SCE&G
A SCANA Company

South Carolina Electric & Gas Company
P.O. Box 88
Jenkinsville, SC 29065
(803) 345-4040

Ollie S. Bradham
Vice President
Nuclear Operations

October 21, 1988

Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Virgil C. Summer Nuclear Station
Docket No. 50/395
Operating License No. NPF-12
NPDES Permit No. SC0030856

Gentlemen:

In accordance with Appendix B of the Operating License for the Virgil C. Summer Nuclear Station, South Carolina Electric & Gas Company (SCE&G) hereby submits a copy of a report submitted October 7, 1988 to the South Carolina Department of Health and Environmental Control (DHEC) concerning an NPDES Permit Violation.

Should you have any further questions, please contact me at your convenience.

Very truly yours,

Ollie Bradham for

O. S. Bradham

DCB/OSB:bgh
Attachment

pc: D. A. Nauman/J. G. Connelly, Jr./O. W. Dixon, Jr./T. C. Nichols, Jr.
Malcolm L. Ernst, Acting Regional Administrator
E. C. Roberts
W. A. Williams, Jr.
J. J. Hayes, Jr.
General Managers
C. A. Price/R. M. Campbell, Jr.
R. B. Clary
K. E. Nodland
J. C. Snelson
G. O. Percival
R. L. Prevatte
J. B. Knotts, Jr.
NSRC
RTS (EPA880010)
NPCF
File (814.07)

C001
1/1

SCE&G
A SCANA Company

South Carolina Electric & Gas Company
Virgil C. Summer Nuclear Station
P.O. Box 88
Jenkinsville, SC 29065
(803) 345-5209
(803) 634-2011

October 7, 1988

Mr. Jerry E. Watson
Facilities Compliance Section
Environmental Quality Control
SC Department of Health and
Environmental Control
2600 Bull Street
Columbia, SC 29201

Subject: Virgil C. Summer Nuclear Station
NPDES Permit No. SC0030856
Compliance Monitoring Report
Response to Violation

Dear Mr. Watson:

On September 26, 1988, the Virgil C. Summer Nuclear Station (VCSNS) received your letter of September 22, 1988, stating that this facility had been placed in violation of Sections 48-1-90 and 48-1-110 of the Code of Laws of South Carolina with respect to conditions of NPDES Permit No. SC0030856. This violation is related to the elevated pH at Outfall 005 and the elevated pH at Outfall 006A as measured by the SC Department of Health and Environmental Control (DHEC) during the Compliance Sampling Inspection of July 18, 19, and 20, 1988. Both 005 and 006A discharge limits for pH are 6.0 to 9.0 as specified in NPDES Permit No. SC0030856. The Compliance Monitoring Report attached to your letter indicated that the pH at Outfalls 005 and 006A exceeded the upper limit at 10.1 and 10.0, respectively.

VCSNS has been experiencing problems with pH intermittently at these outfalls as well as Outfalls 006B, 008 and 011 since May 1987. At that time a notification of noncompliance for elevated pH at Outfall 006A was submitted to DHEC. The pH problems have been attributed to infestations of algae. Visual inspections of lagoon waters, laboratory evaluations, and pH trends during weather changes support this conclusion.

Efforts to combat algae infestation have included treatments with algicide and, in the case of Outfall 006A, desludging the lagoon. Following the desludging process in September 1987, pH at Outfall 006A remained in compliance until late April 1988 except for a short period during the first week of November 1987. An algicide treatment program as approved by DHEC was implemented during the Spring of 1988 with limited success.

An independent consultant was then contracted to perform analyses and provide recommendations for control of pH in the waste-water lagoons at VCSNS. In conjunction with the consultant's report, a more aggressive treatment program was proposed to DHEC on September 26, 1988, for which VCSNS currently awaits approval.

As can be seen from the enclosed copies of pertinent correspondence, detailed discussions of, and proposed solutions to, the pH problems have been and will be pursued with DHEC in order to resolve these issues. Additionally, it must be noted that each month's Discharge Monitoring Report has included comments concerning the pH noncompliance.

Due to milder weather conditions, pH at Outfalls 005 and at 006A has been in compliance since September 16, 1988 and September 17, 1988, respectively. Should you have any further questions, please contact Ms. Deborah C. Blanks of my staff at 345-4721.

Very truly yours,

O. S. Bradham

Enclosures

DCB/OSB:bgh

c: M. N. Browne
M. B. Williams
W. R. Baehr
L. A. Blue
W. F. Bacon
S. E. Summer
RTS EPA 880010
File 814.07

SCE&G
SCANA

South Carolina Electric & Gas Company
P.O. Box 764
Columbia, SC 29218
(803) 748-3513

Dan A. Nauman
Vice President
Nuclear Operations

May 26, 1987

Mr. Steve Thomas
SC Department of Health and
Environmental Control
2600 Bull Street
Columbia, SC 29201

Subject: Virgil C. Summer Nuclear Station
NPDES Permit #SC0030856
Written Notification
Discharge Non-Compliance

Dear Mr. Thomas:

This letter is being provided to your office as a written follow-up report concerning a discharge non-compliance initially reported to Mr. Andre Stanley per telecon of May 12, 1987.

On May 11, 1987 at 0745 hours, a weekly composite sample was taken at the Outfall 006A overflow and analyzed at 0930 hours. A pH analysis of the composite sample revealed an initial pH of 9.31. A backup grab sample taken at 0939 hours and analyzed at 1003 hours, revealed a pH of 9.43. The previous weekly composite sample taken on May 4, 1987, indicated a pH of 8.91. Prior to these values, the weekly composite samples for Outfall 006A revealed pH values ranging from 7.4 to 8.9 since early March, 1987. A DHEC sample taken April 15, 1987 indicated a pH of 7.6.

The source of water to Outfall 006A was the Clarifier Blowdown Sump. Clarifier Effluent has consistently shown, on daily samples since December of 1986, a pH of 7.2 to 7.6. Sampling of the Clarifier Blowdown Sump and basin influent resulted in values of 7.21 and 7.20, respectively, on May 11, 1987.

At 1115 hours on May 11, 1987, the overflow from Outfall 006A was secured by draining Outfall 006A to the Metal Cleaning Waste Pond, Outfall 008, and diverting Clarifier Blowdown Sump to Outfall 008 for containment. As such, no further out-of-specification discharge was allowed until recommended by DHEC personnel on May 19, 1987. Flow into the basin was resumed on May 19, 1987, from the Clarifier Blowdown Sump which contained pH of 7.22. Effluent from the basin was re-initiated on May 20, 1987, with pH at 9.2.

As of today, the pH has not stabilized. Investigations into the pH rise in the Alum Sludge Basin have not determined the exact cause. However, we have suspected that algal growth and photosynthetic activity could be contributory. Laboratory tests have been conducted in accordance with Standard Methods[1] "Metabolic Rate Measurement." The results, 150 mg carbon fixed per cubic meter per day, show positive indications of photosynthetic activity.

[1] Standard Methods for Examination of Water and Wastewater, 16th Edition, 1985

Additionally, review of water flow through the plant systems prior to May 11, 1987, does not provide evidence of residuals which could have contributed to the pH rise in the Alum Sludge Basin.

During conversations with Mr. Ruiter and yourself on May 19, 1987, we had discussed preliminary plans for treating the basin to adjust pH. These plans were outlined in the proposed five day written notification due May 19, 1987, which was not submitted. Neither Mr. Ruiter nor you were agreeable to the pH adjustment, and at that time suggested that the written notification period be extended in order to provide more time for evaluation of the situation relative to the pH in the basin.

As mentioned in our telephone conversation, there was concern that the out-of-specification discharge without treatment (i.e., pH adjustment) would constitute further violation of the permit. Since you have indicated that this is not considered an additional violation, alternative measures in lieu of pH adjustment are described in the following paragraph.

Concurrent with resumption of flow into and out of the Alum Sludge Basin, close observations of the basin (influent and effluent) will be made until such times as the pH should stabilize, or until such time that additional evaluation and corrective measures are implemented. The additional actions include contracted dredging and sludge removal. The process of sludge removal will be coordinated through DHEC as the methodology for sludge dewatering and disposal are subject to DHEC approval.

Should there by any further questions, please contact me at your convenience.

Very truly yours,

D. A. Hauman

DCB/DAN:jez

c: J. G. Connelly, Jr.
O. S. Bradham
W. A. Williams, Jr.
M. B. Williams
M. N. Browne
A. R. Koon
W. R. Baehr
S. E. Summer
W. F. Bacon
W. R. Higgins
NPCF
File 819.30

SCE&G
A SCANA Company

South Carolina Electric & Gas Company
P.O. Box 764
Columbia, SC 29218
(803) 748-3513

Dan A. Nauman
Vice President
Nuclear Operations

July 17, 1987

South Carolina Department of Health
and Environmental Control (DHEC)
Enforcement Division
2600 Bull Street
Columbia, South Carolina 29201

Attn: Mr. Steve Thomas

Subject: Virgil C. Summer Nuclear Station
NPDES Permit #SC0030856
Outfall 006A (Alum Sludge Basin)

Dear Mr. Thomas:

On May 26, 1987, South Carolina Electric & Gas Company (SCE&G) submitted to your office follow-up written notification of pH problems in the Alum Sludge Basin, Outfall 006A. In the meantime, SCE&G has closely monitored the Alum Sludge Basin and feels that it has determined the source of the pH phenomena and has begun to implement corrective action.

During the past month the pH was monitored at several locations in the basin under varying weather conditions. When the weather conditions were sunny and the pH continued to be greater than 9.0. However, when the weather conditions remained cloudy, overcast and less hot, the pH returned to within specification values near 8.0. As the weather cleared, the pH rose above 9.0. Additionally, a light green algae film developed on the surface over the sludge volume.

In light of these findings SCE&G feels that photosynthesis and extensive sludge volume are the root causes of the pH problem. A purchase order has been initiated for a vendor to provide services for removal of the sludge from the basin and dewatering. Samples of the sludge have been taken for EP Toxicity analyses and proper disposal methodology.

Mr. Arnie Cribb has been assigned to coordinate the sludge removal project. His phone number is 345-4346 at Summer Station. We will continue to keep you informed as the project progresses.

Very truly yours,

D. A. Nauman

AJC/js

c: J. G. Connelly, Jr.
O. S. Bradham
M. B. Williams
M. N. Browne
A. R. Koon
W. F. Bacon
Mr. Bart Ruiter, SC-DHEC
Mr. Harold Seabrook, SC-DHEC

SCE&G
South Carolina Electric & Gas Company
P O Box 764
Columbia SC 29218
(803) 748-3513

Dan A. Nauman
Vice President
Nuclear Operations

September 11, 1987

Mr. J. Bart Ruiter
S. C. Department of Health and
Environmental Control
Division of Industrial and
Agricultural Wastewater
2600 Bull Street
Columbia, S. C. 29201

SUBJECT: Virgil C. Summer Nuclear Station
NPDES Permit #SC0030856
Proposed Algaecide Treatment of
Wastewater Lagoons

REFERENCE: Letter dated July 24, 1987 from
D. A. Nauman to S. C. Thomas

Dear Mr. Ruiter:

Due to an increasing problem with bluegreen algae in the wastewater treatment lagoons at the Virgil C. Summer Nuclear Station (VCSNS), the pH in several of the affected lagoons has risen above the maximum permitted specifications. To control the algae, VCSNS proposes to apply an algaecide to the affected lagoons on an "as needed" basis. Details concerning the proposed algaecide treatment, its application and the affected lagoons are enclosed. Documentation on usage, application information, and results of the Monitoring Program discussed in Section III of the Enclosure will be reported annually to the Division of Industrial and Agricultural Wastewater during the fourth quarter of each year.

Your timely consideration of this matter will be greatly appreciated. Should you have any further questions, please contact Deborah Blanks at 748-3962.

Very truly yours,

D. A. Nauman

DCB:DAN:bjh

Enclosure

c: O. S. Bradham
M. B. Williams
W. A. Williams
M. N. Browne
A. R. Koon, Jr.
W. R. Baehr
W. F. Bacon
W. R. Higgins
S. C. Thomas (DHEC)
RTS
File: 819.30

(< 0.5 ppm). Sampling of effluents and the discharge canal will take place within 24 hours of application or resumption of discharges, as appropriate. No further monitoring for the algaecide would take place until subsequent applications.

IV. Affected Lagoons, Containment and Effluent Rate of Flow

A. Treated Sanitary Effluent (005)
Expected maximum containment: 0 hours
Average flow rate: 13,000 GPD

B. Alum Sludge Lagoon (006A)
Expected maximum containment: 36 hours
Average flow rate: 20,000 GPD

C. Plant Surge Lagoon (006B)
Expected maximum containment: 36 hours
Average flow rate: 47,000 GPD

D. Metal Cleaning Waste Lagoon (008)
Expected maximum containment: 36 hours (due to interconnection with 006A)
Average flow rate: No flow

E. Treated Sewage Effluent (011)
Expected maximum containment: 0 hours
Average flow rate: 15,000 GPD

The expected maximum containment is that time during which, if no discharges from the lagoons are allowed, there will be no problems elsewhere in the system. Flow rates are averaged since January, 1987.

MATERIAL SAFETY DATA SHEET

EMERGENCY ASSISTANCE
GRIFFIN: (912) 242-8638
CHEMTREC: (800) 424-9300

MSDS NO. 23
PAGE 1
OCT. 1986

HAZARD RATING

LEAST – 0 SLIGHT – 1 MODERATE – 2 HIGH – 3 EXTREME – 4

ACUTE HEALTH — 1
FIRE — 1
REACTIVITY — 1

SECTION 1 IDENTITY

PRODUCT: K-TEA™
CHEMICAL NAME: Copper (II) Triethanolamine; Cupric Triethanolamine
CHEMICAL FAMILY: Triethanolamine Metal Complex
CHEMICAL FORMULA: $CuC_{12}H_{30}N_2O_6$

SECTION 2 A INGREDIENTS

COMPONENT	%	TLV
1. Copper-triethanolamine complex	37.5	Not Established
2. Inerts	62.5	

The specific chemical identity or percent in composition of component 2 is considered trade secret information.

SECTION 2 B ACUTE TOXICITY DATA

ACUTE ORAL LD50: (Rats) – greater than 470 mg/kg
ACUTE DERMAL LD50: (Rabbits) – greater than 8 g/kg
ACUTE INHALATION LC50: Greater than 1.48 mg/liter of air

MSDS NO. 23
PRODUCT NAME: K-TEA
PAGE THREE
OCT. 1988

SECTION 7 *EMERGENCY AND FIRST AID PROCEDURES

EYE CONTACT: Flush eyes with plenty of water. Get medical attention if irritation persists.

SKIN CONTACT: Wash thoroughly with soap and water. Get medical attention if irritation persists.

INHALATION: Remove victim to fresh air. If not breathing, give artificial respiration, preferably mouth to mouth. Get medical attention.

INGESTION: If ingested, contact physician or call Poison Control Center. Drink 1 or 2 glasses of water and induce vomiting by touching the back of throat with finger. Do not induce vomiting or give anything by mouth to an unconscious person.

SIGNS AND SYMPTOMS: Highly emetic, very seldom toxic.

*Applies to concentrated product.

SECTION 8 EMPLOYEE PROTECTION

RESPIRATORY PROTECTION: Dual cartridge respirator for dusts and mists.

PROTECTIVE CLOTHING: Wear chemical safety glasses or goggles as appropriate. Wear rubber gloves.

ADDITIONAL PROTECTIVE MEASURES: Good ventilation.

SECTION 9 ENVIRONMENTAL PRECAUTIONS

SPILL OR LEAK PROCEDURES: Cover the spill with an absorbent material such as sweeping compound or lime. Sweep up the material and place in an appropriate chemical waste container. Wash the spill area with water containing a strong detergent, absorb it, and place in the chemical waste container. Seal container and dispose of in an approved manner. Flush spill area with water to remove any residue.

WASTE DISPOSAL: Contaminated materials should be placed in drums and shipped to chemical dump for disposal in accordance with federal, state and local regulations.

HANDLING AND STORINC PRECAUTIONS: Store below 35°C. Decomposes at temperatures above 200°C. Average shelf life under proper storage conditions is 2 years. Store in clean dry area. Exercise normal handling precautions for liquid materials.

THE INFORMATION CONTAINED HEREIN IS BASED ON THE DATA AVAILABLE TO US AND IS BELIEVED TO BE CORRECT. HOWEVER, GRIFFIN MAKES NO WARRANTY, EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THIS DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF. GRIFFIN ASSUMES NO RESPONSIBILITY FOR INJURY FROM THE USE OF THE PRODUCT DESCRIBED HEREIN.

South Carolina Department of Health and Environmental Control

2600 Bull Street
Columbia, S.C. 29201

Commissioner
Michael D. Jarrett

October 14, 1987

Mr. D.A. Nauman
S.C. Electric & Gas co.
P.O. Box 764
Columbia, S.C. 29218

Re: NPDES Permit #SC0030856
V.C. Summer Nuclear Station
Algaecide Use

Dear Mr. Nauman:

This Office has reviewed the information which accompanied your letter dated September 11, 1987. This Division has reservations about allowing the use of the proposed algaecide and would like for the following questions to be addressed before a final determination is made:

1. The pond has been in operation for several years. Why is algae now a problem?

2. Has an investigation been conducted to determine the reason for the algae problem? If not, should one be done?

3. Has any other algaecide been considered? If so, please elaborate.

If you should have any questions, please do not hesitate to contact me at 803/734-5249.

Sincerely,

Cynthia Walters

Cynthia Walters, Engineer
Industrial & Agricultural
Wastewater Divis[illegible]

N 10/19

CLW/jf

cc: Steve Thomas

MBN

SCE&G
A SCANA Company

South Carolina Electric & Gas Company
P.O. Box 764
Columbia, SC 29218
(803) 748-3513

Dan A. Nauman
Vice President
Nuclear Operations

November 4, 1987

Ms. Cynthia W. Walters, Engineer
Industrial and Agricultural Wastewater Division
SC Department of Health and Environmental Control
2600 Bull Street
Columbia, S.C. 29201

Subject: Virgil C. Summer Nuclear Station
Algaecide Treatment Program

Dear Ms. Walters:

This letter is submitted to answer the questions in your letter of October 14, 1987. The issues you have addressed are discussed as follows:

1. **The pond has been in operation for several years. Why is algae now a problem?**

Algae is a natural flora of surface waters, especially shallow ponds of the size in use at the Virgil C. Summer Nuclear Station (VCSNS). The drought of 1986 (i.e. lack of cloud cover) resulted in an ideal growing season for algae in shallow ponds. The algae problem surfaced in the Spring of 1987 as evidenced by the "greening" of and excessive growth observed in the ponds at VCSNS. In addition to the above, the onsite wastewater ponds are frequented by Lake Monticello's resident geese population which provide a natural source of nutrients.

2. **Has an investigation been conducted to determine the reason for the algae problem? If not, should one be done?**

In addition to the discussion in (1) above, a nutrient study was performed on composite samples of dewatered sludge removed from the alum sludge pond. The results are included in the following table:

Nutrients	Composite 1	Composite 2
a. Nitrogen	mg/kg	mg/kg
i. Ammonium	37	33
ii. Total Kjeldahl	56	50
iii. Nitrate nitrogen	0.4	0.5
b. Total Phosphorus	205	260
c. Total Potassium	437	613
d. Calcium	31	53
e. Magnesium	520	566

South Carolina Department of Health and Environmental Control

2600 Bull Street
Columbia, S.C. 29201

Commissioner
Michael D. Jarrett

March 16, 1988

Mr. D.A. Nauman
S.C. Electric & Gas Company
P.O. Box 764
Columbia, S.C. 29218

Re: K-TEA Algicide Proposal
V.C. Summer Nuclear Station
NPDES Permit #SC0030856
Fairfield County

Dear Mr. Nauman:

This Office has reviewed your request to use the Griffin K-TEA algicide in the wastewater treatment lagoons at the referenced facility. The September 11, 1987 proposal is approvable with the following conditions:

1. The product as copper should not be discharged at concentrations higher than the 24 hour LC_{50} concentration for rainbow trout (0.35ppm). Even though the Monticello Reservoir may not contain rainbow trout or other fish species with particularly demanding habitat requirements, there may be other aquatic life present that are more sensitive than those for which LC_{50} information was provided. The metal cleaning waste lagoon discharge (Outfall 008) copper concentration should not exceed 1 ppm as specified by the NPDES permit.

2. Use of the product must be recorded in the daily log maintained by the wastewater treatment plant operator. The log should include the amount and duration of use.

3. As proposed, sampling of the effluents and the discharge canal must take place within 24 hours of each application or resumption of discharges. In addition, the affected NPDES outfalls should be sampled weekly and analyzed for Total Copper and pH. The discharge canal should be sampled for Total Copper, Dissolved Oxygen (D.O.) and pH. The results should be submitted to the Enforcement Section on a monthly basis for the duration of the application period (i.e. until the copper concentration is non-detectable in all of the discharges, excluding Outfall 008). Based on the sampling results and the frequency of use of the product, the NPDES permit may be modified to include copper and/or D.O. limitations.

SOUTH CAROLINA ELECTRIC & GAS COMPANY
V. C. SUMMER NUCLEAR STATION
TELEPHONE & CONFERENCE MEMORANDUM

BY W. Frank Bacon DATE 4/7/88

DEPT Chemistry TIME 1530

ATTENDEES: D. Blanks, W. Higgins, A. Crabb

TELEPHONE [X] CONFERENCE [ ]

WITH: Ms. Cynthia L. Walters

COMPANY/GROUP: SC DHEC INDUSTRIAL AND AGRICULTURAL WASTE WATER DIVISION

SUBJECT: Algaecide Addition

NOTES: Informed Ms. Walters that K-Tea had been added to NPDES Outfall 006B and that the 24 hr. after treatment sample indicated a 0.474 ppm Copper value, which exceeded the 0.35 ppm limit established in her letter dated March 16, 1988.

We discussed possible causes; (1) Low density and wind causing the product to remain near the surface (2) Flowing system vs. stagnant pond

We indicated and she agreed that a follow-up report would be sent by May 15, 1988 detailing our findings and the results of algaecide additions for the month of April. Subsequent reports will also be on a monthly basis due by the 15th of each month.

W. Frank Bacon

Copies to:

D. Blanks

File No. 214.26

VCS Form 192 (Rev. 0, 3/30/81)

SCE&G

South Carolina Electric & Gas Company
[illegible]
[illegible]
(803) 345-4040

Dan A. Nauman
Vice President
Nuclear Operations

May 5, 1988

Mr. Stephen C. Thomas
Manager, Enforcement Section
Water Quality and Enforcement Division
South Carolina Department of Health
and Environmental Control
2600 Bull Street
Columbia, SC 29201

Subject: Virgil C. Summer Nuclear Station
NPDES Permit No. SC0030856
Discharge Noncompliance and
Algaecide Treatment Results

Dear Mr. Thomas:

This letter serves a threefold purpose. It is being submitted as a written follow-up report to the telephone notification of April 29, 1988, that pH at Outfalls 005, 006A, and 006B had exceeded the permitted maximum of 9.0 on April 28, 1988 (see Attachment I). Secondly, this letter serves as written notification that the total suspended solids (TSS) of May 5, 1988, 0805 hours at Outfall 005 exceeded the permitted maximum of 45.0 ppm at 49.3 ppm. Additionally, as requested in Mrs. C. W. Walters letter of March 16, 1988, this letter transmits the monthly monitoring results associated with an algaecide treatment program initiated on April 4, 1988, to combat the infestation of algae contributing to pH levels of greater than 9.0 in the wastewater treatment lagoons at the Virgil C. Summer Nuclear Station (VCSNS) and to increases in TSS.

As reported on the Monthly Discharge Monitoring Reports and previous notifications of pH noncompliance at affected outfalls, pH levels of greater than 9.0 were attributed to excessive growth of algae in the lagoons. The effect algae has had on the TSS was discussed in the Engineering Report supplemental to a construction permit application submitted to DHEC on May 4, 1988 for an additional sewer line to Outfall 005. Initial algaecide treatments appeared effective in reducing pH. During the algaecide manufacturer's recommended 10-14 day waiting period prior to subsequent treatments, a noted rise in pH recurred. As pH approached (or exceeded) 9.0 and the waiting period had elapsed, subsequent treatments were performed. At that point, no substantial pH decreases were noted, and increases in some cases were reported.

Trends of pH at Outfalls 005 (Sanitary Effluent), 006A (Alum Sludge Basin), and 006B (Plant Surge Basin) have been included as Attachment II. Laboratory monitoring results have been included as Attachment III. Some copper levels have exceeded the value recommended in Mrs. Walters letter of March 16, 1988 of 0.350 ppm even though calculations to determine treatment concentrations of algaecide incorporated conservatism relative to the manufacturer's recommendations and the volume of each lagoon. The resulting values of copper at these outfalls should cause no environmental impact since copper was not detected in samples taken from the Discharge Canal.

Presently, Virgil C. Summer Nuclear Station is in the process of negotiating for the services of an outside consultant specializing in microbiology to describe more precisely the existing microbiological systems and to make recommendations for further treatment of the affected lagoons. Upon completion of this project a report will be submitted to you detailing the results and requesting augmentation of the algaecide treatment program as warranted. Should you have any further questions, please contact Deborah C. Blanks, Licensing Engineer, at 345-4721.

Very truly yours,

O B Bradham for
D. A. Nauman

DCB/DAN:bgn

c: M. B. Williams
M. N. Browne
W. R. Baehr
L. A. Blue
S. F. Summer
W. F. Bacon
C. W. Walters (DHEC)
RTS EPA 870014
File 814.07-1a

SCE&G
NUCLEAR OPERATIONS
TELEPHONE AND CONFERENCE MEMORANDUM

DATE: 4-29-88
TIME:
FILES: 803.06
818.05

BY: D. C. Blanks, W. F. Bacon
DEPARTMENT: Licensing
TELEPHONE CALL X CONFERENCE ____
WITH: Paul Wise
COMPANY: S. C. DHEC
SUBJECT: NPDES Noncompliance
REFERENCES: NPDES Permit SC0030856
ONO 88-023
ONO 88-024

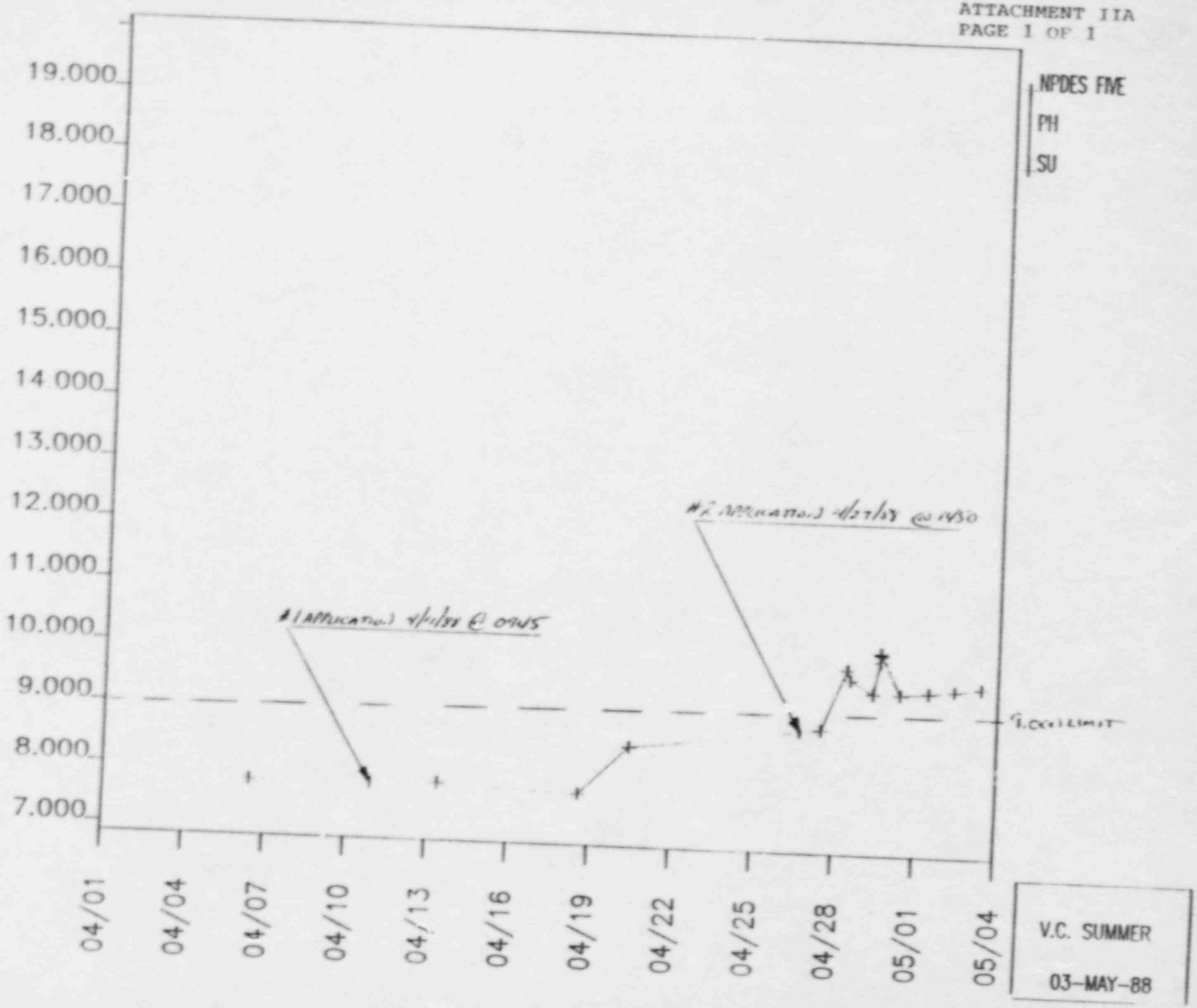
NOTES: 0820 Hours: A call was placed to the office of Steve Thomas, to report pH noncompliance for outfalls 005, 006A and 006B. Mr. Thomas was not in and the call was taken by an individual who refused to identify himself but stated that he would take the information and have Mr. Thomas return a call.

0828 Hours: Mr. Paul Wise called in place of Mr. Thomas who was out of the office. The pH noncompliance was at this time reported in more detail. The pH for outfalls 005, 006A and 006B were stated to be out of compliance as of the morning of 4/28/88 at 9.51, 9.28, and 9.58, respectively. It was also stated that algae had been the problem and an algaecide treatment program was underway for the affected lagoons. The most recent treatment was on the afternoon of 4/27/88 with pH at 005, 006A, and 006B being 9.89, 9.18, and 9.68, respectively on the morning of April 28, 1988. Flow from outfall 006B had been secured. A discussion of the pH and algae problems followed the report of noncompliance

Algaecide treatment of several weeks prior had been effective in reducing pH at 1-2 days following treatment. There was no stated requirement from DHEC to secure flow during treatment as the outfall from 005 was nonsecurable. Mr. Wise did state that the pH levels as reported did not appear to be a problem ("not bad"), but that he was not familiar with this facility. He questioned the pH limits which were then specified as 6.0 - 9.0. Mr. Wise further recommended that VCSNS consult with a DHEC biologist although none would be available for about a week. He would have Mr. Edward (Butch) Younginer, the Head Biologist at DHEC, contact Mr. Bacon at VCSNS.

Mr. Wise would record the notification for the DHEC file and follow up with Mr. Thomas. At that time it was requested that an explanation of the current problem be submitted to Mr. Thomas without a detailed report since it would be sometime before the DHEC biologist would be available. Mr. Wise also suggested that if the problem could not be resolved, an outside consultant may be recommended.

COPIES TO: M. B. Williams
A. R. Koon, Jr.
W. R. Bacon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PH
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#1 APPLICATION 4/18/88 @ 0945
#2 APPLICATION 4/27/88 @ 1430
04/01
04/04
04/07
04/10
04/13
04/16
04/19
04/22
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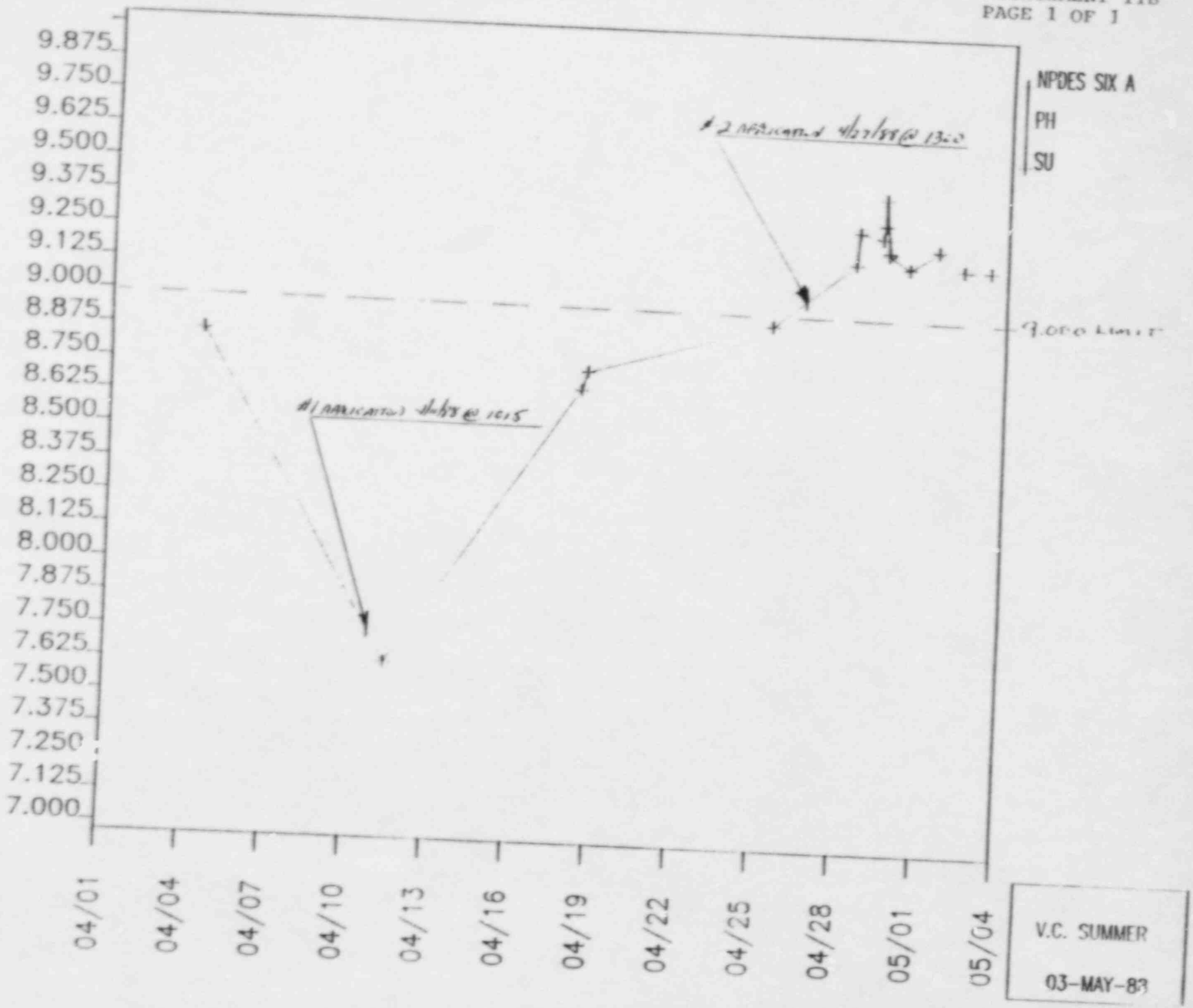
04/28
05/01
05/04
V.C. SUMMER
03-MAY-88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9.750
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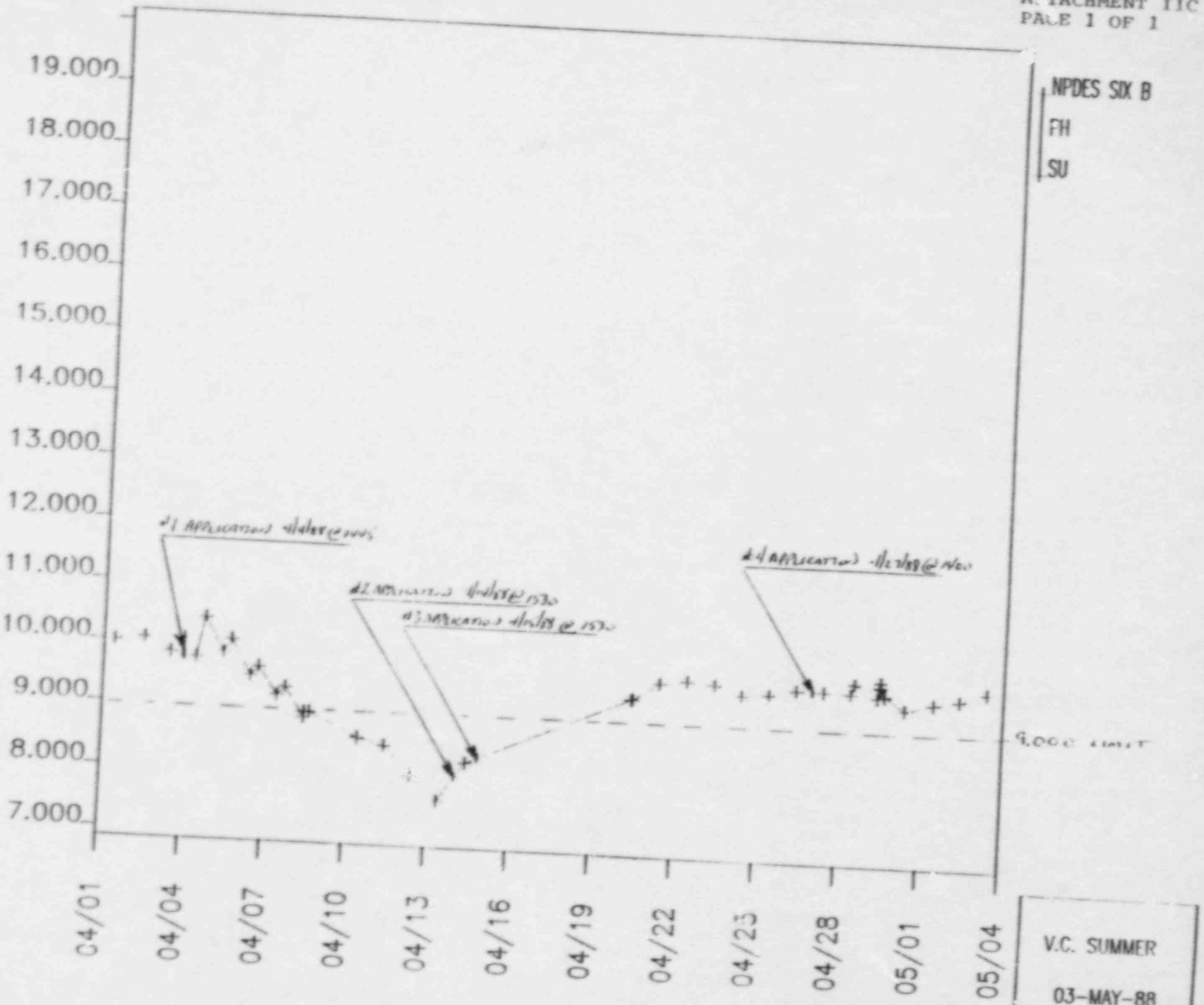
7.000
NPDES SIX A
PH
SU
#2 APPLICATION 4/27/83 @ 1300
#1 APPLICATION 4/13 @ 1015
9.000 LIMIT
04/01
04/04
04/07
04/10
04/13
04/16
04/19
04/22
04/25
04/28
05/01
05/04
V.C. SUMMER
03-MAY-83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7.000
NPDES SIX B
FH
SU
#1 Application started @ 1000
#2 Application started @ 1530
#3 Application started @ 1530
#4 Application started @ 0600
9.000 LIMIT
04/01
04/04
04/07
04/10
04/13
04/16
04/19
04/22
04/23
04/28
05/01
05/04
V.C. SUMMER
03-MAY-88

V.C. SUMMER NUCLEAR STATION
NPDES PERMIT SC0030856
ALGICIDE TREATMENT

#1 APPLICATION — APPLICATION 2 gal L-1 K-TEA

DATE	OUTFALL	PH (SU)	WATER TEMPERATURE (°F)	TIME START	TIME STOP
4/11/88	005	7.74	68°F	0945	0955

0945 PARTLY CLOUDY WINDY

NOTE: RAISED PH AFTERWARDS AFTER APPLICATION

DATE	TIME	SAMPLE DATA				
		OUTFALL		DISCHARGE CANAL		
		PH	CU	DO	PH	CU
		RESULTS (SU)	RESULTS (ppm)	RESULTS (mg/l)	RESULTS (SU)	RESULTS (ppm)
4/12/88	0748		0.218			
4/12/88	0750	7.78				
4/14/88	1436	8.29	0.259			
4/12/88	1515			9.1	6.9	<0.005
4/15/88	1133			9.3	6.3	<0.005
4/18/88	1255	7.68	0.743			
4/20/88	0847	8.50				
4/21/88	1120			8.80	7.0	<0.005

AFTER ADD SAMPLE

WEEKLY SAMPLE

DISCHARGE CANAL TEMP 79.7 °F

DISCHARGE CANAL TEMP 74.7 °F

DISCHARGE CANAL TEMP. 80.6 °F

V.C. SUMMER NUCLEAR STATION
NPDES PERMIT SC0030856
ALGICIDE TREATMENT

#2 APPLICATION			APPLICATION 2.1 gallons K-TEA		
DATE	OUTFALL	PH (SU)	WATER TEMPERATURE (°F)	TIME START	TIME STOP
4/27/88	005	8.9	69°F	1450	1500

Cloudy Partly Sunny

DATE	TIME	SAMPLE DATA				
		OUTFALL		DISCHARGE CANAL		
		PH	CU	DO	PH	CU
		RESULTS (SU)	RESULTS (ppm)	RESULTS (mg/l)	RESULTS (SU)	RESULTS (ppm)
4/27/88	1017	8.4				
4/28/88	0921	8.89	0.411			
4/29/88				9.2	6.7	<0.005
4/28/88	1105	9.73	0.426			
4/29/88	0741	9.51	0.435			
4/29/88	1340	10.04	0.423			
4/29/88	1340	10.14	0.416			
4/29/88	1340	10.18	0.415			
4/30/88	0753	9.51				
5/1/88	0905	9.55				
5/2/88	0751	9.59	0.396			
5/3/88	0747	9.65	0.374			
5/3/88	0909			8.8	7.3	<0.005

AFTER ADD sample

INTERIM SAMPLE

DISCHARGE CANAL TEMP. - 83.5°F

DISCHARGE CANAL TEMP. 83.1°F

V.C. SUMMER NUCLEAR STATION
NPDES PERMIT SC0030856
ALGICIDE TREATMENT

#1 APPLICATION			APPLICATION 5 gallons K-TEA		
DATE	OUTFALL	PH (SU)	WATER TEMPERATURE (°F)	TIME START	TIME STOP
4/11/88	006A	7.63 @ 0900	68°F	1015	1025

WEATHER CONDITIONS: Partly cloudy/windy

NOTE: Rained late afternoon, after application

DATE	TIME	SAMPLE DATA					
		OUTFALL		DISCHARGE CANAL			
		PH	CU	DO	PH	CU	
		RESULTS (SU)	RESULTS (ppm)	RESULTS (mg/l)	RESULTS (SU)	RESULTS (ppm)	
4/11/88	0800	7.63					
4/12/88	0745		0.252				
4/12/88	1437	8.73	0.246				
4/12/88	1515			9.1	6.80	<0.005	Discharge canal temp 79.7°F
4/13/88	1133			9.3	6.30	<0.005	Discharge canal temp. 80.6°F
4/13/88	0900	8.67					
4/13/88	1300	8.74	0.073				
4/20/88	1120			8.8	7.0	<0.005	Discharge canal temp 80.6°F
4/25/88	0905	8.94					

V.C. SUMMER NUCLEAR STATION
NPDES PERMIT SC0030856
ALGICIDE TREATMENT

#2 Application		APPLICATION	6.4 gallons K-TEA		
DATE	OUTFALL	PH (SU)	WATER TEMPERATURE (°F)	TIME START	TIME STOP
4/27/88	006A	8.44	69°F	1300	1310

Entered in 4/28/88 — Partly Sunny

DATE	TIME	SAMPLE DATA — OUTFALL — PH RESULTS (SU)	OUTFALL — CU RESULTS (ppm)	DISCHARGE CANAL — DO RESULTS (mg/l)	DISCHARGE CANAL — PH RESULTS (SU)	DISCHARGE CANAL — CU RESULTS (ppm)
4/28/88	0820	9.18	0.510			
4/28/88	1030			9.2	7.3	<0.005
4/28/88	1100	9.3	0.495			
4/29/88	0940	9.28	0.457			
4/29/88	0953	9.33	0.453			
4/29/88	1325	9.23	0.401			
4/30/88	0756	9.17				
5/1/88	0915	9.24				
5/2/88	0750	9.17	0.241			
5/3/88	0765	9.17	0.167			
5/3/88	0909			8.8	7.3	<0.005

Margin notes:

- 4/28/88 1030: Discharge canal temp. 83.5°F
- 4/28/88 1100: Secured flow ~1500 hrs 4/28/88
- 4/30/88 0756: Restarted discharge 4/30/88 [illegible]
- 5/3/88 0909: Discharge canal temp. 83.1°F

V.C. SUMMER NUCLEAR STATION
NPDES PERMIT SC0030856
ALGICIDE TREATMENT

#1 APPLICATION			APPLICATION 1.8 Gallons K-TEA		
DATE	OUTFALL	PH (SU)	WATER TEMPERATURE (°F)	TIME START	TIME STOP
4/4/88	006B	9.76 @ 0500 12.4/@ 1515	68°F	1445	1455

WEATHER CONDITIONS Very sunny/windy

DATE	TIME	SAMPLE DATA				
		OUTFALL		DISCHARGE CANAL		
		PH	CU	DO	PH	CU
		RESULTS (SU)	RESULTS (ppm)	RESULTS (mg/l)	RESULTS (SU)	RESULTS (ppm)
AFTER ADD SAMPLES 4/5/88	0800	9.83				
4/5/88	1055			9.2	7.0	40.005
4/5/88	1100		0.474			
4/5/88	1445	10.07				
4/6/88	0810	9.49				
4/6/88	1500	9.64				
4/7/88	0800	9.14				
4/7/88	1000		0.215			
4/7/88	1503	9.32				
4/8/88	0800	8.85				
4/8/88	0845	8.93				
4/8/88	1255	8.94	0.174			
4/10/88	0810	8.56				
4/11/88	0700	8.45				
WEEKLY SAMPLE 4/12/88	0800	7.99	0.071			
4/12/88	1435	8.45	0.066			
4/12/88	1515			9.1	6.5	40.005
4/13/88	0800	7.60				

DISCHARGE CANAL TEMP. 74.7°F

DISCHARGE CANAL TEMP 77.1°F

V.C. SUMMER NUCLEAR STATION
NPDES PERMIT SC0030856
ALGICIDE TREATMENT

#2 APPLICATION			APPLICATION 1 Spill - K-Tea		
DATE	OUTFALL	PH (SU)	WATER TEMPERATURE (°F)	TIME START	TIME STOP
4/14/88	006B	8.23	65°F	1530	1540
		Cloud	Partly Cloudy		

DATE	TIME	SAMPLE DATA				
		OUTFALL		DISCHARGE CANAL		
		PH	CU	DO	PH	CU
		RESULTS (SU)	RESULTS (ppm)	RESULTS (mg/l)	RESULTS (SU)	RESULTS (ppm)
4/14/88	0710		0.029			
4/14/88	0900	8.23				
4/15/88	1133			9.3	6.3	<0.005
4/15/88	1325	9.13	0.510			
Flow	RECORDED					

AFTER ADD & WEEKLY SAMPLES

DISCHARGE CANAL TEMP. 52.6°F

V.C. SUMMER NUCLEAR STATION
NPDES PERMIT SC0030856
ALGICIDE TREATMENT

#3 APPLICATION			APPLICATION Iglon K-TEA		
DATE	OUTFALL	PH (SU)	WATER TEMPERATURE (°F)	TIME START	TIME STOP
4/15/88	006	9.13	64°F	1530	1540

@ 1325 Partly Sunny Windy

DATE	TIME	SAMPLE DATA				
		OUTFALL		DISCHARGE CANAL		
		PH	CU	DO	PH	CU
		RESULTS (SU)	RESULTS (ppm)	RESULTS (mg/l)	RESULTS (SU)	RESULTS (ppm)
4/15/88	1325	9.13	0.510			
4/14/88	1535	9.73				
4/20/88	0735	9.36	0.093			
4/20/88	0845	9.36				
4/20/88	1120			8.8	7.0	40.005
4/21/88	0900	9.64	0.056			
4/22/88	0900	9.70				
4/23/88	0905	9.66				
4/24/88	0905	9.50				
4/25/88	0900	9.53				

Flow Restored

After mod & weekly samples

Discharge Canal Temp. 90.6°F

V.C. SUMMER NUCLEAR STATION
NPDES PERMIT SC0030856
ALGICIDE TREATMENT

#4 APPLICATION

APPLICATION 1.7 gpm/0.2 K-TEA					
DATE	OUTFALL	PH (SU)	WATER TEMPERATURE (°F)	TIME START	TIME STOP
4/27/88	006B	9.63	69°	1400	1410

@ 0500 Sunny/Windy

DATE	TIME	SAMPLE DATA				
		OUTFALL		DISCHARGE CANAL		
		PH	CU	DO	PH	CU
		RESULTS (SU)	RESULTS (ppm)	RESULTS (mg/l)	RESULTS (SU)	RESULTS (ppm)
4/27/88	0800	9.63				
4/28/88		9.61				
4/28/88	1030			9.2	6.7	<0.005
4/28/88	1055	9.78	0.360			
4/29/88	0742					
4/29/88	1000	9.83	0.259			
4/29/88	1000	9.73	0.276			
4/29/88	1000	9.75	0.282			
4/29/88	1341	9.59	0.217			
4/29/88	1345	9.61	0.214			
4/29/88	1345	9.61	0.221			
4/29/88	1345	9.61	0.221			
4/30/88	0750	9.39				
5/1/88	0910	9.50				
5/2/88	0745	9.57	0.092			
5/3/88	0744	9.71	0.233			
5/3/88	0909			8.8	7.3	<0.005

AFTER ADD & WEEKLY Samples

Discharge canal Temp. 83.5°F

WEEKLY SAMPLE

Discharge canal Temp. 83.1°F

SCE&G

South Carolina Electric & Gas Company
P. O. Box 88
Jenkins, S. C. 29065
(803) 345-4344

Dan A. Nauman
Vice President
Nuclear Operations

June 14, 1988

Mr. Stephen C. Thomas
Manager, Enforcement Section
Water Quality and Enforcement Division
South Carolina Department of
Health and Environmental Control
2600 Bull Street
Columbia, SC 29201

Subject: Virgil C. Summer Nuclear Station
NPDES Permit No. SC0030856
Algicide Treatment
Monitoring Results

Dear Mr. Thomas

As requested in Mrs. C. W. Walters letter of March 16, 1988, this letter transmits the May 1988 monitoring results associated with an algicide treatment program initiated on April 4, 1988. The program was implemented to combat the infestation of algae contributing to problems associated with NPDES permit compliance.

It should be noted that prior to implementation of the treatment program, a baseline study for copper was conducted on March 28, 1988. The baseline copper values for the respective outfalls are as follows:

Outfall	Baseline Copper Values
005	0.052 ppb
006A	<0.005 ppb
006B	0.006 ppb

Further treatment to control algae, which contributes to high pH in the affected lagoons, is pending recommendations from a consulting microbiologist presently analyzing samples taken from the above referenced outfalls on May 9, 1988. The report documenting his findings and any subsequent recommended modifications to our approved algicide treatment program will be submitted for your consideration.

Should you have any further questions please contact Deborah C. Blanks, Licensing Engineer, at 345-4721.

Very truly yours,

D. A. Nauman

DCB:DAN/bgh
Attachments

c: M. B. Williams
M. N. Browne
W. R. Baehr
L. A. Blue
S. E. Summer
W. F. Bacon
C. W. Walters
File (814.07-1a)
RTS (EPA 870014)
NPCF

V.C. SUMMER NUCLEAR STATION
NPDES PERMIT SC0030856
ALGICIDE TREATMENT

APPLICATION					
DATE	OUTFALL	PH (SU)	WATER TEMPERATURE (°F)	TIME START	TIME STOP
5/2/88	005	9.59	72°F	1100	1115

DATE	TIME	SAMPLE DATA					
		OUTFALL		DISCHARGE CANAL			
		PH	CU	DO	PH	CU	
		RESULTS (SU)	RESULTS (ppm)	RESULTS (mg/l)	RESULTS (SU)	RESULTS (ppm)	
5/2/88	0751	9.59	0.306				
5/3/88	0747	9.65	0.274				
5/3/88	0909			8.8	7.3	<0.005	DISCHARGE CANAL TEMP. 82.1°F
5/4/88	0805	9.72	0.216				
5/5/88	0748	9.86	0.210				
5/6/88	0901	9.65	0.189				
5/7/88	0750	9.92					
5/8/88	0805	9.58					
5/9/88	0902	9.55	0.141				
5/9/88	1200		0.100				
5/10/88	0748	9.57					
5/10/88	0927			7.7	7.2	<0.005	DISCHARGE CANAL TEMP. 86.9°F
5/11/88	0755	9.49					
5/12/88	0746	9.23					
5/13/88	0746	7.34					
5/14/88	1153	7.24					
5/15/88	1250	7.05					
5/16/88	0749	7.06					
5/17/88	0755	7.05					
5/17/88	1154			7.6	7.2	<0.005	DISCHARGE CANAL TEMP. 89.6°F

V.C. SUMMER NUCLEAR STATION
NPDES PERMIT SC0030856
ALGICIDE TREATMENT

APPLICATION					
DATE	OUTFALL	PH (SU)	WATER TEMPERATURE (°F)	TIME START	TIME STOP
	005	CONTINUED page 2573			

DATE	TIME	SAMPLE DATA				
		OUTFALL		DISCHARGE CANAL		
		PH	CU	DO	PH	CU
		RESULTS (SU)	RESULTS (ppm)	RESULTS (mg/l)	RESULTS (SU)	RESULTS (ppm)
5/18/88	0748	7.13				
5/19/88	0755	7.33				
5/20/88	0755	7.67				
5/21/88	0755	9.25				
5/22/88	0807	9.30				
5/23/88	0758	8.92				
5/24/88	0800	9.32				
5/20/88	1407			6.7	7.2	<0.005
5/25/88	0755	8.68				
5/25/88	1045	8.54				
5/26/88	0755	7.70				
5/27/88	0755	7.82				
5/31/88	0758	8.55				
6/1/88	0755	9.00				
6/2/88	0755	9.24				
6/2/88	0940	9.17				
6/3/88	0755	9.05				
6/6/88	0757	9.41				
6/6/88	1315		DP 29			
6/7/88	0755	9.45				

DISCHARGE CANAL TEMPERATURE 91.4°F

V.C. SUMMER NUCLEAR STATION
NPDES PERMIT SC0030856
ALGICIDE TREATMENT

APPLICATION					
DATE	OUTFALL	PH (SU)	WATER TEMPERATURE (°F)	TIME START	TIME STOP
	005	Continued, page 3.3			

DATE	TIME	SAMPLE DATA				
		OUTFALL		DISCHARGE CANAL		
		PH	CU	DO	PH	CU
		RESULTS (SU)	RESULTS (ppm)	RESULTS (mg/l)	RESULTS (SU)	RESULTS (ppm)
6/7/88	0950			6.4	7.1	<0.005
6/8/88	0750	9.11	0.025			

Discharge canal temp. 72.5°F *

* Plant shutdown, flow by recirculating cooling tower, NO discharge to RIVER

V.C. SUMMER NUCLEAR STATION
NPDES PERMIT SC0030856
ALGICIDE TREATMENT

APPLICATION					
DATE	OUTFALL	PH (SU)	WATER TEMPERATURE (°F)	TIME START	TIME STOP
4/27/88	006A	8.94	69°F	1300	1310

DATE	TIME	SAMPLE DATA					
		OUTFALL		DISCHARGE CANAL			
		PH	CU	DO	PH	CU	
		RESULTS (SU)	RESULTS (ppm)	RESULTS (mg/l)	RESULTS (SU)	RESULTS (ppm)	
5/1/88	0915	9.24					
5/2/88	0750	9.17	0.241				
5/3/88	0745	9.17	0.167				
5/3/88	0909			8.8	7.3	<0.005	DISCHARGE CANAL TEMP. 83.1 °F
5/4/88	0802	9.23	0.112				
5/5/88	0743	9.17	0.101				
5/6/88	0905	9.35	0.100				
5/7/88	0755	9.43					
5/8/88	0807	9.37					
5/9/88	0754	9.28	0.051				
5/9/88	1200		0.030				
5/10/88	0753	9.35					
5/10/88	0927			7.7	7.2	<0.005	DISCHARGE CANAL TEMP. 86.9 °F
5/11/88	0758	9.45					
5/12/88	0747	9.58					
5/13/88	0747	9.27					
5/14/88	1157	9.17					
5/15/88	1255	9.34					
5/16/88	0750						
5/17/88	0756	9.20					

V.C. SUMMER NUCLEAR STATION
NPDES PERMIT SC0030856
ALGICIDE TREATMENT

APPLICATION					
DATE	OUTFALL	PH (SU)	WATER TEMPERATURE (°F)	TIME START	TIME STOP
	006A	Containment, Page 2 of 2			

DATE	TIME	SAMPLE DATA				
		OUTFALL		DISCHARGE CANAL		
		PH	CU	DO	PH	CU
		RESULTS (SU)	RESULTS (ppm)	RESULTS (mg/l)	RESULTS (SU)	RESULTS (ppm)
5/17/88	1154	9.20		7.6	7.2	<0.005
5/18/88	0749	8.98				
5/19/88	0756	8.85				
5/20/88	0756	8.99				
5/21/88	0756	9.08				
5/21/88	0911	9.16				
5/22/88	0906	9.10				
FLOW SECURED		5-22-88	thru 5/30/88			
5/31/88	0755	9.47				
6/1/88	0756	9.50				
6/2/88	0755	9.44				
6/3/88	0757	9.43				
6/6/88	0756	9.30				
6/6/88	1316		<0.005			
6/7/88	0756	9.17				
6/7/88	0950			6.4	7.1	<0.005
6/8/88	0758	8.96				

DISCHARGE CANAL TEMP. 89.6°F

DISCHARGE CANAL TEMP. 72.5°F *

* Plant Shutdown, thereby Reducing Cooling Water Discharge Temperature

V.C. SUMMER NUCLEAR STATION
NPDES PERMIT SC0030856
ALGICIDE TREATMENT

APPLICATION					
DATE	OUTFALL	PH (SU)	WATER TEMPERATURE (°F)	TIME START	TIME STOP
4/27/88	003B	9.63 @ 0800	69°F	1400	1410

Sunny/windy

DATE	TIME	SAMPLE DATA				
		OUTFALL		DISCHARGE CANAL		
		PH	CU	DO	PH	CU
		RESULTS (SU)	RESULTS (ppm)	RESULTS (mg/l)	RESULTS (SU)	RESULTS (ppm)
5/1/88	0910	9.5				
5/2/88	0745	9.57	0.092			
5/3/88	0748	9.71	0.233			
5/3/88	0404			8.8	7.3	<0.005
5/4/88	0800	9.71	0.167			
5/5/88	0745	9.70	0.114			
5/6/88	0858	9.61	0.077			
5/7/88	0745	9.72				
5/8/88	0755	9.81				
5/9/88	0800	9.89	0.053			
5/9/88	1200		0.030			
5/9/88	1527	10.23				
5/10/88	0745	9.52				
5/10/88	0427	:		7.7	7.2	<0.005
5/11/88	0752	9.61				
5/12/88	0745	9.75				
5/13/88	0745	9.43				
5/14/88	1150	9.95				
5/15/88	1245	9.93				
5/16/88	0755	9.30				

DISCHARGE CANAL TEMP. 83.1°F

DISCHARGE CANAL TEMP. 86.9°F

V.C. SUMMER NUCLEAR STATION
NPDES PERMIT SC0030856
ALGICIDE TREATMENT

APPLICATION					
DATE	OUTFALL	PH (SU)	WATER TEMPERATURE (°F)	TIME START	TIME STOP
	006B	Continued page 223			

DATE	TIME	SAMPLE DATA					
		OUTFALL		DISCHARGE CANAL			
		PH	CU	DO	PH	CU	
		RESULTS (SU)	RESULTS (ppm)	RESULTS (mg/l)	RESULTS (SU)	RESULTS (ppm)	
5/17/88	0757	9.37					
5/17/88	1154			7.6	7.2	<0.005	Discharge Canal Temp. 89.6°F
5/18/88	0745	9.38					
5/19/88	0800	9.41					
5/20/88	0800	9.50					
5/21/88	0800	9.67					
5/22/88	0805	9.71					
5/23/88	0747	9.60					
5/24/88	0803	9.26					
5/24/88	1407			6.7	7.2	<0.005	Discharge Canal Temp. 91.4°F
5/25/88	0800	9.23					
5/26/88	0800	9.41					
5/27/88	0800	9.58					
5/31/88	0800	9.53					
6/1/88	0800	9.58					
6/2/88	0800	9.37					
6/3/88	0800	8.57					
6/3/88	1430	9.38					
6/6/88	0800	9.20					
6/6/88	1310		<0.005				

V.C. SUMMER NUCLEAR STATION
NPDES PERMIT SC0030856
ALGICIDE TREATMENT

APPLICATION					
DATE	OUTFALL	PH (SU)	WATER TEMPERATURE (°F)	TIME START	TIME STOP
	006B	Continued, page 3 of 3			

DATE	TIME	SAMPLE DATA				
		OUTFALL		DISCHARGE CANAL		
		PH	CU	DO	PH	CU
		RESULTS (SU)	RESULTS (ppm)	RESULTS (mg/l)	RESULTS (SU)	RESULTS (ppm)
6/7/88	0950			6.4	7.1	<0.005
6/7/88	1245	9.37				
6/8/88	0400	8.31				

DISCHARGE CANAL TEMP 72.5°F *

* Plant Shutdown, thereby reducing Circulating water discharge temperature

SCE&G
SCANA Company

South Carolina Electric & Gas Company
P.O. Box 88
Jenkinsville, SC 29065
(803) 345-4040

Ollie S. Bradham
Vice President
Nuclear Operations

September 26, 1988

Mrs. Cynthia W. Walters
Division of Industrial and Agricultural Wastewater
South Carolina Department of Health
and Environmental Control
2600 Bull Street
Columbia, SC 29201

Subject: Virgil C. Summer Nuclear Station
NPDES Permit No. SC0030856
Modification to Algicide Treatment
Program

Dear Mrs. Walters:

South Carolina Electric & Gas Company (SCE&G) herein proposes to modify the algicide treatment program at the Virgil C. Summer Nuclear Station (VCSNS) as approved on March 16, 1988 by the South Carolina Department of Health and Environmental Control (DHEC). The modifications as proposed herein are based on an independent study performed by Richard G. Zingmark, PHD, Water Quality Analysts of Columbia, South Carolina (Attachment II). SCE&G requests your approval and comments on the following modifications:

1) Treat the ponds on an individual basis, i.e., treat a single pond as a unit until algae growth is brought under control in the individual unit before proceeding with the treatment to subsequent units.

2) Increase levels of K-tea during treatment to greater than 1 ppm but less than 5 ppm.

3) Secure flow for as long as possible on each pond where flow can be secured, specifically outfalls 006A, 006B, and 008.

4) Monitor the treatment product as copper in accordance with condition 3 of the approval letter of March 16, 1988 in addition to monitoring Cu, DO, and pH at the combined discharge from the Wastewater ponds to the Discharge Canal. The combined flow path is shown on Attachment I.

6) Apply maximum concentration limitations of 0.35 ppm to the outfall of the combined discharge instead of the unit outfall.

7) Continue the program in accordance with conditions 2 and 4 as stated in the approval of March 13, 1988. During periods of time while treatment is in progress, monthly reports will be provided as specified in condition 3 in lieu of an annual report as originally proposed in a letter from SCE&G to DHEC dated September 11, 1987.

In addition to the above, VCSNS is evaluating a reduction in the concentration of pyrophosphate such that introduction of nutrients in the ponds is decreased but corrosion protection within plant systems is maintained. VCSNS has already begun a chemical inventory/control program as a result of the Superfund Amendments and Reauthorization Act (SARA) which, when fully implemented, should limit the use of phosphate based cleaning agents.

Your timely consideration of this matter will be greatly appreciated. Should you have any further questions, please call Deborah Blanks, Licensing Engineer for this project, at 345-4721.

Very truly yours,

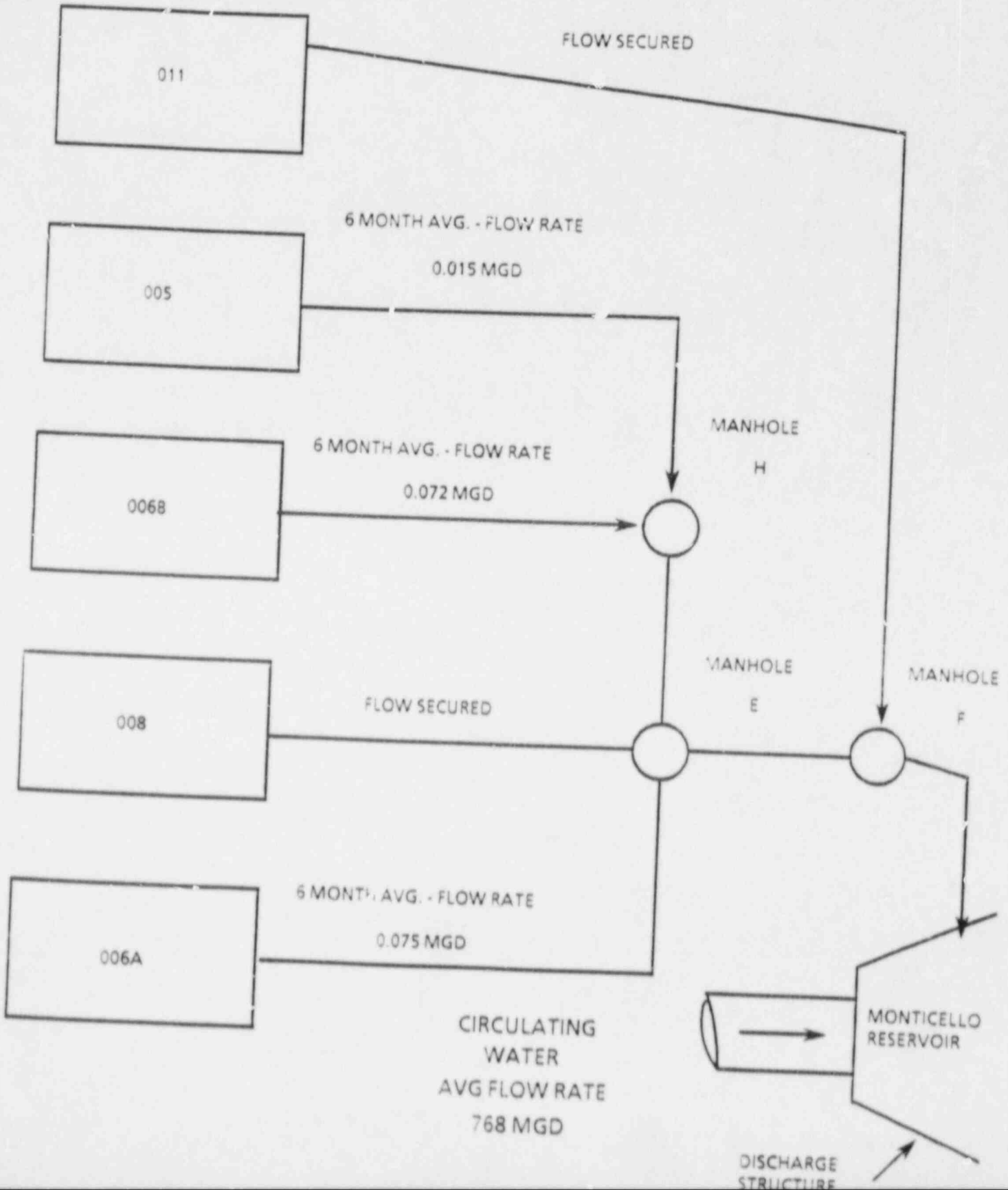
O. S. Bradham

DCB/OSB:lcd
Attachments

c: J. L. Skolds
W. A. Williams, Jr.
M. N. Browne
M. B. Williams
W. R. Baehr
W. F. Bacon
L. A. Blue
S. E. Summer
RTS (EPA 870014)
File (814.07-1a)

ATTACHMENT I

OUTFALL FLOW PATHS



Attachment II

SOLVING THE PROBLEM OF CHRONICALLY HIGH pH IN WASTEWATER PONDS AT THE V. C. SUMMER NUCLEAR STATION (VCSNS)

BY

RICHARD G. ZINGMARK, PHD.
WATER QUALITY ANALYSTS
93 RIVERSIDE CIRCLE
COLUMBIA, SC 29210

Introduction:

Four ponds were constructed about ten years ago to receive and hold wastewater from various parts of the VCSNS. There have been no chronic water quality management problems until recently, when measurements of daily pH in each pond were seen to be above 9.0, the upper pH limit established and mandated by SC DHEC. The rise in pH was coincident with the ponds turning green, presumably due to the growth of algae. Repeated treatment with the usually effective commercial algicide K-TEA (Griffin Chemical Co.), a copper-triethanolamine complex, had measurable but only temporary success in reducing the pH (eg. Fig. 1). Following repeated applications of K-Tea at levels of about 0.35 ppm, daytime pH now typically rises above 9 and frequently above 10. A conference was held with plant Health Physics and Chemistry personnel to learn of past and recent practices of plant operations that might relate to the current wastewater quality. Water samples were taken in each pond and a sampling strategy was established to determine the cause of the problem and to prescribe corrective action. The following is my report and recommendations.

Methods:

An initial site visit was made to the ponds on 9 May 1988, and one liter water and plankton net samples (>15 um) were taken at the inlet and outlet of ponds 005 (sanitary sewage), 006A (Aluminum sludge) and 006B (Plant surge/oil-sludge), and the inlet and only of pond 008 (metal wastes). Samples were transported on ice to Columbia, where water was filtered through glass fiber or millipore filters and subsampled to measure the concentrations of the following dissolved constituents:

Cupric ion
Chlorophyll a
Nitrate/nitrite nitrogen
Ammonia nitrogen
Orthophosphate phosphorus

Slides of live plankton samples were examined using a compound microscope with phase contrast and Nomarski interference contrast optics. Finally, a semidiurnal (twice daily) sampling schedule was initiated to measure dissolved oxygen (DO) and pH at 0600 and 1800 hrs in ponds 005, 006A and 006B initially for 5 days but continuing intermittently through 27 May.

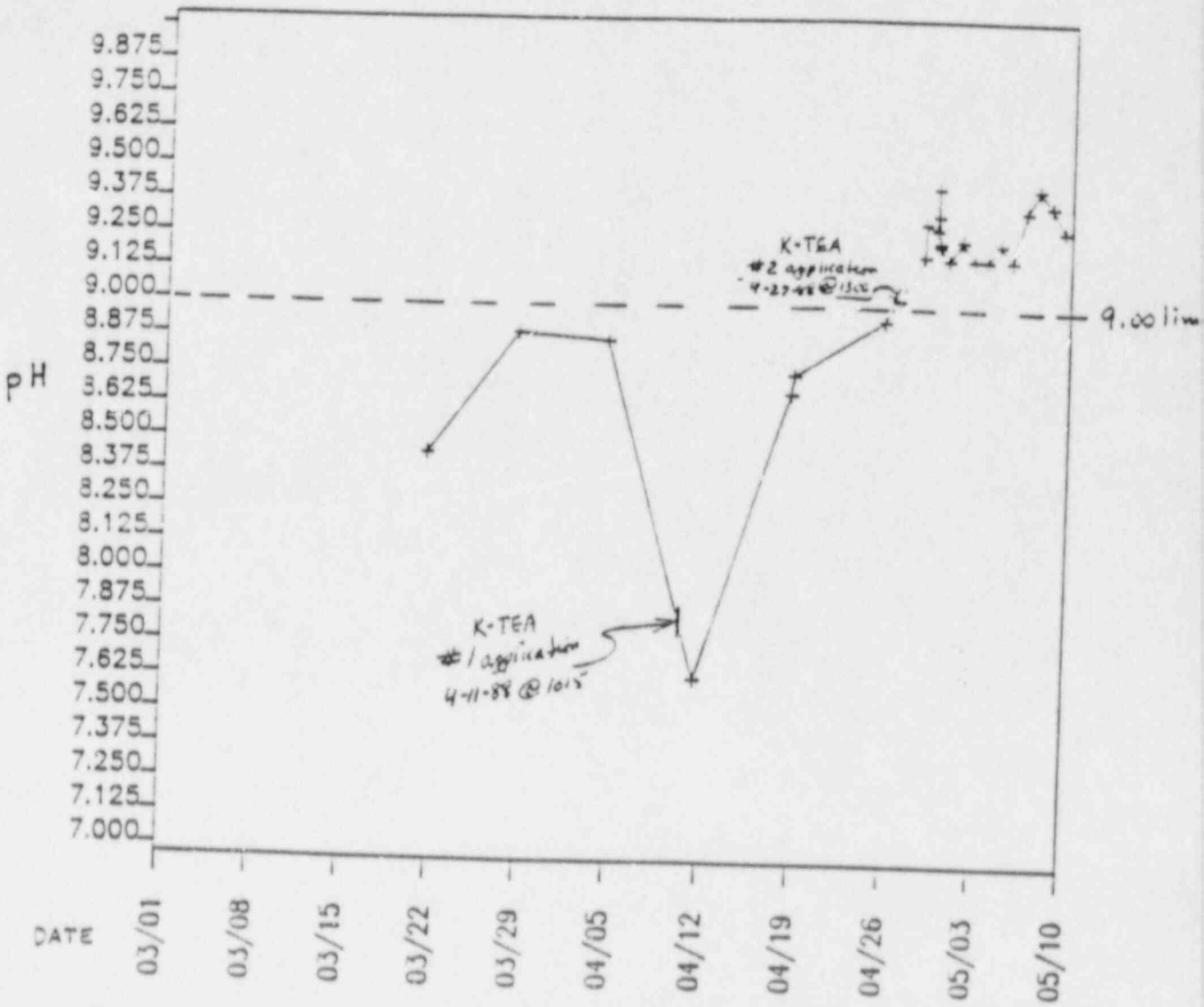


Figure 1. Changes in pH in Pond 006A from March to May, 1988. Arrows indicate dates that copper (as K-TEA) was added at concentrations of about 0.35 ppm.

Results and Discussion:

Plant personnel related several items of information I found to be pertinent to the problem:

1. Previously, corrosion in water pipes was controlled by a polyphosphate compound but only in the filtered drinking water at a concentration of 3-4 ppm in a total volume of approximately 10,000 gal.

2. Corrosion in water pipes has been controlled since April 1987 with 30K (DOW Chemical Co.), an industrial grade of $Na_4P_2O_7$ (tetrasodium pyrophosphate). Pyrophosphate is now used because of its superior properties for sequestering iron. This chemical is put in all filtered water at a concentration of 3 ppm in a total volume of approximately 1 million gallons and can be directed into all the pools, though most ends up in pond 005.

3. K-TEA was used to control algal growth in concentrations of at or less than 0.5 ppm, as mandated by SCDHEC.

4. Canada geese populations are frequent regular visitors to the ponds. Their population numbers have increased steadily since their introduction.

5. The number of plant personnel has increased by about 200 (approximately 25%) in the last year.

During my initial visit to the ponds, I observed the water in ponds 005, 006B and 008 to have a distinctive green to greenish brown color, and concentrated plankton samples were definitely dark green, indicating substantial amounts of phytoplankton (algae), despite the fact that each pond had been treated recently with K-TEA. Subsequent microscopic examinations of the algal species confirmed the abundance of phytoplankton, algae present in each pond (Table 1). The dominant algal genera and most of the species found in the ponds were typical of those characteristic of organically polluted water (Palmer, 1959 and 1969).

Although K-TEA had been added to the ponds as recently as 27 April, cupric ion was at or below 0.1 ppm in all ponds(Table 2, Fig. 2). Losses of copper from the ponds over time were probably due to dilution by incoming flow, active and passive uptake by the resident organisms, and formation of cupric oxide which precipitated to the bottom (Button and Hostetter, 1977).

Chlorophyll A (a quantitative measure of algal biomass) ranged from 18.1 ppb in 006A to 240 ppb in 005 (Table 2, Fig. 3). Typical values in natural waters in South Carolina (such as Lake Monticello) this time of year would average approximately 5-10 ppb (Carr and Associates, 1981). Thus, the green color of the water in each pond was due to unusually high populations of algae.

Table 1. Dominant species of algae collected in each pond on 9 May 1988.

Pond number	Dominant Species
005	Scenedesmus quadricauda var. longispina
	S. acuminatus var. tortuosa
	Ankistrodesmus falcatus var. acicularis
006A	Oscillatoria amphibia
006B	Oscillatoria geminata
	Chlorella vulgaris
	Scenedesmus acuminatus
	S. protuberans
008	Chlorella vulgaris
	Ankistrodesmus sp.

Table 2. Concentration of selected constituents in ponds on 9 May 1988.

Ion	005 inlet	005 outlet	006A inlet	006A outlet	006B inlet	006B outlet	008 inlet
Cu^{++} (ppm)	0.09	0.10	<0.03	0.03	0.04	0.03	<0.03
Chl a (ppb)	240	205	18.1	19.6	67.0	80.9	35.3
NH_4^+ (ppm)	1.30	1.20	0.50	0.40	1.20	1.30	1.00
NO_3^-/NO_2^- (ppm)	0.88	0.87	0.11	0.55	2.20	2.20	0.95
DIN (ppm)	2.18	2.07	0.61	0.95	3.40	3.50	1.95
PO_4 (ppm)	2.45	2.45	0.25	0.25	0.25	0.38	0.25

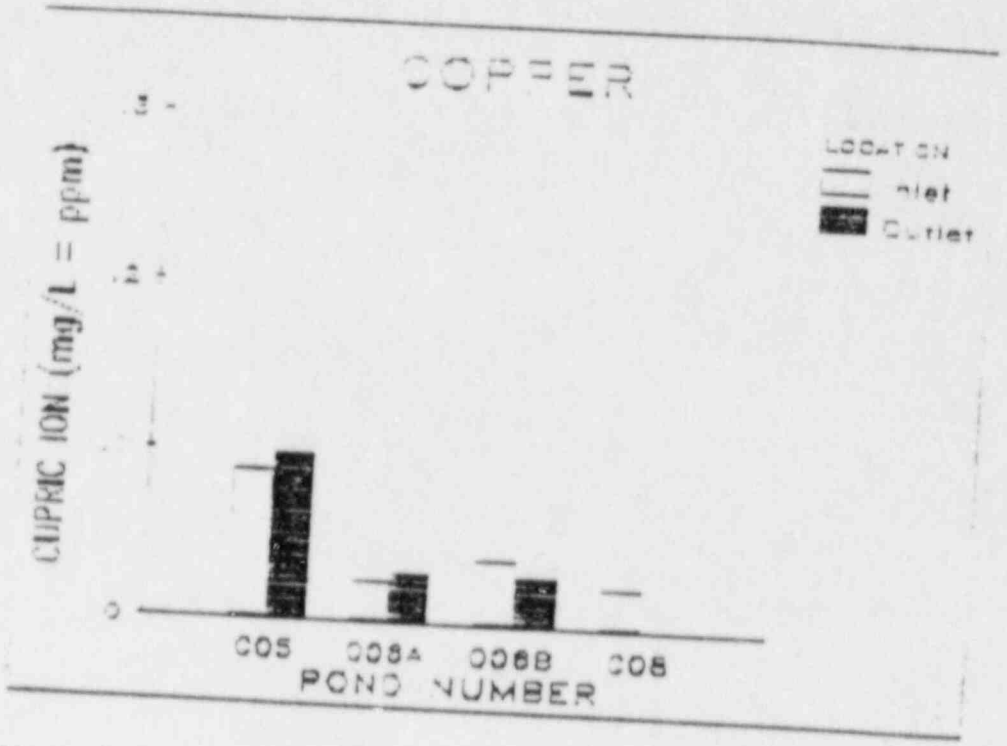


Figure 2. Concentration of copper in each pond on 9 May 1988.

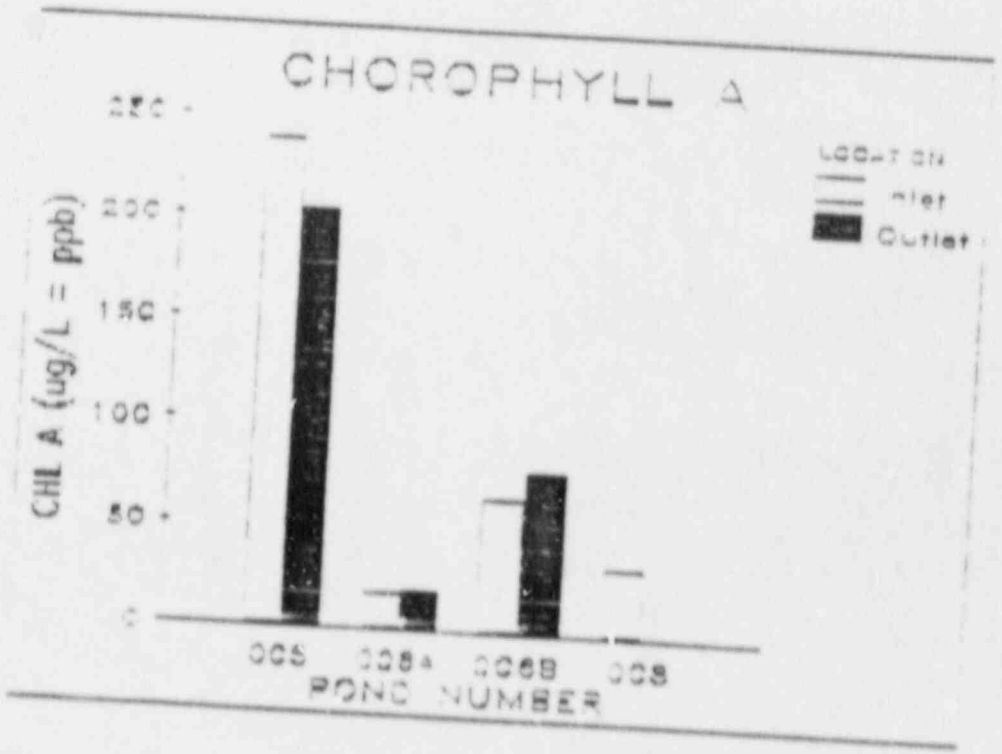


Figure 3. Concentration of chlorophyll a, a measure of algal biomass, in each pond on 9 May 1988.

Ammonia levels ranged from 0.40 ppm in pond 006A to 1.30 p
in ponds 005 and 006B (Table 2, Fig. 4). Nitrate/nitrite rang
from 0.11 ppm in 006A to 3.2 ppm in 006B (Table 3, Fig. 5). A
though algae usually prefer ammonia as a nitrogen source, the
readily take up nitrate. The sums of these sources of dissol
inorganic nitrogen (DIN) ranged from 0.51 ppm in 006A to 3.5
in 006B (Table 3). Typical values for DIN in natural waters
South Carolina this time of year would be about 100-200 ppb,
about 15 times less (Carr and Associates, 1981).

Orthophosphate concentrations ranged from 0.25 ppm in pond
006A, 006B and 008 to an extremely high value of 2.45 ppm in 00
(Table 3, Fig 6). Typical values in natural non-flowing water
this time of year in South Carolina would be expected to be 5-2
ppb, or about two orders of magnitude less. Even in the lowes
concentrations measured of 0.25 ppm, the amount of orthophosphate
is about 12 times that expected in a natural aquatic system
(Wetzel, 1975).

Nitrogen and phosphorous are those chemical elements (i.e.
nutrients) that most frequently limit algal production in aquatic
systems (Wetzel, 1975). The high levels of these elements in the
ponds accounts for the growth and maintenance of the high levels
of algae seen. Domestic sewage typically is high in DIN from
food wastes, urine and fecal matter. And, as the number of plant
personel have increased by about 25% in the past year, it would
follow that so has the amount of domestic sewage. Phosphate con-
centrations would also be elevated in sewage, but not as high as
the levels seen in pond 005. However the addition of large total
amounts of pyrophosphate (which forms orthophosphate later upon
standing) in the plumbing system, explains the high amounts in
005. Previously polyphosphate was used for corrosion control,
which also forms orthophosphate upon standing. But polyphosphate
was applied at a total concentration about 100 times less than is
now being added with pyrophosphate.

While at the ponds I observed numerous juvenile and adult
Canada geese in the vicinity. I was told they are almost always
seen in and around the ponds. Frogs were also seen in abundance,
and tadpoles and juvenile frogs are probably consumed by the
geese. Geese undoubtedly also feed on the rooted vegetation seen
in and around the ponds. Abundant evidence of goose urine and
fecal matter was seen in, on top of and around the periphery of
each pond. Rain washes these wastes into the ponds, though the
magnitude is unknown. I expect the presence of the geese adds
significantly to already high nutrient concentrations and high
algal biomass measured in the ponds. The fact that the numbers
of geese have increased significantly since their introduction
several years ago only exacerbates the problem for the future.

Results of the first 5 days of diurnal DO and pH measure-
ments indicated a highly correlated relationship between changes
in DO and pH (Fig. 7). These results are typical of aquatic en-
vironments that support substantial populations of algae. Algae
consume dissolved carbon dioxide (H_2CO_3 and HCO_3^-) during
daylight hours and generate O_2 as a consequence of photosynthesis

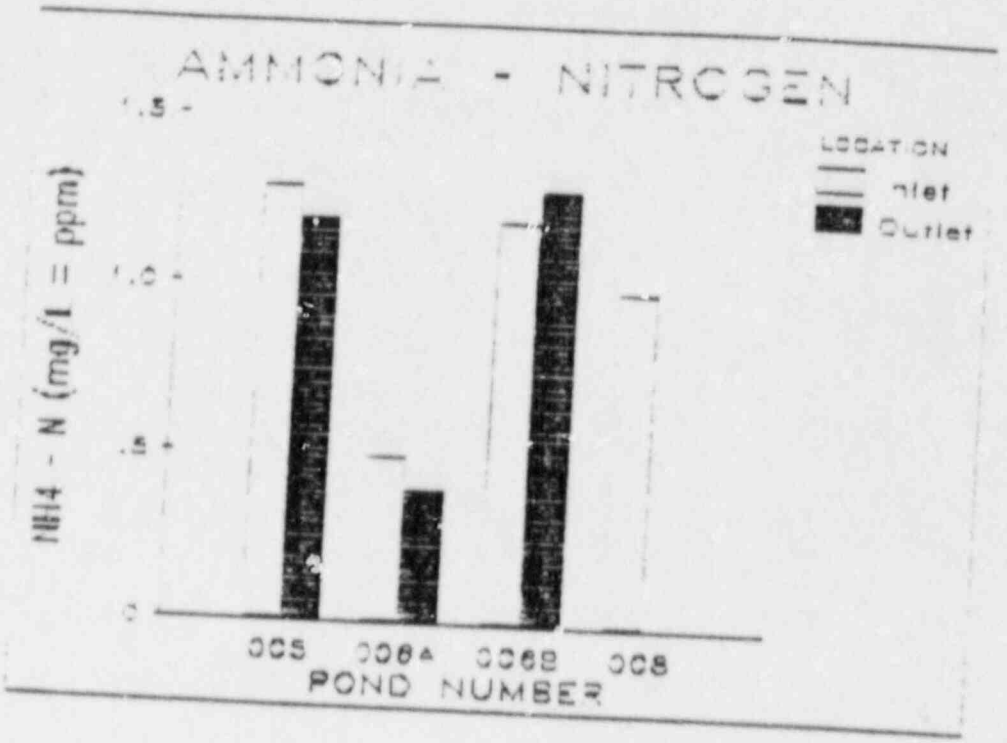


Figure 4. Concentration of ammonia nitrogen in each pond on 9 May 1988

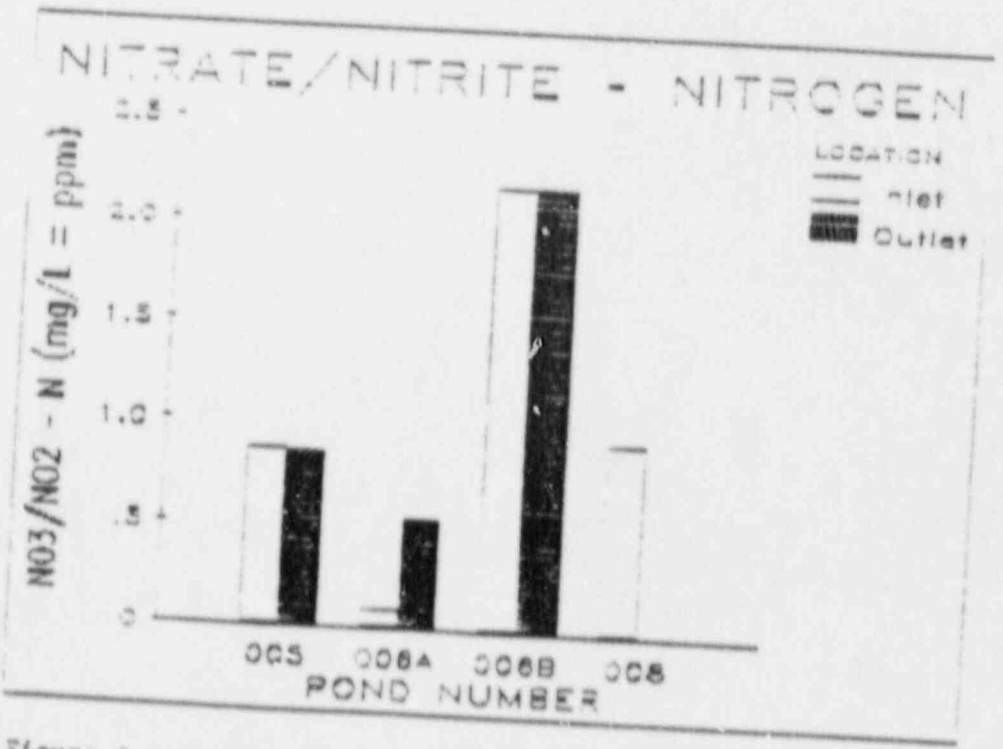


Figure 5. Concentration of nitrate/nitrite nitrogen in each pond on 9 May 1988.

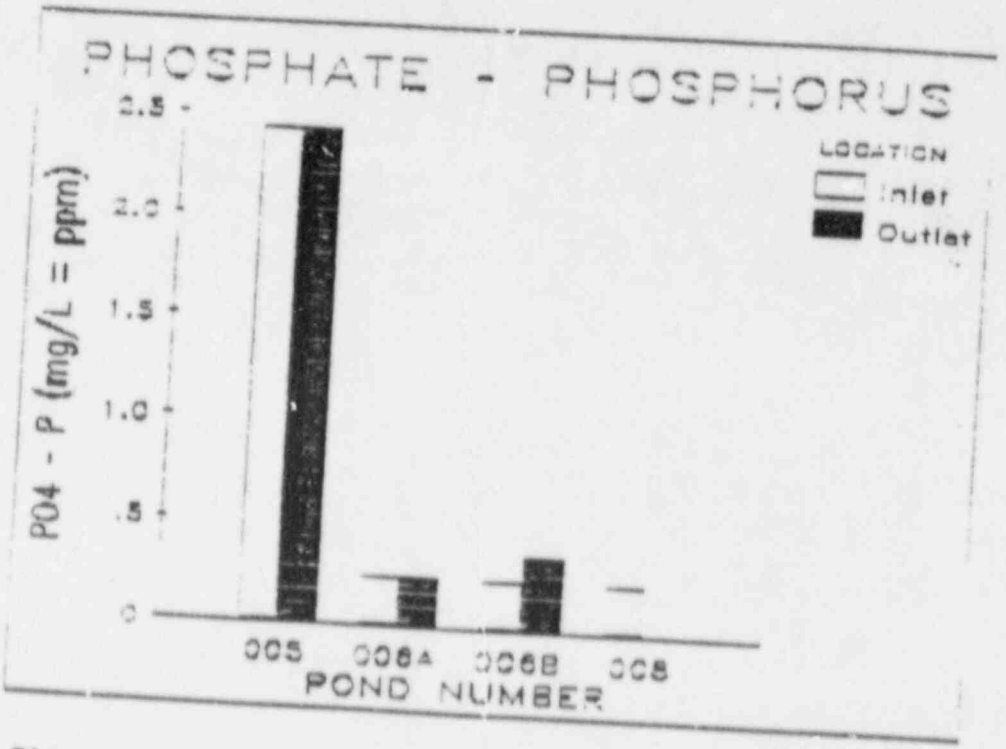


Figure 6. Concentration of orthophosphate phosphorous in each pond on 9 May 1988.

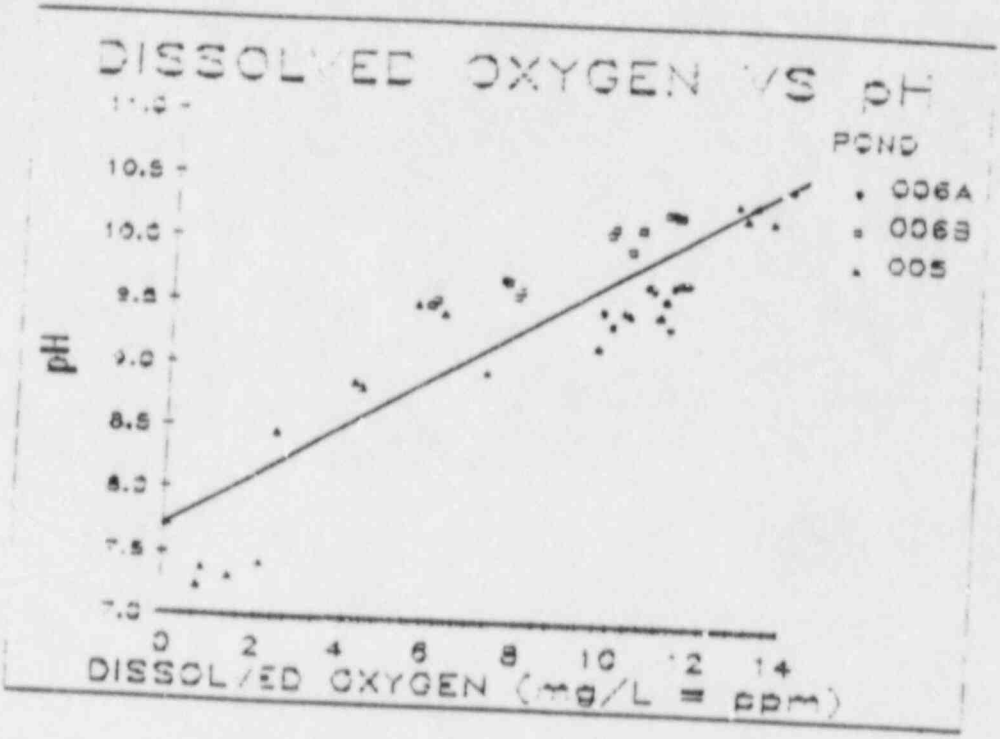


Figure 7. Comparison of dissolved oxygen concentrations and ph in various ponds during 9-13 May 1988. Linear regression analysis: n=42, r^2=0.76.

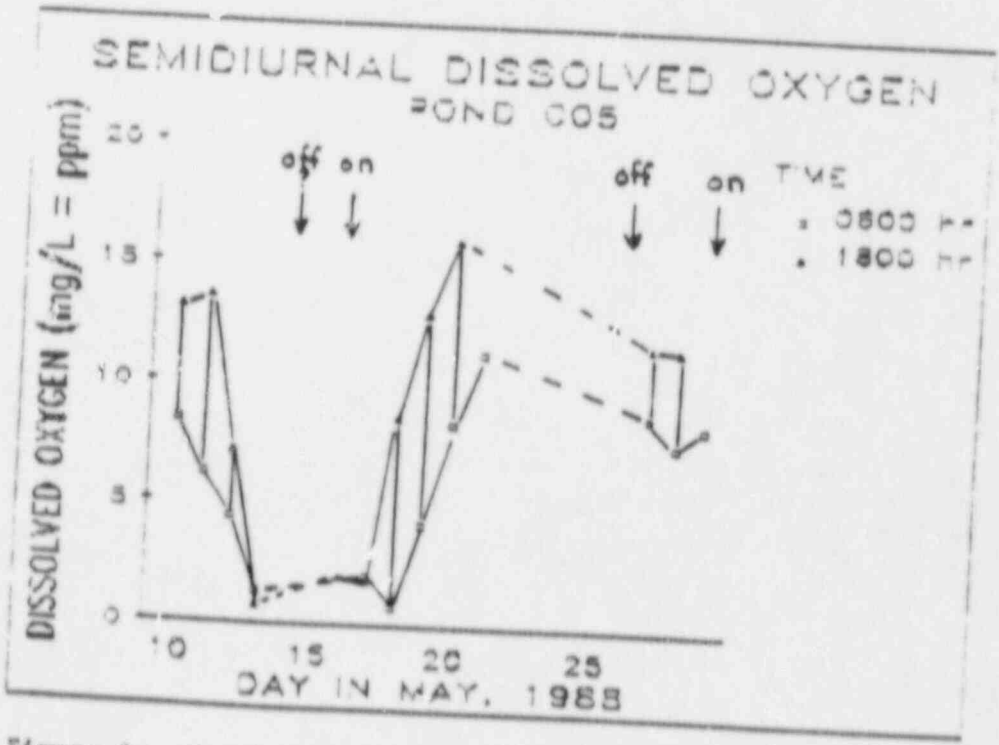


Figure 8. Changes in the ranges of semidiurnal dissolve oxygen (DO) measurements from 9-29 May 1988. Dotted lines indicate possible trends on days when no data

faster than O_2 can be used up by algal, bacterial and ani
aerobic respiration, provided sufficient sunlight is available
maintain algal photosynthesis above the compensation point. T
accounts for the observed rises in DO and pH seen in Table
High DO concentrations provide a suitable environment
desirable aerobic bacteria that decompose organic matter
sewage without giving off objectionable gases such as hydrog
sulfide and methane. At night the algae and other organisms
the ponds consume O_2 and liberate CO_2 as they respire, accounti
for the concomitant declines in pH and DO during the night. Al
although these results showed the same trends in each pond,
plotted separately, linear regression lines would not
identical. This would be expected as each pond contained a di
tinctive algal community (Table 1). The communities we
distinct, as each pond drains from different parts of the pla
and has different chemical characteristics. Because of this t
biological oxygen demand (BOD) was different in each pond.

Subsequent diurnal measurements of pH and DO showed simila
day-night trends. However, oxygen levels in pond 005 droppe
below 2 ppm on 13 and 16-18 May (Table 3, Fig. 3). When th
water is turbid due to living and nonliving suspended organi
matter and the cloud cover is severe as seen on the afternoons o
12, 13, 16 and 17 May, respiration can be greater tha
photosynthesis, O_2 consumption is greater than O_2 production, an
DO levels fall. Most algae cannot survive at such low O_2 levels
which probably accounts for the slow recovery in daily DO in sub-
sequent days as the algae were slow to rebuild their populations.

The high levels of phosphate in the ponds, particularly in
005, was considered excessive. Pyrophosphate is a principal
source of phosphate to the ponds. The addition of 30K was
stopped inadvertently sometime between 13 and 15 May due to a
blocked intake pipe. The blockage was not discovered until 16
May). As DO and pH were not being monitored at that time, it was
not possible to determine the effects of reduced phosphate.
However, the trend for declining DO and pH levels during 10-12
May (Table 3, Fig. 3), suggested phosphate levels might have been
declining before complete blockage.

An experiment was tried to purposely eliminate the addition
of 30K to see if this would result in a lowering of DO and pH.
It was decided to do this during a period when prolonged sunny
weather was forecasted to eliminate the possibility of severe
cloud cover influencing the experiment. One constraint was that
30K could be shut off for only three days (the maximum time that
would still allow for adequate corrosion protection).
Unfortunately, DO and pH were monitored only during the shutoff
period. No measurements were taken the few days before and after
the elimination of 30K (Fig. 3). Thus, the results of this ex-
periment were inconclusive with respect to the effects of added
or eliminated pyrophosphate on DO and pH.

Conclusions and recommendations:

I questioned the necessity of the DHEC mandated pH ceiling
of 9.0 on the ponds' effluents, as their rates of flow and their

Table 3. Measurements of pH and Dissolved Oxygen (DO), measure
twice daily (semidiurnally) during May 1988. DO con-
centrations are in ppm.

Date	Time	Parameter	POND 005 inlet	POND 005 outlet	POND 006A inlet	POND 006A outlet	POND 006B inlet	POND 006B outl
5/09	1800	DO	14.0	13.2	11.8	11.2	10.4	10.
5/10	0600	DO	8.4	8.4	9.8	9.6	8.0	8.
	1800	DO	13.2	12.8	11.4	10.8	11.4	11.
		pH	10.3	10.4	9.7	9.7	10.2	10.
5/11	0600	DO	6.2	5.6	10.4	10.4	7.8	7.
		pH	9.4	9.5	9.5	9.5	9.6	9.
	1800	DO	13.6	13.0	11.4	11.6	11.4	11.
		pH	10.2	10.2	9.7	9.7	10.3	10.
5/12	0600	DO	4.4	2.4	9.8	10.8	7.6	7.
		pH	8.8	8.5	9.5	9.7	9.7	9.
	1800	DO	7.2	4.2	11.2	11.6	10.4	10.
		pH	9.0	8.9	9.6	9.7	10.0	10.
5/13	0600	DO	1.4	2.1	9.7	10.0	5.9	6.
		pH	7.3	7.4	9.2	9.4	9.5	9.
	1800	DO	0.8	0.8	11.4	11.4	10.0	10.
		pH	7.4	7.2	9.4	9.4	10.1	10.
5/16	1800	DO	2.0	2.4	11.6	11.0	11.4	11.
		pH	7.1	7.1	9.5	9.4	10.1	10.
5/17	0600	DO	2.0	2.2	11.2	11.0	8.4	8.
		pH	7.2	7.1	9.2	9.2	9.4	9.
	1800	DO	1.8	3.4	10.4	10.4	11.4	11.
		pH	7.1	7.3	9.5	9.4	10.1	10.
5/18	0600	DO	0.8	0.4	9.2	9.2	7.6	7.
		pH	7.2	7.2	9.0	9.1	9.3	9.
	1800	DO	8.6	7.2	9.8	10.2	13.0	13.
		pH	7.6	7.3	9.0	9.2	9.9	10.
5/19	0600	DO	4.2	2.6	9.2	9.4	8.4	8.
		pH	7.3	7.2	8.7	9.0	9.4	9.
	1800	DO	13.0	14.2	10.8	10.8	13.8	13.
		pH	8.2	7.9	9.3	9.3	10.1	10.

Table 3 continued:

Date	Time	Parameter	POND 003 inlet	POND 003 outlet	POND 006A inlet	POND 006A outlet	POND 006B inlet	POND 006B outlet
5/20	0600	DO	8.4	8.2	9.2	9.4	9.0	9.2
		pH	8.1	7.7	9.0	9.0	9.5	9.5
	1800	DO	16.0	9.1	10.4	10.4	14.1	14.6
		pH	10.0	7.7	8.5	8.5	9.5	9.5
5/21	0600	DO	11.4	11.2	secured flow		9.4	9.8
		pH	9.7	8.9			9.6	9.6
5/27	0600	DO	8.9	7.7			10.1	9.7
		pH	8.5	8.6			9.6	9.6
	1800	DO	11.8	11.2			14.8	14.6
		pH	9.6	9.4			10.2	10.3
5/28	0600	DO	7.7	7.6			7.4	7.0
		pH	8.4	8.5			8.5	8.6
	1800	DO	11.7	13.8			13.8	14.9
		pH	9.9	9.9			10.4	10.3
5/29	0600	DO	8.5	8.1			9.7	9.3
		pH	9.0	9.1			9.4	9.4

total volumes are significantly diluted after they enter th
mixing basin downstream and before they enter Lake Monticello
High pH in itself is not a problem, but those factors that caus
high pH can be. As high pH levels are the result of biologica
activity in response to high nutrients, high nutrient levels
biomass (and perhaps other chemical or biological constituents c
concern) would be in the effluents. Unless the dilution propor-
tion is extremely high (3 or more orders of magnitude), the added
biomass, nutrients and other constituents could eventually inter-
act to cause high algal growths in the mixing basin which in turn
would enter Lake Monticello. This might have adverse effects on
natural food webs in the lake. However, if the dilution rate and
volume are high enough, perhaps VCSNS would be successful in ob-
taining a variance from DHEC's mandate. If SCE&G would like to
pursue this, I could propose a plan to monitor the mixing basin
and lake for signs of excess nutrients and abnormal algal growth.

The following conclusions and recommendations are based on
the assumption that such an appeal would not be successful.

As the various ponds have been used for about 10 years
without chronic pH problems, it is important to focus on what
recent event(s) has/have caused the problem. I am certain the
elevated nutrient levels are the key. However several cir-
cumstances have combined to increase the nutrient load:

1. Increases in sewage flow due to increases in plant personnel.

2. Increase of 100 times the previously added amount of phosphate due to pyrophosphate corrosion control.

3. Increase of nutrients due to the waste matter of geese.

There appear to be two obvious solutions to the problem: 1.
Significantly reduce the sources of nutrients to the ponds, or 2.
kill the algae. Reduction of the nutrients could be accomplished
by one or more of the following:

1. Employ an effective corrosion-inhibiting chemical that is both non-nutritive to algae and non-toxic to organisms downstream. I spoke to Bill Carroll of Betz Chemical Co., who said there may be some polyacrilimide formulations that would be effective anti-corrosion agents.

2. Construct another, larger volume oxidation pond connected to and located downstream from the existing ponds but upstream of the mixing basin to allow additional time and volume for aerobic metabolism of the nutrients in the water.

3. Prevent canada geese from visiting the ponds, by constructing netting or other barrier over the ponds that prevents geese from feeding and swimming in ponds but that still allows sufficient light to enter to for photosynthetic processes to aerate the water.

4. Evaluate the type of cleaning agents used by plant personnel and substitute with effective non-phosphate-based substitutes.

5. Aerate the ponds with carbon dioxide-enriched air to bring down the pH. pH levels rise high when carbon is limiting for photosynthesis. Added CO_2 would have the advantage of increasing photosynthesis without increasing pH and would help produce additional algal biomass, while lowering inorganic nutrient concentrations in the ponds' effluents. CO_2 is expensive however.

Algicides are commonly used to eliminate noxious blooms of algae. Copper is an essential trace element for the growth of algae (Myers, 1962), though in excess it is toxic and has been used to control algal blooms for over 80 years (Moore and Kellerman, 1904). However, some species have higher tolerances than others (Maloney and Palmer, 1956; Erickson et al, 1970). Effective control of those algae typically found in high organically polluted waters, such as the VCSNS ponds, generally require higher applications of copper (Palmer, 1959).

Historically, the form of copper used as an algicide has been applied as cupric sulfate (Moore and Kellerman, 1904), but chelated forms of copper such as K-TEA are often used today. There are many factors that affect the algicical properties of copper, and it is necessary to add more copper in chelated forms than it is in the ionic state (Fitzgerald and Faust, 1963). As previous attempts to control the algae in the VCSNS ponds have had limited success, and if K-TEA must be used, I see no alternative but to increase the copper level above 0.35 ppm. I would recommend a level of at least 1 ppm (and perhaps as high as 5ppm), with repeated applications daily as long as is necessary to keep the copper concentration chronically high, while killing the algae. Copper should be monitored in the pond effluents and in the mixing basin downstream to ensure that high concentrations do not enter Lake Monticello. Once the algal populations have been reduced, frequent applications of copper at reduced levels might maintain continuous control, as algal populations will have a tendency to rapidly re-establish.

Whatever steps are eventually taken to improve the current situation at VCSNS will require a systematic monitoring program to evaluate their effectiveness. I would be available as a continuing advisory consultant to follow up on my report and to assist VCSNS with these efforts.

LITERATURE CITED

Button, K. S., and Hostetter, H. P. 1977. Copper sorption and release by Cyclotella meneghiniana (Bacillariophyceae) and Chlamydomonas reinhardtii (Chlorophyceae). J. Phycol. 13: 198-202.

Carr, J. H., and Associates, Inc. 1982. 1981 Hartwell Lake water quality study. Final Report prepared for U. S. Army Corps of Engineers under Contract DACW 21-81-C-008. 2 Vols.

Erickson, S. J., Lackie, N., and Maloney, T. E. 1970. A screening technique for estimating copper toxicity to estuarine phytoplankton. J. Wat. Poll. Contr. Fed. 42 (No. 8, Pt.2): R270-R278.

Fitzgerald, G. P., and Faust, S. L. 1963. Factors affecting the algicidal and algistatic properties of copper. Appl. Microbiol. 11:345-351.

Maloney, T. E., and Palmer, C. M. 1956. Toxicity of six chemical compounds to thirty cultures of algae. Water Sewage Works. 103:509-513.

Moore, G. T., and Kellerman, K. F. 1904. A method of destroying or preventing the growth of algae and certain pathogenic bacteria in water supplies. U.S. Dept. Agr. Bur. Plant Industry. Bull. No. 54. 44 pp.

Myers, J. 1962. Laboratory cultures. In: Lewin, R. A. (ed.), Physiology and Biochemistry of Algae. NY, Academic Press.

Palmer, C. M. 1959. Algae in water supplies. U. S. Public Health Serv. No. 657, 88 pp.

Palmer, C. M. 1969. A composite rating of algae tolerating organic pollution. J. Phycol. 5:78-82.

Wetzel, R. G. 1975. Limnology. Philadelphia, W. B. Saunder Co., 743 pp.