)

Linear interpolation will be used to obtain impingement densities for the unsampled days. These values will be multiplied by the daily flow(s) to obtain estimates for each unsampled day. The daily impingement estimates will be summed over the week to obtain the weekly impingement estimates and over the month to give the monthly impingement estimates. Likewise, the daily impingement estimates will be summed over the year to determine the annual impingement estimates.

7.3 Nearfield Trawl Sampling Plan

To understand biological variability as it relates to screen impingement, nearfield studies will be conducted in the vicinity of the intake canal. These nearfield studies will provide information regarding the relationship between fish and shellfish in the nearfield (within and outside of the HZI) and what is found at the screens.

7.3.1 Sampling Frequency and Methodology

Three stations will be sampled monthly, once during the day and at night. Trawl sampling will be conducted using a 3.05-meter otter trawl constructed of 3.8 cm mesh in the body, 1.3 cm mesh in the cod end, and 6.5 mm mesh nylon cod end liner. The net will be released from a moving boat and dragged on the bottom for five minutes. Replicate trawls may be conducted at each site. Three stations will be sampled and general locations are shown in Figure 7-1. The number of replicate trawls and exact locations of trawls will be determined during the first field event. One station will be located within the HZI and two stations will be located outside the HZI. The data will be used to characterize the fish and shellfish that enter the intake canal and can become impinged by the operation of the CWIS. The information will also be used to understand the inter-annual variability of the data. All locations will be identified by GPS. Sampling will proceed for a 12 month period.

In the field, fish and shellfish will be identified to the lowest practicable taxonomic level, sorted (typically by species) and enumerated. If there are two distinct size groups of a particular species (e.g. young-of-the-year and older) then each size group will be treated as a separate species. Up to 25 fish or shellfish per species or size group will be individually measured for length (total length, mm). For sample sizes greater than 25, 25 fish or shellfish species will be selected for measurements that are representative of the size distribution in the sample. At times of the year when samples contain excessive numbers of organisms a random splitter will be used to obtain an appropriate subsample that can be analyzed within a one to two-hour period.

All data will be recorded in the field data sheets. Additionally, if sample size and debris load permits, the initial condition of the fish and shellfish will be recorded, e.g. 1) live or 2) dead. Live organisms will be returned to the Gulf and dead organisms will be appropriately disposed. A representative sample will be collected from every sampling event. This sample will consist of 1-2 specimens of each species caught during the sampling event and will be used confirm the accuracy of field identification. Fish and shellfish that could not be identified in the field will be placed in a plastic sample bag, stored on ice, and taken to the laboratory for taxonomic identification. If necessary, fish and shellfish specimens will be sent to a recognized expert on taxonomic identification. A voucher collection of all species collected will be maintained for identification confirmation.

For each sample collected, the following information will be obtained and recorded on field data sheets and transferred to the Crystal River 316(b)-DMS.

- Fish and shellfish taxonomic identifications, numbers, measurements and observations;
- Date and time of day at initiation and completion of the sampling event;
- Names of field staff; and
- Water temperature, dissolved oxygen, salinity, conductivity, pH and environmental variables will be measured and recorded for each trawl.

7.3.2 Treatment of Data

The primary use of the trawl catch data will be to describe the spatial and temporal trends in abundance (general community characterization) and to identify the fish (and shellfish) that may enter the intake canal and become impinged.

7.4 Reports

These reports are for internal purposes and will not be submitted to the FDEP except with the CDS unless otherwise requested.

7.4.1 Quarterly Reports

Quarterly (three month period) reports will be prepared which summarize the findings for the first nine months of sampling. The following information will be provided in the reports:

- Number of samples collected. Any deviations from the number scheduled to be collected will be explained;

- A brief summary of sampling conditions, particularly any unusual conditions;
- A summary of all the physical data collected; and
- Impingement and entrainment data processed.

7.4.2 Final Report

A final report will be prepared describing the study procedures and results. Information presented in the report will include:

- Impingement data as weekly, monthly, and annual estimates by numbers and weights for each species;
- Length frequency data in tabular format for each species; and
- Physical and water quality parameter data in tabular/or figure format. Where appropriate, the data will be evaluated in terms of their possible influence on impingement rates.

7.5 Quality Assurance/Quality Control (QA/QC) Plan

The goal of the QA/QC Plan is to ensure that work performance and work products are provided of the highest quality in a cost-effective, scientifically defensible, and timely manner. All deliverables are subject to QA/QC guidelines, checks, and reviews.

The main functions of the QA/QC Plan include:

- Establishing and maintaining a system of appropriate QA documentation and QC records;
- Maintaining this system by routine project QA audits;
- Ensuring that the technical staff assigned to each task are qualified and appropriately trained;
- Ensuring adequate and appropriate technical and peer review of scopes of work and deliverables;
- Ensuring the data recorded in the field and laboratory are correctly entered in electronic files; and
- Investigating quality problems and recommending corrective actions as necessary.

Effective project QA requires appropriate documentation and that QC records are maintained. QC records and documentation may include the following:

- Computer models and programs – properly tested, documented, and dated;
- Laboratory taxonomic identification QA/QC;
- Records of critical calculations or assessment checks;
- Project Deliverable Review Sheet – properly completed and signed for each submittal of a major deliverable;
- Letters of transmittal; and
- Project files, including project reports, memoranda, and correspondence.

The objective of the QA/QC Plan is to assure all methods used both in the field and laboratory will have written standard operating procedures (SOP) to assure consistency and accuracy in sampling procedures and data analysis. SOPs will be prepared prior to commencement of field studies. In addition to QA/QC procedures for sampling, documentation of sample collection, instrument calibration, chain of custody, and provisions for entering into a database will be developed.

Field and laboratory taxonomic identification and measurements will be standardized for sample specimens. Voucher specimens of all species collected will be retained in a voucher collection. These voucher specimens will be retained until the end of the study.

Field data will be recorded on field sheets at the time of sample collection and analysis, and later entered into electronic spreadsheets/database. Electronic data tables and forms will be imported into such programs as Microsoft Access to develop databases. The data will be subject to several QA/QC validation procedures. For example, initial proofs will be conducted for review for completeness and reasonableness of the data entries. Additional checks will be made to ensure that the records entered in electronic files for the sampling programs match data recorded in the field and laboratory and documented on hard copy data sheets. Data validation procedures will be completed at the conclusion of each year of study. Upon discovery of discrepancies or anomalies, the raw data will be compared to the hard copy data sheets and adjusted as appropriate. A final data validation will be completed after all study data have been entered into the database.

8.0 SCHEDULE

By letter of January 24, 2005 the FDEP provided the following schedule for CDS submittal:

- FL 0036366 - Crystal River Units 4 and 5 – CDS Submittal due no later than January 8, 2008

- FL 0000159 – Crystal River Units 1, 2, and 3 – CDS Submittal with timely NPDES permit renewal application

For purposes of compliance with 316(b) requirements, all 5 units are considered as one facility since essentially one intake canal serves all the units. It is therefore anticipated that the CDS submittal for units 4 and 5 will be a straight-forward demonstration that units 4 and 5 have closed-cycle condenser cooling and are therefore in compliance with 316(b) requirements. The CDS submittal for Units 1, 2, and 3 shall be with the permit renewal application which is scheduled for submittal in early November 2009.

GOLDER ASSOCIATES INC.

Manitia Moultrie
Permitting and Compliance Group Leader
and Associate

Stephen Friant
Stephen Friant, Ph.D.
Senior Scientist

Gregory Powell, Ph.D., P.E.
Water Resource Engineer

9.0 REFERENCES

Federal Register, Volume 69, No. 131, July 9, 2004.

Florida Power Corporation, 1985, Crystal River Units 1, 2, and 3, 316 Demonstration Final Report Appendix.

Stone and Webster Engineering/Mote Marine Laboratory, Final Report – Crystal River 316 Studies, January 1985.

U.S. Environmental Protection Agency, Fact Sheet Application for Crystal River Units 1,2,3 -NPDES Permit FL0000159, Draft, July 16,1993.

U. S. Environmental Protection Agency, Technical Development Document for Proposed Section 316(b) Phase II Existing Facilities Rule, EPA 821-R-02-003, April 2002.

U.S. Nuclear Regulatory Commission, Crystal River Unit 3 – Section 7 Consultation Under the Endangered Species Act Regarding Sea Turtles at the Crystal River Energy Complex (TAC NO. MB1562), September, 2002.

Wiegel, Robert L., Oceanographic Engineering, Prentice-Hall, Inc, Englewood Cliffs, N.J., 1964

TABLES

Crystal River Energy Complex
Impingement Mortality and Entrainment Reduction Strategy (based on flow reduction)
Provided By HCTs and Units 4 & 5 CTs

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2–3		Crystal River Energy Complex Impingement Mortality and Entrainment Reduction Strategy (based on flow reduction) Provided By HCTs and Units 4 & 5 CTs										
4												
5			Maximum Dependable Capacity	Design Intake Flow	Annual Capacity Utilization Rate	Baseline Intake Flow Rate	Baseline IM&E Rate	IM & E Reduction Goal	IM & E Survival Rate	Actual IM & E Mortality Rate	IM & E Reduction	Percent Reduction from Baseline
6			MW	MGD	percent	MGD	mass/day	percent	percent	mass/day	mass/day	percent
7		Units 1 & 2	920	919	90.8%	834.452	834	7.5%	0%	772	63	1%
8		Unit 3	838	979	90.8%	888.932	889	7.5%	0%	822	67	1%
9		HCT	0	1008	29.9%	799	799	0%	0%	0	799	17%
10		Units 4&5	1531	98	100.0%	2196	2196	0%	0%	0	2196	47%
11												
12		Totals	3289	3004	na	4718	4718	na	na	1594	3124	66%
13												

Row	Cell	Note
14	Cell	Note
15	E5	Annual average, based on monthly average circulating water flow divided by maximum allowable flow for month. Developed from NPDES reporting data for period 1999 to 2003.
16	G5	This calculation uses the entrainment survival rate assigned for Units 1 & 2 to adjust for entrainment survival through the baseline condensers (i.e.., whatever entrainment survival rate is used for the actual facility is also applied to the hypothetical baseline facility).
17	I5	316(b) final rule requires the applicant to assume zero survival unless site-specific BTA is used.
18	G6	This analysis assumes a constant unit density of biomass or organisms in the source water (e.g., 1 Kg/MG or 1 organism/MG). For this analysis, the actual value is not important because the calculation is concerned with relative values (e.g., percent reduction).
19	H7 & H8	Seasonal Flow Reduction is mandated by NPDES Permit (May 1 through August 31 maximum intake flow allowed for three units is 1897.9 MGD, other times maximum intake flow is 1613.2 MGD).
20	F9	If HCTs were not used, the once-through condenser flow for Units 1,2 & 3 would have to be increased by 2.65 times the Helper Cooling Tower Design Intake Flow to provide the same cooling capacity and meet the state thermal surface water standards (Delta T = 4 Deg F).
21	F10	This is the condenser flow that would be required, if Units 4 & 5 had used once-through cooling systems. It is based on the flow per MW for Units 1, 2, & 3, after accounting for the HCT and the utilization capacity of each unit.

Table 5-1
Crystal River South (Units 1, 2 and 3)
List of Selected Important Organisms (SIO)

Species Name	Common Name
Anchoa mitchilli	Bay anchovy
Ogcocephalus radiatus	Polka-dot batfish
Orthopristis chrysoptera	Pigfish
Lagodon rhomboides	Pinfish
Bairdiella chrysura	Silver perch
Cynoscion nebulosus	Spotted Seatrout
Leiostomus xanthurus	Spot
Sciaenops ocellatus	Red drum
Mugil cephalus	Striped mullet
Lolliguncula brevis	Brief squid
Penaeus duorarum	Pink shrimp
Menippe mercenaria	Stone crab
Callinectes sapidus	Blue Crab

Source: Florida Power Corporation, 1985, Crystal River Units 1, 2 and 3, 316(b) Demonstration Final Report Appendix.

Table 5-2

Crystal River South (Units 1, 2 and 3)
Annual Impingement by Unit for Selected Important Organisms

	UNIT 1		*UNIT 2*		*UNIT 3*		*ALL UNITS*	
	Number	**Weight in kg**	**Number**	**Weight in kg**	**Number**	**Weight in kg**	**Number**	**Weight in kg**
Bay anchovy	7,224	14	16,236	29.8	64,518	114.6	87,978	158.4
Polka dot batfish	11,983	712.6	21,772	1,284.2	40,728	1,978.0	74,483	3,974.8
Pigfish	487	1.2	2,254	5.2	956	9.3	3,697	15.7
Pinfish	1,990	6.5	7,056	39.0	6,189	33.5	15,235	79
Silver perch	960	4.6	4,826	24.1	6,214	35.6	12,000	64.3
Spotted seatrout	257	1.2	940	3.3	1,607	8.2	2,804	12.7
Spot	1,550	2.2	13,800	31.0	12,744	29.5	28,094	62.7
Red drum	0	0.0	0	0.0	8	0.0	8	0.0
Striped mullet	68	4.3	690	24.2	362	5.1	1,120	33.6
Pink shrimp	100,043	449.9	149,387	676.2	391,457	1,952.6	640,887	3,078.7
Blue crab	45,488	350.3	82,554	3,570.4	255,518	9,186.0	383,560	13,106.7
Stone crab	400	16.4	527	11.2	608	34.5	1,535	62.1
Brief squid	4,323	23.5	26,916	90.1	55,715	309.0	86,954	422.6

Source: Florida Power Corporation, 1985, Crystal River Units 1, 2 and 3, 316(b) Demonstration Final Report Appendix.

Table 5-3

Crystal River South (Units 1, 2 and 3)
Total Impingement by Unit

Unit	Number	Weight in kg
1	278,854	2,256.3
2	747,830	10,191.9
3	1,601,800	21,505.6

Source: Florida Power Corporation, 1985, Crystal River Units 1, 2 and 3, 316(b) Demonstration Final Report Appendix.

Table 7 - 1
Crystal River Energy Complex
Hydraulic Zone of Influence

	Variable	Units	Scenarios					
			1a	1b	2a	2b	3a	3b
Intake Flow	Q_i	cfs	7303.5	7303.5	2937	2937	2496	2496
Mean Depth at Radius R_{HZI}	d_r	ft	8	8	8	8	8	8
Arc Angle	θ	deg	90	90	90	90	90	90
Mean Ambient Velocity	V ma	ft/sec	0.1	0.3	0.1	0.3	0.1	0.3
HZI Radius from Intake	R_{HZI}	ft	***5,813***	***1,938***	***2,338***	***779***	***1,987***	***662***

Baseline Intake Flow Rates (Units 1,2,3,4, 5 and HCT) = 4718 MGD (7303.5 cfs)
Daily Maximum Permitted Flow May 1 - Oct. 31 (Units 1,2 & 3) = 1898 MGD (2937 cfs)
Daily Maximum Permitted Flow Nov. 1 - April 30 (Units 1,2 & 3) = 1613.2 MGD (2496 cfs)

Scenario 1a - Baseline intake flow of 7303.5 cfs (4718 MGD) and Ambient Mean Velocity (Vma) = 0.1 ft/sec
Scenario 1b - Baseline intake flow of 7303.5 cfs (4718 MGD) and Ambient Mean Velocity (Vma) = 0.3 ft/sec
Scenario 2a - Maximum Flow of 2937 cfs (1898 MGD) and Ambient Mean Velocity (Vma) = 0.1 ft/sec
Scenario 2b - Maximum Flow of 2937 cfs (1898 MGD) and Ambient Mean Velocity (Vma) = 0.3 ft/sec
Scenario 3a - Maximum Flow of 2496 cfs (1613.2 MGD) and Ambient Mean Velocity (Vma) = 0.1 ft/sec
Scenario 3b - Maximum Flow of 2496 cfs (1613.2 MGD) and Ambient Mean Velocity (Vma) = 0.3 ft/sec

TABLE 7-2

CRYSTAL RIVER ENERGY COMPLEX
SUMMARY OF PROPOSED SAMPLING PLAN

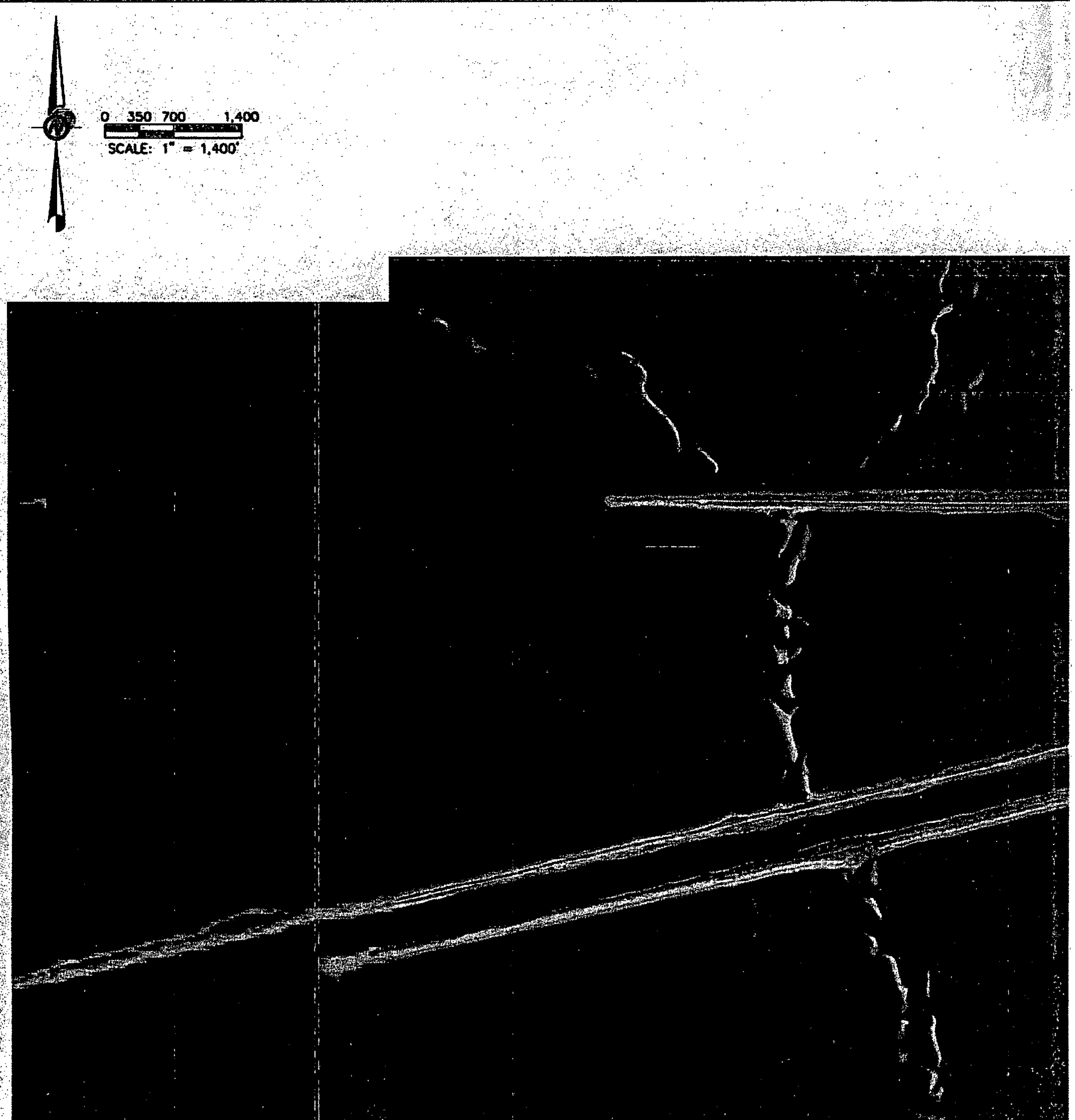
Sample Type	Sample Location(s)	Sampling Gear	Sample Frequency	Sample Summary
Impingement	• Collection sumps of Units 1, 2 and 3	3/8-inch mesh wire basket which fits into the screen wash collection sump of each unit	Bi-weekly (every 6 hours)	4 samples/unit 12 samples/event 26 events
Nearfield	• Crystal River Estuary/Gulf within HZI – just West of intake canal entrance • Crystal River Estuary/Gulf outside of HZI – West of the intake canal entrance, but North of the spoil island • Crystal River Estuary/Gulf outside of HZI (2) – West of intake canal entrance, but South of spoil island (3 locations)	3.05-meter otter trawl (3 trawl/location)	Monthly (day and night)	6 samples/location 3 locations 18 samples/event 12 events

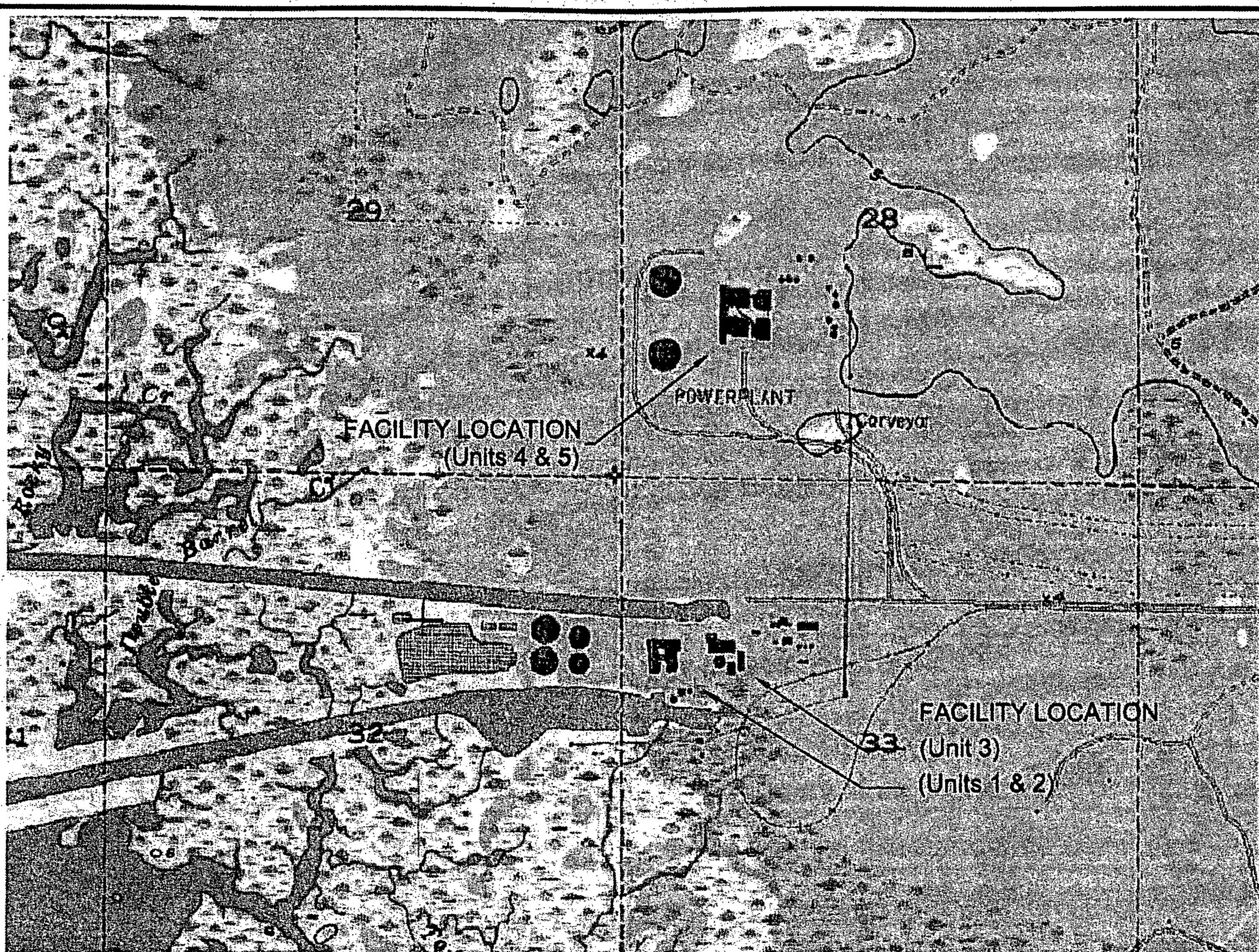
H:\PROJECTS\2004proj\043-9513 Progress Energy 316(b) Services\Draft Reports\PICs\PIC-Crystal River\TABLE CR 7-1.doc

FIGURES

SOURCE: LABINS; AERIAL PHOTO DATE - FEBRUARY 1999.

Golder Associates, Tampa, Florida	SCALE 1" = 1,400'	TITLE		
	DATE 10/05/04	**Crystal River Energy Complex Aerial Photo**		
	DESIGN MM			
	CADD KT			
FILE No. 043-9513 CR Intake.dwg	CHECK			
PROJECT No. 043-9513 / REV. 0	REVIEW	316(b) Compliance Project	FIGURE	3-1


0 350 700 1,400
SCALE: 1" = 1,400'



SOURCE: USGS QUADRANGLE MAP: RED LEVEL, FLORIDA, PHOTOREVISED, 1988.

0 375 750 1,500
SCALE: 1" = 1,500'

Golder Associates
Tampa, Florida

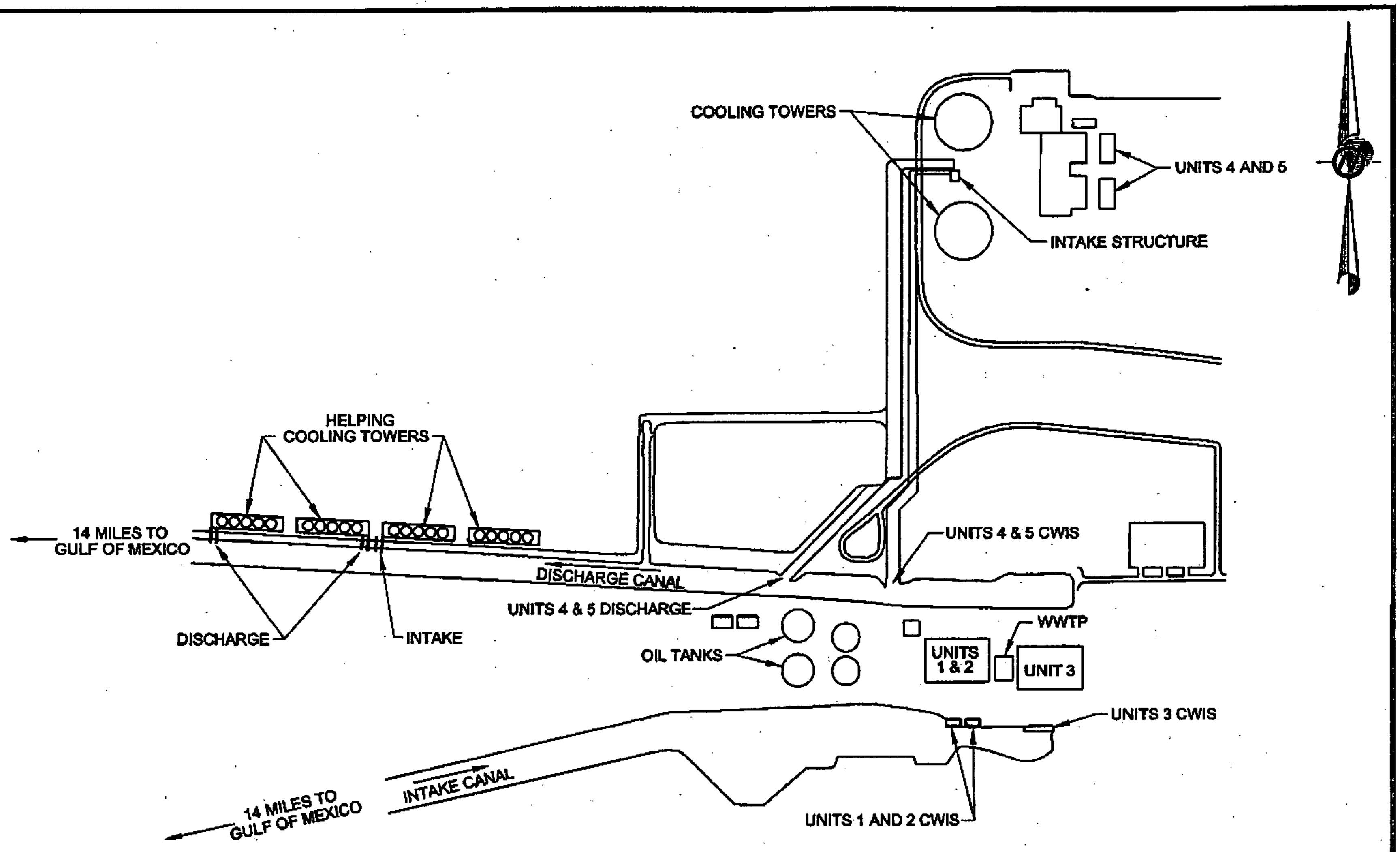
SCALE	1" = 1,500'
DATE	06/07/04
DESIGN	MM
CADD	KT
CHECK	
REVIEW	
FILE No.	043-9513 A001.dwg
PROJECT No.	043-9513
REV.	0

TITLE

Crystal River Energy Complex Topo Map

316(b) Compliance Project

FIGURE **3-2**

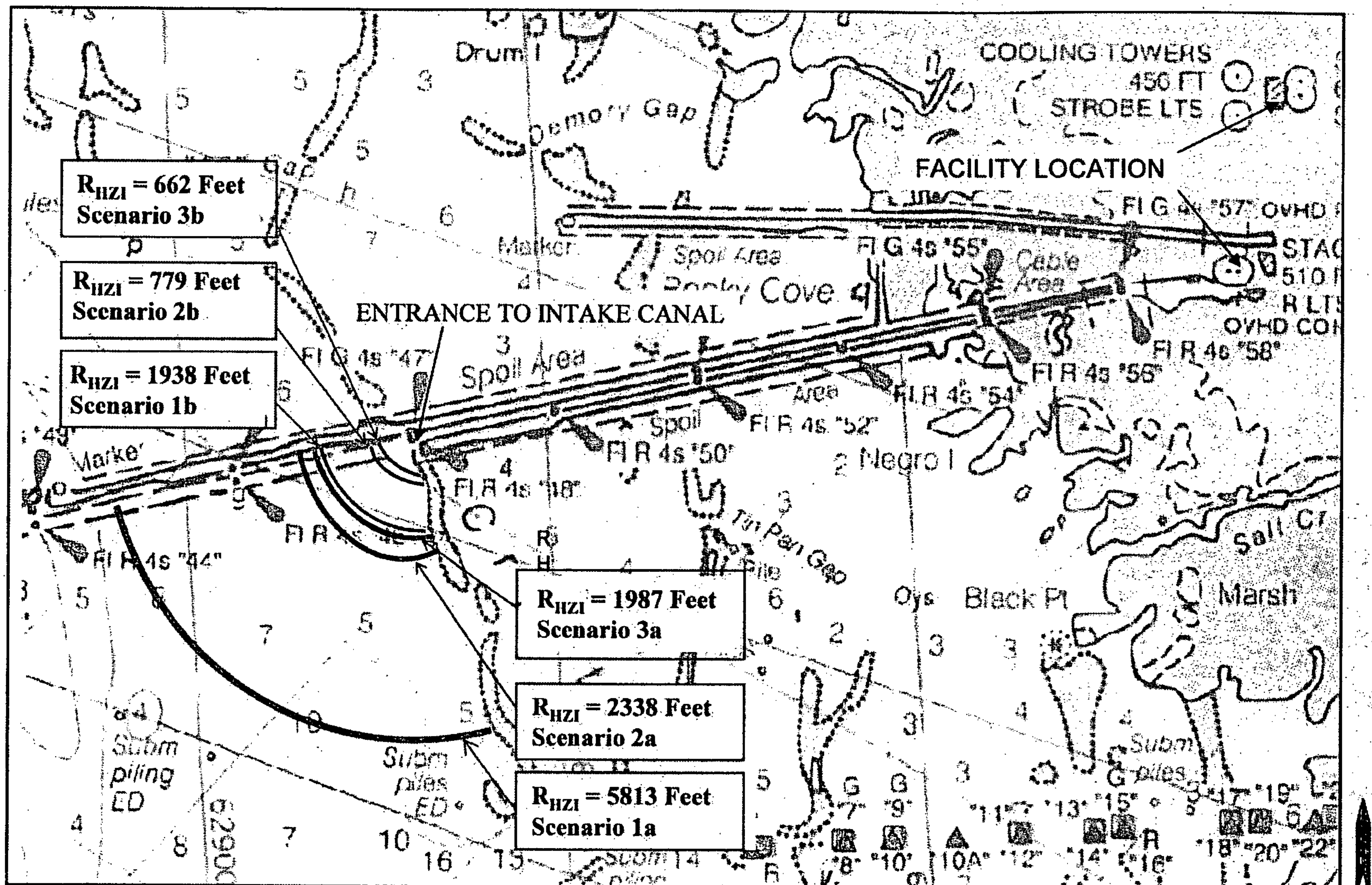


SOURCE: GOLDER, 2004.

0 250 500 1,000
SCALE: 1" = 1,000'

Golder Associates
Tampa, Florida

SCALE	1" = 1,000'	TITLE	**Crystal River Energy Complex CWIS Locations**
DATE	1/5/05		
DESIGN	MM		
CADD	KT		
FILE No. 043-9513 A001 r1.dwg	CHECK	316(b) Compliance Project	FIGURE 3-3
PROJECT No. 043-9513 REV. 0	REVIEW		



MEAN VELOCITY = 0.1 ft/sec
MEAN VELOCITY = 0.3 ft/sec

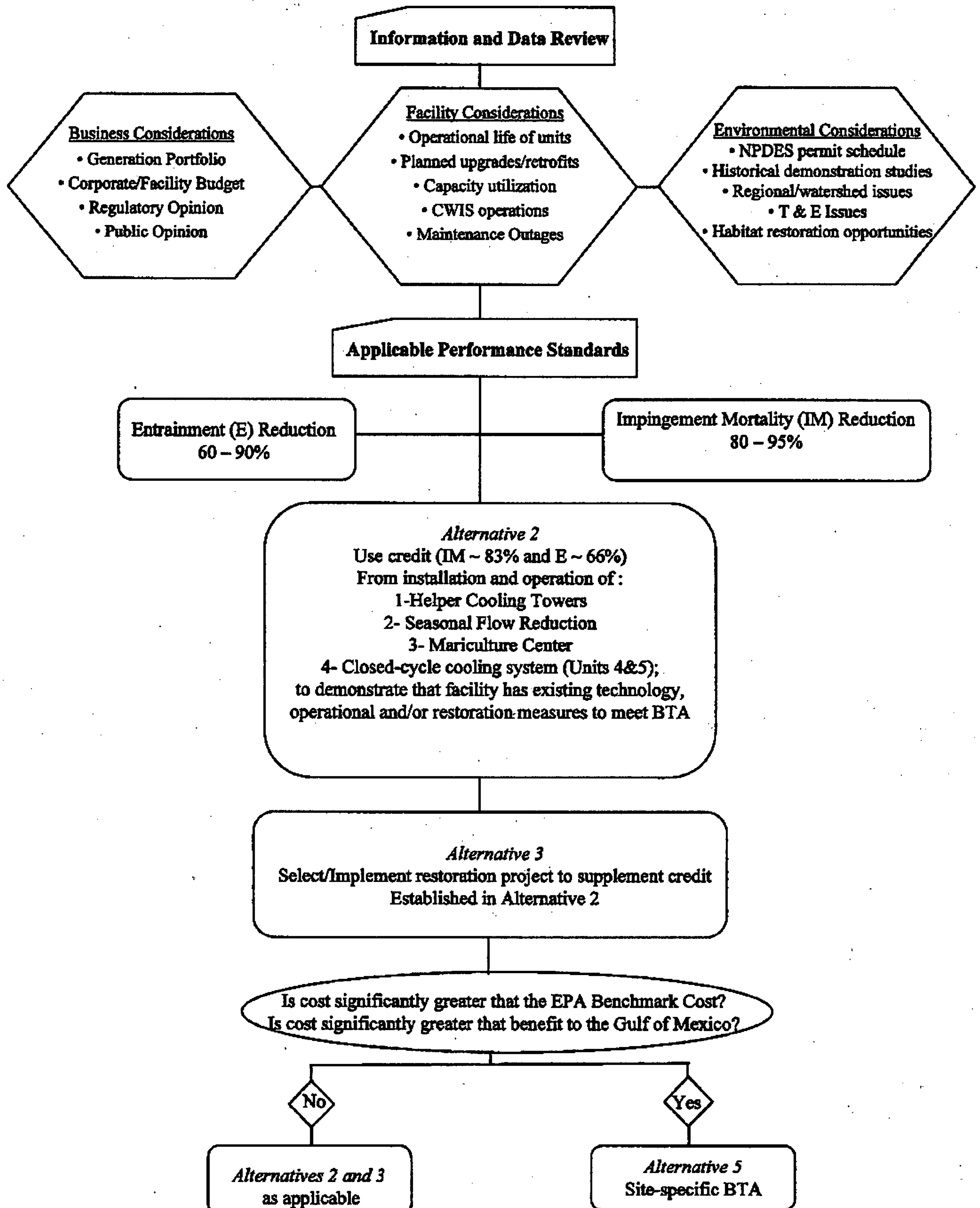
SCALE 1" ≈ 3,000 ft.

CRYSTAL RIVER
Hydraulic Zone of Influence

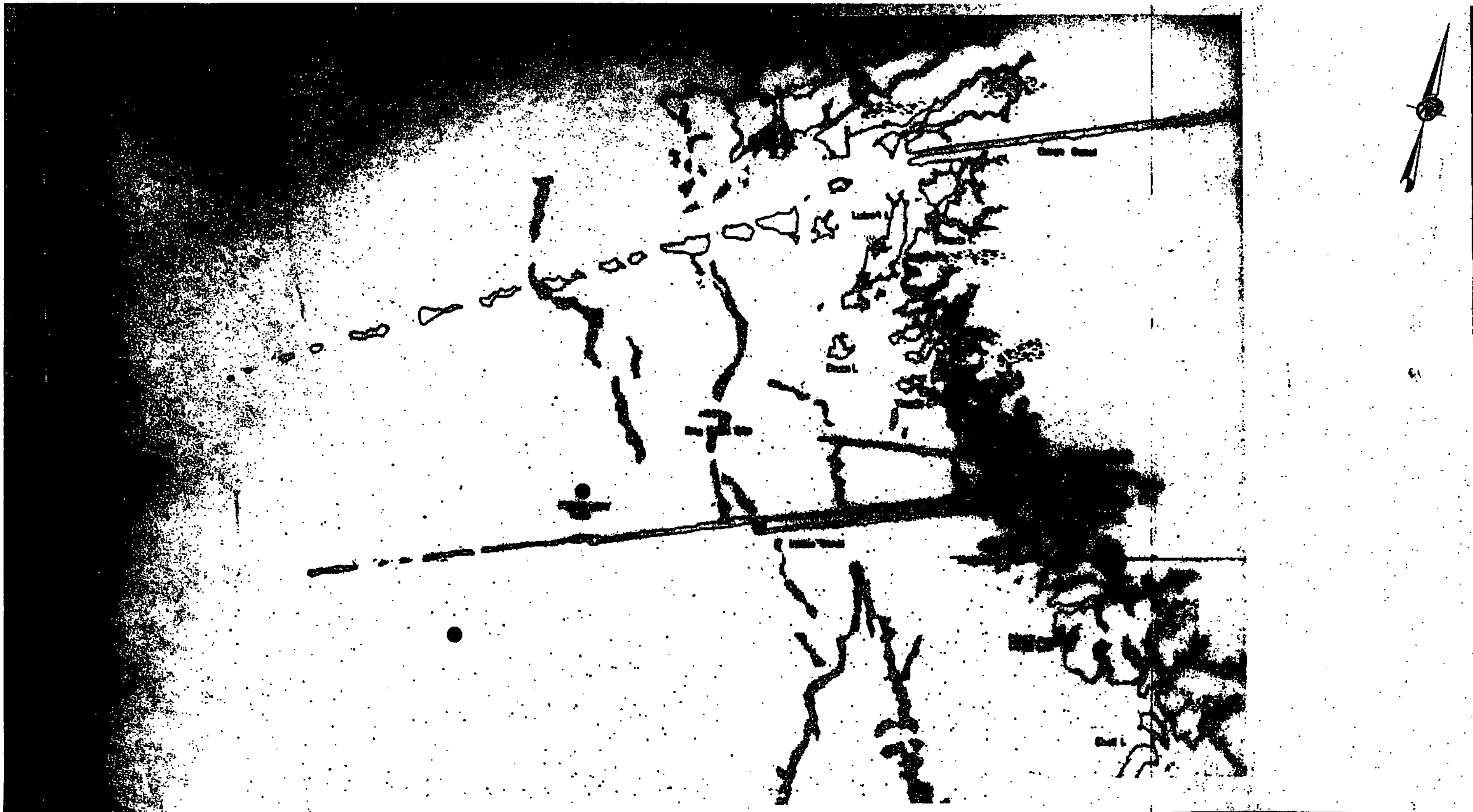
FIGURE 3 - 4

Progress Energy

Figure 4-1
316(b)
Crystal River Energy Complex



Progress Energy



LEGEND

● NEARFIELD SAMPLING LOCATIONS

Golder Associates Tampa, Florida	SCALE AS SHOWN	TITLE	CRYSTAL RIVER SOUTH NEARFIELD TRAWL SAMPLING LOCATIONS
	DATE 11/18/04		
	DESIGN KT		
	CADD KT		
FILE No. 043-8513 A023.dwg	CHECK MM		
PROJECT No. 043-8513 REV. 0	REVIEW MM	31[illegible] Project	FIGURE 7-1

APPENDIX A

HYDRAULIC ZONE OF INFLUENCE IN AN OPEN BODY OF WATER

Appendix A - Hydraulic Zone of Influence in an Open Body of Water

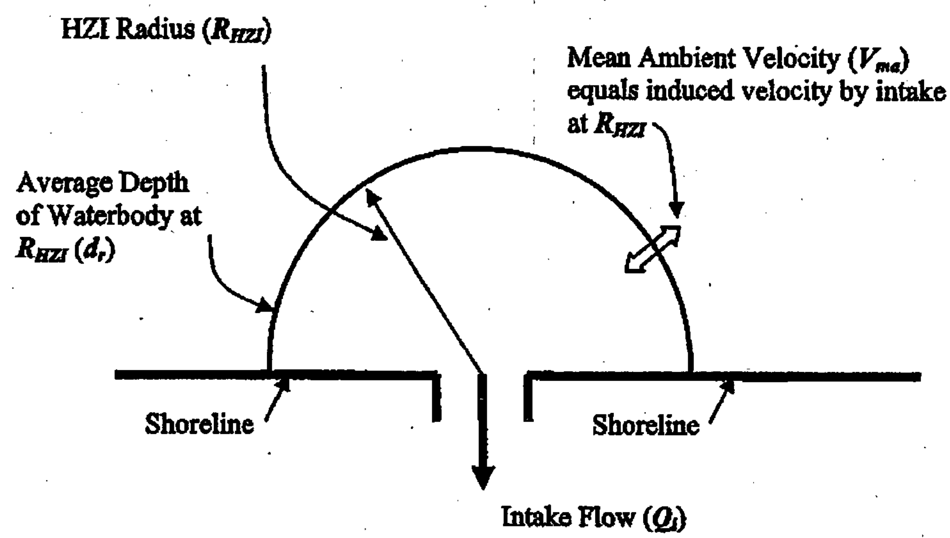


Figure 1: Hydraulic Zone of Influence Definition Sketch

In this scenario, the HZI is defined as the location where the mean ambient wind-induced velocity (V_{ma}) in the source waterbody is equal to the velocity induced by the intake. Beyond this point, the wind-induced currents will dominate the flow patterns. The radial distance from the intake structure at the shoreline to the dividing line that defines the boundary of the Hydraulic Zone of Influence in an open body of water, R_{HZI} (see definition sketch above), can be estimated from continuity using the following formulas:

$$\boxed{Q_i = \pi \times R_{HZI} \times d_r \times V_{ma}} \quad (1)$$

Rearranging terms in equation (1) gives:

$$\boxed{R_{HZI} = (Qi) / (\pi \times d_r \times V_{ma})} \quad (2)$$

Equation (2) assumes radial flow through half the circumference of a circle at radius R_{HZI}. In some instances, radial flow may be limited through only a quarter circumference of a circle. In this case, the R_{HZI} can be estimated using the following formula:

$$\boxed{R_{HZI} = (Qi \times 2) / (\pi \times d_r \times V_{ma})} \quad (3)$$

In other instances, radial flow to an intake may occur through the entire arc of a circle. In this case, R_{HZI} may be estimated using the following formula:

$$\boxed{R_{HZI} = (Qi) / (2 \times \pi \times d_r \times V_{ma})} \quad (4)$$

Wind induced surface drift velocities are typically 2 to 3 percent of the average wind speed (Wiegel, 1964). Therefore, under conditions of a gentle breeze (average wind speed of 8 - 12 miles per hour) the surface drift velocity would be **0.2 ft/s to 0.5 ft/s**. The mean ambient velocity (i.e., the velocity averaged over the depth of the water column) will be less than the surface drift velocity. The relationship will depend on many factors including the speed and duration of the wind, and the depth of the water. In coastal waters, the mean velocity is typically **40 to 60 percent** of the surface drift current. Therefore, 0.1 ft/s to 0.3 ft/s represent reasonable estimates of V_{ma} for wind induce currents. These values are also typical of **net** tidal induced currents (peak flood and ebb tide currents are often much greater). In other words, at a location where the intake induced velocity is less than 0.1 ft/s to 0.3 ft/s, the ambient wind-induced currents and/or tidal drift currents likely will dominate the flow patterns and the "hydraulic influence" of the intake will no longer be significant.

APPENDIX B

AGENCY CORRESPONDENCE

Florida Power
A Progress Energy Company

July 3, 2001

Ms. Wanda Parker-Garvin
Wastewater Facilities Regulation Section
Florida Department of Environmental Protection
Twin Towers Office Building, MS 3550
2600 Blair Stone Road
Tallahassee FL 32399-2400

Dear Ms. Parker-Garvin:

Re: Florida Power
Crystal River Mariculture Center
NPDES Permit No. Floooo159-001-IW1S

In accordance with Part I.G of the permit referenced above, enclosed are two (2) copies of the 2000 Annual Report for the Crystal River Mariculture Center.

If you have any questions or comments concerning this report, please contact me at 727-826-4050.

Sincerely,

Michael L. Shrader
Senior Technical Specialist
Environmental Services Section

MLS
Enclosures
CERTIFIED MAIL

CRYSTAL RIVER MARICULTURE CENTER
2000 ANNUAL REPORT

Introduction

The overall objective of the Mariculture Center is to mitigate fisheries impacts related to the once-through cooling system at Florida Power Corporation's Crystal River Units 1, 2, and 3. Environmental studies identified twelve marine species considered to be affected by entrainment and impingement at those units. As part of a negotiated NPDES permit settlement, Florida Power Corporation (FPC) agreed to construct and operate a multi-species marine hatchery to address these entrainment and impingement concerns.

The Mariculture Center began operation in October 1991. A phased implementation program was developed for the facility to enable restocking of some species and allow time for the development of techniques for others. A Technical Advisory Committee (TAC) has been established to review reports and offer suggestions on Mariculture Center operation and species prioritization.

Facility Status

The TAC recommended red drum, spotted seatrout, pink shrimp, and striped mullet as the first four species for culture. Pigfish has been added as the fifth species for production at the facility. In accordance with our genetic management plan, spawning broodstock are rotated on an average one-year cycle. In support of this policy, field collections are initiated as needed to acquire new broodstock from the wild.

Red Drum

The red drum was selected as the first species to be cultured at the Mariculture Center. A total of 285,366 red drum fingerlings were released during 2000. Over 775,000 red drum fingerlings have been released since the beginning of red drum culture at the Mariculture Center.

Four red drum broodstock were held in one spawn tank for production during the year. An estimated 15,800,000 fertilized eggs were collected from 21 spawns. Seventy eight percent of the fertilized eggs were viable.

A total of ten ponds with red drum fingerlings were harvested during 2000. Seven ponds were stocked for grow-out during the year. Three additional ponds had been stocked at the end of 1999 and were maintained into 2000 for harvest. Following pond harvest, fingerlings were transported to suitable release sites. Release sites were selected based on water quality as well as the size and number of fish to be released. A site with the best conditions for survival of the fingerlings was chosen at the time of harvest.

Red drum fingerlings were also provided to the University of Florida (UF) as part of a challenge-grant partnership between the U.S. Fish & Wildlife Service (USFWS), UF, and FPC. A total of 25,875 fingerlings were released in tidal creeks of the Chassahowitzka National Wildlife Refuge and monitored to determine movements and survival after release.

The red drum fingerlings were released at the following sites:

RELEASE SITE	NUMBERS	AVERAGE SIZE
Gulf Island Beach	50,000	89 mm
Gulf Island Beach	101	228 mm
Ozello	90,000	89 mm
Yankeetown Dump Road	48,390	89 mm
Yankeetown Boat Ramp	42,500	89 mm
Rocky Cove	28,500	101 mm
Chassahowitzka study	25,875	89 mm
TOTAL	285,366	

In support of West Coast red drum production efforts, over 600,000 fertilized red drum eggs were also provided to the Florida Fish & Wildlife Conservation Commission (FWC) Stock Enhancement Research Facility (SERF) facility on Tampa Bay.

Spotted Seatrout

The spotted seatrout was selected as the second species to be cultured at the Mariculture Center. A total of 11,000 seatrout fingerlings were harvested for release during 2000. Over 375,000 seatrout fingerlings have been released since the beginning of seatrout culture at the facility.

Ten broodstock fish were conditioned for spawning in one tank. A total of 4 spawns were recorded during 2000. An estimated 1,850,000 eggs were collected from these spawns, of which a total of 73% of the eggs were viable.

One pond was stocked for harvest. The release site was selected based on water quality as well as the size and number of fish to be released. A site with the best conditions for survival of the fingerlings was chosen at the time of harvest. A total of 11,000 fingerlings with an average length of 127 mm were transported and released at the Yankeetown Dump Road release site.

Pink Shrimp

The pink shrimp was selected as the third species to be cultured at the Mariculture Center. A total of 9,839 pink shrimp were harvested for release during 2000. A total of 56,291 shrimp have been released since the beginning of shrimp culture at the facility.

During 2000, the pink shrimp program utilized broodstock collected by commercial shrimpers based in Ft. Myers, Florida. These suppliers provided 165 broodstock shrimp from three shrimping trips.

The broodstock were maintained in tanks at the facility and monitored for spawning activity. A total of 15 spawns were recorded during the year, from which over 500,000 nauplii were produced. Maintaining the nauplii larvae through successive molts resulted in approximately 75,000 post larvae (PL) remaining for pond stocking. This represents an overall survival rate of 14%. One pond was stocked with 60,000 PLs, and the additional 15,000 PLs were released into Crystal Bay. In November 2000, a total of 9,893 shrimp were harvested and released south of the intake canal as well as further south in the area of Dixie Shores Inlet. Overall post larvae survival in the pond at time of harvest was determined to be 17%.

Striped Mullet

The striped mullet was selected as the fourth species to be cultured at the Mariculture Center. Due to the limited window for the collection of suitable broodstock, and the need to concentrate efforts on other species at that time, no striped mullet spawning, stocking, or harvest was attempted during 2000.

Pigfish

The pigfish has been selected as the fifth species for culture at the Mariculture Center. Pigfish collected from the Crystal River area were initially held for several months in a grow-out pond due to their small size. In August 1999, two spawn tanks were populated with 10 pigfish broodstock each from the pond. A conditioning regime was started during September 1999, with spawning activity noted by March 2000.

An estimated 1,070,000 fertilized eggs were collected from 14 spawns in one of the broodstock tanks. No spawning activity was observed in the other tank. Of these, 75% were viable eggs.

Three ponds were stocked at different levels through different strategies with pigfish larvae, with little success. No larvae survived to fingerling stage. It has subsequently been determined that the pigfish larvae go through a demersal developmental stage. When stocked in a typical grow-out pond prior to this stage, this demersal activity will result in the larvae sinking to the bottom of the pond. Under these conditions the larvae are exposed to lower oxygen conditions and reduced food availability, greatly reducing their survival potential.

Procedures are now being developed whereby the pigfish larvae will be reared in tanks past the demersal stage, then stocked in the grow-out ponds. This should greatly enhance the survival of the larvae.

Live Feed Production

A live feed production program continues at the Mariculture Center. This program is designed to provide adequate concentrations of phtyo- and zooplankton to satisfy production needs

During 2000, phytoplankton was produced using batch culture methods. Stock cultures were obtained from three different sources to ensure viable cultures were available when needed. Culture densities were maintained in tanks at approximately 1 - 2 million cells per milliliter of seawater to meet the nutritional requirements of larval shrimp.

The brine shrimp *Artemia* sp. was produced using batch culture methods. Using standard culture methods, cysts were decapsulated and hatching rates averaged 95%. The newly hatched *Artemia* nauplii were used to meet the nutritional requirements of the larval shrimp.

Staffing

The Mariculture Center staff includes three full-time technical specialists. Environmental Department staff handles management and administrative duties.

Facility Improvements

Facility modifications continue to be made to support program modifications and increase production and efficiency. Standard practices are assessed and modified to increase production yield through more efficient feeding and grow-out. Effluent concerns have been minimized through the utilization of best management practices and improved sampling techniques.

Cooperative Agreements

The Mariculture Center staff continues to maintain professional networks as well as pursue new cooperative opportunities that benefit facility operation.

The Mariculture Center provided red drum fertilized eggs to the FWC Stock Enhancement Research Facility to augment the West Coast broodstock stocks being maintained at that facility.

Red drum fingerlings were provided for a tagging and release demonstration at Inverness Middle School.

Red drum fingerlings were provided for a post-release survival, movement, growth and condition study of hatchery-reared juvenile red drum in the Chassahowitzka National Wildlife Refuge.

The facility continues to support research and business projects that promote the development of mariculture while maintaining protection of our natural resources.

Aquatic Ecology

AQ-17

1. CRS Fact Sheet Amendment
2. NPDES Permit Fact Sheet – CR 1,2,3

SECOND AMENDMENT TO THE FACT SHEET

DATE: April 21, 2005

PERMIT NUMBER: FL0000159

PERMITTEE: Progress Energy Florida (PEF)
Crystal River Units 1,2,&3 Power Plant

The following minor corrections have been made to the proposed permit. None of these corrections alter any of the limitations for discharge to waters of the state.

1. **Typographical Errors in the Proposed Permit:** The Department and the Permittee noted several minor typographical errors which are not itemized below. The Department has corrected these errors, which were non-substantive and did not affect any permit limitations or monitoring requirements.

2. **Permittee Comments**

The Permittee requested the following minor corrections to the permit.

Condition I.A.9: The Permittee pointed out that that pH limitation for Internal Outfall I-0FE in the Draft and Proposed permits (6.5 to 8.5) was incorrect, and should be 6.0 to 9.0, which is the appropriate Technology Based Effluent Limitation (TBEL) pursuant to 40 CFR Part 423.12, and is consistent with the previous permit. The Department concurs, and corrected the limitation in the permit.

Condition I.E.14: The Permittee requested that the Department clarify the requirement regarding the Amertap condenser cleaning system at Unit 3, by stating in the condition that any substantive changes to the cleaning ball devices or retrieval system must be approved by the Department. This would enable the facility to make minor mechanical repairs that do not potentially impact discharge without requiring specific approval. The Department concurs and has revised the condition in the permit.

3. **Department Comment**

Condition I.E.17.: The Department added this condition, which was erroneously omitted from the draft and proposed permits, and authorizes the continued use of biocides and chemical additives that were approved for use in the previous permit renewal and its revisions.. The condition does not authorize the use of any new biocides or chemical additives.

FACT SHEET
FOR
FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
INDUSTRIAL WASTEWATER FACILITY PERMIT

Permit No.: FL0000159 (Major)   Permit Writer: Bala Nori

Application No.: .: FL0000159-009-IW1S/NR

Application Date: June 20, 2003

Additional Information: August 25, 2003; September 24, 2003; and October 8, 2003

1. SYNOPSIS OF APPLICATION

a. Name and Address of Applicant

Progress Energy - Crystal River plant

P.O. Box 14042

St. Petersburg, FL 34428

For:

Progress Energy - Crystal River Plant Units 1,2 and 3

15760 West Powerline Street

Crystal River, Citrus County, FL 34428

b. Type of Facility

Primary SIC code 4911- Electrical Services.

The facility consists of two fossil fired units (Unit 1 and Unit 2) and a nuclear fired unit (Unit 3). The units have a total name plate rating of 1854.8 megawatts (MW). The facility's industrial wastewater discharge consists of non-contact once-through condenser cooling water (OTCW), treated process waste water streams, treated ash sluice water, treated coal pile rainfall runoff, intake screen washwater, and treated non-radioactive wastewater.

The radioactive component of the discharge is regulated by the U.S. Nuclear Regulatory Commission under Atomic Energy Act and not by the U.S. Environmental Protection Agency under the Clean Water Act.

The Crystal River site also includes Units 4 and 5 which discharge under NPDES permit FL0036366 and which are not included in this permit.

The Crystal River generating facility is located adjacent to Crystal Bay, an estuarine nursery area between the town of Crystal River and the Cross Florida Barge Canal. The five operating units were placed into operation in the following sequence: Unit 1, 1966; Unit 2, 1969; Unit 3, 1977; Unit 4, 1982; and Unit 5, 1984.

c. Design Capacity of Facility

Number of Units-3

Total name plate Rating- 1854.8 MW

d. Applicant's Receiving Water

Surface Water Discharge:

An existing discharge of OTCW to the site discharge canal and thence to the Gulf of Mexico, a Class III marine water, via **Outfall D-011,** located approximately at latitude 28° 57'30.8" N, longitude 82° 42' 00.7" W.

An existing discharge of OTCW to the site discharge canal and thence to the Gulf of Mexico, a Class III marine water, via **Outfall D-012,** located approximately at latitude 28° 57'31.2" N, longitude 82° 42' 03.0" W.

An existing discharge of OTCW to the site discharge canal and thence to the Gulf of Mexico, a Class III marine water, via **Outfall D-013,** located approximately at latitude 28° 57'30.9" N, longitude 82° 41' 54.9" W.

An existing discharge of intake screen washwater to the site discharge canal and thence to the Gulf of Mexico, a Class III marine water, via **Outfall D-091,** located approximately at latitude 28° 57'24 " N, longitude 82°42 '0.4" W.

An existing discharge of intake screen washwater to the site discharge canal thence to the Gulf of Mexico, a Class III marine water, via **Outfall D-092,** located approximately at latitude 28° 57'23.2 " N, longitude 82°42 '01.9" W.

An existing discharge of intake screen washwater to the site discharge canal and thence to the Gulf of Mexico, a Class III marine water, via **Outfall D-093,** located approximately at latitude 28° 57'21.6 " N, longitude 82°41 '56.2" W.

An existing discharge from the ash pond to the site discharge canal and thence to the Gulf of Mexico, a Class III marine water, via **Outfall D-0C1,** located approximately at latitude 28° 57'34.7 " N, longitude 82°42 '28.8" W.

An existing discharge from the ash pond to the site discharge canal and thence to the Gulf of Mexico, a Class III marine water, via **Outfall D-0C2,** located approximately at latitude 28° 57'31.0 " N, longitude 82°42 '32.4" W.

An existing discharge of Nuclear Services and Decay Heat Seawater System effluent to the site discharge canal and thence to the Gulf of Mexico, a Class III marine water, via **Outfall D-00F,** located approximately at latitude 28° 57'31.2 " N, longitude 82°41 '55.4" W.

An existing discharge of Coal Pile runoff (Units 1 and 2) to an adjacent salt marsh, a Class III marine water, via **Outfall D-0H,** located approximately at latitude 28° 57' 08.8 " N, longitude 82°42 '12.7" W.

Existing discharges of OTCW from the Helper Cooling Tower system to the site discharge canal and thence to the Gulf of Mexico, a Class III marine water, via **Outfalls D-071 and D-072,** located approximately at latitudes 28° 57' 34.5 " N, longitude 82° 42 '32.0" W, and 28° 57'35.8 " N, longitude 82° 42 '48.5" W, respectively.

An existing discharge of intake screen washwater to the site discharge canal and thence to the Gulf of Mexico, a Class III marine water, via **Outfall D-094,** located approximately at latitude 28° 57'34.4 " N, longitude 82°42 '30.4" W.

Internal Discharges

An existing discharge from internal outfall **I-FG** Regeneration Waste Neutralization Tank to **Outfall D-00F.**

An existing discharge from internal outfall **I-FE** Laundry and Shower Sump Tank effluent to **Outfall D-00F.**

Stormwater Discharges

Existing discharges of stormwater from plant areas to the site discharge canal and thence to the Gulf of Mexico via **Outfalls D-100, D-200, D-300, D-400, D-500.** and **D-600.**

See attached map(s) for the location(s) of effluent disposal and land application sites.

e. Description of Wastewater Treatment Facilities

A seasonal maximum daily flow of 1,898 MGD is required for the cooling systems of the two coal-fired units (Units 1 and 2) and the nuclear unit (Unit 3). Approximately 50 percent of this total flow is used by Unit 3. Water for the once-through mode of operation is obtained from the site intake canal extending westerly into Crystal Bay. Separating the site intake canal from the discharge area of the facility is a seven-mile long dike which flanks the northern side of the site intake canal. This canal also serves barge traffic for the delivery of coal to the plant site. Heated water from the condenser cooling systems is returned to Crystal Bay via the site discharge canal on the northern side of the seven-mile dike.

OTCW for Units 1,2, and 3 (Outfalls D-011, D-012, and D-013) and nuclear auxiliary cooling water (Outfall D-00F) is passed through bar racks and intake screens, chlorinated (except Outfall D-00F), and discharged to the site discharge canal. Water used to sluice ash from Units 1 and 2 is treated in ash ponds (outfalls 004 and 009) with effluent to the site discharge canal. Rainfall runoff from the coal pile is treated in a pond which infrequently discharges to an adjacent salt marsh (Outfall D-0H). Debris from the site intake canal is disposed in an onsite landfill and intake screen washwater is returned to the site intake canal (Outfalls D-091, D-092, and D-093). Evaporation/percolation ponds are provided for all other wastes from Units 1 and 2. Non-radioactive wastes and radiation waste from Unit 3 (I-FE and I-FG) are treated by neutralization, settling, filtration and /or oil removal and discharged to outfall D-00F or onsite percolation ponds.
Mechanical draft, once- through helper cooling towers are located adjacent to site discharge canal. and provide additional cooling with discharge via Outfalls D-071 and D-072 back to the site discharge canal.

The radioactive component of this discharge is regulated by the U.S. Nuclear Regulatory Commission under the Atomic Energy Act and not by the U.S. Environmental Protection Agency under the Clean Water Act.

f. Description of Discharges (as reported by applicant)

Monitoring Group D-011: Discharge of OTCW from Unit 1. Pollutants which are present in significant quantities or which are subject to effluent limitations are as follows:

EFFLUENT CHARACTERISTIC	DAILY AVERAGE	DAILY MAXIMUM
Flow, MGD		446.44
Temperature, °F (Summer)		96.44
Temperature, ^{0} F (winter)		95.72
pH (Standard Units)		7.9-8.3
Total Arsenic		<0.010
Total Cyanide		<0.010
Total Residual Oxidants, mg/l	Not Detectable	Not Detectable

Monitoring Group D-012: Discharge of OTCW from Unit 2. Pollutants which are present in significant quantities or which are subject to effluent limitations are as follows:

EFFLUENT CHARACTERISTIC	DAILY AVERAGE	DAILY MAXIMUM
Flow, MGD		472.32
Temperature, °F (Summer)		96.44
Temperature, ^{0} F (winter)		95.72
pH (Standard Units)		7.9-8.3
Total Arsenic, mg/l		<0.010
Total Cyanide, mg/l		<0.010
Total Residual Oxidants, mg/l	Not Detectable	Not Detectable

Monitoring Group D-013: Discharge of OTCW from Unit 3. Pollutants which are present in significant quantities or which are subject to effluent limitations are as follows:

EFFLUENT CHARACTERISTIC	DAILY AVERAGE	DAILY MAXIMUM
Flow, MGD		985
Temperature, °F (Summer)		96.44
Temperature, ^{0} F (winter)		95.72
pH (Standard Units)		7.9-8.3
Total Arsenic		<0.010
Total Cyanide		<0.010
Total Residual Oxidants, mg/l	Not Detectable	Not Detectable

Monitoring Group D-00F. Nuclear Services and Decay Heat Seawater System effluent. Pollutants which are present in significant quantities or which are subject to effluent limitations are as follows

EFFLUENT CHARACTERISTIC	DAILY AVERAGE	DAILY MAXIMUM
Flow, MGD		34.5
Temperature, °F (Summer)		
Temperature, ^{0} F (winter)		71.96
pH (Standard Units)		7.9-8.3
Total Arsenic		<0.010
Total Copper		<0.010
Total Iron		<0.050
Total Ammonia		0.056
Total Cyanide		<0.010
Total Residual Oxidants, mg/l	Not Detectable	Not Detectable

Monitoring Groups D-091, D-092, and D-093. Plant Intake. Pollutants which are present in significant quantities or which are subject to effluent limitations are as follows

Effluent Characteristic	Daily Average	Daily Maximum
Flow, MGD		3.11
Temperature, °F (Summer)		
Temperature, ^{0} F (winter)		55.94
pH (Standard Units)		7.9-8.3
Total Iron		0.090
Total Arsenic		<0.010
Total Residual Oxidants, mg/l	Not Detectable	Not Detectable

Monitoring Group I-0FE. Laundry and Shower Sump Tank. Pollutants which are present in significant quantities or which are subject to effluent limitations are as follows

Effluent Characteristic	Daily Average	Daily Maximum
Flow, MGD		0.015
Temperature, °F (Summer)		86
Temperature, °F (winter)		
pH (Standard Units)		6-6.8
Total Copper, mg/l		<0.020
Total Iron, mg/l		0.56
Oil and Grease, mg/l		<5.0
Total Suspended Solids, mg/l		<5.0
Total Residual Oxidants, mg/l	Not Detectable	Not Detectable

Monitoring Group I-0FG. Regeneration Waste Neutralization Tank effluent. Pollutants which are present in significant quantities or which are subject to effluent limitations are as follows

Effluent Characteristic	Daily Average	Daily Maximum
Flow, MGD		0.5
Temperature, °F (Summer)		74.12
Temperature, °F (winter)		
pH (Standard Units)		8.1-9.0
Oil and Grease, mg/l		<5.0
Total Suspended Solids, mg/l		8.4
Total Copper, mg/l		0.69
Total Iron, mg/l		2.6
Total Residual Oxidants, mg/l	Not Detectable	Not Detectable

2. PROPOSED EFFLUENT WATER LIMITATIONS

a. Discharge from **Outfalls D-011, D012, D-013** shall be limited and monitored by the Applicant as specified below

Parameters	Effluent Limitations		
	Daily Maximum	Daily Average	Daily Minimum
Flow (MGD)	See item 2.2, below	Report	--
Chlorination Duration, Minutes	See item 2.3, below	Report	--
Oxidants, Total Residual, mg/l	0.01, see item 3	Report	--
Temperature (DEG F) intake	Report	Report	--
Temperature (DEG F) Discharge	See item 2.4	Report	--
Temp. Diff between Intake and Discharge	Report	Report	--

b. Combined OTCW discharge from Units 1, 2 and 3 shall not exceed 1,897.9 MGD during the period May 1st through October 31st of each year, nor 1,613.2 MGD during the remainder of the year.

c. Discharge of TRO from the condenser of each unit shall not exceed a maximum of 60 minutes in any calendar day, except as follows. . TRO may be discharged from one or more individual condensers via outfalls D-011, D-012, D-013, provided that TRO discharge concentration is monitored continuously by recorder(s). Additionally, the maximum instantaneous TRO concentration at each outfall (D-011, D-012, or D-013) shall not exceed 0.01 mg/l.

d. Limitations and monitoring requirements for total residual oxidants (TRO) and time of TRO discharge for outfalls D-011, D- 012 and/or D-013 are not applicable for any calendar day in which chlorine is not added to the outfall effluent.

e. The discharge temperature monitored at Sampling Point EFF-3D shall not exceed 96.5^{0}F for a period of more than three consecutive hours.

f. Intake screen washwater may be discharged from outfalls D-091, D-092 and D-093 without limitation or monitoring requirements.

g. Discharge from **Internal Outfall I-0FE to Outfall D-00F** shall be limited and monitored by the Applicant as specified below

Parameters	Effluent Limitations		
	Daily Average	Daily Maximum	Daily Minimum
Flow (MGD)	Report	Report	--
Oil and Grease (MG/L)	15.0	20.0	--
Solids, Total Suspended (MG/L)	30.0	100.0	--
pH (SU)		8.5	6.5

h. The discharge of metal cleaning wastes through this outfall is not authorized

i. Discharge from **Outfall D-0C1 and D-0C2** shall be limited and monitored by the Applicant as specified below

Parameters	Effluent Limitations		
	Daily Average	Daily Maximum	Daily Minimum
Flow (MGD)	Report	Report	--
Oil and Grease (MG/L)	-------	5.0	--
Solids, Total Suspended (MG/L)	30.0	100.0	--
Arsenic, Total Recoverable (UG/L)	--	50.0	--
Cadmium, Total Recoverable (UG/L)	--	5.0	--
Chromium, Total Recoverable (UG/L)	--	50.0	--
Copper, Total Recoverable (UG/L)	--	2.9	--
Lead, Total Recoverable (UG/L)	--	5.6	--
Iron, Total Recoverable (MG/L)	--	300.0	--
Mercury, Total Recoverable (UG/L)	--	0.025	--
Nickel, Total Recoverable (UG/L)	--	100.0	--
pH Standard units (Background)	--	8.5	6.5
pH standard units	--	8.5	6.5
Zinc , Total Recoverable (UG/L)	--	8.5	6.5

j. Limitations and monitoring are required only when the ash pond is discharging via D-0C1 and/or the wastewater pond system is discharging via D-0C2.

k. Discharge from **Outfall D-00F**, which includes discharge from **Outfall I-FE** and **Outfall I-FG** shall be limited and monitored by the Applicant as specified below:

Parameters	Effluent Limitations		
	Daily Average	Daily Maximum	Daily Minimum
Flow (MGD)	Report	Report	--
Oil and Grease mg/l (CD and ECST)	20	15	--

Parameters	Effluent Limitations		
	Daily Average	Daily Maximum	Daily Minimum
Oil and Grease mg/l (CD and ECST)	5.0 See item l	---	--
Flow (ESCT) MGD	Report	Report	--
Flow (CD System) MGD	Report	Report	--
Total Suspended Solids , mg/l	Report	Report	--
Total Suspended Solids (D-00F), mg/l	100. 0 See item m	30.0	--
Total recoverable Copper, ug/l	3.7 See item n	Report	--
Total recoverable Iron , ug/l	300.0 See item n	Report	--
Total Iron, lbs/ MG of metal cleaning waste generated	Report	8.345, See item n	--
Total Copper, lbs/MG of metal cleaning waste generated	Report	8.345, See item n	--
Hydrazine, mg/l	-----	Report, See item o and 16	-----
Hydrazine , mg/l	-----	0.341, See items o and p	------
Hydroquinone, mg/l	-----	Report, See items o and p	
Hydroquinone, mg/l	-----	0.12, See items o and p	
Total Ammonia (as N), mg/l		Report, See item o and p	
Total Ammonia (as N), mg/l		0.047, See item o and p	
Morpholine, mg/l		Report, See items o and p	
Morpholine, mg/l		1.78, See item p	
pH, mg/l			
pH, mg/l	8.5		6.5
Spectrus CT 1300	See Permit		
Total Suspended solids , mg/l	Report		Report
Turbidity, NTU (at D-00F)	Report		Report
Turbidity, NTU (at POD)	Report		Report
Spectrus CT 1300 (mg/l)	Report		Report
Whole Effluent Toxicity	See Permit		

l. Monitoring requirements oil & grease are only applicable if the discharge from I-FE and I-FG , exceeds the daily maximum limitation of 20.0 mg/l or a minimal dilution rate of 4 to 1 is not achieved.

m. Monitoring requirements for total suspended solids are only applicable if the discharge from I-FE and I-FG, the CD discharge or the ECST (following adequate mixing) exceeds the daily maximum limitation of 100.0 mg/l or a minimal dilution rate of 4 to 1 is not achieved.

n. Limitations and monitoring requirements for mass loading of copper and iron, and concentration of total recoverable copper and total recoverable iron are applicable only on any calendar day when metal cleaning waste is discharged in the effluent from I-FG the Evaporator Condensate Storage Tank and/or the Condensate System.

o. Limitations apply to discharge from outfall I-FG, ECST and the Condensate System. One grab sample shall be taken from any batch potentially containing ≥1.0 mg/l of hydrazine, based on the operator's knowledge of the process. The measured concentrations of hydrazine, hydroquinone, ammonia and morpholine shall be reported monthly on the DMR. The following calculation shall be used to evaluate the concentrations of hydroquinone, hydrazine, ammonia and morpholine at D-00F:

$$\text{D-00F concentration (mg/l)} = \frac{\text{(measured concentration (mg/l)) (discharge flow)*}}{\text{flow to D-00F}}$$

p. * The calculation applies to any batch with >1.0 mg/l of hydrazine.

q. Conditions for the evaluation and use of the biocide Spectrus CT1300 are detailed in the permit and were developed through the Department's Toxicity Coordinator.

r. Discharge from **Internal Outfall I-0FG** to **Outfall D-00F** shall be limited and monitored by the Applicant as specified below:

Parameters	Effluent Limitations		
	Daily Average	Daily Maximum	Daily Minimum
Flow (MGD)	Report	Report	--
Copper, Total Recoverable (UG/L)	--	8.345	--
Iron, Total Recoverable (MG/L)	--	8.345	--
Total Suspended Solids	30	100	
pH (SU)	--	--9.0	6.0
Oil and Grease (MG/L)	15.0	20.0	--

s. Discharge from **Outfall D-00H** shall be limited and monitored by the Applicant as specified below:

Parameters	Effluent Limitations		
	Daily Average	Daily Maximum	Daily Minimum
Flow (MGD)	-----	Report	--
Solids, Total Suspended , mg/l	--	50.0, See item. 20	--
Arsenic, Total Recoverable, ug/l		50.0	--
Cadmium, Total Recoverable, ug/l		9.3	--
Chromium, Total Recoverable (ug/l)	--		--
Copper, Total Recoverable (ug/l)	--	3.7	--
Iron, Total Recoverable (ug/l)	--	300	--
Lead, Total Recoverable (ug/l)	--	5.6	--
Mercury, Total Recoverable (ug/l)	--	0.0125	--
Nickel, Total Recoverable (ug/l)	--	3 8.3	--
Selenium, Total Recoverable (ug/l)		71.0	--
Zinc, Total Recoverable (ug/l)		86.0	--
Vanadium, Total Recoverable (ppm)		Report	--
pH		8.5	6.5
pH		8.5	6.5

t. Applicable to any flow up to the flow resulting from a 10-year, 24 hour (10Y24H) rainfall event. The treatment system shall be capable of containing a 10Y24H rainfall event.

u. Discharge from **Outfall D-**071 and **D-072** shall be limited and monitored by the Applicant as specified below:

Parameters	Effluent Limitations		
	Daily Maximum	Daily Average	Daily Minimum
Flow (MGD)	Report	Report	--
Oxidants, Total Residual (MG/L)	0.01, See 22	Report	--
TRO-Discharge Time (MIN/DAY)	60.0, See 23	--	--
pH (SU)	--	--	--
pH (SU)	--	--	--

v. Limitations and monitoring requirements for TRO and time of TRO discharge for outfall D-071 and Outfall D-072 are not applicable for any calendar day when chlorine is not added.

w. Discharge of TRO from either cooling water outfall shall not exceed a maximum of 60 minutes in any calendar day.

x. Cooling towers shall be operated as necessary to ensure that the discharge temperature at Sampling Location EFF-3D does not exceed 96.5 F as a three-hour rolling average.

y. Discharge from **Outfall D-00H** shall be limited and monitored by the Applicant as specified below:

z. Monitoring requirements for Outfalls D-071 and D-072 are only applicable during periods of discharge .

aa. Discharge from D-094 is authorized without limitation or monitoring requirements.

bb. Discharge from **Outfall D-600** shall be limited and monitored by the Applicant as specified below

Parameters	Effluent Limitations		
	Daily Maximum	Daily Average	Daily Minimum
Flow (MGD)	monthly, when discharging	--	--
Total Recoverable Iron, ug/l	monthly, when discharging	--	--

cc. Stormwater from Diked Petroleum Storage or Handling Area

Permittee is authorized to discharge stormwater from diked petroleum storage or handling areas, provided the following conditions are met:

1. The facility shall have a valid SPCC Plan pursuant to 40 CFR 112.
2. In draining the diked area, a portable oil skimmer or similar device or absorbent material shall be used to remove oil and grease (as indicated by the presence of a sheen) immediately prior to draining.
3. Monitoring records shall be maintained in the form of a log and shall contain the following information, as a minimum:
   A.) Date and time of discharge,
   B.) Estimated volume of discharge,
   C.) Initials of person making visual inspection and authorizing discharge, and
   D.) Observed conditions of storm water discharged.
4. There shall be no discharge of floating solids or visible foam in other than trace amounts and no discharge of a visible oil sheen at any time.

dd. As specified above, sampling for the storm water discharge shall be conducted once per discharge event. The permittee may complete the discharge without additional sampling unless another storm event occurs prior to the completion of the on – going discharge in which case the permittee shall conduct another round of sampling.

ee. There shall be no discharge of floating solids or visible foam in other than trace amounts.

ff. The discharge shall not cause a visible sheen on the receiving water.

3. BASIS FOR EFFLUENT LIMITS AND MONITORING REQUIREMENTS

The following tables provide the basis for Part I. A. provisions.

a. Outfall D-00F (includes discharge from Outfalls I-FE and I-FG)

Parameter	Units	Limit	Statistical Basis	Rationale
Flow (MGD)	MGD	Report Report	Daily Average Daily Maximum	Based on BPJ and are consistent with 308(a) of the CWA.
Solids, Total Suspended (MG/L)	MG/L	Report Report	Daily Average Daily Maximum	Based on BPJ and consistent with 308(a) of the CWA.
Turbidity (NTU)	NTU	Report Report	Daily Average Daily Maximum	Based on BPJ and consistent with 308(a) of the CWA.
Turbidity (NTU)	NTU	Report Report	Daily Maximum Daily Average	Based on BPJ and consistent with 308(a) of the CWA.
Flow [ECST] (MGD)	MGD	Report Report	Daily Maximum Daily Average	Based on BPJ and consistent with 308(a) of the CWA.
Flow [CD System] (MGD)	MGD	Report Report	Daily Maximum Daily Average	Based on BPJ and 308(a) of the CWA.
Solids, Total Suspended [CD and ECST] (MG/L)	MG/L	30.0 100.0	Daily Average Daily Maximum	40 CFR Section 423.12 (b)(5)
Solids, Total Suspended [D-00F] (MG/L)	MG/L	30.0 100.0	Daily Average Daily Maximum	Based on BPJ and consistent with 308(a) of the CWA.
Copper, Total Recoverable (UG/L)	UG/L	2.9 Report	Daily Maximum Daily Average	Based on Rule 62-302.530 F.A.C. Based on BPJ and consistent with 308(a) of the CWA.
Iron, Total Recoverable (UG/L)	UG/L	300.0 Report	Daily Maximum Daily Average	Based on Rule 62-302.530F.A.C. Based on BPJ and consistent with 308(a) of the cWA.
Hydrazine	MG/L	Report	Daily Maximum	See note below.(a)

Parameter	Units	Limit	Statistical Basis	Rationale
Hydrazine	MG/L	0.341	Daily Average	See note below (a)
Hydroquinone	MG/L	Report	Daily Maximum	See note below (a)
Hydroquinone	MG/L	0.12	Daily Average	See note below (a)
Total Ammonia (as N)	MG/L	Report	Daily Maximum	See note below (a)
Total Ammonia (as N)	MG/L	0.047	Daily Average	See note below (a)
Morpholine	MG/L	Report	Daily Maximum	See note below (a)
Morpholine	MG/L	1.78	Daily Average	See note below (a)
Oil and Grease (MG/L)	MG/L	15 20	Daily Average Daily Maximum	40CFR Section 423.12(b)(3) for low volume wastes.
Oil and Grease (MG/L)	MG/L	5.0	Daily Maximum	Based on Rule 62-302.530 F.A.C.
Spectrus				See note below (b)

The following were used as the basis of the permit limitations/conditions:

A. FAC refers to various portions of the Florida Administrative Code.

The effective dates of FAC Rule Chapters cited in the permit and in this document are as follows:

Chapter	Effective Date
62-4	05-01-03
62-302	05-15-02
62-520	12-09-96
62-522	08-27-01
62-550	05-28-03
62-620	08-25-03
62-650	12-26-96
62-660	10-01-98

B. FS refers to various portions of the Florida Statutes

C. CFR refers to various portions of the Code of Federal Regulations, Title 40

D. BPJ refers to Best Professional Judgment

b. Outfall D-00H

Parameter	Units	Limit	Statistical Basis	Rationale
Flow (MGD)	MGD	Report	Daily Maximum	BPJ and 308(a) of CWA.
Solids, Total Suspended (MG/L)	MG/L	50	Daily Maximum	BPJ and 308(a) of CWA.
Arsenic, Total Recoverable (UG/L)	UG/L	50	Daily Maximum	Rule 62-302.530 F.A.C.
Cadmium, Total Recoverable (UG/L)	UG/L	9.30	Daily Maximum	BPJ and 308(a) of CWA.
Chromium, Total Recoverable (UG/L)	UG/L	50	Daily Maximum	Rule 62-302.530 F.A.C.
Copper, Total Recoverable (UG/L)	UG/L	3.7	Daily Maximum	Rule 62-302.530.F.A.C.
Iron, Total Recoverable (MG/L)	MG/L	300.0	Daily Maximum	BPJ and 308(a) of CWA.
Lead, Total Recoverable (UG/L)	UG/L	5.60	Daily Maximum	Rule 62-302.530 F.A.C..
Mercury, Total Recoverable (UG/L)	UG/L	0.0125	Daily Maximum	Rule 62-302.530 F.A.C.
Nickel, Total Recoverable	UG/L	8.30	Daily Maximum	Rule 62-302.530 F.A.C.
Selenium, Total Recoverable (UG/L)	UG/L	71.0	Daily Maximum	Rule 62-302.530 F.A.C..
Zinc, Total Recoverable (UG/L)	UG/L	86.0	Daily Maximum	Rule 62-302.530.F.A.C..
Vanadium, Total Recoverable (PPM)	PPM	Report	Daily Maximum	BPJ and 308(a) of CWA.

Parameter	Units	Limit	Statistical Basis	Rationale

The following were used as the basis of the permit limitations/conditions:

A. FAC refers to various portions of the Florida Administrative Code.

The effective dates of FAC Rule Chapters cited in the permit and in this document are as follows:

Chapter	Effective Date
62-4	05-01-03
62-302	05-15-02
62-520	12-09-96
62-522	08-27-01
62-550	05-28-03
62-620	08-25-03
62-650	12-26-96
62-660	10-01-98

B. FS refers to various portions of the Florida Statutes

C. CFR refers to various portions of the Code of Federal Regulations, Title 40

D. BPJ refers to Best Professional Judgment

c. Outfall D-011, D-012 and D-013

Parameter	Units	Limit	Statistical Basis	Rationale
Flow (MGD)	MGD	See permit	Daily Maximum Daily Average	Based on BPJ and consistent with 308(a) of the CWA.
Chlorination Duration (MINUTES)	MINUTES	See permit	Daily Maximum	40 CFR Section 423.12 (6).
Oxidants, Total Residual (MG/L)	MG/L	Report 0.01	Daily Average Daily Maximum	Based on BPJ and consistent with 308 (a) of the CWA. Rule.62-302.530(19) F.A.C.
Temperature (F), Water [Intake] (DEG.F)	DEG.F	See permit	Daily Average Daily Maximum	Based on Rule 62-302.520(1) F.A.C.
Temperature (F), Water [Discharge] (DEG.F)	DEG.F	See permit	Daily Average Daily Maximum	Based on Rule 62-302.520(1) F.A.C.
Temp. Diff. Between Intake and Discharge (DEG.F)	DEG.F	See permit	Daily Average Daily Maximum	Based on BPJ and consistent wit 308(a) of the CWA.

The following were used as the basis of the permit limitations/conditions:

A. FAC refers to various portions of the Florida Administrative Code.

The effective dates of FAC Rule Chapters cited in the permit and in this document are as follows:

Chapter	Effective Date
62-4	05-01-03
62-302	05-15-02
62-520	12-09-96
62-522	08-27-01
62-550	05-28-03
62-620	08-25-03
62-650	12-26-96
62-660	10-01-98

B. FS refers to various portions of the Florida Statutes

C. CFR refers to various portions of the Code of Federal Regulations, Title 40

Parameter	Units	Limit	Statistical Basis	Rationale
D. BPJ refers to Best Professional Judgment				

d. Outfall D-071 and D-072

Parameter	Units	Limit	Statistical Basis	Rationale
Flow (MGD)	MGD	Report Report	Daily Average Daily Maximum	BPJ and 308(a) of CWA.
Oxidants, Total Residual (MG/L)	MG/L	Report 0.01	Daily Average Daily Maximum	Based on Rule 62-302.500(19 F.A.C.
TRO-Discharge Time (MIN/DAY)	MIN/DAY	60.0	Daily Maximum	423.12(b)(7) for cooling tower blowdown.

e. Outfall D-0C1 and D-0C2

Parameter	Units	Limit	Statistical Basis	Rationale
Flow (MGD)	MGD	Report Report	Daily Maximum Daily Average	Based on BPJ and 308 (a) of clean water Act.
Oil and Grease (MG/L)	MG/L	------- 5.0	Daily Average Daily Maximum	Based on Rule 62-302.530 F.A.C.
Solids, Total Suspended (MG/L)	MG/L	100.0 30.0	Daily Maximum Daily Average	Based on 40CFR Section 423.12(b)(5).
Arsenic, Total Recoverable (UG/L)	UG/L	50.0	Daily Maximum	Based on Rule 62-302.530 F.A.C.
Cadmium, Total Recoverable (UG/L)	UG/L	5.0	Daily Maximum	Based on Rule 62-302.530 F.A.C..
Chromium, Total Recoverable (UG/L)	UG/L	50.0	Daily Maximum	Based on Rule 62-302.530 F.A.C.
Copper, Total Recoverable (UG/L)	UG/L	2.9	Daily Maximum	Based on Rule 62-302.530 F.A.C.
Lead, Total Recoverable (UG/L)	UG/L	5.6	Daily Maximum	Based on Rule 62-302.530 F.A.C.
Iron, Total Recoverable (MG/L)	MG/L	300.0	Daily Maximum	Based on Rule 62-302.530 F.A.C.
Mercury, Total Recoverable (UG/L)	UG/L	0.025	Daily Maximum	Based on Rule 62-302.530 F.A.C.
Nickel, Total Recoverable (UG/L)	UG/L	100.0	Daily Maximum	Based on rule 62-302.530 F.A.C.
Selenium, Total Recoverable (UG/L)	UG/L	25.0	Daily Maximum	Based on Rule 62-302.530 F.A.C.
Zinc, Total Recoverable (UG/L)	UG/L	86 86.0	Daily Maximum	Based on Rule 62-302.530 F.A.C.

The following were used as the basis of the permit limitations/conditions:

A. FAC refers to various portions of the Florida Administrative Code.

The effective dates of FAC Rule Chapters cited in the permit and in this document are as follows:

Chapter	Effective Date
62-4	05-01-03
62-302	05-15-02
62-520	12-09-96
62-522	08-27-01
62-550	05-28-03
62-620	08-25-03
62-650	12-26-96

Parameter	Units	Limit	Statistical Basis	Rationale
62-660 10-01-98 B. FS refers to various portions of the Florida Statutes C. CFR refers to various portions of the Code of Federal Regulations, Title 40 D. BPJ refers to Best Professional Judgment				

f. Internal Outfall I-0FE

Parameter	Units	Limit	Statistical Basis	Rationale
Flow (MGD)	MGD	Report Report	Daily Maximum Daily Average	BPJ and 308 (a) of CWA.
Oil and Grease (MG/L)	MG/L	20.0 15.0	Daily Maximum Daily Average	40CFR Section 423.12(b)(5) for low volume wastes.
Solids, Total Suspended (MG/L)	MG/L	100.0 30.0	Daily Maximum Daily Average	40CFR Section 423.12(b)(5) for low volume wastes.
pH (SU)	SU	6.0-8.5	Min- Max.	40CFR Section 423.12(b)

g. Internal Outfall I-0FG

Parameter	Units	Limit	Statistical Basis	Rationale
Flow (MGD)	MGD	Report Report	Daily Maximum Daily Average	BPJ and 308(a) of CWA.
Copper, Total Recoverable (UG/L)	UG/L	8.345	Daily Maximum	Based on 40CFR Section 423.12(b)(5) for metal cleaning wastes.
Iron, Total Recoverable (MG/L)	MG/L	8.345	Daily Maximum	Based on 40CFR Section 423.12(b)(5) for metal cleaning wastes
PH	S.U.	6.0 – 9.0	Min-Max.	Based on 40CFR Section 423.12(b)(5) for metal cleaning wastes
Oil and Grease (MG/L)	MG/L	20.0 15.0	Daily Maximum Daily Average	Based on 40CFRSection 423.12(b)(5) for metal cleaning wastes,

h. Reasonable Assurance: The facility has provided reasonable assurance that the discharge will not adversely affect the designated use of receiving water. Available Fifth Year Inspection Reports and monitoring data have been evaluated in accordance with the Department's reasonable assurance procedures to ensure that no limits other than those included in this permit are needed to maintain Florida water quality standards.

i. WQBEL Considerations: A Level 1 WQBEL was performed for the discharge, and is embodied in this Fact Sheet. Based on historical discharge monitoring data, effluent characterization, and available inspection report information, the current effluent limitations are protective of water quality and meet water quality standards.

j. Impaired Waters Considerations: The receiving water is within Water Body Identification (WBID) 1339, which encompasses Gulf of Mexico west of U.S. Hwy 98. WBID 1339 is listed in the 2002 303(d) verified list for "biology," indicating issues within the overall WBID of potential impairment to biological integrity. Monitoring locations for 303(d)-related studies typically are selected to avoid direct influence by point-source discharges, in order to evaluate ambient conditions in the waterbody. Moreover, existing biological monitoring studies (including 316(a) studies) designed to evaluate impacts of discharge from the Crystal River power complex, provide reasonable assurance that the facility does not have a significant adverse impact.

k. Thermal Considerations: In addition to the thermal variance under Section 316(a) CWA (see Item 5, below), the facility is subject to the requirements of Rule 62-302.520(1)(a), F.A.C. which states that facilities with heated water discharges existing on July 1, 1972 " shall not increase the temperature of the RBW (receiving body of water) so as to cause substantial damage or harm to the aquatic life or vegetation therein or interfere with beneficial uses assigned to the RBW." Rule 62-302.520(1)(b), F.A.C. further requires that the discharger conduct verification monitoring. In this context, the permit requires the permittee to prepare a Plan of Study (POS) for Department review and approval to evaluate the compliance noted in the previous paragraph. The POS may propose to incorporate existing data from various sources and include new data, as needed.

l. 316(b) Considerations: Section 316(b) CWA requires that the location, design, construction, and capacity of a cooling water intake structure reflect the best technology available for minimizing environmental impacts. In 1988, EPA determined that a reduction of plant flow by 15 percent during the months of November through April, in conjunction with the construction and operation of a fish hatchery over the remaining operating life of the three units constituted minimization of the environmental impacts of the cooling water intake.

4. GROUND WATER MONITORING REQUIREMENTS

This Section is not applicable to this facility.

5. REQUESTED VARIANCES OR ALTERNATIVES TO REQUIRED STANDARDS

In the application for this renewal permit, the Permittee requested that the Department continue the facility's thermal variance under Section 316(a) of the CWA as part of permit renewal. The Department reviewed the information provided in the application with reference to the USEPA Region IV guidance document titled, "316 Guidance for Permit Reissuance," dated August 11, 1988 and has determined that the continuation of the 316(a) variance is appropriate for this facility. There have been no physical or operational changes since the last permit renewal and no changes are expected in the upcoming permit cycle that will materially change the plant cooling water system intake and discharge characteristics. Recent biological and thermal impact studies conducted by the facility as indicated above support the Department's determination to renew the 316(a) variance for the facility.

Section 316(a) of the CWA allows alternative thermal limitations after demonstration that the WQS limitations are more stringent than necessary to assure the protection and propagation of a balanced, indigenous population of fish and wildlife in, and on, the receiving waters. These limits were established for the facility by EPA 1988, require the plant to maintain a discharge temperature with a three-hour rolling average not to exceed 96.5°F and an instantaneous maximum temperature not to exceed 97.0°F.

6. COMPLIANCE SCHEDULE AND EFFECTIVE DATE OF PROPOSED EFFLUENT LIMITS

This section is not applicable to this facility

7. DISCUSSION OF PREVIOUS PERMIT EFFLUENT LIMITS

The wastewater permit for this facility, FL0000159, which expired on January 7, 2004 and is administratively continued contains the same effluent limits as described in Item 2 of this fact sheet. Effluent limits and monitoring requirements for this renewal permit have not been changed from the previous permit .

8. NEW OR EXPANDED DISCHARGES TO SURFACE WATERS; ANTIDEGRADATION INFORMATION

This facility does not have a new or expanded discharge.

9. EFFECTS OF SURFACE WATER DISCHARGE ON THREATENED OR ENDANGERED SPECIES

The Permittee shall continue compliance with the Manatee Protection Plan approved by the Department on May 15, 2002. The Department does not anticipate adverse impacts on threatened or endangered species as a result of permit issuance.

10. FDEP CONTACT

Additional information concerning the permit may be obtained during normal business hours from:

Allen Hubbard, P.E.
Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, FL 32399-2400
Telephone Number: (850) 245-8589
Fax Number: (850) 245-8669

11. THE ADMINISTRATIVE RECORD

The administrative record including application, draft permit, fact sheet, public notice (after release), comments received and additional information is available by writing FDEP or for public inspection during normal business hours at the location specified in item 10. Copies will be provided at a minimal charge per page.

12. PROPOSED SCHEDULE FOR PERMIT ISSUANCE

Draft permit to Applicant and EPA	July 30, 2004
Applicant to Publish Public Notice	August 8, 2004
Beginning of Proposed Public Comment Period	August 8, 2004
Ending of Proposed Public Comment Period	September 7, 2004
Proposed Permit to EPA	September 12, 2004
Notice of Agency Action	September 12, 2004
Proposed Issuance Date of Permit	September 12, 2004

13. PROCEDURES FOR THE FORMULATION OF FINAL DETERMINATIONS

a. Public Comment Period

The Department of Environmental Protection proposes to issue a wastewater facility permit to this applicant subject to the aforementioned effluent limitations and conditions. This decision is tentative and open to comment from the public.

Interested persons are invited to submit written comments regarding permit issuance on the draft permit limitations and conditions to the following address:

Department of Environmental Protection
2600 Blair Stone Road
Mail Station 3545
Tallahassee, FL 32399-2400
Attn.: Vincent Seibold, P.E.

All comments received within 30 days following the date of public notice, pursuant to Rule 62-620.550, F.A.C., will be considered in the formulation of the final decision with regard to permit issuance.

Any interested person may submit written comments on the Department's proposed permitting decision or may submit a written request for a public meeting to the address specified above, in accordance with Rule 62-620.555, F.A.C. The comments or request for a public meeting must contain the information set forth below and must be received in the above named District office of the Department within 30 days of receipt or publication of the public notice. Failure to submit comments or request a public meeting within this time period will constitute a waiver of any right such person may have to submit comments or request a public meeting under Rule 62-620.555, F.A.C.

The comments or request for a public meeting shall contain the following information:

(1) The commenter's name, address and telephone number, the applicant's name and address, the Department Permit File Number and the county in which the project is proposed;

(2) A statement of how and when notice of the draft permit was received;

(3) A description of any changes the commenter proposes for the draft permit;

(4) A full explanation of the factual and legal reasons for each proposed change to the draft permit; and

(5) A request that a public meeting be scheduled (if applicable) including a statement of the nature of the issues proposed to be raised at the meeting.

b. Public Meeting

The Department will hold a public meeting if there is a significant degree of public interest in the draft permit or if it determines that useful information and data may be obtained thereby. Public notice of such a meeting shall be published by the applicant at least 30 days prior to the meeting.

If a public meeting is scheduled the public comment period is extended until the close of the public meeting. If a public meeting is held any person may submit oral or written statements and data at the meeting on the Department's proposed action.

c. Issuance of the Permit

The Department will make its decision regarding permit issuance after consideration of all written comments, including comments from the United States Environmental Protection Agency on surface water discharge (NPDES) aspects of the draft or proposed permit; the requirements of Chapter 403, F.S., and appropriate rules; and, if a public meeting is held, after consideration of all comments, statements and data presented at the public meeting. The Department will respond to all significant comments in writing. The Department's response to significant comments will be included in the administrative record of the permit and will be available for public inspection at the above named District office of the Department.

Unless a request for a administrative hearing, or an extension of time to file a petition for an administrative hearing, pursuant to Chapter 120, F.S., as indicated in d. below, is granted, the Department will take final agency action by issuing the permit or denying the permit application. If an administrative hearing is convened, final agency action will be based on the outcome of the hearing.

d. Administrative Hearing

A person whose substantial interests are affected by the Department's proposed permitting decision has the opportunity to petition for an administrative proceeding (hearing) to challenge the Department's decision in accordance with Section 120.57, F.S.

An administrative hearing is an evidentiary proceeding in which evidence is presented by testimony and exhibits before an independent hearing officer. The result of an administrative hearing is the issuance of the hearing officer's recommended order to the Department, including the hearing officers findings of fact, based on the evidence presented at the hearing. The Department will issue a final order, granting or denying the permit, based on the hearing officer's recommended order.

The petition for an administrative hearing must contain the information set forth below and must be filed (received) in the Office of General Counsel of the Department at 3900 Commonwealth Boulevard, Tallahassee, Florida 32399-3000, within 14 days of publication of notice of agency action or within 14 days of personal receipt of notice of agency action, whichever occurs first. The petitioner is to mail a copy of the petition to the applicant at the time of filing. Failure to file a petition within this time period will constitute a waiver of any right such person may have to request an administrative determination (hearing) under section 120.57, F.S. The petition is to contain the following information:

(1) The name, address and telephone number of each petitioner, the applicant's name and address, the Department Permit File Number and the county in which the project is proposed;

(2) A statement of how and when each petitioner received notice of the Department's action or proposed action;

(3) A statement of how each petitioner's substantial interests are affected by the Department's action or proposed action;

(4) A statement of the material facts which the petitioner contends warrant reversal or modification of the Department's action or proposed action;

(5) A statement of which rules or statutes petitioner contends require reversal or modification of the Department's action or proposed action; and

(6) A statement of the relief sought by the petitioner, stating precisely the action the petitioner wants the Department to take with respect to the Department's action or proposed action.

If a petition is filed, the administrative hearing process is designed to formulate agency action. Accordingly, the Department's final action may be different from the position taken by it in the notice of agency action. Persons whose substantial interests will be affected by any decision of the Department on the application have the right to petition to become a party to the proceeding, regardless of their agreement or disagreement with the Department's proposed action indicated in the notice of agency action.

Aquatic Ecology

AQ-18

1. FWC (Undated)
2. Progress Energy (2004)
3. Progress Energy (2005)

FWC Undated

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION
FISH AND WILDLIFE RESEARCH INSTITUTE

Crystal River Mariculture Center

The Crystal River Mariculture Center is located at Progress Energy Complex in Crystal River near the Gulf of Mexico.

A BRIEF HISTORY

Progress Energy Florida, a subsidiary of Progress Energy, provides electricity and related services to more than 1.5 million customers in Florida. The company is headquartered in St. Petersburg, Fla., and serves a territory encompassing over 20,000 square miles including the cities of St. Petersburg, Clearwater, as well as the central Florida area surrounding Orlando. It operates five electric generating units at the Crystal River energy complex. Progress Energy is required to have several environmental permits for the operation of these electric generating units. In response to Environmental Protection Agency (EPA) permit requirements, environmental studies were conducted at the Crystal River Power Station from June 1983 through January 1985. Data collected as part of these studies projected annual impact levels on local fishery populations. The annual impact levels for some species were determined to be unacceptable by EPA.

The concept of a multi-species marine hatchery to mitigate fisheries impacts at Crystal River was developed as an innovative, cost-effective, alternative to conventional engineering solutions. The Crystal River Mariculture Center became part of a negotiated settlement, which included flow reduction at two of the power plants and helper cooling towers to further decrease the discharge water temperature.

The Crystal River Mariculture Center began operation October 1991. The facility will remain operative as long as water from the Gulf of Mexico is utilized for condenser cooling at the power plants. Besides offsetting the impacts of power plant operation, the facility will provide educational opportunities for students, teachers, and the general public. New and innovative aquaculture techniques will be developed as different species are selected for culture. Since the Mariculture Center represents an innovative, cost-effective, solution for the mitigation of environmental impacts, the success of this program is of interest to the utility industry as well as federal and state agencies.

WHAT IS MARICULTURE?

Mariculture is defined as the farming and husbandry of marine plants or animals. Mariculture can be used to replenish natural populations which have been depleted by natural or man-made effects. The Mariculture Center will integrate technology associated with fisheries science, marine ecology, and the aquaculture industry to develop effective production techniques for the cultivation of several marine species.

The Mariculture Center complex includes a two-story, 8100-square-foot, hatchery building and eight one-acre ponds. The hatchery building includes a water-chemistry laboratory, four spawn rooms, an incubation tank room, aglae production room, and administrative spaces. Each spawn room contains two 12-foot-diameter tanks connected to a recirculation system. This system includes a biological filter for the removal of dissolved waste products, a sand filter for removal of particulate matter, and an ultraviolet filter for pathogenic bacteria control. The grow-out ponds are located a short distance from the hatchery building. Each one-acre pond has a synthetic rubber liner to prevent water leakage, will hold approximately one million gallons of seawater when filled to capacity, and is three to five feet deep. At one end of the pond is a specially designed concrete drain structure, complete with adjustable drain valve, two removable screens, and a sump area where fish are collected during harvest.

WHAT SPECIES ARE CULTURED?

This is a multi-species marine hatchery with twelve species targeted for culture. Species were selected based on abundance and the estimated level of impact from the power plant. Since not all species are cultured simultaneously, species are listed by priority based on level of impact, ecological importance, and availability of aquaculture information. The first species selected for culture are redfish, spotted seatrout, and pink shrimp. It is important to note that the selection of species is not restricted to recreationally and commercially important fishes but also includes forage fish such as pinfish and pigfish, unique non-game species such as batfish, and certain crustaceans such as stone crab and blue crab.

Each species requires a unique set of conditions under which it will spawn and the newly hatched larvae will grow. For some of the species, those conditions are well documented; for others, they have yet to be discovered. One of the biggest challenges at the Mariculture Center will be to meet the special conditions required by the individual species.

WHICH FISH FIRST?
Since there is a great deal of information available regarding the successful culture of redfish, it was a logical species to start with at the Mariculture Center. The production of fingerling fish for release basically involves a three step process: (1) egg production by the adult fish; (2) collection and incubation of the fertilized egges, and (3) the grow-out of the hatched larval fish.

HOW IS IT DONE?
Adult redfish, called broodstock, are conditioned by careful manipulation of photoperiod and water temperature to spawn in 12-foot diameter tanks. In the tanks, a one-year natural cycle can be condensed into 120 days and the fish will begin to spawn at the end of this shortened cycle. With four spawn rooms available at the site, it is possible to have fish producing eggs at various times throughout the year. A single redfish can release over 500,000 eggs during a single spawning event. The released eggs float to the surface of the water where they can then be skimmed off and placed in incubation tanks until hatching.

Upon hatching, the fish larvae are ready to feed and must either be stocked in ponds or provided with live food in the incubation tanks. Organic and inorganic fertilizers are used prior to stocking to prepare the ponds. The fertilizers create a thick "soup" of microscopic organisms as food for the pond-stocked larvae. Larvae kept in incubation tanks must also be provided with live food. For redfish, a microscopic animal called a rotifer is an ideal live food organism. Rotifers are relatively easy to grow in large numbers using certain types of algae as their food; they then provide good nutrition for the larval fish.

The larvae stocked in the ponds are grown to what is called fingerling size, about one to three inches in length. That takes approximately 60 days, depending upon water temperature and food availability. At harvest, the ponds are drained and the fingerlings are collected and placed in a fish trailer for transport. A single pond may yield as many as 30,000 three-inch fingerlings at harvest time.

WHERE DO THEY GO?
The harvested fish are released into the Gulf of Mexico in areas determined suitable for their survival. The determination is based upon the numbers of fish released, the size of fish, the time of the year, and the availability of acceptable water conditions. Several release sites are identified so no one area is overloaded and to better ensure the survivability of the released fingerlings. To avoid mixing different fish stocks, broodstock are collected on the west coast of Florida only.

HOW DO WE KNOW?
One of the most difficult tasks for a stock replacement program such as this one is an accurate assessment of success. How do we know that the released fingerlings survive? In order to determine the success of releases, it is necessary to tag as many fish as possible. Returns on these tags can be used to calculate survivability and track movements after release.

Tagging large numbers of small fish is a very difficult task. One of the recommended techniques for tagging one-to-three-inch fingerlings involves the use of coded wire tags. The tag is a tiny piece of wire marked with a binary code. The tag is inserted under the skin of the fish near the head. This efficient tagging process allows large numbers of small fingerlings to be tagged with a minimum of handling and disturbance. The only drawback to this system is that there are no external marks on the fish, making identification after release difficult. The tags can only be detected with the use of a special device, and this requires a labor intensive effort for the capture and identification of marked fish. The Mariculture Center will continue to investigate the latest technologies available for the most effective and efficient tagging of fish to be released.

WHAT IS NEXT?
The Crystal River Mariculture Center integrates marine ecology, the aquaculture industry, and the technology associated with fisheries science to develop effective production techniques for the cultivation of several marine species. The great thing about the Mariculture Center is the many opportunities that will be available. The center will not only be able to offset the impacts of the power plants at Crystal River, but it can go far beyond that goal and enhance local fish populations. Procedures developed at the center can be utilized by the aquaculture industry. There will be many educational opportunities through cooperative programs and working agreements.

The Mariculture Center has a small staff of dedicated biologists, and there will be occasion to seek outside assistance for specific aquaculture needs. The center is in the process of developing cooperative programs with several agencies and institutions throughout the state. These agreements will provide the Mariculture Center access to a network of aquaculture experts, and the center can, in turn, provide culture space for their use. For additional information call (352) 563-4584.

Progress Energy 2004

PROGRESS ENERGY CORPORATION
CRYSTAL RIVER MARICULTURE CENTER
2003 ANNUAL REPORT
March 22, 2004

Introduction

The overall objective of the Mariculture Center is to mitigate fisheries impacts related to the once-through cooling system at Progress Energy Corporation's Crystal River Units 1, 2, and 3. Environmental studies identified twelve marine species considered to be significantly affected by entrainment and impingement at those units. As part of a negotiated NPDES permit settlement, Progress Energy Corporation agreed to construct and operate a multi-species marine hatchery to address these entrainment and impingement concerns.

The Mariculture Center began operation in October 1991. A phased implementation program was developed for the facility to enable restocking of some species and allow time for the development of techniques for others. A Technical Advisory Committee (TAC) was established to review reports and offer suggestions on Mariculture Center operation and species prioritization.

CRPP-0069

Facility Status

The TAC recommended red drum, spotted seatrout, pink shrimp, and striped mullet as the first four species for culture. Pigfish and silver perch were added as the fifth and sixth species for production at the facility. Blue Crab and Stone Crab were added during 2003. In accordance with the facility's genetic management plan, spawning broodstock are rotated on an average one-year cycle. In support of this policy, field collections are initiated as needed to acquire new broodstock from the wild.

Red Drum

The red drum was selected as the first species to be cultured at the Mariculture Center. A total of 125,064 red drum fingerlings were released during 2003. A total of 932,394 red drum fingerlings have been released since the beginning of red drum culture at the Mariculture Center.

These fingerling totals include fish harvested from 4 ponds stocked during 2003. All spawns came from one production room housing one set of redfish broodstock. These fish were induced to spawn a total of five times, producing a total of 1.1 million viable eggs.

Following pond harvest, fingerlings were transported to suitable release sites. Release sites were selected based on water quality as well as the size and number of fish to be released. A site with the best conditions for survival of the fingerlings was chosen at the time of harvest.

The red drum fingerlings harvested at the Mariculture Center were released at the following sites:

RELEASE SITE	NUMBERS	AVERAGE SIZE
Rocky Cove wetlands	13,500	85 mm
Yankeetown 49,733	75 mm	
Ozello	51,731	47 mm
North of Discharge canal	10,100	50 mm
TOTAL	125,064	

Spotted Seatrout

The spotted seatrout was selected as the second species to be cultured at the Mariculture Center. Over 791,665 seatrout fingerlings have been released since the beginning of seatrout culture at the facility. During 2003, facility production was 163,200 seatrout fingerlings.

Thirty broodstock fish were subjected to photothermal conditioning regimes in two spawn tanks. Twenty spawns were recorded totaling 7,000,000 good, viable eggs(85%), and 1,200,000 non-viable eggs(15%). Five ponds were stocked during the year.

Following pond harvest, fingerlings were transported to suitable release sites. Release sites were selected based on water quality as well as the size and number of fish to be released. A site with the best conditions for survival of the fingerlings was chosen at the time of harvest.

The seatrout fingerlings harvested at the Mariculture Center were released at the following sites:

RELEASE SITE	NUMBERS	AVERAGE SIZE
1) Ozello	19,041 and 67,948	90 mm and 39 mm
2) Johnson's Bay	7,000	80 mm
4) Ft. Island Road	46,200	96 mm
5) Dump Road Creek	23,011	100 mm
6) Fort Island Road	14,000	100mm
TOTAL	163,200	

Pink Shrimp

The pink shrimp was selected as the third species to be cultured at the Mariculture Center. Significant effort was put towards increasing the numbers of shrimp harvested and released during 2003. A total of 49,755 pink shrimp were harvested for release during 2003, with a total of 241,898 shrimp having been released since the beginning of shrimp culture at the facility.

A commercial shrimp boat operator based in Ft. Myers, Florida was hired to locate and collect suitable shrimp broodstock. Potential broodstock shrimp were collected and transferred to the Mariculture Center for evaluation and holding. A total of 160 broodstock shrimp with an average length of 140 mm were selected for spawning trials at the Mariculture Center.

Shrimp broodstock collection, maturation and spawning was moderately successful in 2003. Broodstock survival was 85%, and the maturation tank was successfully maintained to hold the broodstock with optimum water quality and adequate space. Eyestalk ablation was utilized to induce spawning, with no problems developing in ablated shrimp as a result of this technique. The shrimp molted frequently, mated and spawned consistently.

Over a four month period, an estimated 1,257,840 nauplii were produced. The average number of nauplii produced per spawn was 62,892. It is expected this number can be increased with the additional fine-tuning of techniques and procedures.

3 ponds were stocked for pink shrimp grow-out. The first pond, stocked with an estimated 20,000 postlarvae, yielded 15,000 shrimp with an average length of 81.5 mm at harvest. The second pond, stocked with an estimated 150,000 nauplii and 80,000 postlarvae, yielded 34,755 pink shrimp with an average length of 80.2 mm at harvest. The third pond, stocked with an estimated 50,000 nauplii and 60,000 postlarvae, had no survival of pink shrimp.

Release sites were selected based on water quality as well as the size and number of shrimp to be released. A site with the best conditions for survival of the shrimp was chosen at the time of harvest. Pink shrimp harvested at the Mariculture Center were released at the following sites:

RELEASE SITE	NUMBERS	AVERAGE SIZE (mm)
Dump Road Bridge	15,000	81.5
Ozello Ramp	34,755	80.2

TOTAL 49,755

Striped Mullet

The striped mullet was selected as the fourth species to be cultured at the Mariculture Center. Techniques and procedures for successful striped mullet production have been developed and fine-tuned over several mullet spawning seasons.
Mullet broodstock were collected during their natural spawning season and induced to spawn with the use of hormone replacements. No attempt was made to culture the larvae pas their first feeding stage, and as such 500,000 first feeding larvae were released into suitable habitats during February 2003.

Silver Perch

Silver perch was selected as the sixth species to undergo production trials at the facility. Broodstock collected during 2002 were induced to spawn for the first time this year. Larvae were released at the onset of feeding ability. A total of 40,000 larvae were released into suitable habitats during April 2003.

Stone Crab

Stone crab was selected as the seventh species to undergo production trials. Gravid females were collected from the wild during their normal spawning season. Females were held in isolated tanks until they spawned. Early larval stages (zoeal) were released into suitable habitats. A total of 692,166 zoea I and zoea II were produced. One tank was held back for further growth and the larvae were maintained until megalop stage.

Blue Crab

Blue crab was the eight species to undergo production trials during 2003. A limited number of gravid females were collected and spawned. The zoea were then stocked into a pond for grow out until 2004.

Live Feed Production

A live feed production program continues at the Mariculture Center. This program is designed to provide adequate concentrations of phyto- and zooplankton to satisfy production needs.

During 2003, phytoplankton was produced using batch culture methods. Stock cultures were obtained from two different sources to ensure viable cultures were available when needed. Culture densities of *Chaetoceros gracilis* were maintained in tanks at approximately 1 - 2 million cells per milliliter of seawater to meet the nutritional requirements of larval shrimp.

The brine shrimp *Artemia* sp. was produced using batch culture methods. Cysts were decapsulated and hatching rates averaged 90%. The newly hatched *Artemia* nauplii were cultured at an average density of 3.5 *Artemia*/ml to meet the nutritional requirements of the larval shrimp.

Staffing

The Mariculture Center staff presently includes two full-time technical specialists. Part time non-technical work has been delegated to contractors hired through the year on an as-needed basis. Management and administrative support services are handled by offsite Environmental Services Section staff.

Operations support and supplemental manpower requirements are provided through temporary staffing positions, volunteers, and consulting services. Duties include field support during broodstock collection, maintenance and operations support, and harvest and release.

Facility Improvements

Additional modifications to facility systems and support equipment were made to support operational needs and increase efficiencies and success rates.

Standard practices are constantly being assessed and modified to increase production yield through more efficient feeding and grow-out. Effluent concerns have been minimized through the utilization of best management practices and improved operational oversight.

An Aquaculture Certificate from the Florida Department of Agriculture and Consumer Services was obtained for the Mariculture Center in 2001. This removed specific effluent monitoring requirements for the facility. The facility continues to hold the certificate and it is in full compliance with its requirements.

Cooperative Agreements

The Mariculture Center staff continues to maintain professional networks as well as pursue new cooperative opportunities that benefit facility operation.

The Mariculture Center provided red drum fingerlings to agencies and research organizations, such at the FWC Stock Enhancement Research Facility including a cultured spotted seatrout parasite load study.
The facility staff continues to support research and business projects that promote the development of mariculture while maintaining protection of fisheries stocks and natural resources.

Facility staff supports and encourages environmental education of students and the general public through facility tours and speaking engagements. They participated in local educational outreach events at the Homosassa Springs State Wildlife Park, Earth Day Celebration, Citrus Springs Elementary School Wetlands Festival, and events at the Academy of Environmental Science. They also served as mentors for students from the Academy of Environmental Science, sponsoring work interns throughout the year and also providing guidance for their science fair projects.

Progress Energy 2005

PROGRESS ENERGY CORPORATION
CRYSTAL RIVER MARICULTURE CENTER
2004 ANNUAL REPORT
March 29, 2005

P-0070

Introduction

The overall objective of the Mariculture Center is to mitigate fisheries impacts related to the once-through cooling system at Progress Energy Corporation's Crystal River Units 1, 2, and 3. Environmental studies identified twelve marine species considered to be significantly affected by entrainment and impingement at those units. As part of a negotiated NPDES permit settlement, Progress Energy Corporation agreed to construct and operate a multi-species marine hatchery to address these entrainment and impingement concerns.

The Mariculture Center began operation in October 1991. A phased implementation program was developed for the facility to enable restocking of some species and allow time for the development of techniques for others. A Technical Advisory Committee (TAC) was established to review reports and offer suggestions on Mariculture Center operation and species prioritization.

Facility Status

The TAC recommended red drum, spotted seatrout, pink shrimp, and striped mullet as the first four species for culture. Pigfish and silver perch were added as the fifth and sixth species for production at the facility. Blue Crab and Stone Crab were added during 2003. In accordance with the facility's genetic management plan, spawning broodstock are rotated on an average one-year cycle. In support of this policy, field collections are initiated as needed to acquire new broodstock from the wild.

Red Drum

The red drum was selected as the first species to be cultured at the Mariculture Center. A total of 15,000 red drum fingerlings were released during 2004. A total of 945,394 red drum fingerlings have been released since the beginning of red drum culture at the Mariculture Center.

These fingerling totals include fish harvested from 1 pond stocked during 2004. All spawns came from one production room housing one set of redfish broodstock. These fish were induced to spawn a total of eight times, producing a total of 5.2 million viable eggs.

Following pond harvest, fingerlings were transported to suitable release sites. Release sites were selected based on water quality as well as the size and number of fish to be released. A site with the best conditions for survival of the fingerlings was chosen at the time of harvest.

The red drum fingerlings harvested at the Mariculture Center were released at the following sites:

RELEASE SITE	NUMBERS	AVERAGE SIZE
Boat release over grass flats	15,000	89 mm
TOTAL	15,000	

Spotted Seatrout

The spotted seatrout was selected as the second species to be cultured at the Mariculture Center. Over 808,164 seatrout fingerlings have been released since the beginning of seatrout culture at the facility. During 2004, facility production was 16,500 seatrout fingerlings.

Fourteen broodstock fish were subjected to photothermal conditioning regimes in one spawn tank. Twenty spawns were recorded totaling 2,500,000 good, viable eggs(82%), and 450,000 non-viable eggs(18%). Three ponds were stocked during the year.

Following pond harvest, fingerlings were transported to suitable release sites. Release sites were selected based on water quality as well as the size and number of fish to be released. A site with the best conditions for survival of the fingerlings was chosen at the time of harvest.

The seatrout fingerlings harvested at the Mariculture Center were released at the following sites:

RELEASE SITE	NUMBERS	AVERAGE SIZE
1) Yankeetown	12,500	95mm
2) North of Discharge Canal	4,000	91 mm
TOTAL	16,500	

Pink Shrimp

The pink shrimp was selected as the third species to be cultured at the Mariculture Center. No pink shrimp were released during 2004.

Striped Mullet

The striped mullet was selected as the fourth species to be cultured at the Mariculture Center. Techniques and procedures for successful striped mullet production have been developed and fine-tuned over several mullet spawning seasons.
No attempt was made to culture mullet during 2004.

Silver Perch

Silver perch was selected as the sixth species to undergo production trials at the facility. No attempt was made to culture silver perch during 2004.

Stone Crab

Stone crab was selected as the seventh species to undergo production trials. Gravid females were collected from the wild during their normal spawning season. Females were held in isolated tanks until they spawned. Early larval stages (zoeal) were released into suitable habitats. A total of 4,000,000 zoea I and zoea II were produced.

Blue Crab

Blue crab was the eight species to undergo production trials during 2003. Twenty seven gravid females were collected from the wild and brought to the hatchery. These animals were held until natural spawning occurred. A total of 33,000,000 zoea I and II were released into suitable habitats.

Live Feed Production

A live feed production program continues at the Mariculture Center. This program is designed to provide adequate concentrations of phyto- and zooplankton to satisfy production needs.

During 2004, phytoplankton was produced using batch culture methods. Stock cultures were obtained from two different sources to ensure viable cultures were available when needed. Culture densities of *Chaetoceros gracilis* were maintained in tanks at approximately 1 - 2 million cells per milliliter of seawater to meet the nutritional requirements of larval shrimp.

Staffing

The Mariculture Center staff operated for more than half the year with one full time technical position. The other available position was staffed early 2005. Part time non-technical work has been delegated to contractors hired through the year on an as-needed basis. Management and administrative support services are handled by offsite Environmental Services Section staff.

Operations support and supplemental manpower requirements are provided through temporary staffing positions, volunteers, and consulting services. Duties include field support during broodstock collection, maintenance and operations support, and harvest and release.

Facility Improvements

Additional modifications to facility systems and support equipment were made to support operational needs and increase efficiencies and success rates. Included were two new air handlers for the conditioning rooms, new pump systems, new shrimp quarantine/spawning space, renovation of office space, new utility vehicle, new feed shed, new lights in the live feed culture room and new lab equipment.

Standard practices are constantly being assessed and modified to increase production yield through more efficient feeding and grow-out. Effluent concerns have been minimized through the utilization of best management practices and improved operational oversight.

An Aquaculture Certificate from the Florida Department of Agriculture and Consumer Services was obtained for the Mariculture Center in 2001. This removed specific effluent monitoring requirements for the facility. The facility continues to hold the certificate and it is in full compliance with its requirements.

Cooperative Agreements

The Mariculture Center staff continues to maintain professional networks as well as pursue new cooperative opportunities that benefit facility operation.

The Mariculture Center provided red drum fingerlings to agencies and research organizations, such at the FWC Stock Enhancement Research Facility including redfish for Marine Quest 2005. These fish will be tagged and released by FWC.
The facility staff continues to support research and business projects that promote the development of mariculture while maintaining protection of fisheries stocks and natural resources.

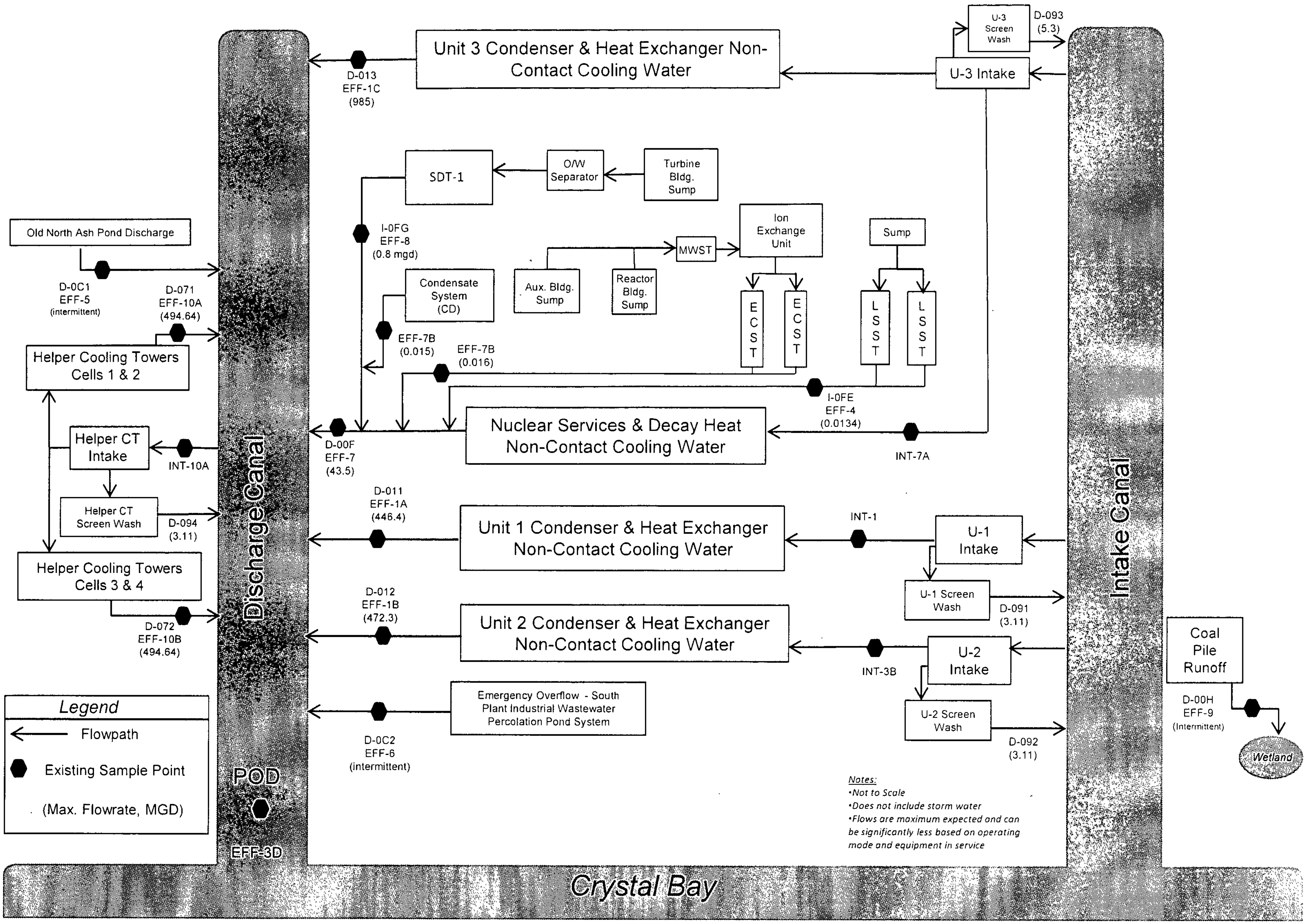
Facility staff supports and encourages environmental education of students and the general public through facility tours and speaking engagements. They participated in local educational outreach events at the Homosassa Springs State Wildlife Park, Earth Day Celebration, Citrus Springs Elementary School Wetlands Festival, and events at the Academy of Environmental Science. They also served as mentors for students from the Academy of Environmental Science, sponsoring work interns throughout the year and also providing guidance for their science fair projects.

Aquatic Ecology

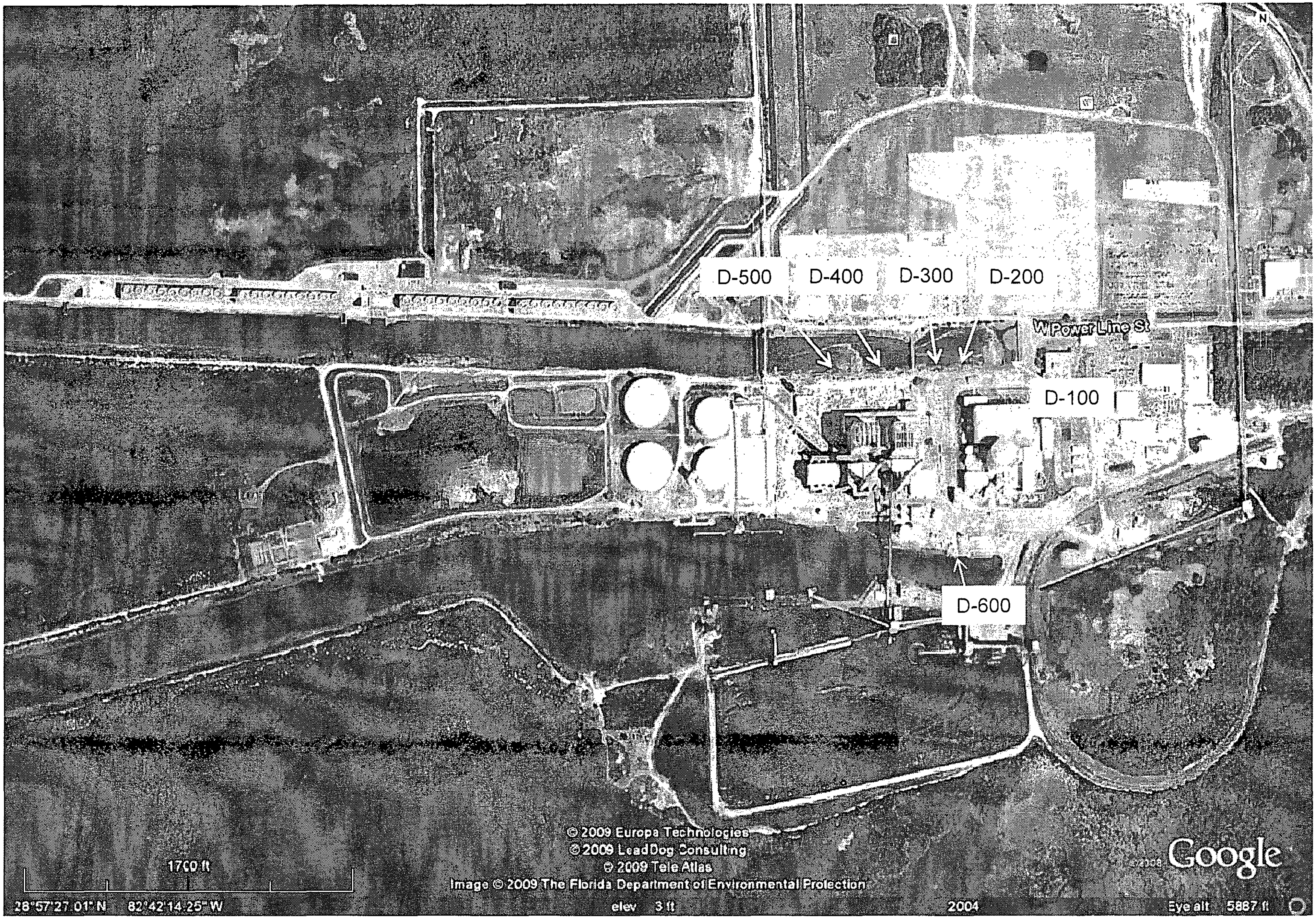
AQ-19

1. Crystal River Units 1, 2, 3 NPDES Flow Diagram - FL0000159
2. NPDES Water Outfalls - Permit No. FL0000159
3. Crystal River Units 1, 2, 3 DPDEA Discharge Outfalls - FL0000159

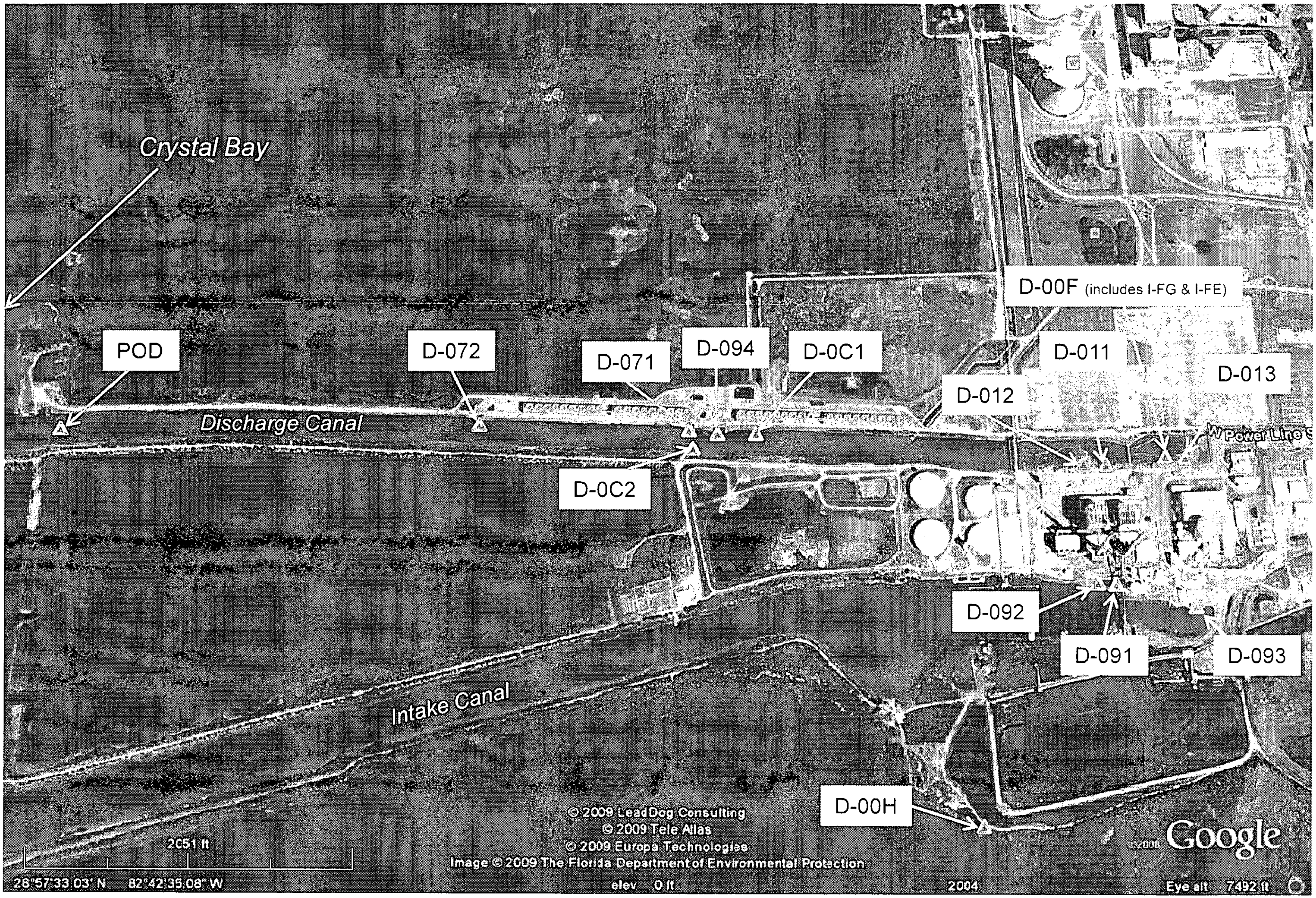
Crystal River Units 1, 2, & 3 NPDES Flow Diagram – FL0000159



NPDES Storm Water Outfalls – Permit No. FL0000159



Crystal River Units 1, 2, & 3 NPDES Discharge Outfalls – FL0000159



Aquatic Ecology

AQ-20

1. Crystal River Manatee Protection Plan

Jeb Bush
Governor

Department of Environmental Protection

Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

David B. Struhs
Secretary

RECEIVED
MAY 15 2002
...nmental Svcs
Department

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

In the matter of:
Approval of Florida Power Crystal River Plant Manatee Protection Plan

DEP Permit Nos. FL0000159 (Units 1, 2, & 3) and FL0036366 (Units 4 & 5)
Citrus County

Mr. Kent Hedrick
Florida Power
P. O. Box 14042
St. Petersburg, FL 33733-4042

NOTICE OF AGENCY ACTION

The Department of Environmental Protection hereby gives notice of its approval of the enclosed Manatee Protection Plan for the Florida Power Crystal River Plant (Units 1, 2, 3, 4, & 5), dated June 22, 2001. The Manatee Protection Plan was completed pursuant to Specific Condition 14 of Permit Number FL0036366 and Specific Condition 16 of Permit Number FL0000159.

A person whose substantial interests are affected by the Department action may petition for an administrative hearing in accordance with sections 120.569 and 120.57 of the Florida Statutes.

The petition must contain the information set forth below and must be filed (received) in the Department of Environmental Protection, Office of General Counsel, Mail Station 35, 3900 Commonwealth Boulevard, Tallahassee, Florida, 32399-3000. Petitions filed by the applicant or any of the parties listed below must be filed within twenty-one days of receipt of this notice of intent. Petitions filed by any other person must be filed within twenty-one days of publication of the public notice or within twenty-one days of receipt of this notice of intent, whichever occurs first. A petitioner must mail a copy of the petition to the applicant at the address indicated above, at the time of filing. The failure of any person to file a petition within the appropriate time period shall constitute a waiver of that person's right to request an administrative determination (hearing) under sections 120.569 and 120.57 of the Florida Statutes, or to intervene in this proceeding and participate as a party to it. Any subsequent intervention will be only at the discretion of the presiding officer upon the filing of a motion in compliance with rule 28-5.207 of the Florida Administrative Code.

A petition must contain the following information:
(a) The name, address, and telephone number of each petitioner; the Department case identification number and the county in which the subject matter or activity is located;
(b) A statement of how and when each petitioner received notice of the Department action;
(c) A statement of how each petitioner's substantial interests are affected by the Department action;

(d) A statement of the material facts disputed by the petitioner, if any;
(e) A statement of facts that the petitioner contends warrant reversal or modification of the Department action;
(f) A statement of which rules or statutes the petitioner contends require reversal or modification of the Department action; and
(g) A statement of the relief sought by the petitioner, stating precisely the action that the petitioner wants the Department to take.

Because the administrative hearing process is designed to formulate final agency action, the filing of a petition means that the Department final action may be different from the position taken by it in this order. Persons whose substantial interests will be affected by any such final decision of the Department on the application have the right to petition to become a party to the proceeding, in accordance with the requirements set forth above.

Mediation under section 120.573 of the Florida Statutes is not available for this proceeding.

This action is final and effective on the date filed with the Clerk of the Department unless a petition is filed in accordance with the above. Upon the timely filing of a petition this order will not be effective until further order of the Department.

Any party to the order has the right to seek judicial review of the order under section 120.68 of the Florida Statutes, by the filing of a notice of appeal under rule 9.110 of the Florida Rules of Appellate Procedure with the Clerk of the Department of Environmental Protection, Office of General Counsel, Mail Station 35, 3900 Commonwealth Boulevard, Tallahassee, Florida, 32399-3000; and by filing a copy of the notice of appeal accompanied by the applicable filing fees with the appropriate district court of appeal. The notice of appeal must be filed within 30 days from the date when the final order is filed with the Clerk of the Department.

Executed in Tallahassee, Florida.

STATE OF FLORIDA DEPARTMENT
OF ENVIRONMENTAL PROTECTION

Mimi Drew

Mimi Drew
Director
Division of Water Resource Management

2600 Blair Stone Road
Tallahassee, FL 32399-2400
(850) 487-1855

CERTIFICATE OF SERVICE

The undersigned duly designated deputy agency clerk hereby certifies that this NOTICE OF AGENCY ACTION and all copies were mailed before the close of business on 05-13-02 to the listed persons.

FILING AND ACKNOWLEDGMENT

FILED, on this date, under section 120.52(7), Florida Statutes, with the designated Department Clerk, receipt of which is hereby acknowledged.

S. Shields 05-13-02
(Clerk) (Date)

Copies furnished to:

Kipp Frohlich, FWC Tallahassee
Chairman, Board of Citrus County Commissioners
Jim Valade, U.S. Fish and Wildlife Service
Save the Manatee Club
Tim Parker, DEP Tampa
Betsy Hewitt, DEP Office of General Counsel

Florida Power Corporation - Crystal River Power Plant
Secondary Warm Water Refuge
Manatee Protection Plan
Rev. 6/22/01

Purpose:

The purpose of this Manatee Protection Plan is to set forth Florida Power Corporation's procedures to comply with Specific Condition 13 of the facility's NPDES Permit Numbers FL0000159 and FL0036366. This Specific Condition reads:

13. The permittee shall develop a plan and procedures addressing potential manatee impacts. The plan shall include an implementation schedule and shall address:

(a) Reporting of intake and discharge water temperatures during the winter, as currently monitored by the Permittee.

(b) Provision of gross bathymetry for the discharge canal, using currently available information.

(c) Provision of a thermal infrared aerial photograph taken during the winter, as close to the passage of a cold front as possible.

(d) precautions to minimize hazards to manatees at intake and outfall areas.

(e) timely communication to manatee recovery program personnel of any long term changes in the availability of warm water.

(f) Provision to allow access for staff from the Florida Department of Environmental Protection (DEP), Florida Fish and Wildlife Conservation Commission (FWC) and the U. S. Fish and Wildlife Service (FWS) to conduct manatee monitoring and research activities.

The plan shall be developed and submitted to DEP and FWS within six (6) months from the issuance date of this permit. DEP shall review the plan within 60 days of its receipt and shall, in writing, either approve the plan or notify the permittee of deficiencies that must be corrected. The permittee shall either make such corrections and re-submit the plan within 60 days of DEP's notification or file a petition for formal or informal administrative proceeding, pursuant to Chapter 120, F.S., and Chapter 62-103, Florida Administrative Code, if it disagrees with or otherwise disputes DEP's determination. The petition must conform to the requirements of rule 62-103.155, F.A.C., and must be received by DEP's Office of General Counsel, 3900 Commonwealth Boulevard, Tallahassee, Florida 32399-3000, within twenty-one (21) days after receipt of written notice. Failure to file a petition within this time period shall constitute a waiver by the permittee of its right to request an administrative proceeding under chapter 120, F.S. The plan shall be implemented according to the proposed schedule upon expiration of the 21-day time period following DEP's determination if no petition is filed, or DEP's final order entered after any administrative hearing held pursuant to this paragraph.

Copies of the final plan shall be maintained at the plant site and submitted to DEP, FWS and FWC at the following addresses.

U.S. Fish and Wildlife Service 6620 Southport Drive, South Suite 310 Jacksonville, FL 32216 Attention: Jim Valade	Florida Fish and Wildlife Commission OES - BPS 620 South Meridian Street Tallahassee, FL 32399-1600 Attention: Ron Mezich	Florida Department of Environmental Protection, Bureau of Water Facilities 2600 Blair Stone Road Tallahassee, Florida 32399-2400 Attention: Michael Hatcher

Florida Power Corporation - Crystal River Power Plant
Secondary Warm Water Refuge
Manatee Protection Plan
Rev. 6/22/01

Compliance With Specific Condition 13:

This Manatee Protection Plan will be in effect during the term of the permit (FL0002992). From November 15 through March 31 each year:

a) Florida Power Corporation will provide copies of the monthly Discharge Monitoring Reports to the BPSM each winter from the period of November 15 through March 31.

b) Florida Power Corporation will, within two (2) years of the effective date of this plan, provide a thermal infrared aerial photograph of the Crystal River discharge taken during the winter as close to the passage of a cold front as possible, as well as its gross bathymetry, at the mean rate of discharge when the ambient water temperature reaches a seasonal low.

c) Should Florida Power Corporation decide to retire the Crystal River units, notice will be provided to FDEP, BPSM and USFWS as soon as practical after a definite decision is made or, if possible, at least five years prior to the date of retirement.

d) If an unplanned shutdown occurs that is expected to result in no thermal discharge for 24 hours or longer, regardless of the ambient water temperature, FMRI should be notified within 24 hours of the shutdown at the contact numbers listed below.

FMRI: (727) 893-2904

e) The DEP and BPSM shall be provided a schedule of any anticipated in-water work within the discharge canal during the period of November 15 through March 31 each year. No major in-water maintenance work shall occur in the discharge canal from November 15 through March 31, unless it is considered essential by Crystal River Power Plant and approved by BPSM prior to the start of work. However, minor routine work which is necessary to maintain compliance with the facility's NPDES Permit, such as replacement and maintenance of thermal monitoring equipment or cleaning of intake and discharge structures, may be performed without notification. Performance of such minor routine in-water work must be in compliance with the attached Standard Manatee Construction Conditions. If major in-water work is necessitated by emergency conditions, the BPSM will be notified and consulted no later than two weeks following the commencement of the activity. All vessels used in the operation or associated with the activity shall be operated pursuant to the attached Standard Manatee Construction Conditions.

f) Florida Power Corporation will provide personnel from the BPSM, USFWS, Florida Marine Research Institute (FMRI), U. S. Geological Service (USGS)-Sirenia Project, or a designee of these agencies, access to the Crystal River Power Plant Site to conduct manatee research or monitoring activities, including placing, maintaining and downloading data from temperature data loggers. If utilized at the Crystal River Facility, these temperature data loggers will be used to collect air and water temperature data in an ongoing research effort to better understand manatee behavior patterns in response to artificial warm water refugia and environmental variables. The temperature data loggers would be placed in the discharge canal and at designated control (ambient) locations. Access shall be limited to normal business hours (8:00am - 5:00pm) unless arrangements are made in advance with plant personnel.

g) Intake and Discharge Areas: If a distressed (i.e.; injured, orphaned, cold stress) animal(s) are observed at any time, the following notifications should be made:

FWC - Florida Marine Research Institute - Marine Mammal Pathology Lab: (727) 893-2904

USFWS - Jacksonville Field Office: (904) 232-2580

h) Florida Power Corporation will provide phone numbers for weekday and weekend notification of appropriate plant personnel for the purpose of allowing FWC or FWS to coordinate manatee rescue operations as necessary.

i) Within thirty days of approval of this plan, provide a site map of the facility as a part of the plan. Additionally, the site map will be updated and resubmitted to the DEP and BPSM within thirty days of any significant physical or operational changes to the facility which have the potential to affect manatees. The site map will include the following information:

j) The location of the intake pipes and outfall pipes.
Proximate streams, rivers, bays, etc.
The location of the condenser inlet and outlet temperature monitoring stations.
The location of any fuel barge docking facilities in relation to the discharge canal.
The delineation of the no-entry boundary at the discharge canal.

FLORIDA POWER CORPORATION – CRYSTAL RIVER PLANT MANATEE PROTECTION PLAN

1a) STANDARD MANATEE CONSTRUCTION CONDITIONS FOR ARTIFICIAL WARM WATER REFUGIA DURING THE PERIOD OF NOVEMBER 15 THROUGH MARCH 31.

The permittee shall comply with the following manatee protection conditions:

a. The permittee shall instruct all personnel associated with in-water work within the warm water refuge of the potential presence of manatees and the need to avoid collisions with manatees. All vessels used in the operation or in association with the in-water work shall have an observer on board responsible for identifying the presence and location of manatee(s).

b. The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing manatees which are protected under the Marine Mammal Protection Act of 1972, The Endangered Species Act of 1973, and the Florida Manatee Sanctuary Act.

c. All vessels associated with in-water work associated with the warm water refuge shall operate at "no wake/idle" speeds at all times while in the manatee warm water refuge area. All vessels will follow routes of deep water whenever possible.

d. If manatee(s) are seen within the warm water refuge area all appropriate precautions shall be implemented to ensure protection of the manatee(s). These precautions shall include the immediate shutdown of equipment if necessary. Activities will not resume until the manatee(s) has departed to a safe distance on its own volition.

e. Any collision with and/or injury to a manatee shall be reported immediately to the Florida Fish & Wildlife Conservation Commission at (1-800-342-5367). Collision and/or injury should also be reported to the U.S. Fish and Wildlife Service in Jacksonville (1-904-232-2580).

CREC Sea Turtle Stranding Database Report

Stranding Site	Stranding Date	Take Category	Action
CR 1 & 2 Intake	7/7/2009	Live	Released Untagged
CR 1 & 2 Intake	2/18/2009	Non-causal Mortality	Necropsy Lab
CR 1 & 2 Intake	3/4/2006	Live	Released Untagged
CR3 Intake	1/8/2009	Live	Transferred Custody
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	6/30/2009	Non-causal Mortality	CRMC Freezer
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	4/13/2009	Live	Transferred Custody
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	4/12/2009	Live	Released Untagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	3/25/2009	Causal Mortality	Necropsy Lab
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	3/22/2009	Live	Transferred Custody
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	3/4/2009	Live	Released Tagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	3/4/2009	Live	Released Tagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	3/3/2009	Live	Transferred Custody
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	2/9/2009	Causal Mortality	Necropsy Lab
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	2/1/2009	Live	Released Untagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	1/29/2009	Live	Released Untagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	10/5/2008	Non-causal Mortality	
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	7/8/2008	Causal Mortality	Necropsy Lab
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	4/8/2008	Causal Mortality	Necropsy Lab
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	3/31/2008	Live	Released Untagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	3/26/2008	Live	Released Tagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	3/25/2008	Live	Released Untagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	3/12/2008	Live	Released Untagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	3/1/2008	Live	Released Untagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	1/21/2008	Live	Transferred Custody
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	11/6/2007	Detail Archived	Buried
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	10/5/2007	Detail Archived	Necropsy Lab

Stranding Site	Stranding Date	Take Category	Action
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	6/6/2007	Live	Transferred Custody
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	4/17/2007	Live	Released Untagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	3/28/2007	Live	Transferred Custody
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	12/28/2006	Detail Archived	CRMC Freezer
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	12/4/2006	Live	Released Untagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	8/26/2006	Live	Transferred Custody
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	8/25/2006	Detail Archived	
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	8/12/2006	Live	Released Tagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	8/10/2006	Non-causal Mortality	Buried
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	8/2/2006	Detail Archived	CRMC Freezer
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	7/19/2006	Live	Transferred Custody
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	6/24/2006	Non-causal Mortality	Buried
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	3/31/2006	Live	Released Tagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	3/19/2006	Live	Released Untagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	3/6/2006	Detail Archived	Transferred Custody
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	2/17/2006	Live	Released Untagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	2/12/2006	Live	Released Untagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	10/3/2005	Live	Transferred Custody
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	7/22/2005	Live	Transferred Custody
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	4/8/2005	Live	Released Untagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	3/26/2005	Live	
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	2/28/2005	Non-causal Mortality	Buried
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	1/24/2005	Live	Released Untagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	12/22/2004	Detail Archived	
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	12/22/2004	Live	Released Tagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	11/24/2004	Live	Transferred Custody
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	11/17/2004	Live	Released Tagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	10/5/2004	Live	Transferred Custody
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	10/3/2004	Live	Released Untagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	8/26/2004	Live	Transferred Custody

Stranding Site	Stranding Date	Take Category	Action
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	6/25/2004	Non-causal Mortality	CRMC Freezer
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	4/20/2004	Live	Released Tagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	4/13/2004	Non-causal Mortality	CRMC Freezer
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	4/11/2004	Live	Transferred Custody
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	4/10/2004	Live	Released Tagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	4/8/2004	Live	Released Tagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	4/8/2004	Non-causal Mortality	CRMC Freezer
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	3/25/2004	Live	Released Untagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	1/14/2004	Live	Released Tagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	1/12/2004	Live	Released Tagged
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	9/26/2003	Live	Transferred Custody
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	8/7/2003	Live	Transferred Custody
CR3 Intake (Lat 28 57.315 Lon 082 41.917)	4/3/2003	Non-causal Mortality	Transferred Custody

Aquatic Ecology

AQ-22

1. **Crystal River Unit 3 Procedure AI-571, Sea Turtle Rescue and Handling Guidance**

PROGRESS ENERGY

CRYSTAL RIVER UNIT 3

PLANT OPERATING MANUAL

AI-571

Sea Turtle Rescue and Handling Guidance

TABLE OF CONTENTS

1.0 **PURPOSE**

This procedure provides instructions for sea turtle observation, rescue, handling, notifications, and reporting requirements at the Crystal River Energy Complex (CREC).

2.0 **REFERENCES**

2.1 **Developmental References**

2.1.1 CP-151, External Reporting Requirements

2.1.2 CR-3 Safe Work Practices Manual

2.1.3 CR-3 Operating License, Appendix B, Environmental Protection Plan (Non-Radiological)

2.1.4 National Marine Fisheries Biological Opinion (BO)

2.1.5 AI-151, Reporting Requirement Program

2.1.6 FWC, Marine Turtle Permit

3.0 **PERSONNEL INDOCTRINATION**

3.1 **Description**

3.1.1 <u>Sea Turtle Characteristics</u>

Sea turtles are graceful saltwater reptiles, well adapted to life in the marine environment. They are able to swim long distances in a relatively short time due to their streamlined bodies and flipper-like limbs.

Sea turtles are air-breathing, and when they are active they must swim to the water surface for breathing purposes every few minutes. Turtles have been observed swimming underwater for periods of up to 20 minutes, and when resting some have been observed to remain underwater for as long as 2 hours without breathing.

The sea turtle influxes, which occurred in March-May 1998, led to the development of this procedure.

3.1.2 <u>Sea Turtle Protection</u>

Sea turtles are an endangered species protected under the Endangered Species Act. The National Marine Fisheries Service (NOAA Fisheries), in conjunction with the Florida Fish and Wildlife Conservation Commission (FWC), enforce protection of sea turtles.

3.1.3 National Marine Fisheries Service (NOAA Fisheries)

The NOAA Fisheries issued a Biological Opinion (BO) on the potential jeopardy to sea turtles species at the intake area of the Crystal River Energy Complex. The Biological Opinion concluded that there was no jeopardy to any of the sea turtle species, and established terms and conditions governing reporting thresholds and rescue of sea turtles.

3.1.4 NRC Requirements

License Amendment No. 190 incorporated the NOAA Fisheries non-discretionary terms and conditions into the CR-3 Operating License, Appendix B, Environmental Protection Plan, Section 4.2, Endangered or Threatened Sea Turtles. This procedure implements the NOAA Fisheries' non-discretionary terms and conditions.

3.1.5 Turtle Rescue

ERC or EHSS will rescue turtles and may need assistance from other plant personnel due to the size or condition of the turtle. Other personnel may rescue turtles when acting under the direction of ERC or EHSS.

3.2 **Definitions**

3.2.1 Annual Period

From January 1, 2002 through December 31, 2002, and each calendar year thereafter.

3.2.2 Clearwater Marine Science Center

An FWC authorized facility for the treatment of sick or injured sea turtles.

3.2.3 Florida Fish and Wildlife Conservation Commission (FWC)

The State Agency responsible for controlling activities related to protected species.

3.2.4 National Marine Fisheries Service (NOAA Fisheries)

A branch of the National Oceanic and Atmospheric Administration responsible for controlling activities related to endangered sea turtles.

3.2.5 Nuclear Regulatory Commission (NRC)

The Federal Agency responsible for ensuring the health and safety of the general public relative to the actions and activities of the Crystal River Unit 3 nuclear plant.

3.2.6 Take

For the purposes of this procedure, take is defined as the capture of endangered species sea turtles, including stranded, healthy, sick, or deceased turtles.

3.3 **Responsibilities**

3.3.1 Environmental Specialist

The CR-3 Environmental Specialist is responsible for:

- Managing and coordinating the sea turtle program
- Establishing the appropriate observation/surveillance schedule
- Making required notifications and submitting reports
- Submitting any revisions of this procedure pertaining to turtle rescue and handling to the NOAA Fisheries and FWC for their review (post issuance)
- Assuring CR3 Operations is notified when an NRC notification is required

3.3.2 Environmental Health & Services Section (EHSS)

Environmental Health & Services Section staff is responsible for:

- Training of observation rescue personnel
- Notifying the Operations Work Coordinator of all dead or injured turtles
- Sea turtle evaluations and care
- Tagging and release or disposition
- Determining the causation of mortality, and for requesting FWC to verify the determination
- Making required notifications and submitting reports
- Preparing records required by NOAA Fisheries and submitting these records to the Environmental Specialist
- Maintaining a sea turtle stranding log
- Assuring CR3 Operations is notified when an NRC notification is required
- Rescue of sea turtles

3.3.3 Nuclear Security

Nuclear Security personnel are responsible for performing intake canal observations and bar rack inspections, making internal notifications to facilitate sea turtle rescues, and assisting in sea turtle rescues.

CR-3 Operations

CR-3 Operations personnel are responsible for performing CR-3 bar rack inspections (visual and underwater through trash rake operation) and providing support for turtle rescue efforts as needed. Operations may contact ERC for assistance with rescue and Operations personnel may assist ERC or EHSS with rescue.

CR-1 and 2 Operations

CR-1 and 2 Operations personnel are responsible for performing bar rack inspections and providing support for turtle rescue efforts as needed

Aquatic Ecology

AQ-21

CREC Sea Turtle Stranding Database Report

CR-3 Maintenance

CR-3 Maintenance personnel are responsible for performing bar rack inspections (underwater through trash rake operation) and bar rack cleaning maintenance.

CR-3 Operations Work Coordinator

CR-3 Operations Work Coordinator is responsible for ensuring that NRC notifications are made upon notification that a report or notification to the National Marine Fisheries Service must be made. Ensure any Mariculture Center or EHSS notification or notification of an injured or deceased sea turtle is noted in the Autolog and a NCR is created.

3.3.5 Site Emergency Response Coordinators (ERC)

Emergency Response Coordinators provide support for rescue of sea turtles from the intake areas of Units 1, 2, and 3, although other site personnel may also assist with rescue of the sea turtles or rescue under the direction of EHSS or ERC. Notify the Mariculture Center of any take of a sea turtle.

3.4 Limits and Precautions

3.4.1 Sea turtles have powerful crushing jaws. They will bite when handled and can cause significant bodily harm. Keep clear of the turtle's head whenever possible.

3.4.2 Sea turtles may have claws on their front flippers. Keep clear of the front flippers whenever possible. Gloves should be worn when handling sea turtles.

3.4.3 Sea turtles should be handled with the rescue nets. Only if necessary, handle the turtle by the front and back of the shell. They should not be picked up by the flippers, head, or tail.

3.4.4 All safety procedures should be observed when working at the waterfront. Personal flotation devices or harnesses must be worn when working on the catwalk at the waterfront, as required by established safety practices.

3.4.5 Reasonable precautions should be taken to avoid contact with sea turtle blood secretions, or other bodily fluids.

3.4.6 Equipment used for the rescue or recovery of sea turtles exhibiting fibropapilloma tumor should be disinfected with a mild bleach solution (~ 10 ppm) following each use in an effort to prevent transmission of the disease to other turtles. Mariculture Center staff can assist with proper disinfection.

3.4.7 NOAA Fisheries anticipates that no more than 75 live sea turtle takes and 3 causally related sea turtle mortalities will occur annually. If takes reach one of these levels, the NRC must request reinitiation of formal consultation.

3.4.8 NOAA Fisheries reporting thresholds summary (see sections 4.3 & 4.4 for details):

- The 70th non-lethal take occurs in the annual period
- The 2nd causally related mortality occurs in the annual period
- The 8th non-causally related mortality occurs in the annual period
- Any injury or death in the intake canal or the bar racks causally related to CREC operations. Unlike the three notifications above, which are 5 day notifications, this 30 notification is required any time there is an injury or death causally related to CREC operations, regardless of count.

3.4.9 The Operations Work Coordinator must be notified of all injured or dead of sea turtles.

4.0 INSTRUCTIONS

4.1 Observation and Rescue

4.1.1 Observation Schedule

4.1.1.1 The CR3 Environmental Specialist in conjunction with Environmental Health & Services Section will determine the appropriate observation schedule based on the frequency of turtle sightings or takes. The following guidance will be used by energy complex staff in the absence of specific instructions requiring more frequent observations:

4.1.1.1.1 Turtle watch observations are normally conducted 24 hours per day at CR3 during periods of high turtle population observations and/or strandings on the bar racks. During this period it is likely that supplemental staff will be used to perform observations and make rescue notifications.

4.1.1.1.2 During periods with low numbers of sea turtle strandings, or infrequent observations, or absence of sea turtles, a reduced turtle observation schedule is established. This reduced program will normally consist of the following:

- Nuclear Security will perform a sea turtle watch by:
  - Inspecting CR3 bar racks an average of once every 2 hours (except when responding to a non-routine Security call out).
  - Making observations of the intake basin during inspections of bar racks to determine presence of sea turtles.
- CR-1, 2 Operations
  - Visually inspect bar racks approximately once per shift.
- CR-3 Operations
  - Visually inspect bar racks approximately once per shift.
- CR-3 Maintenance or CR-3 Operations
  - Inspect CR-3 bar racks for underwater strandings using the trash rake as requested by the Environmental Specialist.

4.1.2 Rescue Notifications

4.1.2.1 Nuclear Security performs turtle watches and records turtle observations so that the presence/absence of turtles is known.

4.1.2.2 When a turtle is found stranded against the bar racks Nuclear Security will notify designated recovery personnel.

4.1.2.3 Nuclear Security may provide support personnel to help with the turtle rescue and transport.

4.1.2.4 Supplemental staff may be used for turtle watch, and to perform rescue notifications.

4.1.2.5 Staff will notify the ERC when ERC is needed for rescue or recovery. ERC will notify the Mariculture Center of all takes of sea turtles.

4.2 Turtle Rescue and Handling Guidance

4.2.1 <u>Sea Turtle Rescue & Evaluation</u>

NOTE
All steps possible should be taken to minimize stress and prevent harassment to sea turtles.

4.2.1.1 Sea turtles stranded on the bar racks should be rescued using a dip net or other equipment provided (do not release turtle back to the intake canal since the turtle may become stranded again).

4.2.1.2 Sea turtles that have been stranded against the intake bar racks should be held for identification and evaluation by the Environmental Health & Services Section staff.

4.2.1.3 Turtle recovery personnel should try to make a preliminary evaluation of the physical condition of sea turtle in order to determine whether the turtle appears sick or injured, and therefore needs immediate attention by the Environmental Health & Services Section staff.

4.2.1.4 Environmental Health & Services Section staff must make a sea turtle evaluation which includes general health, species, size, and date and time of stranding, and disposition.

4.2.2 <u>Healthy Turtles</u>

4.2.2.1 Turtle recovery personnel should transport the turtle to the designated sea turtle holding tank at the Mariculture Center.

4.2.2.2 Observe the turtle's behavior for several minutes before leaving to assure the turtle appears healthy.

4.2.2.3 If the turtle appears weak (e.g. is not strong enough to lift its head), an Environmental Health & Services Section staff member should be called out (24 hours per day) to evaluate the turtle and provide appropriate care. Otherwise, notify Environmental Health & Services Section staff of the turtle rescue 7 days a week, during the first hours of day shift.

4.2.2.4 Environmental Health & Services Section will inform the FWC of the rescue of a stranded healthy turtle.

4.2.2.5 Environmental Health & Services Section will also notify the CR3 Environmental Specialist during normal work hours of any rescued sea turtle.

4.2.2.6 Environmental Health & Services Section or the Environmental Specialist will determine whether a live take meets the notification thresholds of Section 4.3.

4.2.3 Sick or Injured Turtles

NOTE
Do not place turtle on any hot or abrasive surface.

4.2.3.1 Place turtle on a wet towel in a cool, quiet area out of direct sunlight. Cover turtle shell with wet towel to prevent desiccation, and leave head exposed so turtle can breathe freely.

4.2.3.2 Turtle recovery personnel immediately (24 hours per day) notify Environmental Health & Services Section regarding condition of turtle.

NOTE
The Clearwater Marine Science Center is an authorized facility for the treatment of sick or injured turtles.

4.2.3.3 Environmental Health & Services Section will notify the FWC or the Clearwater Marine Science Center and make arrangements for the care of the sick or injured turtle.

4.2.3.4 Environmental Health & Services Section will determine whether the turtle injury was causally related to CREC operations.

4.2.3.5 If the sea turtle injury was causally related to CREC operations, Environmental Health & Services Section or the CR3 Environmental Specialist will immediately notify Unit 3 Operations (normally the Operations Work Coordinator) of the intent to make a notification to NOAA Fisheries and the need to make an NRC notification.

4.2.3.6 Environmental Health & Services Section will also notify the Environmental Specialist during normal work hours of any injured sea turtle causally related to CR-3 operations.

4.2.4 Comatose Turtles

NOTE
Sea turtles can remain motionless and appear dead for up to several hours.

4.2.4.1 Place the turtle on its belly.

4.2.4.2 Elevate the hind quarters several inches.

4.2.4.3 Place turtle on a wet towel in a cool, quiet area out of direct sunlight.

4.2.4.4 Attend to sea turtle until the Environmental Health & Services Section staff responds to the call out.

4.2.4.5 The Environmental Health & Services Section staff will perform advanced resuscitation techniques if appropriate.

4.2.4.6 IF the turtle revives,
THEN follow the appropriate instructions in Section 4.2.3 for injured or sick turtles.

4.2.4.7 IF the turtle expires,
THEN follow the appropriate instructions in Section 4.2.5 for dead turtles.

NOTE

If a necropsy is done to aid in the determination of causality care must be taken not to exceed the NOAA Fisheries 30 day reporting requirement and the 4 hour NRC reporting requirement.

4.2.5 Dead Turtles

4.2.5.1 Turtle recovery personnel will notify the Environmental Health & Services Section staff 24 hours per day, 7 days a week, to arrange for dead turtle pick-up and disposal per FWC instructions.

4.2.5.2 IF Environmental Health & Services Section is unable to respond in a timely manner,
THEN recovery personnel should place dead turtles in a container or bag with ice to prevent decomposition, until Environmental Health & Services Section is able to respond.

4.2.5.3 Environmental Health & Services Section will determine if the mortality was causally related to plant operations. Environmental Health & Services Section staff will notify the FWC and request verification of the determination of causation. If some cases, a necropsy or other analysis will be done to help assess the cause of death.

4.2.5.4 IF the sea turtle mortality was found to be causally related to CREC operations,
THEN Environmental Health & Services Section, or CR3 Environmental Specialist, will immediately notify Unit 3 Operations (Operations Work Coordinator) that a report to the National Marine Fisheries Services is required and that this also requires a report to the NRC.

4.2.5.5 Environmental Health & Services Section will also notify the CR3 Environmental Specialist of any dead sea turtle.

4.3 **Notifications**

4.3.1 Environmental Health & Services Section or CR3 Environmental Specialist

Upon determination that a recovered turtle is a protected species and that a report or notification to NOAA Fisheries is required to be made, Environmental Health & Services Section or the CR3 Environmental Specialist will notify the CR3 Operations (normally the Operations Work Coordinator) as soon as possible, and inform CR3 Operations of the need to make an NRC report. CR-3 Operations may have only 4 hours to report the incident to the NRC in accordance with CP-151, so it imperative that they be notified as soon as possible upon determining that a NOAA Fisheries report or notification is required.

4.3.2 Healthy Turtles

Environmental Health & Services Section or CR-3 Environmental Specialist informs the FWC of the turtle stranding and rescue.

4.3.3 Injured Turtles

For injured sea turtles, Environmental Health & Services Section staff notifies (depending on the sea turtle's condition) the FWC and/or Clearwater Marine Science Center rehabilitation facility. A follow-up report to NOAA Fisheries is required within 30 days of the incident if the injury was causally related to CREC operations. The Mariculture Center is the interim facility to hold sea turtles prior to pick-up for rehabilitation.

EHSS staff will also notify CR-3 Operations Work Coordinator of any injured sea turtle.

4.3.4 Dead Turtles and 30-Day Reports

For dead sea turtles, the Environmental Health & Services Section staff notifies the FWC within the next working day to request independent confirmation of Progress Energy's determination of causation. A follow-up report to NOAA Fisheries is required within 30 days of the incident for any mortality which was causally related to CREC operations. An NRC report is also required, in accordance with Section 4.1 of the Environmental Protection Plan, if the sea turtle mortality was due to CR3's operation.

If it appears likely that cause of death cannot be determined within 30 days of the incident, and causality cannot be ruled out, then report the mortality as if it were caused by site operations. EHSS staff will also notify CR-3 Operations Work Coordinator of any dead sea turtle. Once it is determined that a report of the incident will be submitted to NOAA Fisheries, then immediately notify CR-3 Operations (normally the Operations Work Coordinator) as soon as possible, and inform CR3 Operations of the need to make an NRC report. If it is determined at a later date that cause of death was not related to site operations, then submit and amended report to NOAA Fisheries and the NRC.

4.3.5 <u>5-Day Notifications</u>

The Environmental Specialist or Environmental Health & Services Section staff notifies NOAA Fisheries within 5 days whenever:

- The 70th non-lethal take occurs in the annual period, or
- The 2nd causally related mortality occurs in the annual period, or
- The 8th non-causally related mortality occurs in the annual period.

Turtle takes beyond these threshold values do not require NOAA Fisheries notification within 5 days.

4.3.6 <u>NRC Notification</u>

CR-3 Operations (normally the Operations Work Coordinator) notifies the NRC in accordance with the requirements of CP-151, External Reporting Requirements.

4.4 Reports

4.4.1 Procedure Revisions and Reviews

The Environmental Specialist must submit revisions (updates) to this procedure that pertain to rescue and handling of sea turtles to NOAA Fisheries and FWC (post issuance) for review.

4.4.2 Annual Report

The CR3 Environmental Specialist assures that a report on sea turtle strandings is submitted to NOAA Fisheries and FWC annually, by March 1 of each following year. The report shall include species, size, and date and time of stranding, location, condition, and disposition. A copy of this report is also provided to the NRC within 30 days of its submittal to NOAA Fisheries.

4.4.3 30-Day Written Report

The Environmental Specialist assures that a written report is submitted to NOAA Fisheries within 30 days of any causally related injured or dead sea turtle in the intake canal or the bar racks. The report must summarize the incident. An NRC report is also required, in accordance with Section 4.1 of the Environmental Protection Plan, if the sea turtle mortality was due to CR3's operation.

If it appears likely that cause of death cannot be determined within 30 days of the incident, and causality cannot be ruled out, then report the mortality as if it were caused by site operations. Once it is determined that a report of the incident will be submitted to NOAA Fisheries, then immediately notify CR-3 Operations (normally the Operations Work Coordinator) as soon as possible, and inform CR3 Operations of the need to make an NRC report. If it is determined at a later date that cause of death was not related to site operations, then submit and amended report to NOAA Fisheries and the NRC.

4.5 Documentation

4.5.1 Turtle recovery personnel should provide date, time, and location of stranding to the Environmental Specialist and Environmental Health & Services Section.

4.5.2 Environmental Health & Services Section Environmental Specialists maintain a turtle log, which will be used as a tool to track the dates and types (i.e. live, causal death, or non-causal death) of each take. The turtle log cannot be maintained up to date at all times because of takes that occur after hours and on weekends. It should be used in conjunction with Operation's logs and condition reports to determine the numbers of each type of stranding. The turtle log should include: date, time, size, species, location found, disposition, causal or non-causal, condition (live, dead, injured, sick, appearance). The log should only track protected species. The log should also provide a running total of each type of take and the date and time of the last update.

4.6 **Reinitiation of Consultation**

The Environmental Specialist will ensure that a reinitiation of formal consultation occurs if the annual take reaches 75 live sea turtles or 3 sea turtles killed as a result of CREC operations.

4.7 **Records**

The report prepared in step 4.4.2 is a lifetime quality assurance record. Licensing and Regulatory Programs is responsible for submitting this report to Document Services on an annual basis.

REVISION SUMMARY

1. Clarified reporting thresholds in step 3.4.8 PRR 290159

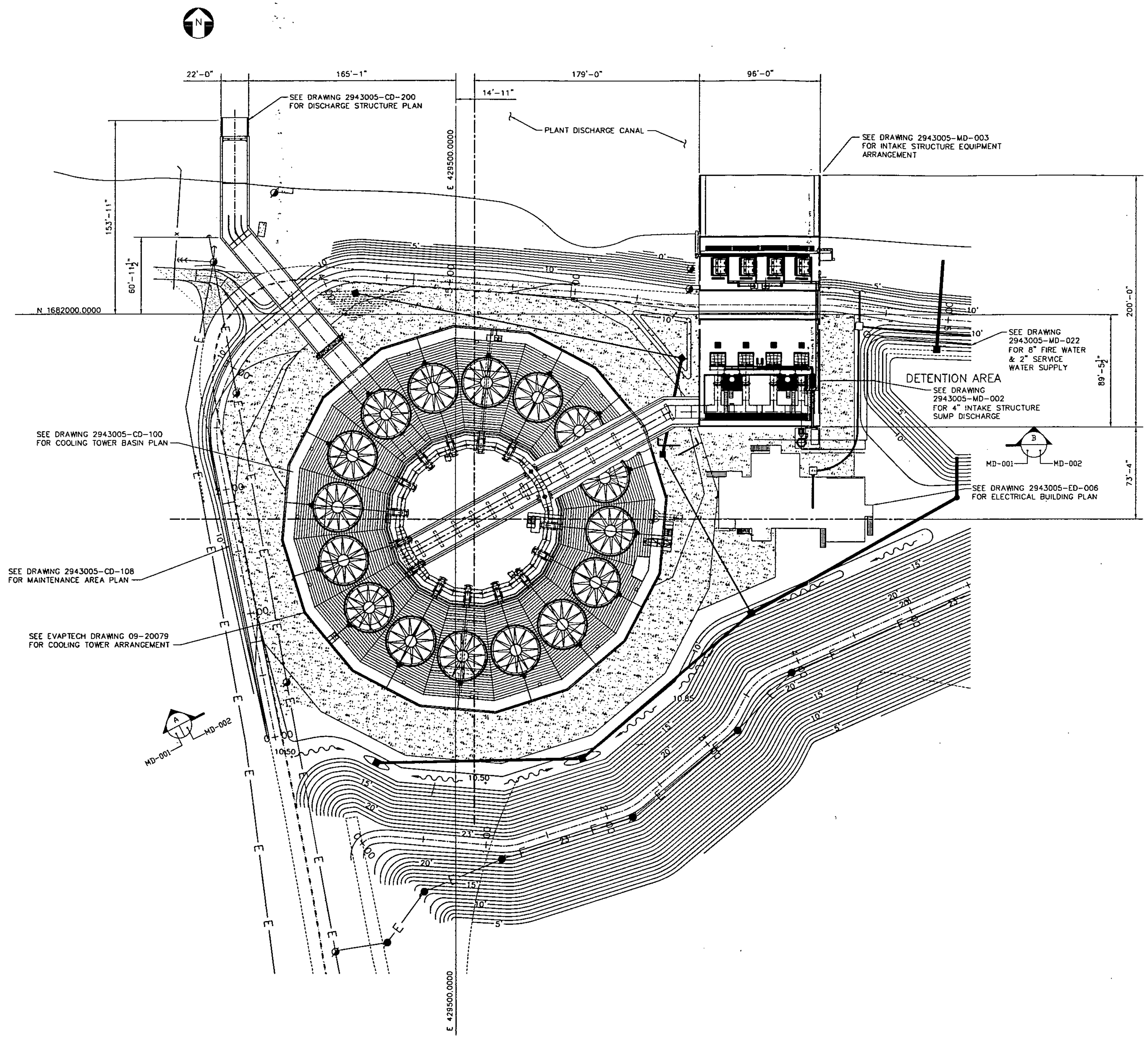
Aquatic Ecology

AQ-25

Drawing 2943004-MD-001, CREC Helper Cooling Tower South Overall Site Plan

REV	DESCRIPTION	DATE	DRAWN	APPR
A	ISSUED FOR INFORMATION	6/12/09	JMF	
B	ISSUED FOR 60% REVIEW	6/24/09	JMF	

REVISIONS



OVERALL SITE PLAN

COMPANION DRAWING LIST

2943005-MD-002 OVERALL SITE PLAN SECTIONS
2943005-MD-003 INTAKE STRUCTURE EQUIPMENT ARRANGEMENT PLAN VIEW AT ELEVATION 11'-6"
2943005-MD-004 INTAKE STRUCTURE EQUIPMENT ARRANGEMENT PLAN VIEW AT ELEVATION 9'-6"
2943005-MD-005 INTAKE STRUCTURE EQUIPMENT ARRANGEMENT SECTIONS
2943005-MD-006 COOLING TOWER DISTRIBUTION HEADER, DETAIL AND SECTIONS
2943005-MD-007 INTAKE STRUCTURE PIPING ARRANGEMENT PLAN VIEW AT ELEVATION 11'-6"
2943005-MD-008 INTAKE STRUCTURE PARTIAL PLAN 1
2943005-MD-009 INTAKE STRUCTURE PARTIAL PLAN 2
2943005-MD-010 INTAKE STRUCTURE PARTIAL PLAN 3
2943005-MD-011 INTAKE STRUCTURE PARTIAL PLAN 4
2943005-MD-012 INTAKE STRUCTURE PIPING SECTION
2943005-MD-013 INTAKE STRUCTURE PIPING SECTION
2943005-MD-014 INTAKE STRUCTURE PIPING SECTION
2943005-MD-015 INTAKE STRUCTURE PIPING SECTION
2943005-MD-016 TANK DATA SHEET
2943005-MD-017 INTAKE PUMP DISCHARGE SPOOL DATA SHEET
2943005-MD-018 INTAKE STRUCTURE PIPING SUPPORTS
2943005-MD-019 INTAKE STRUCTURE PIPING SUPPORTS
2943005-MD-022 INTAKE STRUCTURE UNDERGROUND UTILITIES SITE PLAN
2943005-MD-023 INTAKE STRUCTURE UNDERGROUND UTILITIES SECTION DETAILS
2943005-MD-024 HVAC SYSTEM GENERAL LAYOUT
2943005-MD-025 HVAC SYSTEM DETAILS, NOTES AND BOM
2943005-MD-026 HVAC SYSTEM NOTES AND BOM

MECHANICAL SPECIFICATIONS

2943005-MS-001 INTAKE PUMP SPECIFICATION
2943005-MS-002 TRAVELING SCREEN SPECIFICATION
2943005-MS-003 FRP PIPING SPECIFICATION
2943005-MS-005 VALVE SPECIFICATION (LARGE BORE)
2943005-MS-006 HORIZONTAL CENTRIFUGAL PUMP SPECIFICATION
2943005-MS-007 VACUUM PRIMING SPECIFICATION
2943005-MS-008 PROJECT PIPE SPECIFICATION

MECHANICAL CALCULATIONS

2943005-MC-001 DISCHARGE CANAL STUDY/CALCULATION
2943005-MC-002 INTAKE STRUCTURE CALCULATION
2943005-MC-003 INTAKE LIFT PUMP CALCULATION – PRELIMINARY
2943005-MC-004 INTAKE LIFT PUMP CALCULATION – FINAL
2943005-MC-005 SCREEN WASH/PRIMING PUMP CALCULATION
2943005-MC-006 INTAKE STRUCTURE LARGE BORE PIPE STRESS CALCULATION
2943005-MC-007 LINE SIZING CALCULATION
2943005-MC-008 BUILDING HEAT LOAD CALCULATION

MECHANICAL COMPONENTS

2943005-MF-001 MOTOR LIST
2943005-MF-002 PIPE LINE LIST
2943005-MF-003 VALVE LIST
2943005-MF-004 FUNCTIONAL SPECIFICATION

60%
DESIGN REVIEW

UNLESS OTHERWISE SPECIFIED

DIMENSIONS ARE IN INCHES
TOLERANCES ON:
2 PL DECIMALS ±.05
3 PL DECIMALS ±.025
ANGLES ± 0.5°
FRACTIONS ± 1/32

SIGNATURES		DATE
DRAWN	J. FRANKLIN	45/18/09
CHECKED		
APPROVED		
PROJ ENGR	R. LANNING	
PROJ MGR	T. RAMSEY	
USE CLIENT DWG NO	N/A	

MESA ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
10604 MURDOCK DRIVE KNOXVILLE, TN 37932 (865) 671-5400

CREC HELPER COOLING TOWER SOUTH
OVERALL SITE PLAN

SIZE	CAGE CODE	DWG NO.	REV
E		2943005-MD-001	B

SCALE 1/32=1' | PROJECT NO. 2943005 | SHEET 1 OF 1

Aquatic Ecology

AQ-31

GAI Report No. 1702, Circulating Water System Study

Hydraulic Design Review, Nuclear Services Seawater System, Crystal River, Unit No. 3

JUNE 9, 1969

GAI Report No. 1702

CIRCULATING WATER SYSTEM STUDY

By:
R. J. WAHANIK

PREPARED FOR

FLORIDA POWER CORPORATION

Prepared By:
Gilbert Associates, Inc.
525 Lancaster Avenue
Reading, Pennsylvania 19603

TABLE OF CONTENTS

LIST OF FIGURES

1. SUMMARY

1.1 GENERAL

This report presents the results of a study to determine the optimal operation of the circulating water system facilities, serving the condenser and the secondary service closed cycle cooling system for Crystal River Unit 3.

The study examines the hydrodynamical and hydromechanical problems based on the characteristics of the system during operating conditions and outlines some of the steps to be followed during construction and operation.

Additionally, this report gives graphical and written information about the following topics:

a. Gulf water level analysis

b. Hydraulic gradient at intake and discharge channels

c. Outfall structure discharge characteristics

d. Pump head, discharge, and required bhp

e. Siphon recovery

f. Flow distribution through condenser and secondary service closed cycle cooling system

g. Hydraulic gradient throught the system

h. Hydraulic transients during start and shut-down of the circulating water pumps

i. Liberated air-steam mixture during priming and operation of the system

j. System operation

k. Water surface temperatures

2. INTRODUCTION

Sea water will be drawn from the Gulf of Mexico to the circulating water system for condensing steam at the turbine exhaust of Unit No. 3, through the existing canals which are presently conveying water to and from existing Units No. 1 and No. 2, as shown in Figure 1.

The cooling system consists essentially of:

- Intake canal,
- Intake structure and pumps,
- Circulating water inlet piping (pump discharge to condenser inlet),
- Condenser,
- Circulating water discharge piping (condenser outlet to outfall structure),
- Outfall structure, and
- Discharge canal.

3. GULF TIDAL LEVELS

A probability analysis (Reference 1) was performed of normal spring tide levels for the months of April and May, 1967, for the plant site. The summarized data are as follows:

Gulf mean low water elevation	88.00	86 percent of the time
Gulf mean water elevation	90.00	50 percent of the time
Gulf mean high water elevation	92.00	12 percent of the time
Maximum registered April, 1967	93.00	
Minimum registered May, 1967	86.40	

The intake water level varies over a wide range. After a study of the tidal variations in the Gulf, a design water elevation of 88.00 ft was selected for Unit No. 3. This level will permit an operation very close to the design point over the operating life span of the pumps. Figures 2 and 3 illustrate the duration and probability curves for tide variations at the plant site.

4. CHARACTERISTICS OF THE EXISTING CIRCULATING WATER SYSTEM

4.1 CIRCULATING WATER PUMPS

The characteristics of the circulating water pumps for the existing units (Reference 2) are:

UNIT	PUMPS	GPM/PUMP	TOTAL FLOW cfs	T.D.H. Ft	RPM
1	4	77.500	690	20.00	272
2	4	82.000	730	19.00	252

4.2 CIRCULATING WATER CANALS

The intake and discharge canals both have a trapezoidal section with 2H:1V lateral slopes and have no longitudinal bottom slope. Other physical features are:

Canal	Bottom El.	Base Width	Length
Intake	73.00 ft	150 ft	16,090 ft
Discharge	78.00 ft	125 ft	13,248 ft

5. CIRCULATING WATER SYSTEM DESCRIPTION FOR UNIT NO. 3

5.1 COOLING WATER CONSUMPTION OF UNIT NO. 3

The secondary service closed cycle heat exchangers and the condenser require a total flow of 1565 cubic feet per second.

5.2 SYSTEM DESCRIPTION

Sea water is supplied from the Gulf to the main condenser pumping structure of Unit No. 3 through the existing canals. From the intake canal, the sea water enters the pump structure where 4 circulating water pumps furnish 700,000 gpm of sea water to four 90 in. internal diameter reinforced concrete pipes connected to four 6 ft 6 in. by 7 ft 6 in. rectangular reinforced concrete flumes, which are connected to the four condenser tube banks.

Each condenser tube bank discharges separately into a 6 ft 6 in. by 7 ft 6 in. rectangular reinforced concrete flume, which is connected to a 90 in. diameter reinforced concrete pipe.

The four discharge pipes terminate in a common outfall structure provided with a weir. From the outfall structure the water flows over the weir into the discharge canal. Depending upon the operating condition and the Gulf tidal elevation, the discharge will either be free or submerged.

5.2.1 Intake and Discharge Canals

The intake canal is an unlined trapezoidal section of lateral slopes, two horizontal to one vertical, with a bottom width of 150 feet and a constant elevation of 73.00. As the canal approaches Unit No. 3, it widens into a rectangular forebay at the screenhouse and dips down to elevation 67 ft - 0 in. to meet pump requirements. Transition sections are provided to assure uniform distribution of the circulating water into the pump structure.

The water in the intake canal will have a velocity that varies between 1 and 4 fps according to the water elevation and operating conditions.

The discharge canal is level at elevation 78.00 with a bottom width of 125 feet and lateral slopes 2H:1V; the water velocity will vary between 2 and 8 fps according to the water elevation and operating conditions.

5.2.2 Pump House

The condenser and the secondary service closed cycle heat exchangers require a water flow of 700,000 gpm which will be supplied by four vertical wet pit pumps, each of which will have a design capacity of 175,000 gpm and a total design head of 30.0 ft.

The submergence obtainable at normal conditions at mean sea level (90.00) is approximately 19 ft - 0 in. Even at minimum registered sea water level (86.40) the submergence will be on the order of 14 ft - 2 in. This gives an additional safety margin against the possibility of excessive accumulation of trash at the intake racks and screens, as a drawdown in the suction chamber of as much as 3 ft - 4 in. will still give a substantial seal over the suction of the pump.

To protect the pumps and facilitate maintenance, bar racks, traveling screens, and stop logs will be provided.

5.2.3. Reinforced Concrete Pipes and Flumes

In order to avoid increased head losses caused by barnacles and other marine growth on the inside pipe surface, the velocity in the pipe system will be maintained at a minimum of 8.5 feet per second.

The center line of the pipe through which water flows from the pumps into the condenser will be at elevation 88.50 ft. Leaving the condenser the center line of the pipe will be at elevation 88.00, and it will enter the outfall structure at elevation 80.25 ft. Stop log slots will be provided in the outfall structure for maintenance purposes.

Manholes are provided to facilitate access to the pipe during routine maintenance operations.

5.2.4 Outfall Structure

The final discharge point for the circulating water system is well below the upper pipe of the water box of the condenser, which is at elevation 119 ft - 0 in.

This difference in elevations limits the reduction of the pumping head and the maximum vacuum, or siphon recovery, permitted in the system. Any increase of the crest elevation or reduction of the weir length will affect the pumping head and with it the total necessary bhp of all pumps at a rate of 210 hp for each additional foot of discharge head.

Gilbert/Commonwealth, Inc. engineers and consultants
P.O. Box 1498, Reading, PA 19603-1498/Telephone 215-775-2600 Cable Gilasoc/Telex 836-431

DOCUMENT CONTROL
FEB 18 1992

February 17, 1992

ROY W. ADLER
Project Manager
Nuclear Services

FCS-12881
W.O. 04-5520-013
Contract NPM009AD, WA #013

Mr. R. T. Bowles
Nuclear Project Management Engineer
Florida Power Corporation
P. O. Box 14042/C2I
St. Petersburg, Florida 33733

Attention: Mr. R. A. Frohnerath

Re: Crystal River Unit 3
Original Civil/Structural Hydraulic Calculations for NSSW System Exterior to Buildings

Ref: FCS-12106 Dated February 12, 1991

Action By: N/A

Dear Mr. Bowles:

Per your request, as part of our final deliverable we are enclosing herewith one (1) copy of the original civil/structural calculations used as the basis for the assumptions of open channel flow in the RW system.

Should you have any questions, please advise.

Very truly yours,

C. W. Edwards
Mechanical Engineer

for
R. W. Adler
Project Manager

CWE/RWA/mjk

cc: W. W. Nisula
R. T. Bowles (2)
R. A. Frohnerath w/attachment
B. Gutherman
R. W. Adler (2)
T. C. Lutz

HYDRAULIC DESIGN REVIEW

NUCLEAR SERVICES SEAWATER SYSTEM

CRYSTAL RIVER, UNIT NO. 3

Originator:
J. L. Caves

Reviewer:
J. F. Borchardt

December 18, 1975

At the time the final hydraulic analysis was made (1970-71) a fourth unit at Crystal River was planned. Crystal River Unit 4 was to be a nuclear unit of similar size and design to Unit 3. In late 1971 or in 1972 FPC decided not to build Unit 4. Since it seems conceivable that another unit will eventually be constructed and since consideration of Unit 4 results in a greater head differential (between the intake and discharge canal levels at Unit 3) for the NSSW related pumps, the following review will presume the eventual existence of a Unit 4.

3.0 INTAKE SYSTEM DESIGN

3.1 Losses Through the Intake Structure, Dwg. Ref. L-012-009.

The total headloss incurred from the forebay to the inlets of the dual 48" ϕ intake lines is concentrated across the trash rack and traveling screens. Frictional resistance may be reasonably neglected in view of the comparatively short channel length and low velocities.

3.1.1 The headloss across the trash rack may be determined by the relation, (1)

$$h_r = B \sin \phi \frac{1.33\, d\, V_o^2}{2\, a\, g}$$

Where

B = flow coefficient
= 2.42, for a bar of rectangular cross-section

d = bar width

a = space between bars

V_o = incident flow velocity (fps)

ϕ = angle between rack and direction of flow.

The headloss will be greatest when V_o is a maximum. This will occur at the lower shutdown canal level of 82.4' with the alternate intake channel blocked and the maximum service water flow of 77.9 cfs entering the side channel from the main pump chamber. It is assumed that four units are operating with an additional cooling water flow of 4860 cfs entering the 7 main intake bays. The width of each bay is 11'-2" and the water depth is 82.4 - 67.0 = 15.4.[2]

Thus,

$$V_o = \frac{Q}{A} = \frac{(4860 + 77.9)}{(7)\ (11.17)\ (15.4)} = 4.10 \text{ fps}$$

In comparison, the velocity through the alternate intake channel would be much less.

$$V_o = \frac{Q}{A} = \frac{(77.9)}{(7.17)\ (15.4)} = 0.71 \text{ fps}$$

With ϕ given as 75°, a bar width of d = 3/8", and a spacing width of 4", the headloss is computed to be

$$h_r = 0.07 \text{ ft.}$$

With 3 units operating and a cooling water flow of 3210 cfs, the corresponding velocity is,

$$V_o = \frac{Q}{A} = \frac{(3210 + 77.9)}{(7)\ (11.17)\ (15.4)} = 2.73 \text{ fps}$$

The headloss is then,

$$h_r = 0.03 \text{ ft}$$

3.1.2 The headloss through the traveling screens is a function of the flow velocity and the relative amount of debris blocking the screen openings. Assuming this dependence to be separable in the form

$$h_s = K\, V_o^{\,2},$$

where K varies with the condition of the screen, the headloss may be represented as in the graph contained in the original notes (see Vol. 2). This graph is based on data supplied by H. Haesler and is accepted as given.

It is also noted[3] that the screens are equipped with wash pumps which are activated automatically whenever the water level differential across the screen exceeds 10" = 0.83 ft.

Thus, the maximum headloss which may reasonably occur through the intake structure is

$$h_{max} = 0.83 + 0.07 = 0.90 \text{ ft.}$$

Neglecting the velocity head differential between the forebay and the circulating water system pump chamber the water surface elevation at the 48" ϕ pipe inlet is (at "lower shutdown" gulf level, 4 unit circulating water flow and NSSW condition E4).

$$Z_{inlet} = 82.4 - 0.90 = 81.5 \text{ ft}$$

Aquatic Ecology

AQ-32

Alden, Summary of Plant Operations and Intake Equipment

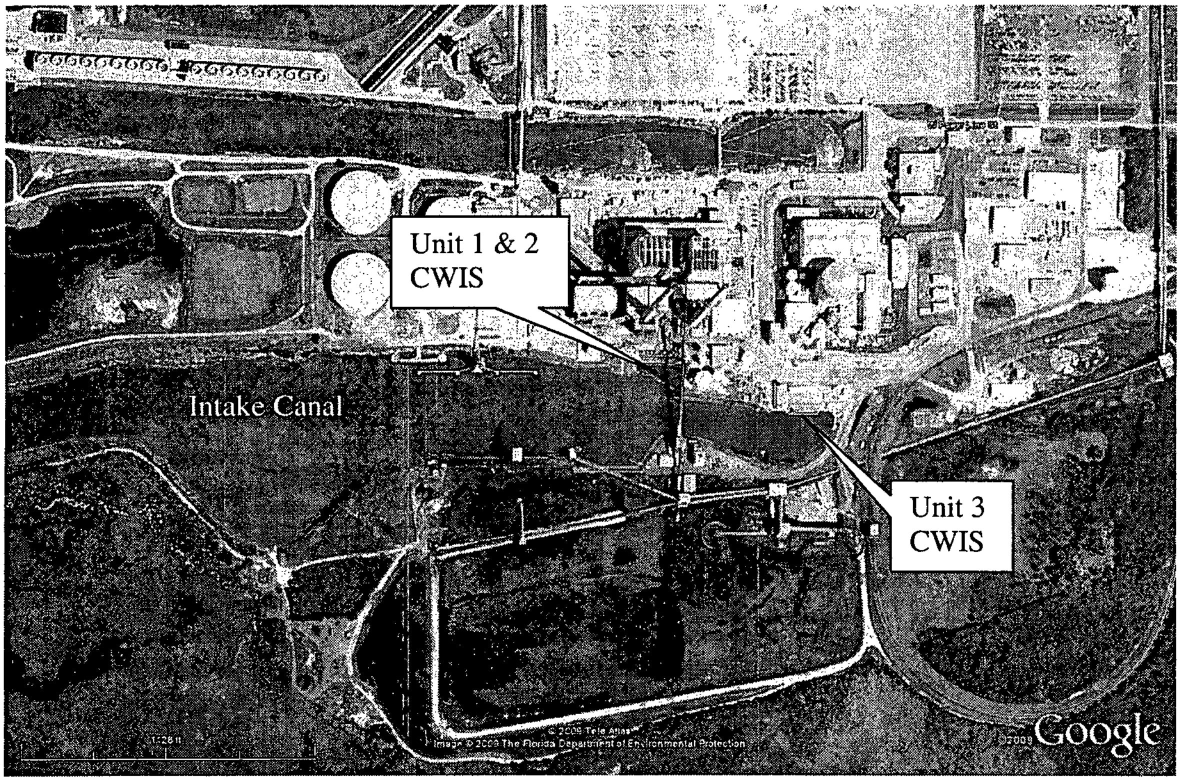


Figure 2 Detail of the Terminus of the Intake Canal Showing the Layout of the CWISs

Summary of Plant Operations and Intake Equipment

The Crystal River intake canal runs west to east and is approximately 8 miles long (See Figure 1). This canal is used for both intake water and as a shipping canal for fuel shipments to the fossil units. Breakwaters line the last 3.3 miles of the canal. The first 2.8 miles of this section is approximately 400 ft wide and maintained to provide a mid-channel depth of 20 ft. The last 0.5 miles of the canal widens to accommodate the fuel unloading piers and both CWISs. To reduce the impact of sea grass on the CWISs, barge captains radio ahead to notify the station if large mats of grass are present in the canal.

The CWIS for the fossil units is located approximately 400 ft west and upstream from the Unit 3 CWIS (See Figure 2). The flow into the fossil CWIS intercepts a large portion of the debris from the intake canal before it can interact with the Unit 3 CWIS. The fossil CWIS is not the focus of this evaluation and therefore the CWIS will only be mentioned in general terms.

The Unit 3 CWIS is located at the end of the intake canal. Approximately 200 ft from the face of the CWIS is a security boom. This boom delays grass intrusion into the CWIS. When grass accumulates on the security boom a pontoon boat with a mounted crane is used to remove the debris. The Unit 3 CWIS is divided into eight intake bays (See Figure 3). Seven of these bays are used for circulating water while the eighth is used to screen safety related water. The invert of the CWIS is at El. 67 ft and the top deck is located at El. 99 ft (plant datum). Each of these bays is equipped with a bar rack and traveling screen. Divers inspect the CWIS every two years.

The Unit 3 bar racks have 4 inch by 3/8 inch carbon steel bars spaced 4 inches apart. There is a cat walk in front of the bar racks to allow operators to inspect the racks for debris. When there is debris present an overhead rail mounted trash rake is used to remove the debris. Debris removed from the trash rack and traveling water screens is placed in a dumpster for disposal. To further clean the bar racks, they are removed and cleaned by a high pressure wash approximately four times a year. This wash is needed to remove barnacles that grow on the bars. When the racks are removed a second set is installed in their place.

There are eight traveling screens for Unit 3. Seven of these screens are 10 ft wide and the eighth is 6.0 ft wide. All of the screens are 35 ft high, measured from the top and bottom sprocket. These screens are rotated twice a day and are cleaned by an 80 psi spraywash. The screens are also rotated when there is a 6 inch or greater pressure differential across the screens. Once the pressure differential across the screens is less than 4 inches, the screens can be set back to manual mode. Depending on the operating mode, the screens can rotate at either 2.5 ft/min or 10 ft/min. In 1985 a second spraywash header with spraywash nozzles was added to improve the traveling screen cleaning. In addition to adding a second set of nozzles the screenwash pumps have been upgraded to increase the flow and auto backwashing strainers installed to reduce fouling. Corrosion of the spraywash headers and flanges has been a significant operation and maintenance issue in the past. To reduce corrosion, these components have been replaced with red brass components and have been performing well. Every 7 years the traveling water screens are removed and sent back to the manufacturer for refurbishment.

Downstream of the circulating water pumps is a Beaudrey W–filter (debris filter) and a Beaudrey zero-ball loss condenser cleaning system. The W-filter prevents debris that carried over or bypassed the traveling water screens from entering the condenser. The zero ball loss system is used to prevent biofouling and to remove any debris from the condenser tubes.

There is no debris strainer or ball cleaning system in the raw water system. To clean the raw water heat exchangers, they are brushed and scraped every 8 weeks to remove hard deposits. The raw water (RW) system provides cooling water to the service water (SW) system heat exchanger, during normal operations, for heat removal. During plant cool down and refueling operations the RW system provides removal of heat rejected to the decay heat closed cycle cooling (DC) system. During accident conditions, the RW system provides heat removal from the SW and DC systems.

Due to excessive corrosion, the screen wash water pumps are replaced about every 5 years or sooner if they fail.

Summary of Hydraulic Conditions

The normal water level in the canal is El. 88 ft (plant datum), which corresponds to El. 0 ft MSL. Under low water conditions the water level can get as low as El. 73.7 ft. The normal tidal range averages 2 to 3 ft.

The Unit 3 CWIS is located at the end of the intake canal. The total circulating water flow in the intake canal is 2,738 cfs and 1,515 cfs or 55 % of this flow is for Unit 3.

Velocities within the CWIS were calculated at the normal water level El. 88 ft and full-flow conditions (1,515 cfs). Under these conditions the velocity approaching the bar racks is 0.9 ft/sec and increases to 1.0 ft/sec at the traveling water screens.