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1977

ANNUAL ENVIRONMENTAL OPERATING REPORT (NONRADIOLOGICAL)

SALEM NUCLEAR GENERATING STATION – UNIT NO. 1

January 1 through December 31, 1977

Docket No. 50-272
Operating License No. DPR-70

Volume 1 of 3

- GENERAL
- LIMITING CONDITIONS FOR OPERATION
- ABIOTIC ENVIRONMENTAL SURVEILLANCE

MARCH 31, 1978

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GENERAL

LIMITING CONDITIONS FOR OPERATION

ABIOTIC ENVIRONMENTAL SURVEILLANCE

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
80 Park Place
Newark, New Jersey
March 31, 1978

DEC:pac
P78 30 25/30

SALEM NUCLEAR GENERATING STATION
ANNUAL ENVIRONMENTAL OPERATING REPORT
(NON-RADIOLOGICAL)

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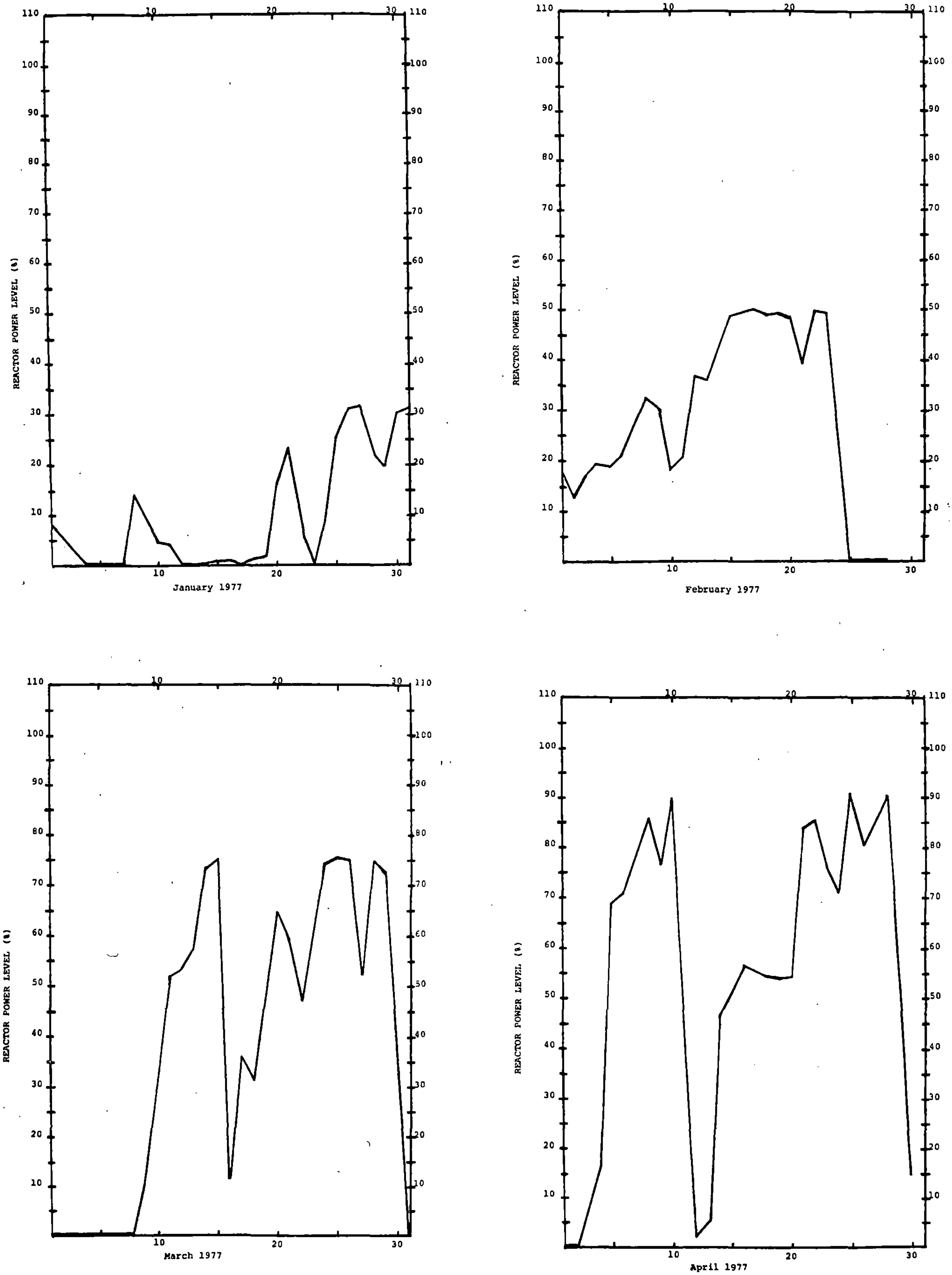
1.0 GENERAL

1.1 Introduction

This report is required by Section 5.6.1.1.1.a of the Environmental Technical Specifications (Appendix B) to Salem Nuclear Generating Station Operating License No. DPR-70. It includes the results of analyses carried out under the nonradiological environmental monitoring requirements described in the Environmental Technical Specifications (ETS). This is the second such Annual Non-radiological Environmental Operating Report. Appendix B became effective on December 11, 1976 at 7:36 p.m. EST when Salem Nuclear Generating Station (SNGS), Unit No. 1, attained initial criticality. Information from December 11 through December 31, 1976 is reported for all required monitoring programs in the 1976 Annual Environmental Operating Report (Non-radiological), April 1977. This report in three volumes covers the same information for the period January 1, 1977 through December 31, 1977.

1.2 Conclusions

During 1977, all environmental monitoring results were within expectations for a single unit under initial operating conditions. Daily average reactor power levels achieved during the reporting period are shown in Figures 1.3-1 through 1.3-3.



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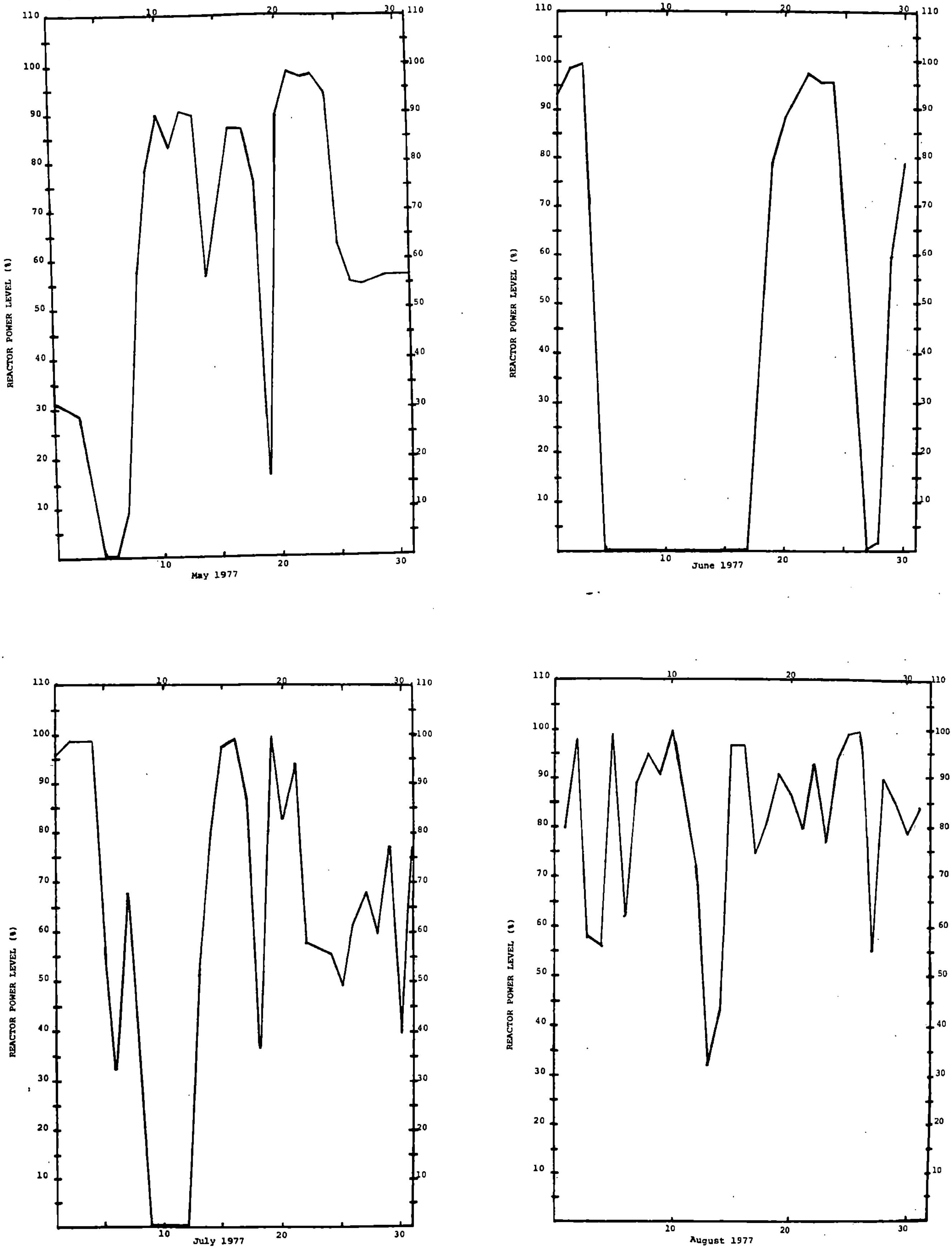
DAILY AVERAGE REACTOR POWER LEVEL 1977

Figure 1.3-1



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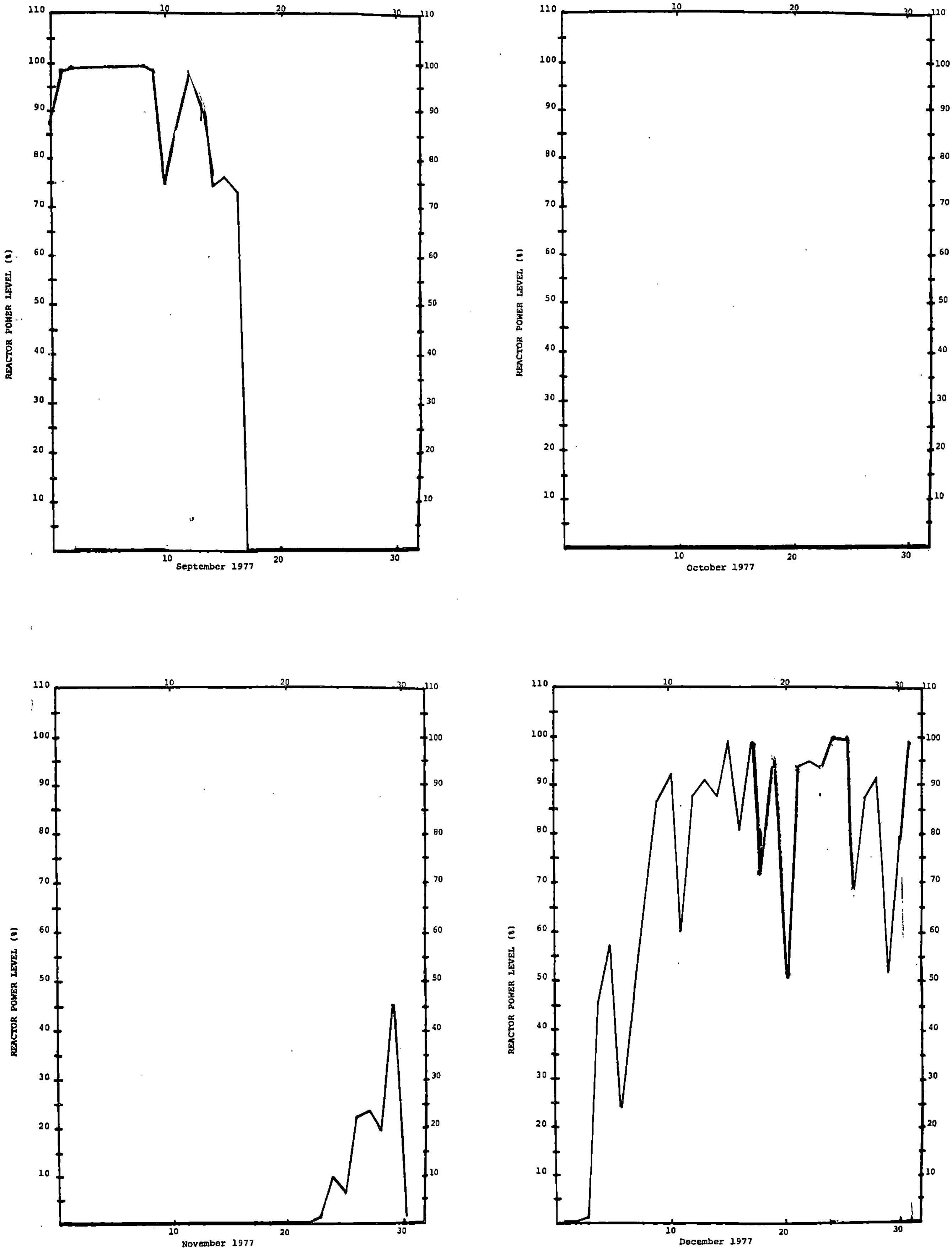
SALEM NUCLEAR GENERATING STATION

DAILY AVERAGE REACTOR POWER LEVEL
1977

Figure 1.3-2



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SALEM NUCLEAR GENERATING STATION

DAILY AVERAGE REACTOR POWER LEVEL
1977

Figure 1.3-3

1.2 Conclusions (Continued)

Plant chemical discharges were made in accordance with the Environmental Technical Specification provisions and chemical usage was compared with predicted waste discharge concentrations. No unusual or significant water quality impacts or chemical concentrations were noted during the period in which estuary water quality samples were taken.

Heat dissipation through the condensers was generally related to reactor power level. Although the circulating water system continued to experience intake screen failure, condenser tube plugging and other startup problems in 1977, the system usually operated within the limiting conditions specified in the Environmental Technical Specification. No environmental impact from the operation of the system was detected in the Delaware River estuary.

The general ecological survey was conducted in accordance with the provisions of ETS Section 3.1.2.1 to determine the effect of plant operation on the ecology of the Delaware River estuary. The 1977 survey resulted in the first complete year of operational data. No significant changes in the ecology of the river in the vicinity of SNGS were observed. Aquatic and terrestrial species

1.2 Conclusions (Continued)

compositions, densities and abundances were within expected ranges when compared to preoperational monitoring data.

The only notable exception outside the normal range of expected values was the number of blue crab, *Callinectes sapidus*, within the estuary. Following a prolonged period of unusually low water temperatures, a 90% reduction in blue crab population level, relative to the 1976 level was noted. The mean catch in 1977 was 5.5 crabs/pot as compared to the preoperational range of 11.7 crabs/pot in 1972 to 21.6 crabs/pot in 1976. The reduction in crab population level was unrelated to Salem operation.

Summaries of monthly impingement and entrainment monitoring data are included as required by ETS Section 3.1.2.2 and 3.1.2.3. The interim impingement program commenced in April and continued through June when the ETS program began and continued through December 1977. The entrainment monitoring program was initiated in August and continued through December 1977.

2.0 LIMITING CONDITIONS FOR OPERATION

2.1 THERMAL

During 1977 Salem Unit No. 1 progressively increased in power level from the test conditions which immediately followed reactor initial criticality in December, 1976. During these early months at low power levels, steam was usually vented to the atmosphere without heat dissipation to the condensers. At certain times heat was dissipated through the condensers without turbine generator operation.

Salem Unit 1 reached the 50% reactor power level on February 16, 1977, the 75% power level on March 14, and finally the 100% power level was obtained on June 1. Operation continued throughout the summer until September 17, when Unit 1 was taken out of service for scheduled maintenance. This outage continued until November 23, when the Station returned to operation. Normal reactor power levels and operating conditions continued through December.

2.1 THERMAL (Continued)

There are three parts to the condenser serving the Salem Unit 1 steam turbine, and each is divided into two separate halves. As required by the ETS, condenser temperatures were monitored at the inlet to each condenser half or shell, for a total of six measurements. Similarly discharge temperatures were measured in each of the six discharge lines.

The Salem condenser monitoring system utilizes probes called resistor temperature detectors (RTD). These RTD's are interfaced with the plant computer which records the condenser temperature readings on an hourly basis. The data are processed to produce the delta T, and maximum discharge temperature information required by the ETS. Whenever the computer monitoring system was out of service, the intake and discharge temperatures were monitored every two hours utilizing local instrumentation located on the condensers.

The results of the temperature monitoring program are summarized in Table 2.2-1. Presented are the average intake, discharge and delta temperatures for the three Unit 1 condenser circuits. The coldest intake temperatures occurred during January while the highest occurred during July. The Station produced the maximum average power output during December, 1977 with additional significant output during the spring and summer. No data are reported for October since, as indicated previously, the Station underwent scheduled maintenance from mid September to mid December. The temperature averages reported for September and November as well as other months during which planned outages occurred, cover only periods when the Station was operating.

TABLE 2.1-1

AVERAGE CONDENSER TEMPERATURES - 1977

Date	Intake Temp. Average* (^{o}F)	Discharge Temperature Average* (^{o}F)	Delta T Average* (^{o}F)
January	31.7	34.6	3.2
February	32.6	43.4	10.8
March	47.6	59.2	12.2
April	55.8	68.1	12.1
May	66.5	77.4	12.2
June	74.7	86.8	12.6
July	81.5	90.6	9.2
August	81.0	94.9	13.9
September	77.7	91.6	13.9
October	-	-	-
November	46.9	52.7	5.7
December	39.9	54.7	14.9

*Average of Condenser Circuits 11, 12, and 13

2.1.1 MAXIMUM DELTA T (Δ T) ACROSS THE CONDENSER

The Station gradually increased power output during the first few months of 1977 and heat rejected through the condensers similarly increased. However, startup problems continued with the circulating water system such that the overall efficiency of the system decreased. Most of the problems were associated with the traveling intake screens or resulted from plugged condenser tubes. Instances did occur when delta T's as indicated by the plant computer did exceed 16.5°F across the Salem Unit 1 condenser for the six circulating pump operating condition (ETS Section 2.1.1.1.a). However, the locations of the condenser outlet RTDs were also such that under certain operating conditions nonrepresentative readings were recorded. In most instances local readings were taken which indicated the condenser delta T to be less than 16.5°F. But applicable delta T limitations were complied with for fewer than six pumps in service (ETS Section 2.1.1.1.b). Corrective action will include moving the RTDs to locations where accurate readings can be obtained. A design change request (DCR) to relocate the instrumentation will be completed in 1978.

2.1.2 MAXIMUM DISCHARGE TEMPERATURE

The circulating water intake temperature reached the maximum during July when the temperature averaged 81.5°F. Although the Station operated at a relatively high reactor power level during most of the month, the maximum discharge temperatures, as specified in ETS Section 2.1.2, were complied with during July as well as during the rest of the year.

2.1.3 RATE OF CHANGE OF DISCHARGE TEMPERATURE

Section 2.1.3 of the Salem ETS requires that "The rate of change of discharge temperature shall not exceed 8°F per hour during normal plant shutdown". In 1977 the Station, during normal power level reductions did not exceed a rate of change of greater than 15% of full power in one hour. This rate of change is substantially less than the 25% which would require additional monitoring. Correspondingly, the specified rate of change requirement was not exceeded and there was no necessity to increase the frequency of discharge temperature monitoring.

Unplanned power reductions did occur because of the need to protect plant equipment or when, for certain reactor safeguard operations, the plant decreased reactor power level rapidly. No cold shock or other environmental impact attributable to shutdown was observed.

2.2 CHEMICAL

The Environmental Technical Specifications require a group of complementary effluent monitoring efforts to enable the assessment of the Station's environmental impact due to the circulating and service water biocide systems and the discharge from the non-radioactive chemical liquid waste basin. These programs involve the analysis of chlorine residual from the operation of the biocide systems and continuous determination of pH and daily measurements of total suspended solids (TSS) in the effluent of the waste basin when discharging. The following sections report the results of these activities between January 1, 1977 and December 31, 1977. A discussion of chemical usage resulting in discharges from the non-radioactive chemical waste disposal system is presented in Section 3.1.1.5.

2.2.1 Biocides

The addition of a biocide to a once through cooling water system at a generating station is necessary to reduce biofouling in pumps, piping, and condensers. Optimally the biocide injection rate should be sufficient to totally preclude the attachment of aquatic and marine growth which reduce system efficiency and performance. To prevent an undesirable effect on the aquatic community surrounding the discharge, limitations are placed on the biocide discharge concentration. This affects the injection rate and strength, minimizing ecological impact while providing adequate protection against biofouling.

Salem Nuclear Generating Station uses sodium hypochlorite (NaOCl) as the biocide for the once through cooling water systems. Chlorination occurs at the intakes immediately behind the vertical traveling screens and effectively eliminates biofouling in the circulating water system (residence time approximately 5 minutes) and in the service water system (residence time approximately 5 minutes).

Both systems are chlorinated a maximum of three times a day and chlorination is limited to thirty minutes per period. The system is designed and operated to prevent

2.2.1 Biocides (Continued)

chlorination of more than three of the six Unit 1 circulating water system intakes at any one time. chlorination of the service water system occurs separately from the circulating water system chlorination cycle.

The biocide system was not placed into service until April 26, 1977. By this time the ambient river water temperature had reached approximately 60°F (16°C) and biofouling was observed. An operating summary of the Salem Unit 1 biocide injection system is given in Table 2.2.1-1.

To reduce the environmental impact in the vicinity of the discharge the chlorination rate for Unit 1 has been selected to produce a relatively low chlorine residual. The Environmental Technical Specifications require that "the concentration of free chlorine in the circulating water system and service water system shall not be greater than 1.0 mg/liter at the outlet of the final heat exchanger." Analyzers for free chlorine residual were operational in 1977 to continuously monitor circulating and service water systems during chlorination.

2.2.1 Biocides (Continued)

During this first full year that Unit 1 was operating, Station personnel were continually adjusting the chlorine injection rate to overcome the chlorine demand and produce an acceptable free chlorine residual. The chlorine demand varies with tide and related water quality changes, amount of chlorine injected, time of contact, pH, and temperature. There were also calibration problems with the free chlorine residual analyzers. Thus there were instances when the ETS limitation of 1.0 mg/liter free chlorine may have been exceeded, based on strip chart records produced by the analyzers.

However, close examination of the data collected from the biological monitoring program indicate no effect on the aquatic community from the biocide system in the vicinity of Artificial Island. In addition, the weekly river biocide surveys taken during periods of chlorination (described in Section 3.1.1.1) never detected a total chlorine residual of 0.1 mg/liter or greater.

PSE&G maintained an average free chlorine residual near 1.0 mg/liter in the above systems. This was confirmed by a mass balance of the total quantity of chlorine injected to the total volume of circulating and service

2.2.1 Biocides (Continued)

water chlorinated in 1977. This analysis, summarized in Table 2.2.1-2, demonstrates that the total amount of chlorine injected and reduced by chlorine demand, would have resulted in a free chlorine residual on the order of 0.8 mg/liter at the outlet of the final heat exchanger. In addition, the free chlorine residual at the release point to the river would be even lower because the system contact (residence) times mentioned above are significantly longer than the time between intake and the point at which chlorine monitoring occurs in the Station.

TABLE 2.2.1-1
1977 OPERATING SUMMARY
BIOCIDE INJECTION SYSTEM

I. CIRCULATING WATER SYSTEM

April 26 - Biocide system placed in service.

September 18 (1) - Biocide system taken out of service.

II. SERVICE WATER SYSTEM

April 26 - Biocide system placed in service.

October 1 (2) - System taken out of service.

November 28 - System placed in service.

December 31 - System continuing in service.

(1) Salem Unit 1 was down for scheduled maintenance for most of September, October, and November. On September 18, repairs to the circulating water biocide system commenced. These repairs continued through December.

(2) Minor repairs were completed on the service water biocide system during October and November.

TABLE 2.2.1-2
CHLORINE USE - 1977
BIOCIDE INJECTION SYSTEM

Total quantity of Cl_2 injected (1)	354,000 pounds
Total volume of circulating and service water chlorinated (2)	1.53×10^{10} gallons

Biocide Injection Rate (3)			2.8	mg/l
Chlorine Demand	(3 min.)	(3,4)	- 1.1	
Chlorine Residual-Combined	(3 min.)	(3,4)	- 0.9	
1977 Average Free Chlorine Residual			0.8	mg/l

(1) 1977 Purchase records and quantity on hand January 1 less quantity on hand December 31, 1978. See Section 3.1.1.5.

(2) Refer to Table 2.2.1-1 for operating schedules.

(3) 1977 Average

(4) Monthly river water survey data (Section 3.1.1.4).

2.2.2 Suspended Solids

Liquid effluents, primarily from demineralizer (DM) regeneration, steam generator blowdown, and steam generator blowdown quench water, empty into the non-radioactive chemical liquid waste basin. The basin allows some suspended solids to settle, enables pH adjustment if necessary, and permits some evaporative cooling of the effluent prior to being discharged to the river.

The basin was operational during Station operation throughout 1977 and effluents containing suspended solids were discharged to the river every month except October when Salem Unit 1 was out of service for scheduled maintenance. Samples for suspended solids were taken from the basin discharge pipe on days when the collecting basin was being discharged. These samples were analyzed for year-end comparison with ETS Specification 2.2.2 which states that "the average suspended solids concentration in the effluent from the non-radioactive chemical liquid waste disposal system shall not exceed 25 mg/liter on an annual basis."

Review of the suspended solids data indicated that the annual average suspended solids content for 1977 exceeded 25 mg/liter. As shown in Table 2.2.2-1 the monthly values from the Salem river water surveys resulted in an annual average of suspended solids released to the river of 63.9 mg/liter. Two Licensee Event Reports (LER 78-09/04L, and LER 78-10/04L) pertaining to the suspended solids monitoring program were consequently filed with the NRC. One identified the fact that the 25 mg/liter annual limiting condition for operation (LCO) was exceeded and the second identified days when suspended solids samples were inadvertently missed.

The 1977 total suspended solids data have stimulated a review of the basin system to develop improvements where necessary. Two reasons for the high suspended solids content were higher steam generator blowdown and demineralizer regeneration flow rates than anticipated which contributed to shorter basin detention times. In addition, the steam generator blowdown quench water is supplied directly by the service water system whose source is the Delaware River. Engineering changes to the nonradiological chemical liquid waste disposal system which should lower the Station's contribution to the basin effluent total suspended solids content are being evaluated. These proposed improvements include a closed recovery system for steam generator blowdown, installation of a closed heater, and the redesign of the waste basin to include coagulation.

It is important to recognize that quench water is supplied directly from the Delaware River. The average total suspended solids content of the Delaware River in the vicinity of Artificial Island for 1977 was approximately 158 mg/liter (Table 2.2.2-2; also see Section 3.1.1.3). Since steam generator blowdown and demineralizer regeneration are similar in volume and since quench water is supplied in approximately equal proportions to blowdown, it is reasonable to estimate that approximately one third of the basin discharge is made up of quench water. Consequently it can be shown that, since the suspended solids content in the quench water is relatively high, the suspended solids contribution from the in-plant blowdown and regeneration systems averages only approximately 17 mg/liter; considerably below 25 mg/liter.

The real purpose of limiting conditions for operation is to protect the environment of the area. The suspended solids content of the ambient river is significantly higher than in the blowdown or regeneration effluents. Furthermore, the field monitoring program conducted in the vicinity of Artificial Island in 1977 detected no environmental impact from the suspended solids released from the non-radiological chemical liquid waste disposal basin.

A change to the ETS suspended solids specification will be requested (with appropriate requests to the agencies administering other related permits) which will take into account the contribution of the higher suspended solids content of blowdown water quench.

TABLE 2.2.2-1
SALEM NON-RADIOACTIVE WASTE BASIN
SUMMARY OF SUSPENDED SOLIDS - 1977

Month	Average Monthly TSS* Concentration (mg/liter)
January	26.8
February	43.8
March	19.1
April	51.6
May	61.9
June	82.1
July	107.4
August	91.2
September	43.0
October	-
November	54.4
December	63.9

11 Month Average = 63.9 mg/liter

*TSS - Total Suspended Solids

TABLE 2.2.2-2
SALEM MONTHLY RIVER WATER SURVEY
SUMMARY OF SUSPENDED SOLIDS DATA - 1977

Date	Discharge Area (mg/liter)	Intake Area (mg/liter)	Outside and Downstream of the Mixing Zone (mg/liter)
February	107	181	65
March	384	226	273
April	226	189	138
May	143	186	137
June	124	152	35
July	64	139	47
August	158	158	110
September	109	96	109
October	59	75	215
November	159	188	190
December	218	301	251
Average	172	159	143

1977 Annual average of total suspended solids (TSS) in the Delaware River = 158 mg/liter.

2.2.3 pH

As discussed in Section 2.2.2, effluents from demineralizer (DM) regeneration, steam generator blowdown, and blowdown quench water empty into the non-radioactive chemical liquid waste disposal basin. Depending upon plant operation, a slightly basic or slightly acidic effluent is discharged to the basin, where pH adjustment occurs if necessary.

Discharges from the waste basin to the Delaware River are controlled by an automatic release system that operates only when the effluent pH of the basin is within an allowable range. Between January 1, 1977 and September 7, 1977, the allowable range was 6.5-8.5. On September 8, 1977 the NRC approved a PSE&G request to expand the pH limits to 6.0-9.0 after mixing with the circulating water discharge stream. Some instances did occur early in the year when the pH was maintained between 6.0-9.0 rather than the narrower approved range in effect then.

As the Salem Unit 1 reactor power level was gradually increased early in 1977, it became apparent that the frequency of makeup demineralizer regeneration and the volume of steam generator blowdown were higher than originally anticipated. Consequently, it became necessary to continue pH adjustment of the waste basin effluent with the addition by contracted services, of a caustic (sodium hydroxide-NaOH) or acidic (sulfuric acidH_2SO_4) solution. This procedure allowed higher volumes to pass through the basin while keeping the pH of the discharged effluent within the limits specified by the ETS.

No influence on the Delaware River or surrounding area from the operation of the non-radioactive liquid chemical waste basin has been detected by any of the ecological or water quality monitoring programs. This is as expected, especially since the waste basin effluent is combined with the much higher volume circulating and service water systems before being discharged to the river.

3.0 ENVIRONMENTAL SURVEILLANCE

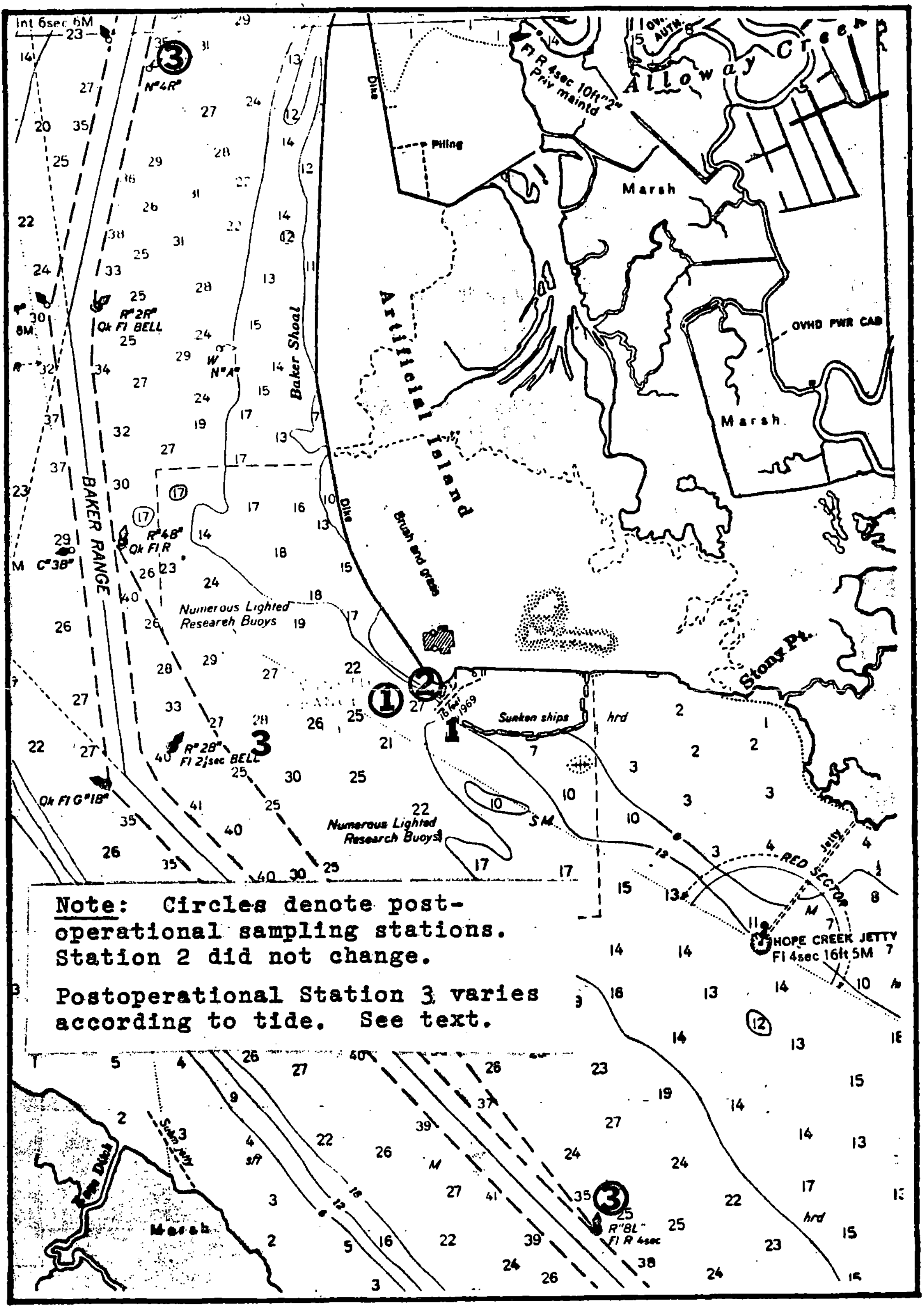
3.1 NONRADIOLOGICAL

3.1.1 Abiotic

From February through December 1977 PSE&G conducted an ambient river water quality sampling and analysis program in accordance with provisions of the Environmental Technical Specifications. In January, weather and ice conditions on the river prevented safe sampling. Where potentially significant data were not taken or are missing (e.g. biochemical oxygen demand, phenols, sodium, potassium, Kjeldahl nitrogen and weekly biocide sampling) an appropriate Licensee Event Report was submitted.

Samples were taken near the intake, the discharge and outside and downstream of the mixing zone (see Fig. 3.1.1-1). The sample from outside and downstream of the mixing zone was actually collected at one of two points, depending on tide. On incoming and high slack tides, the sampling point was buoy N4R, approximately 2-1/2 miles north of the discharge. On outgoing and low slack tides, the same point was buoy R8L, about 2 miles south of the discharge.

Preoperational data were available from three sampling points: one near the present intake, one opposite the Station in the river channel, and one near Sunken Ship Cove (see Fig. 3.1.1-1). Depending on the availability of preoperational data, appropriate comparisons with postoperational data have been made.



Note: Circles denote post-operational sampling stations. Station 2 did not change.

Postoperational Station 3 varies according to tide. See text.

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SALEM NUCLEAR GENERATING STATION

SAMPLING STATIONS

Fig 3.1.1-1

An assessment of Station discharges of identifiable chemicals based on an inventory of chemical usage was also made to highlight levels of discharges whose effects should be evaluated.
Several chemicals were identified whose discharges varied by more than three times the amounts predicted in Environmental Technical Specification Table 3.1-3. None however, produced an impact on ambient water quality identifiable from the preoperational versus postoperational comparisons, nor was any impact indicated by the results of the aquatic ecological monitoring program.

3.1.1.1 Chlorine

In addition to the monthly ambient water quality sampling program, discussed in Sections 3.1.1.2 through 3.1.1.4, Section 3.1.1.1 of the Environmental Technical Specification, requires that "Grab samples shall be taken weekly (weather permitting) during a chlorination cycle and analyzed for free and total residual chlorine." These weekly grab samples, which were taken at the same three locations as the monthly samples (Figure 3.1.1-1), commenced on April 26, 1977. This was in the first full week that Salem Nuclear Generating Station Unit 1 biocide system operated. The chlorine monitoring program continued throughout the remainder of the year except when the circulating and service water chlorination systems were out of service or weather conditions prevented sample collection. A few of the weekly biocide samples were inadvertently omitted. The NRC has been informed through Licensee Event Report 78-20/04L and procedures have been established to correct the situation.

The weekly chlorine samples were normally collected during biocide injection of the circulating and/or service water systems. The ETS requires that the total residual chlorine at a point outside and downstream of the discharge water mixing zone not exceed the ambient total residual chlorine level in the river by more than 0.1 mg/liter.

Results of the weekly chlorine monitoring program indicated that at no time did the total residual chlorine at any of the sampling stations exceed the 0.1 mg/liter value. Therefore, the difference between the total residual chlorine concentration at the "outside and downstream" location (Station #3) and at the "ambient" location (Station #2) is consequently much less than that required by the ETS.

Since the weekly biocide monitoring program commenced in April 1977, these data cannot be compared with any preoperational information. The results collected during 1977 biocide injections clearly indicate that, even at the point of discharge to the river, the total residual chlorine was never greater than 0.1 mg/liter. This leads to the conclusion that the circulating and service water biocide injection rates, coupled with natural chlorine demand of the river water produced low total chlorine residuals. Verification that the biocide treatment system produced a minimal impact on the aquatic environment is made by the fact that no effect was detected by the biological monitoring program.

3.1.1.2 <u>Dissolved Gases</u> (Fig. 3.1.1.2-1)

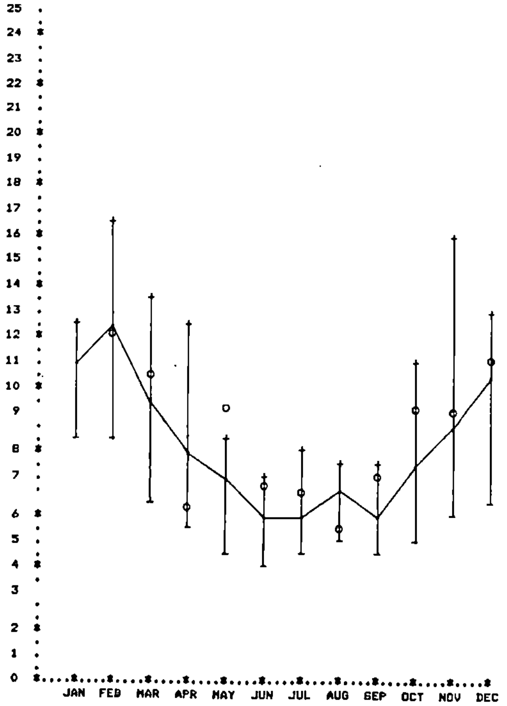
Dissolved oxygen concentrations observed throughout 1977 were generally higher than the preoperational near shore and off shore averages. A low of 5.78 milligrams per liter was observed on April 9 at the sampling point outside and downstream of the mixing zone. The value observed at the discharge on April 9, was 6.12 milligrams per liter. The year's data do not indicate that dissolved oxygen content was significantly reduced between the intake and discharge areas.

No dissolved oxygen concentrations below 6.0 milligrams per liter were observed near the discharge. See Figure 3.1.1.2-1 for a summary of 1977 dissolved oxygen values versus preoperational maximums, minimums, and averages for each month of the year.

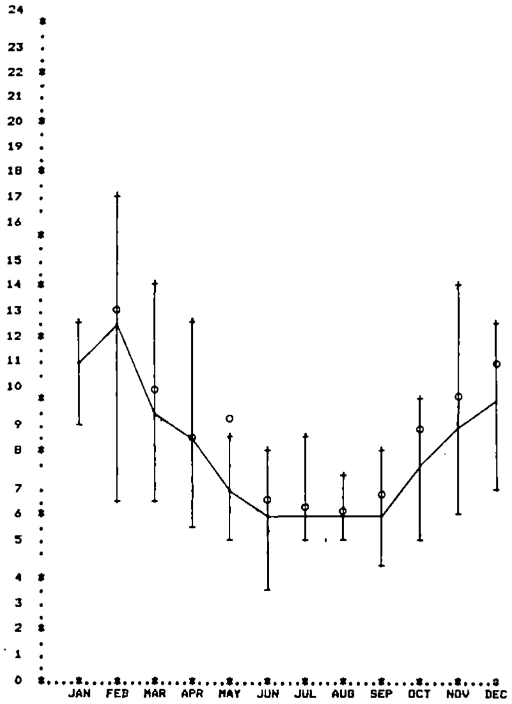
3.1.1.3 <u>Suspended Solids</u> (Fig. 3.1.1.3-1)

Suspended solids concentrations observed throughout 1977 were generally within monthly preoperational ranges except for the sample taken near the discharge on March 22. On that date a suspended solids concentration of 384 milligrams per liter was recorded, with 223 milligrams per liter measured near the intake and 273 milligrams per liter outside and downstream of the mixing zone.

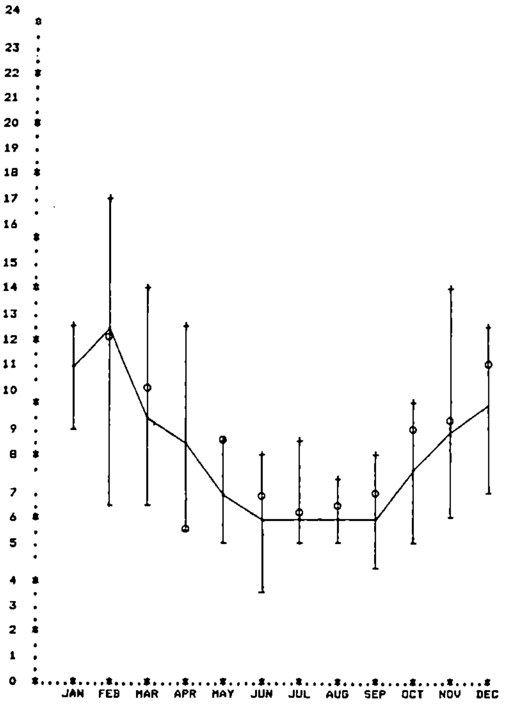
Sampling personnel noted heavy rains preceding and during the March survey. On the same day the discharge from the nonradioactive liquid waste disposal basin contained 47.0 milligrams per liter suspended solids. Therefore, it is concluded that the suspended solids concentrations mentioned above were due to natural variations.



DISSOLVED OXYGEN AS O2.... INTAKE AREA



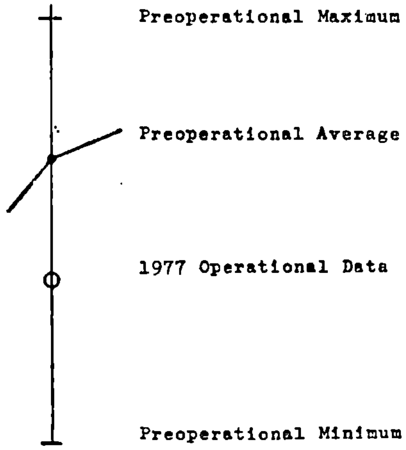
DISSOLVED OXYGEN AS O2.... DISCHARGE AREA



DISSOLVED OXYGEN AS O2....

OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

KEY TO GRAPHICAL SYMBOLS



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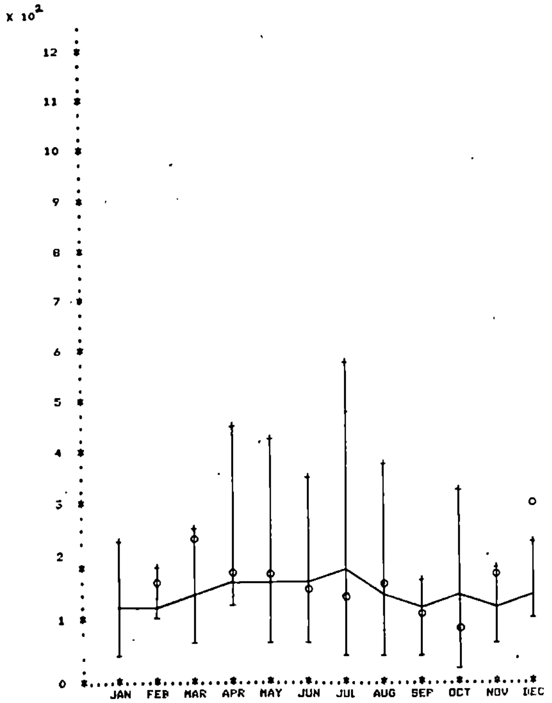
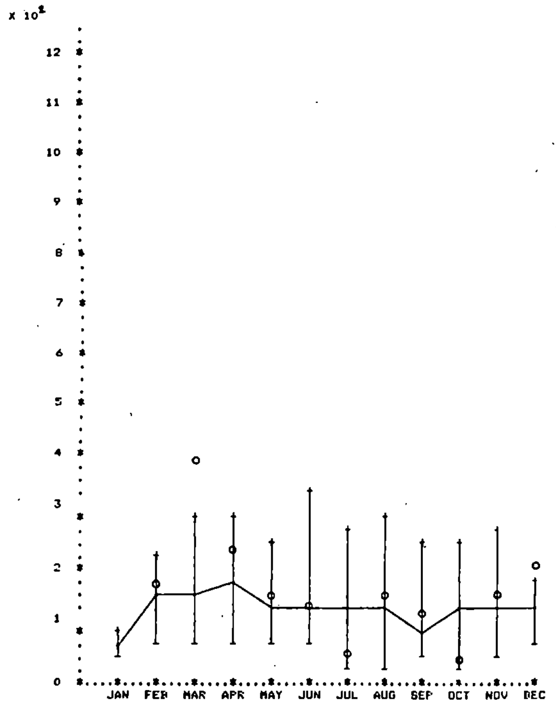
DISSOLVED OXYGEN AS O_2
(mg/l)

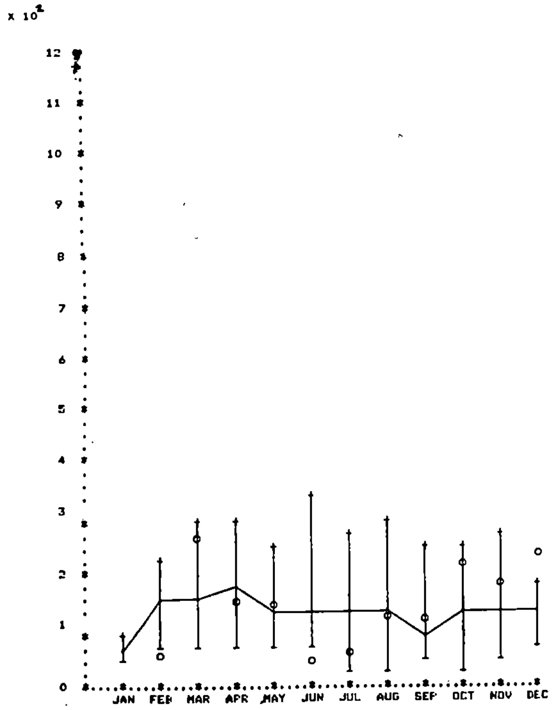
FIG. 3.1.1.2-1



SOLIDS, FILTRABLE, SUSPD AS TSS.. INTAKE AREA

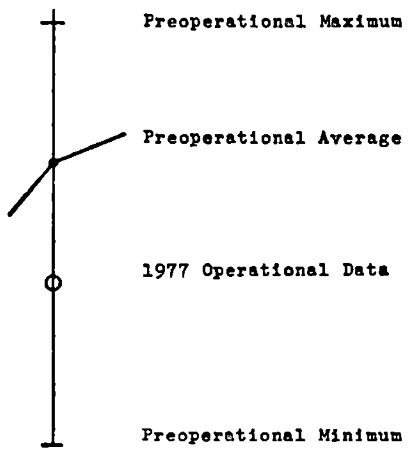


SOLIDS, FILTRABLE, SUSPD AS TSS.. DISCHARGE AREA



SOLIDS, FILTRABLE, SUSPD AS TSS..
OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

KEY TO GRAPHICAL SYMBOLS



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SALEM NUCLEAR GENERATING STATION

SUSPENDED SOLIDS AS TSS
(mg/l)

Fig. 3.1.1.3-1

No other significant increases in suspended solids concentrations between intake and discharge areas were observed.

Since preoperational values as high as 550 milligrams per liter were observed (July 1968) and since natural variation from one point to another may be substantial, it is recommended that the establishment of reporting levels be deferred at least one more year.

3.1.1.4 Other Chemicals

A broadly based group of water quality parameters has been measured since 1968. Some are good indicators of potential power plant impacts while others are more representative of the general condition of an estuary such as the Delaware.

Approximately six months have elapsed since Unit 1 achieved consistent full power operation. In accordance with Environmental Technical Specification Section 3.1.1.4 (Bases), the following parameters have been shown to be not significantly affected by Station operation and will be recommended for deletion from the annual reporting requirement in a forthcoming ETS change request:

1. Methyl Orange Alkalinity
2. Phenolphthalein Alkalinity
3. Free Carbon Dioxide
4. Total Volatile Solids
5. Silica
6. Total Organic Carbon
7. Reducing Substances
8. Sulfides
9. Zinc
10. Chromium
11. Manganese
12. Phenols

The detailed sections supporting the above recommended list are found below. As for reporting levels recommended for the remaining group, PSE&G recommends deferring their establishment at least one more year to develop a broader postoperational base of data.

3.1.1.4.1 Saline/Fresh Water Relationships (Figs. 3.1.1.4.1-1 through 3.1.1.4.1-6).

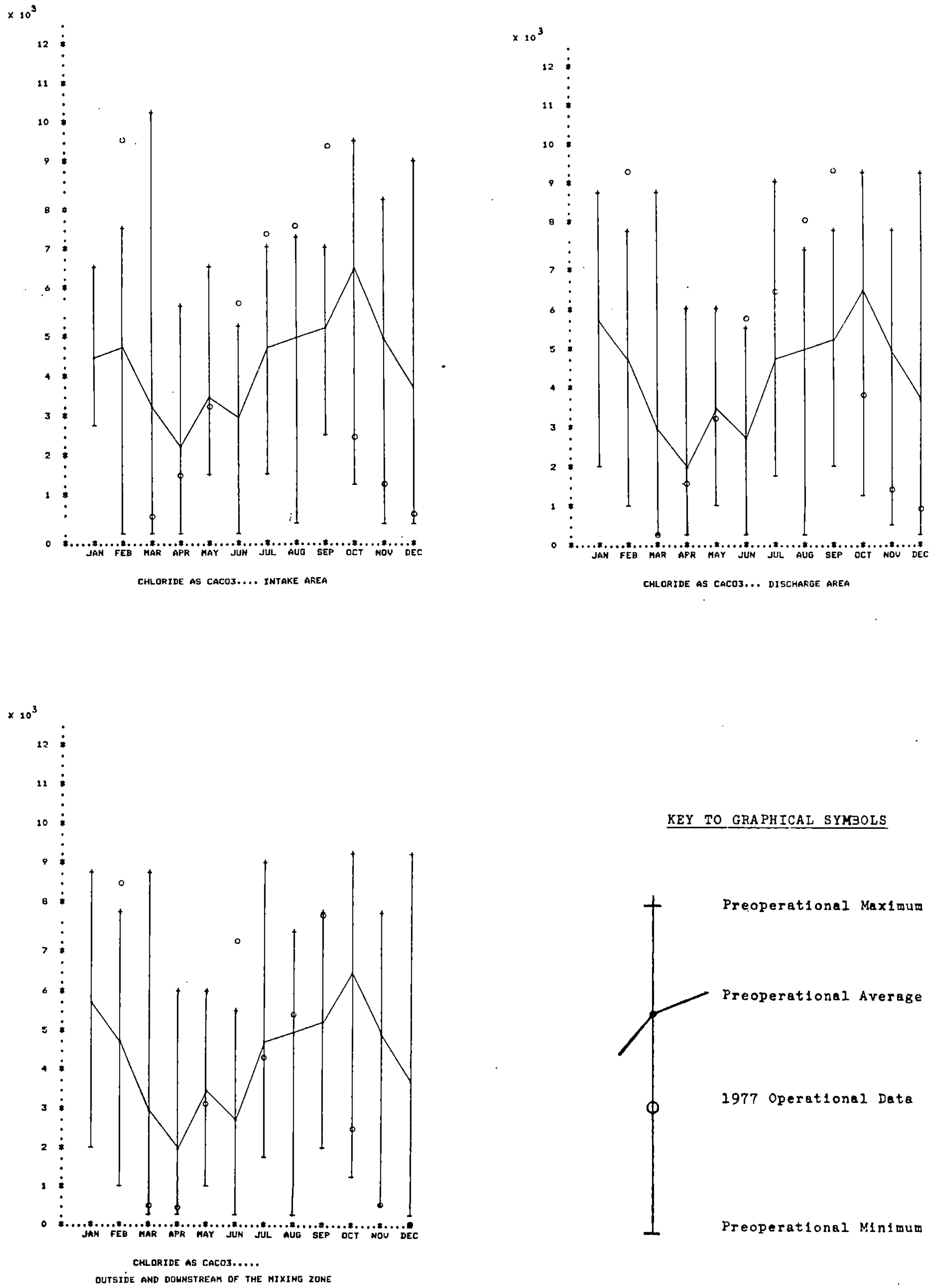
The Delaware River near Artificial Island exhibits substantial tidal mixing. This leads to limited vertical stratification of salinity and a spectrum of salinity related chemical concentrations depending on season, fresh water runoff, and tidal stage. A typically wide range of values for the following salinity-related chemical parameters was observed in 1977.

Chloride varied from well below 1,000 milligrams per liter as calcium carbonate to nearly 10,000 milligrams per liter. The typical seasonal pattern of low values in the spring followed by higher summer concentrations was observed at all three sampling stations. Instances where chloride concentrations in the discharge area exceeded preoperational ranges were accompanied by corresponding high values at the intake.

Note - for chloride as NaCl multiply values given by 1.17.

Conductivity ranged from below 500 umho to above 15,000 umho. The typical seasonal pattern described above was observed at all locations. All values recorded were below preoperational maximums and were strongly influenced by fresh water runoff (e.g. March). In view of the broad natural variation, discharge area values were not significantly higher than those recorded near the intake.

Sulfate values were recorded between approximately 45 and 1,100 milligrams per liter as calcium carbonate. Except for February, values compared favorably with preoperational



CHLORIDE AS CACO3.... INTAKE AREA

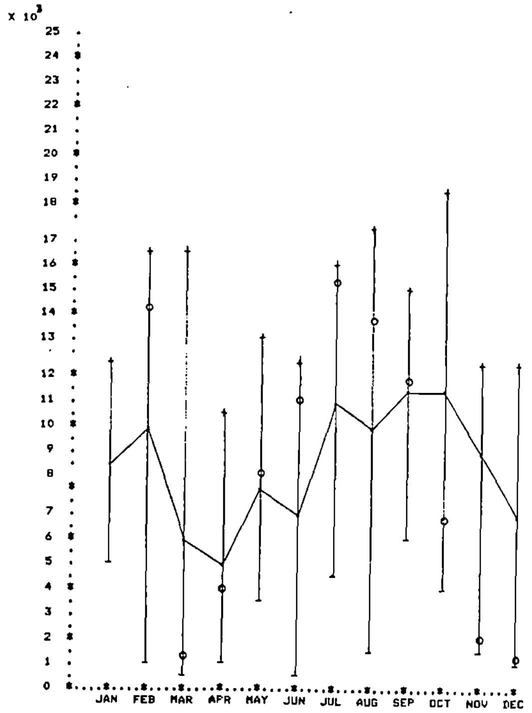
CHLORIDE AS CACO3... DISCHARGE AREA

CHLORIDE AS CACO3.....
OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

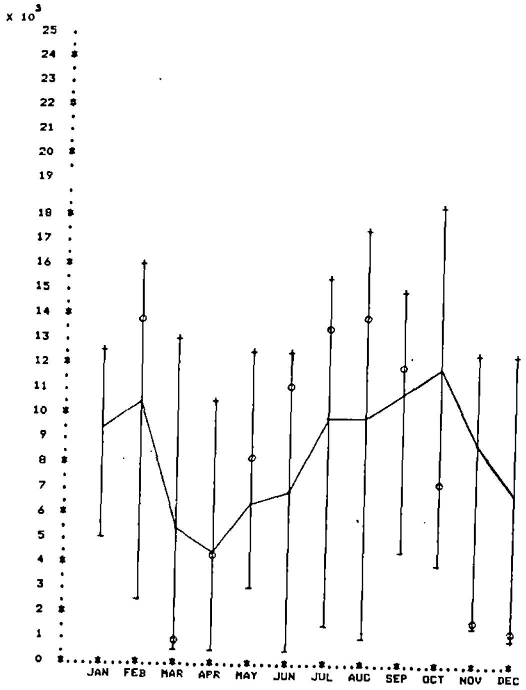
PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SALEM NUCLEAR GENERATING STATION

CHLORIDE AS $CaCO_3$
(mg/l)

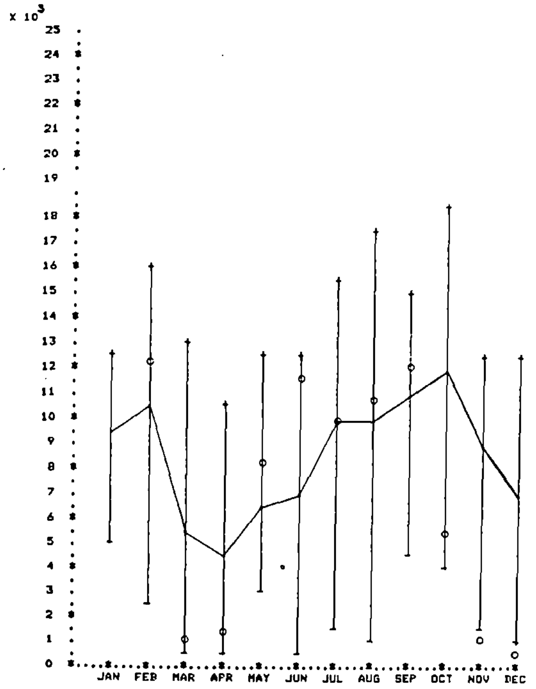
FIG. 3.1.1.4.1-1



CONDUCTIVITY AS UMHOS.. INTAKE AREA



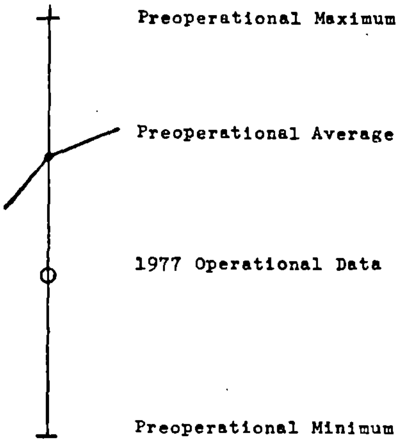
CONDUCTIVITY AS UMHOS... DISCHARGE AREA



CONDUCTIVITY AS UMHOS.....

OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

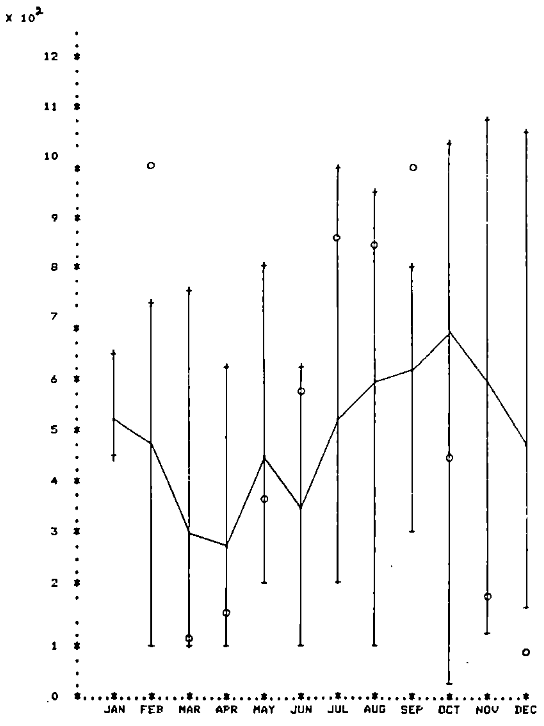
KEY TO GRAPHICAL SYMBOLS



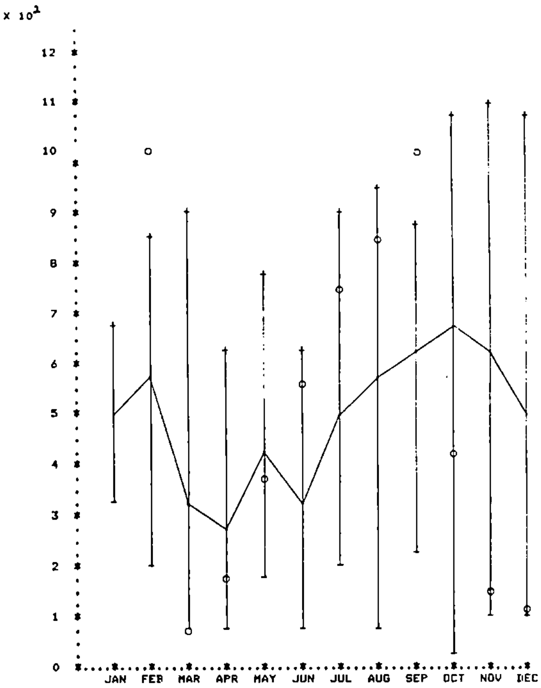
PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SALEM NUCLEAR GENERATING STATION

CONDUCTIVITY AS UMHOS

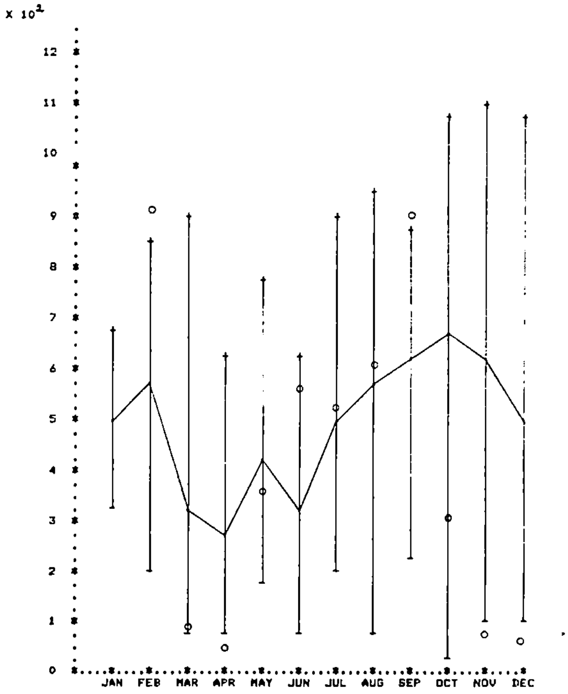
FIG. 3.1.1.4.1-2



SULFATE AS CACO3....INTAKE AREA

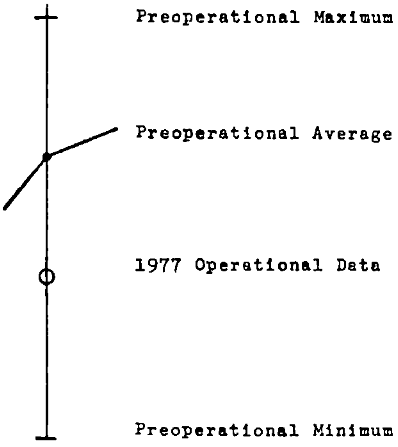


SULFATE AS CACO3.. DISCHARGE AREA



SULFATE AS CACO3....
OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

KEY TO GRAPHICAL SYMBOLS



PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SALEM NUCLEAR GENERATING STATION

SULFATE AS $CACO_3$
(mg/l)

FIG. 3.1.1.4.1-3

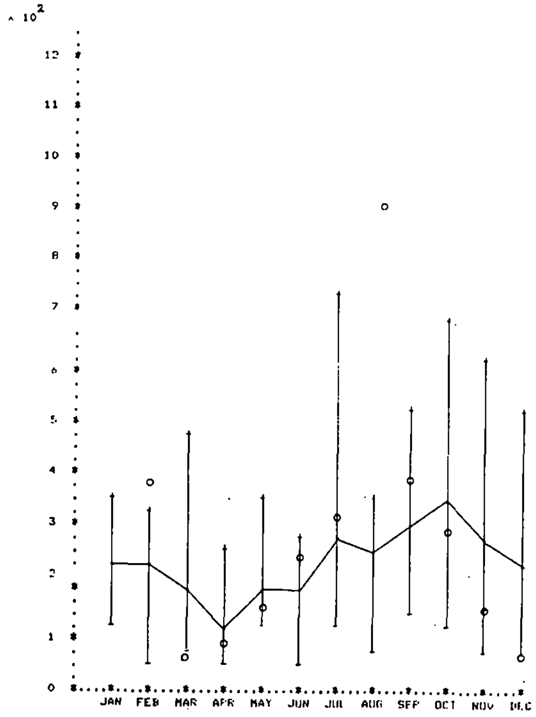
ranges and trends. In February values of 1,033, 1,006 and 910 mg/l were obtained at the intake, discharge and downstream areas respectively. Such high values are normally observed in the fall. However, since the intake and discharge area values are comparable no Station impact is inferred.

Note - For sulfate as SO_4 multiply values given by 0.96.

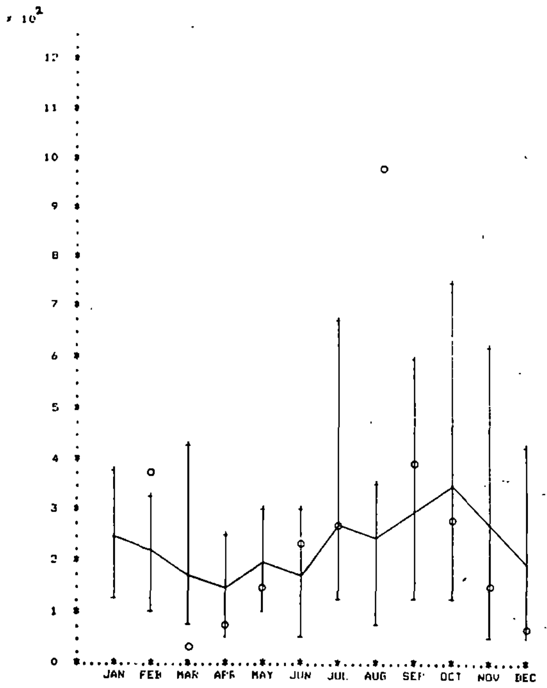
Calcium concentrations as calcium carbonate followed previously observed seasonal trends and remained within or near preoperational ranges for all months except August. Although sampling personnel noted no unusual river conditions, calcium values on August 30, exceeded all preoperational maximums (920 milligrams per liter at the intake, 980 milligrams per liter at the discharge, and 840 milligrams per liter outside and downstream of the mixing zone).

Since all three calcium values were high in August, and since the other intake/discharge area relationships for calcium appear to be within the range of natural variation, Station impact on river calcium levels is interpreted to be negligible.

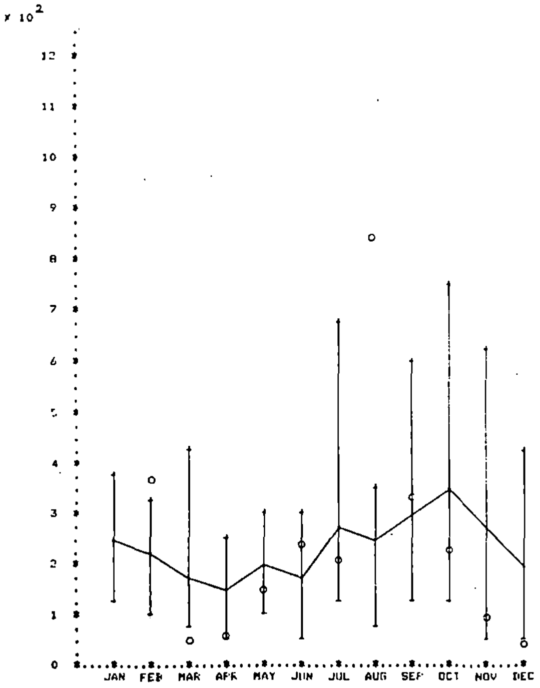
Magnesium measured as calcium carbonate ranged from below 20 to nearly 2,300 milligrams per liter and reached a seasonal peak several months earlier in 1977 than had been preoperationally observed. Thus, preoperational maximums were exceeded several times at all three stations. On September 13, the magnesium concentration near the discharge was 2,045 milligrams per liter, 67% higher than the value near the intake or outside and downstream of the mixing zone.



CALCIUM AS CACO3.... INTAKE AREA



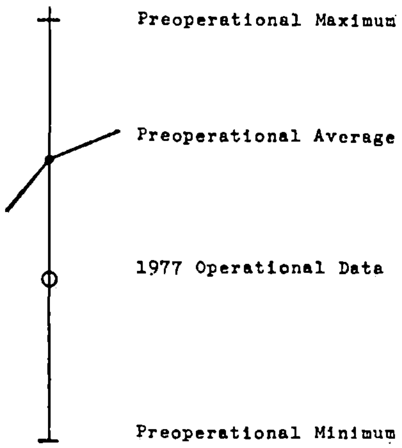
CALCIUM AS CACO3... DISCHARGE AREA



CALCIUM AS CACO3.....

OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

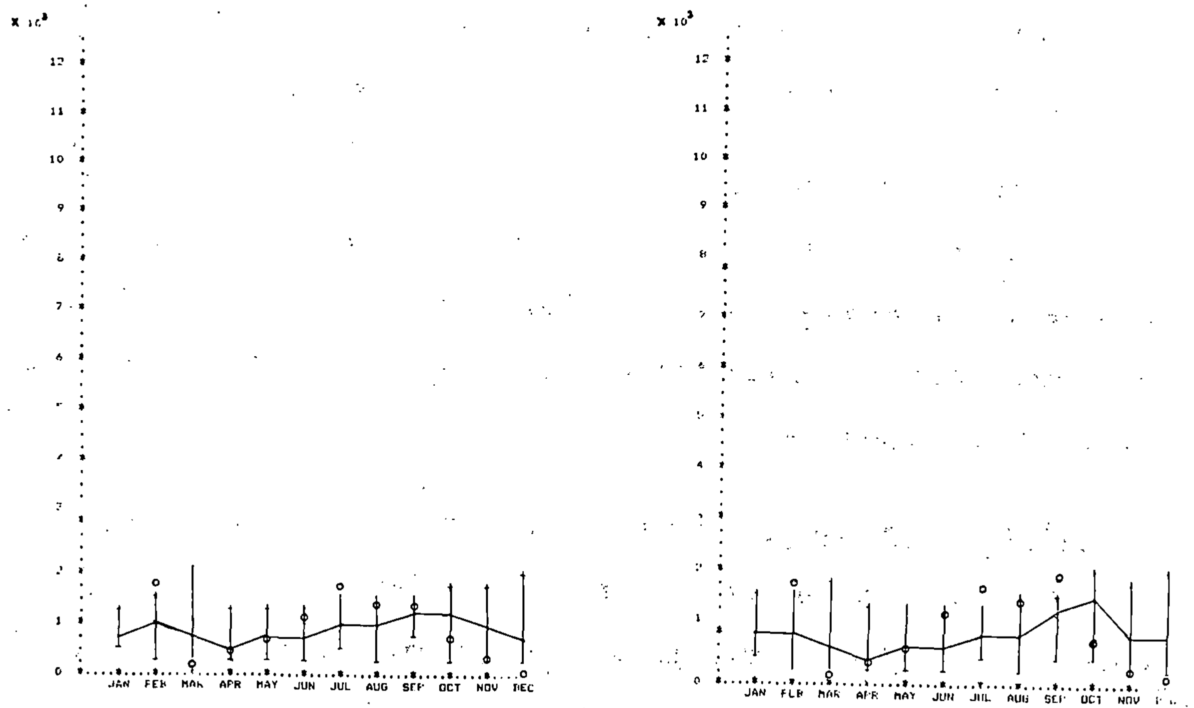
KEY TO GRAPHICAL SYMBOLS



PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SALEM NUCLEAR GENERATING STATION

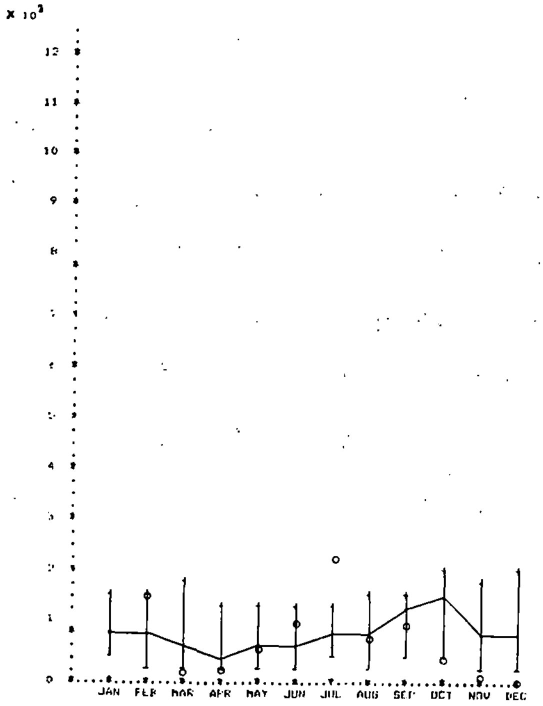
CALCIUM AS CACO$_3$
(mg/l)

FIG. 3.1.1.4.1-4



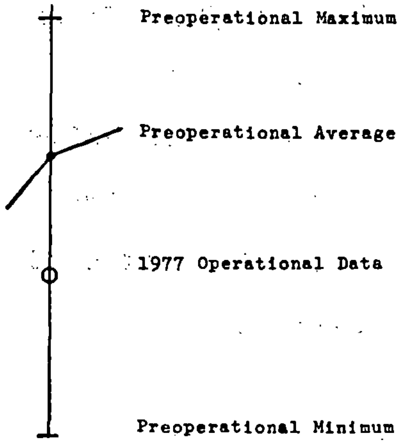
MAGNESIUM AS CACO3.... INTAKE AREA

MAGNESIUM AS CACO3.... DISCHARGE AREA



MAGNESIUM AS CACO3....
OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

KEY TO GRAPHICAL SYMBOLS



PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SALEM NUCLEAR GENERATING STATION

MAGNESIUM AS $CACO_3$
(mg/l)

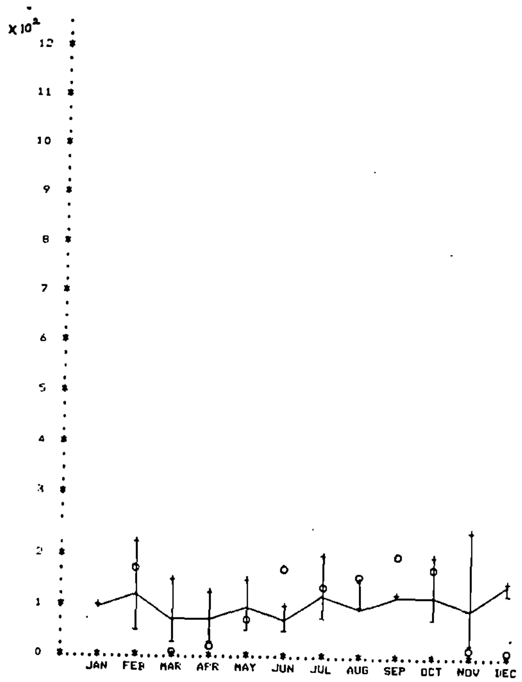
FIG. 3.1.1.4.1-5

But on July 19, the situation had been nearly reversed, with the discharge area concentration below that of the intake area and only 73% of the value found outside and downstream of the mixing zone.

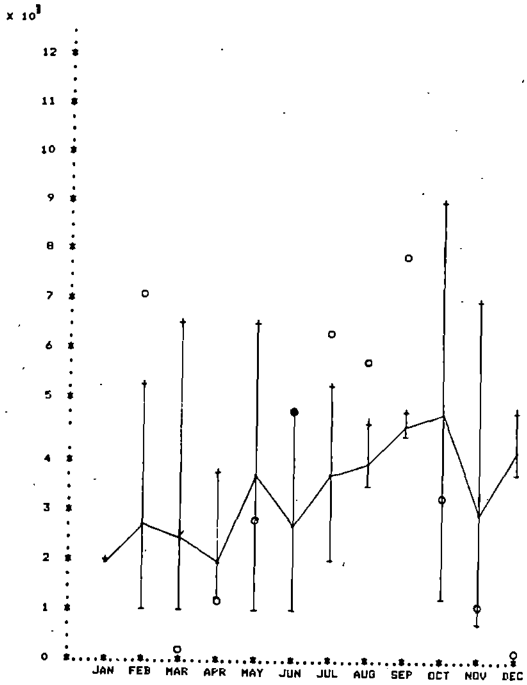
Since the Station does not discharge significant quantities of magnesium (See Section 3.1.1.5) and since preoperational data occasionally showed wide variations among stations, it is concluded that the Station had no significant impact on the ambient river magnesium levels.

Sodium and potassium concentrations as calcium carbonate were measured since October 1972 only at one station, near Sunken Ship Cove, during the preoperational program. During 1977 sodium and potassium concentrations were determined for the discharge area only, except for July when all three stations were sampled. Licensee Event Report 78-19/04L discusses the missing data and their significance.

1977 sodium and potassium values from the discharge area appeared to lie within reasonable seasonal ranges if allowance is made for the small preoperational data base (only three preoperational values each are available for the months of July and August, and only two for September). The pattern followed by sodium and potassium appears to match well with that exhibited in 1977 by chloride, and conductivity, for which much more preoperational data are availble.

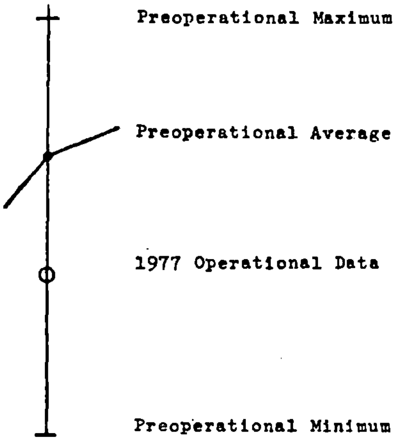


POTASSIUM AS CACO3.. DISCHARGE AREA



SODIUM AS CACO3... DISCHARGE AREA

KEY TO GRAPHICAL SYMBOLS



PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SALEM NUCLEAR GENERATING STATION

SODIUM AND POTASSIUM AS $CACO_3$
(mg/l)

FIG. 3.1.1.4.1-6

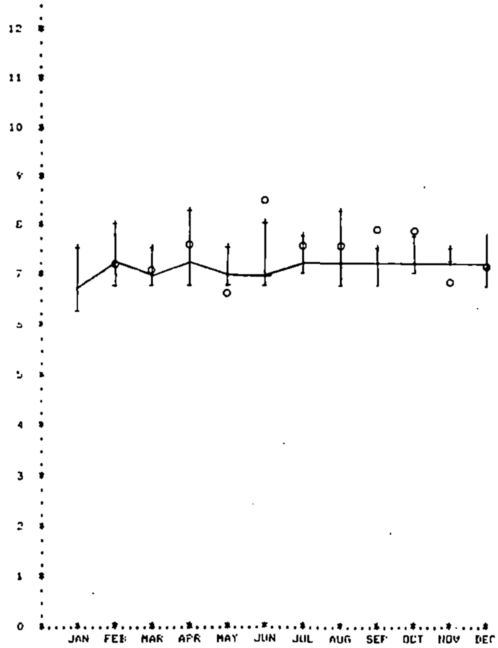
Since the Station discharges significant quantities of chemicals containing sodium (See Section 3.1.1.5) the possibility of a moderate increase in ambient sodium levels near the discharge cannot be discounted. No detectable impact on the aquatic ecosystem related to sodium, salinity, or total dissolved solids has been observed.

3.1.1.4.2 Acidity/Alkalinity Relationships (Figs. 3.1.1.4.2-1 through 3.1.1.4.2-3)

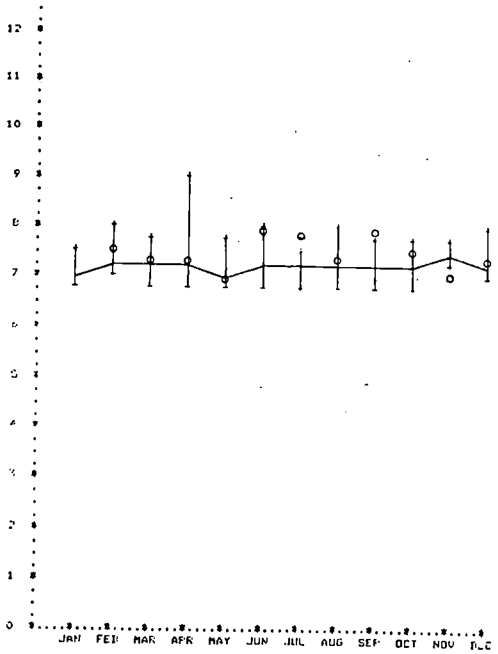
The lower Delaware River is well buffered in the vicinity of Artificial Island and the pH has ranged between 6.0 and 9.0 throughout the years of preoperational monitoring. The chemical parameters which relate to acidity/alkalinity relationships are discussed below.

pH ranged between 6.7 and 7.8 in 1977 among the three locations sampled. There was no discernable seasonal trend in the preoperational data nor any in 1977. Since the pH of the Salem discharge is determined primarily by the pH of the intake water, no significant Station impact on the river was expected and none was observed.

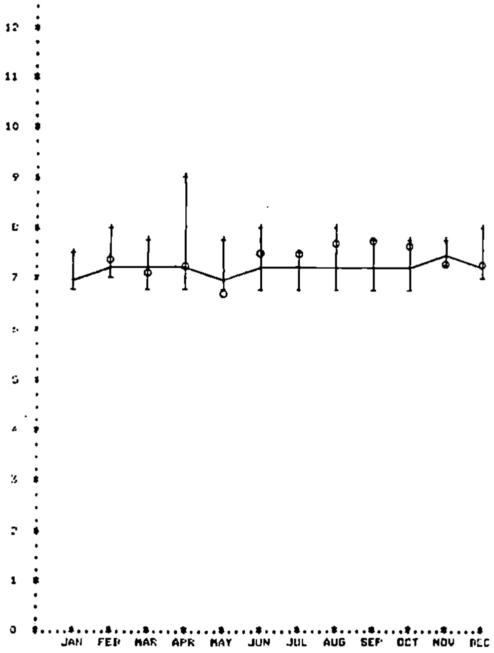
Methyl Orange Alkalinity as calcium carbonate was observed to lie within reasonable bounds, exceeding preoperational maximums only in February for all three sampling stations. Since all stations were similarly affected and since pH was very close to average, no Station impact is inferred from the data.



PH AS PH....... INTAKE AREA



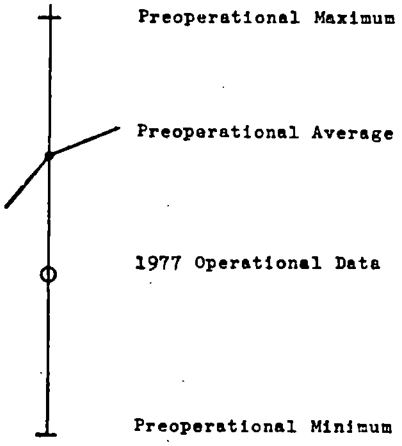
PH AS PH..... DISCHARGE AREA



PH AS PH.......

OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

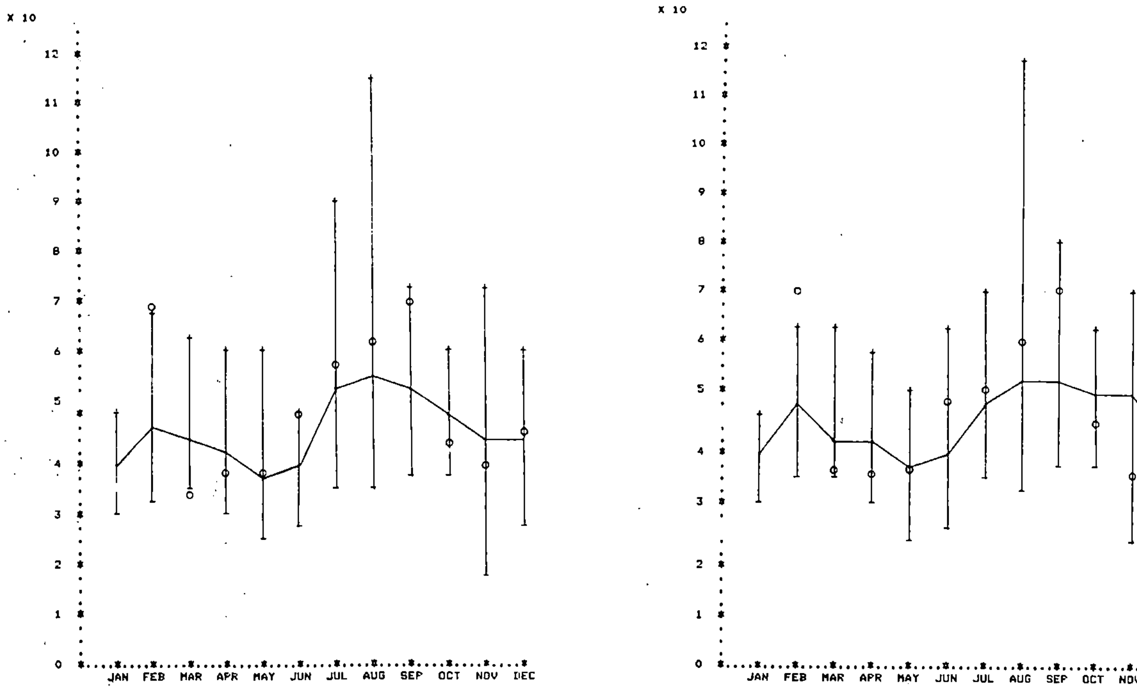
KEY TO GRAPHICAL SYMBOLS



PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SALEM NUCLEAR GENERATING STATION

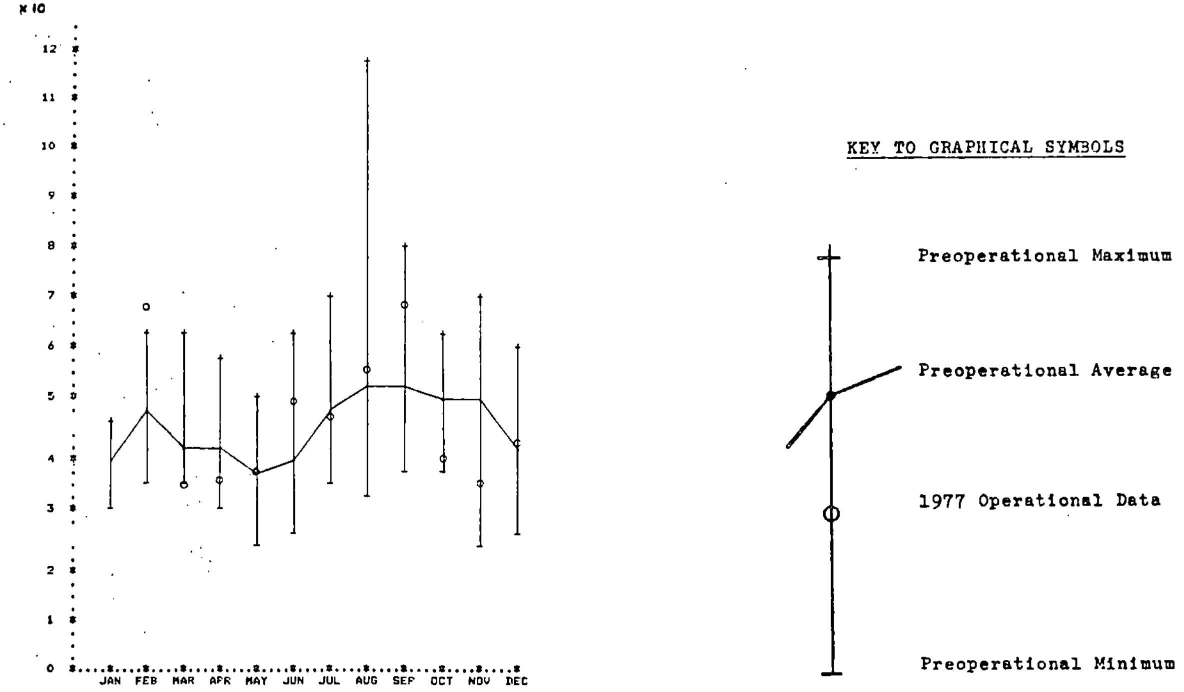
PH AS PH

FIG. 3.1.1.4.2-1



M O ALKALINITY AS CACO3..... INTAKE AREA

M O ALKALINITY AS CACO3.. DISCHARGE AREA



M O ALKALINITY AS CACO3.....
OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SALEM NUCLEAR GENERATING STATION

METHYL ORANGE ALKALINITY AS $CACO_3$
(mg/l)

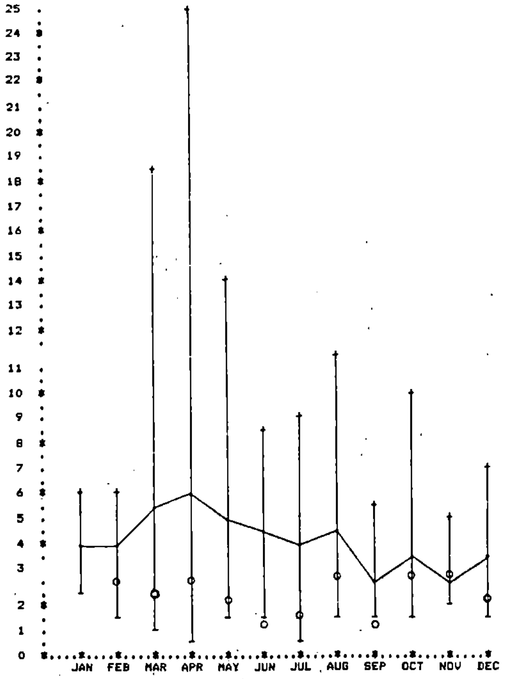
FIG. 3.1.1.4.2-2

Phenolphthalein Alkalinity has been zero in all samples taken at Salem under this program and continued to be zero throughout 1977. This is reasonable since the pH has always bracketed the neutral range.

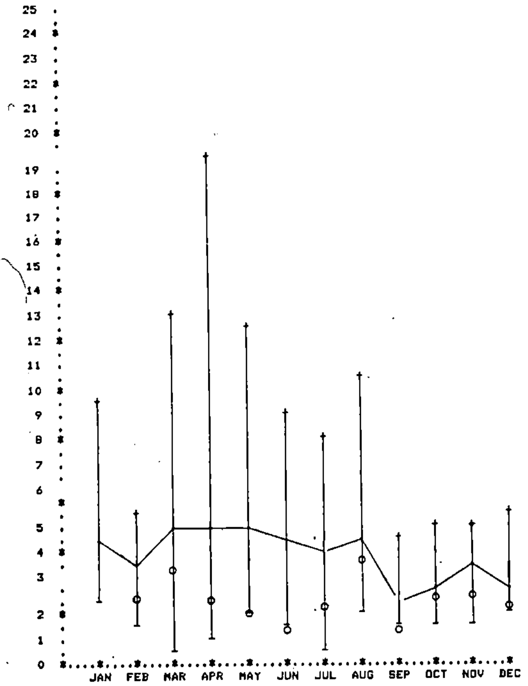
Free Carbon Dioxide as CO_2 is a parameter more useful in assessing the water quality of a polluted water body with a depressed pH conducive of high CO_2 solubility. In 1977 free carbon dioxide values were at the low end of the preoperational range, especially for the sampling point outside and downstream of the mixing zone There is no reason to expect Salem to influence free CO_2 values in the ambient water, and this was the case for 1977.

3.1.1.4.3 Solids Relationships (Figs. 3.1.1.4.3-1 through 3.1.1.4.3-3) In Section 3.1.1.3 it was stated that 1977 ambient suspended solids concentrations were generally observed to lie within preoperational ranges. The following postoperational measurements related to suspended and dissolved solids also appeared reasonable in light of baseline data.

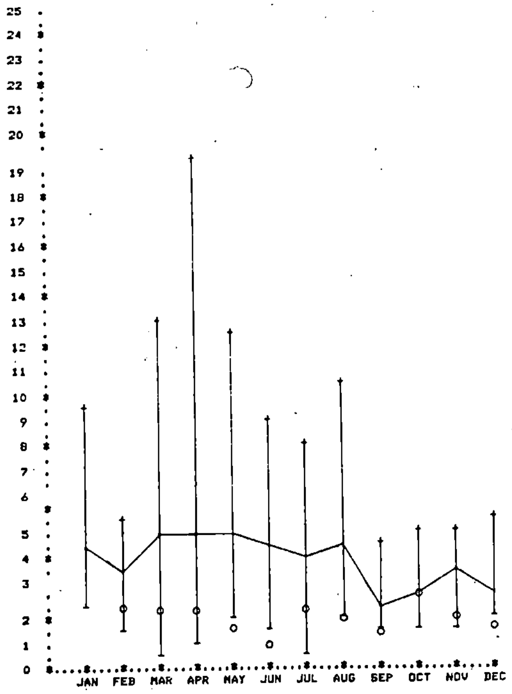
Turbidity is measured at Salem as nephelometric turbidity units (NTU) which "are considered comparable to the previously reported . . . Jackson turbidity units (JTU)" (USEPA, Methods for Chemical Analysis of Water and Wastes, 1974), since the traditional Jackson Candle turbidimeter is difficult to use at low turbidity levels.



FREE CARBON DIOXIDE AS CO2.... INTAKE AREA

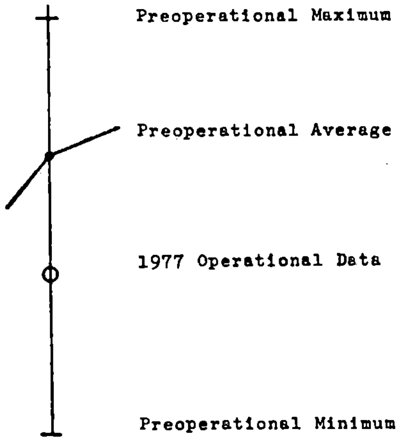


FREE CARBON DIOXIDE AS CO2... DISCHARGE AREA



FREE CARBON DIOXIDE AS CO2....
OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

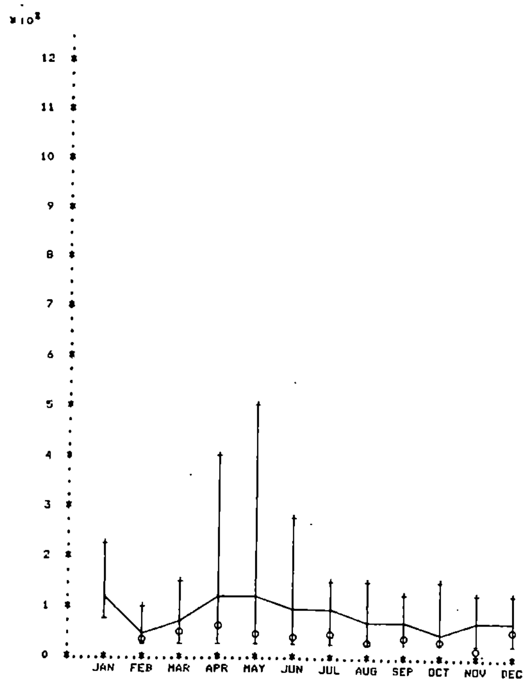
KEY TO GRAPHICAL SYMBOLS



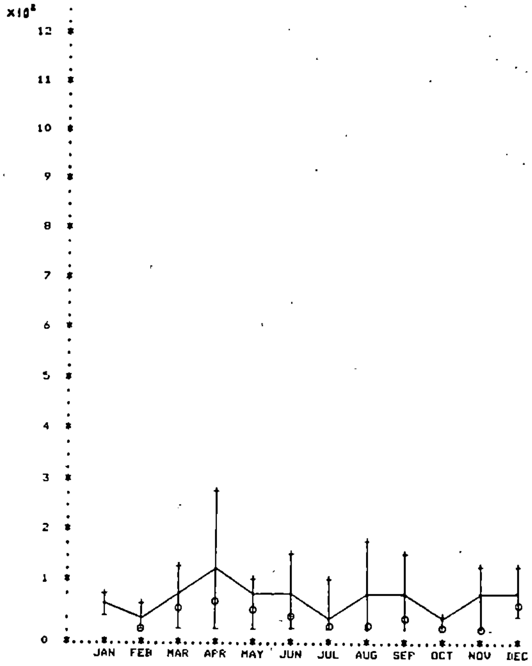
PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SALEM NUCLEAR GENERATING STATION

FREE CARBON DIOXIDE AS CO_2
(mg/l)

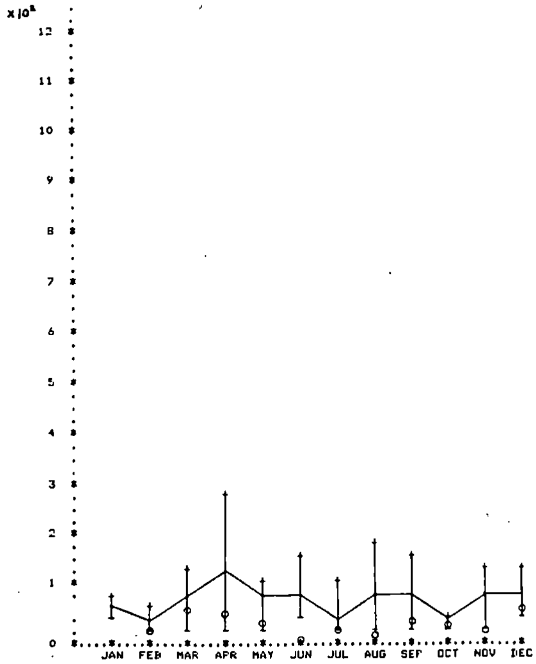
FIG. 3.1.1.4.2-3



TURBIDITY AS NTU INTAKE AREA



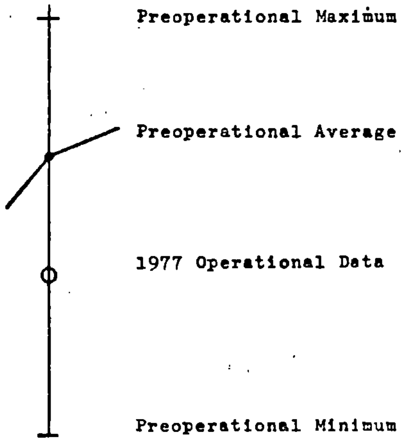
TURBIDITY AS NTU . DISCHARGE AREA



TURBIDITY AS NTU ..LOCATION 3

OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

KEY TO GRAPHICAL SYMBOLS

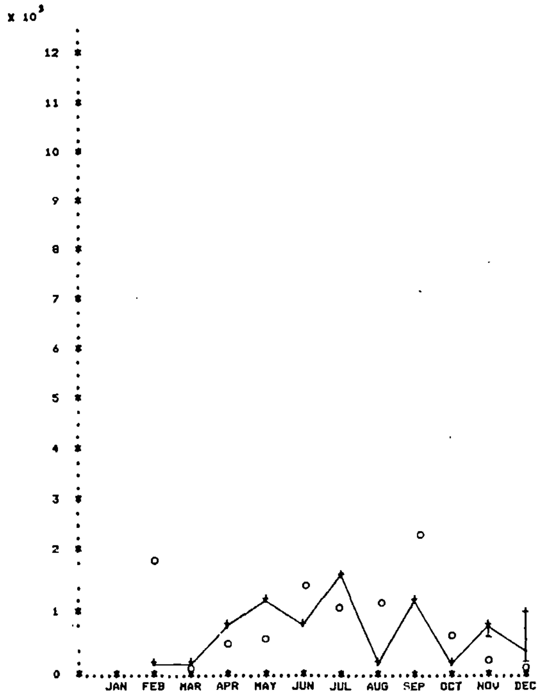


PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	TURBIDITY AS NTU FIG. 3.1.1.4.3-1

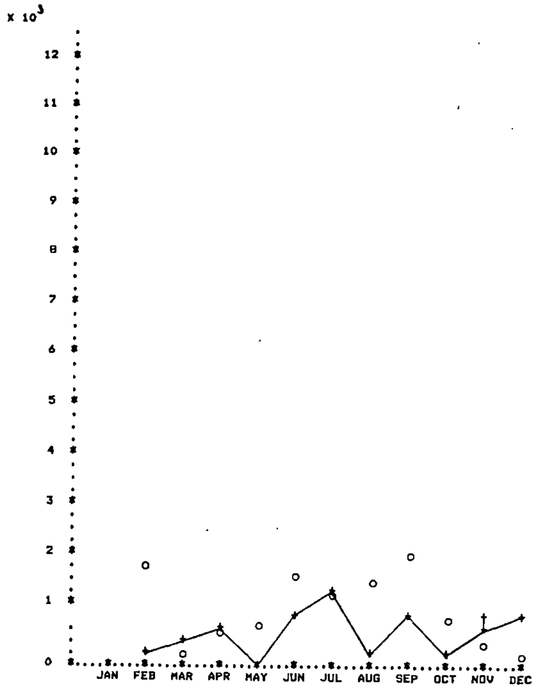
Throughout 1977 turbidity was observed to lie below preoperational monthly averages. No significant differences between intake and discharge values were observed either. Low turbidity levels such as were observed in 1977 aid photosynthetic productivity in the Delaware estuary.

Total Volatile Solids measurements were regularly taken in 1977, but preoperational data sampling concentrated on a station near Sunken Ship Cove (See Fig. 3.1.1-1). Since some preoperational data do exist for the near shore (intake area) and offshore (discharge and outside and downstream of the mixing zone areas) they have been used in this comparison. TVS varied between 80 and 2,407 milligrams per liter with higher values generally recorded during the summer and also February. This is reasonable since TVS is primarily a measure of organic content. Preoperational values were exceeded in approximately half the samples due to limited preoperational data used in making the comparison. No significant change in TVS between intake and discharge areas was recorded. This is reasonable, since the Station does not discharge organics in any significant quantity.

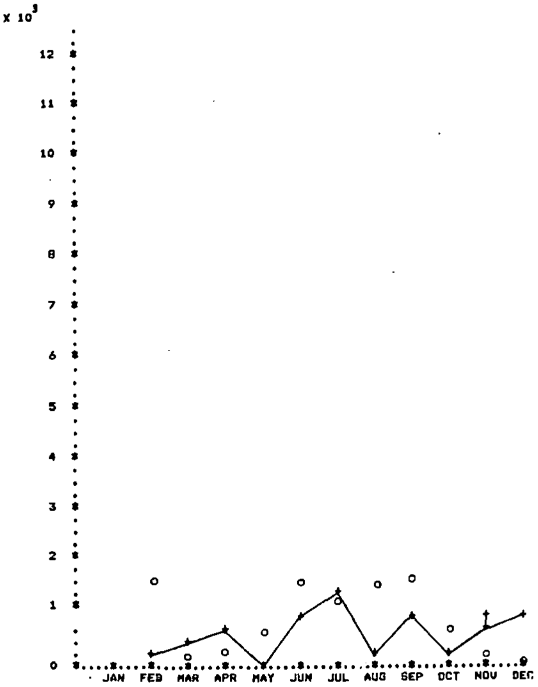
Silica as SiO_2 values ranged between 0.145 and 7.13 milligrams per liter with a definite seasonal correlation. As was the case with the limited preoperational data, higher silica values were related to winter and spring periods of greater runoff. No environmental signficance is associated with postoperational values.



TOTAL VOLATILE SOLIDS AS TVS.... INTAKE AREA



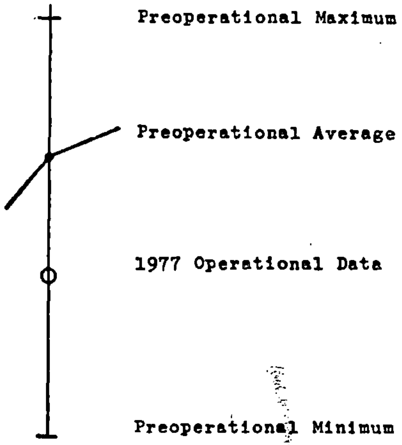
TOTAL VOLATILE SOLIDS AS TVS... DISCHARGE AREA



TOTAL VOLATILE SOLIDS AS TVS.....LOCATION 3

OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

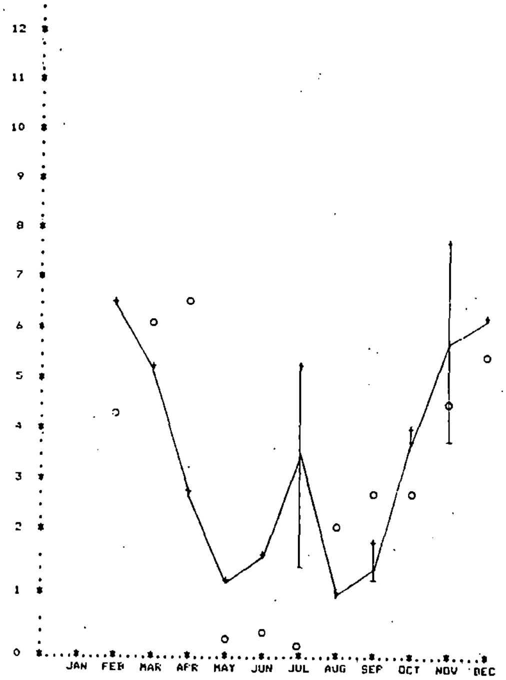
KEY TO GRAPHICAL SYMBOLS



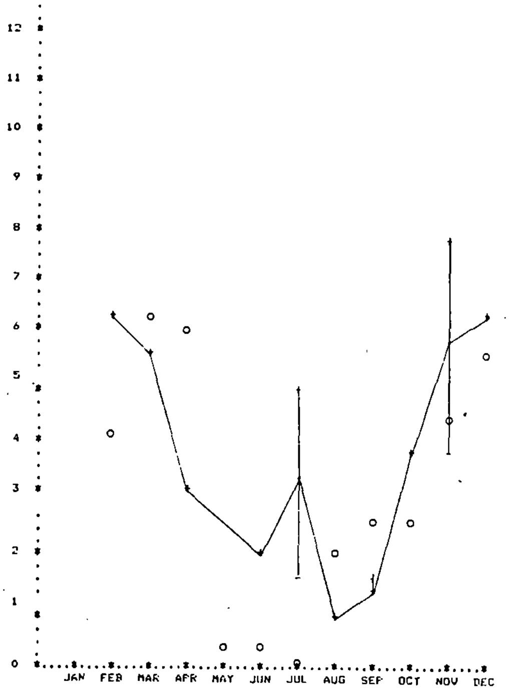
PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SALEM NUCLEAR GENERATING STATION

TOTAL VOLATILE SOLIDS AS TVS
(mg/l)

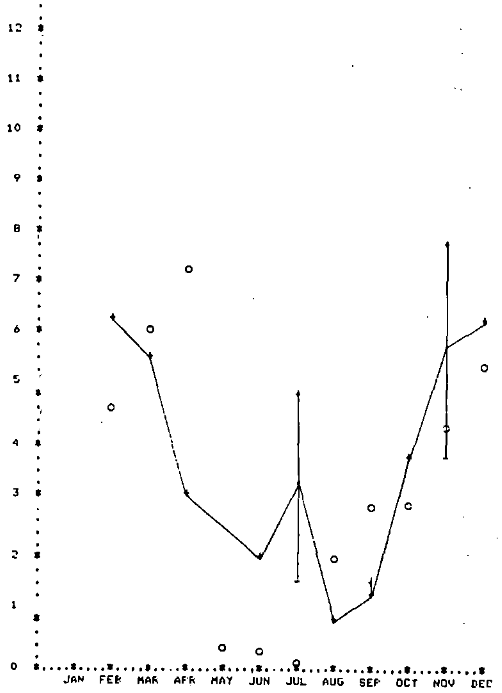
FIG. 3.1.1.4.3-2



SILICA AS SIO2.... INTAKE AREA



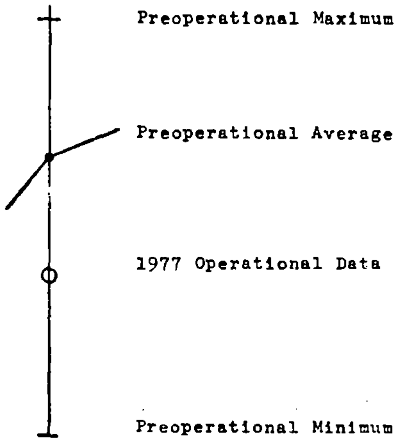
SILICA AS SIO2.. DISCHARGE AREA



SILICA AS SIO2.....

OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

KEY TO GRAPHICAL SYMBOLS



PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	SILICA AS SIO_2 (mg/l)
	FIG. 3.1.1.4.3-3

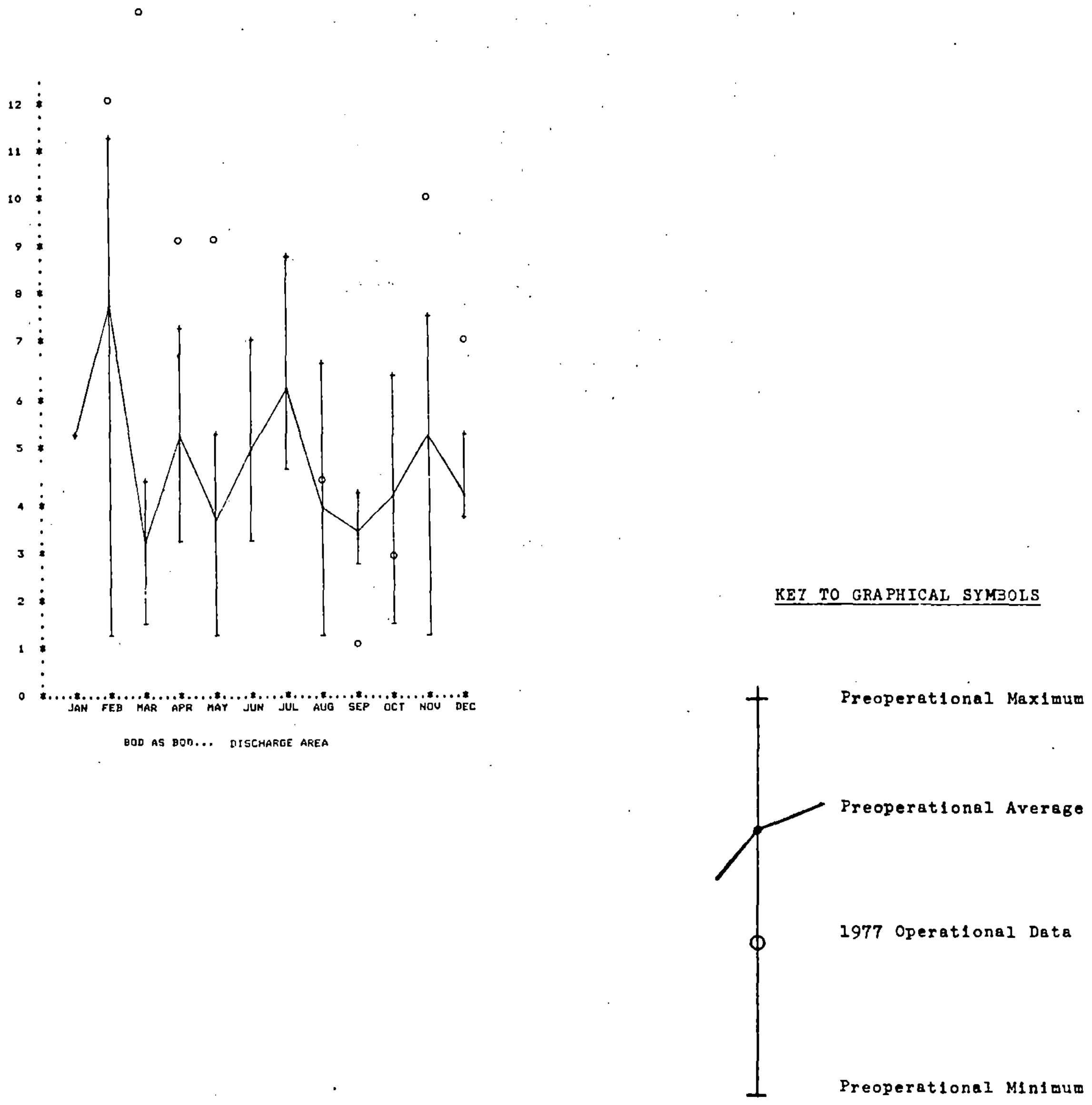
3.1.1.4.4 Oxygen/Organic Relationships (Figs. 3.1.1.4.-1 through 3.1.1.4.4-5)

Dissolved oxygen levels near Salem for 1977 were observed to average higher than those observed prior to Station operation. This is described fully in Section 3.1.1.2.

Biochemical Oxygen Demand data were recorded prior to 1977 only at a sampling station near Sunken Ship Cove (See Fig. 3.1.1-1). Post-operational data were collected only at the sampling station near the discharge and were missed during June and July 1977. Licensee Event Report 78-19/04L has been submitted covering this situation.

Observed BOD levels ranged between 1.8 and 12.1 milligrams per liter, reasonable levels for a relatively unpolluted area of the Delaware, influenced mainly by organics of natural origin.

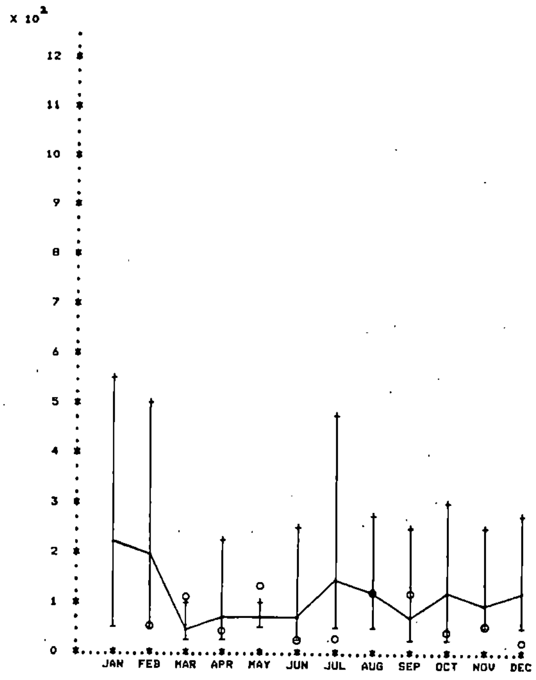
Chemical Oxygen Demand was measured at all sampling stations and ranged between 26 and 160 milligrams per liter. These values generally lay within preoperational extremes except for May 24, when values between 140 and 160 milligrams per liter were measured. Since dissolved oxygen levels were satisfactory, and since higher preoperational values were observed in six other months (without any apparent seasonal trend) these values were not considered environmentally significant nor attributable to Salem operation.



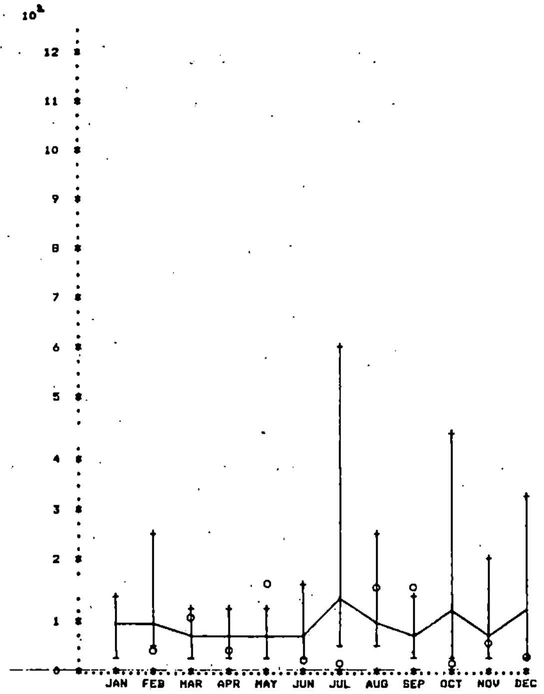
PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SALEM NUCLEAR GENERATING STATION

BIOCHEMICAL OXYGEN DEMAND AS BOD
(mg/l)

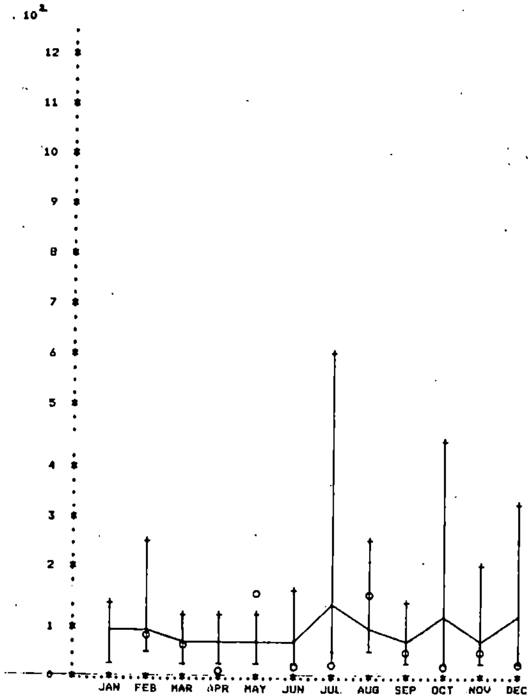
FIG. 3.1.1.4.4-1



CHEMICAL OXYGEN DEMAND AS COD.... INTAKE AREA



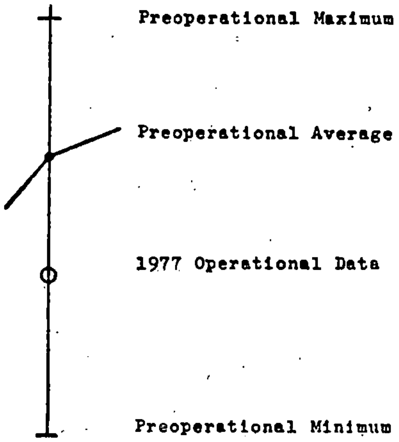
CHEMICAL OXYGEN DEMAND AS COD... DISCHARGE AREA



CHEMICAL OXYGEN DEMAND AS COD.....

OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

KEY TO GRAPHICAL SYMBOLS

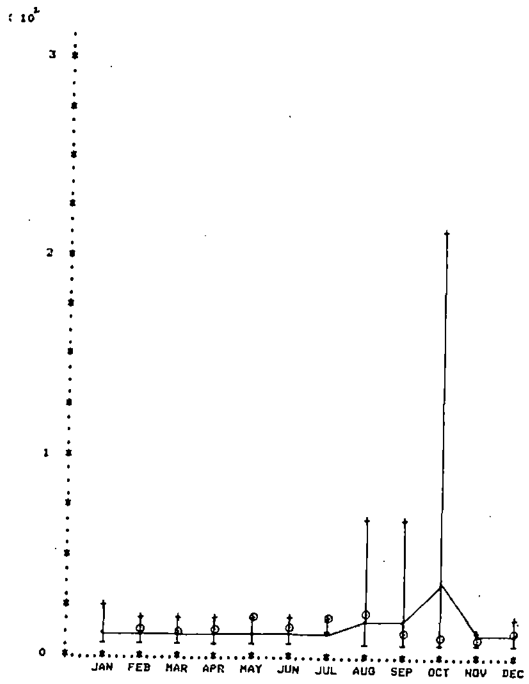


PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	CHEMICAL OXYGEN DEMAND AS COD (mg/l)
	FIG. 3.1.1.4.4-2

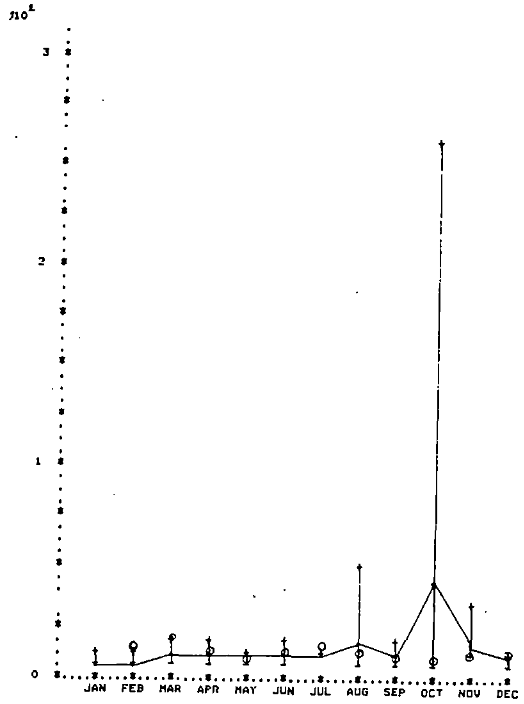
Total Organic Carbon remained well below all preoperational maximums, reaching a peak of only 21.5 milligrams per liter near the intake on August 30. The Station discharges very little organic matter (treated sewage and a few specialized chemicals - see Section 3.1.1.5) and no impact was expected or observed.

Reducing substances as H_2S was measured to assess the oxidation-reduction potential of the Delaware River water near Salem, and values ranged between 0.13 and 2.98 milligrams per liter. In April and August, preoperational maximums were exceeded slightly near the discharge area while values from the two other areas remained ed within preoperational extremes. Salem does not discharge any chemicals which would lead to significant reducing substances levels. This is substantiated by the absence of any definite increase in reducing substances levels between samples taken in the intake and discharge areas.

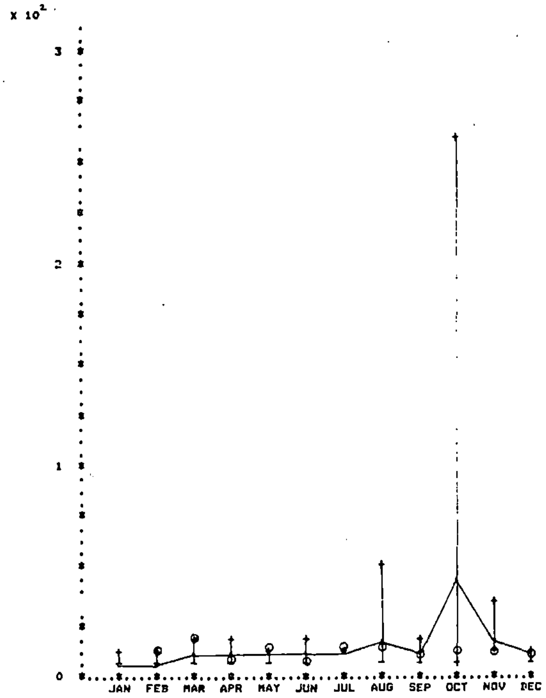
Sulfides is a measure of water quality which is more appropriate to a highly polluted area, perhaps with anerobic conditions present. The Delaware River near Artificial Island has been well proven to be low in pollution loading and high in dissolved oxygen throughout most of the preoperational and postoperational sampling period. In that context the range of 1977 observed sulfide values (as S) of 0.01 to 0.18 milligrams per liter, although exceeding preoperational maximums in April, May, and June at the intake and discharge areas, can be said to indicate no particular impact on the Delaware River. No consistent increase between intake and discharge areas was observed.



TOTAL ORGANIC CARBON.... INTAKE AREA



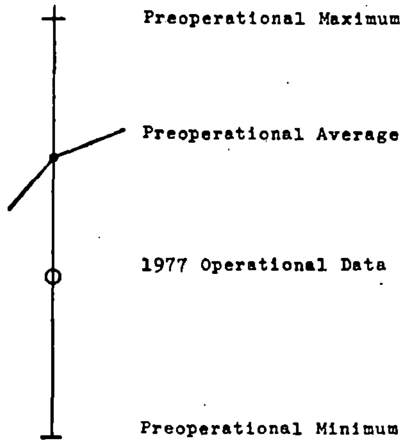
TOTAL ORGANIC CARBON... DISCHARGE AREA



TOTAL ORGANIC CARBON....

OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

KEY TO GRAPHICAL SYMBOLS



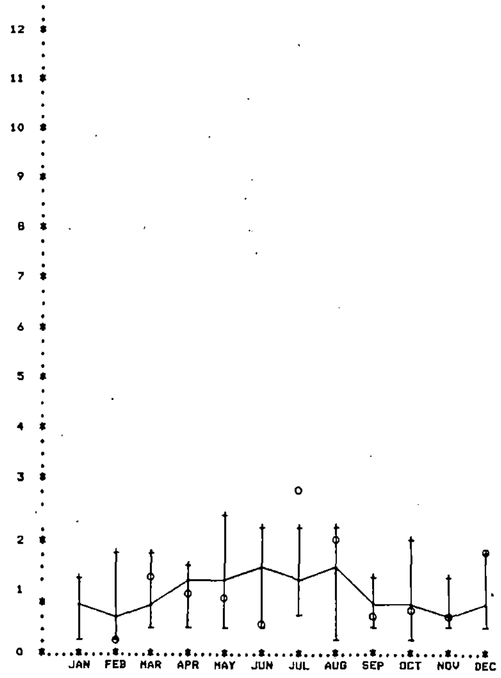
PUBLIC SERVICE ELECTRIC AND GAS COMPANY

SALEM NUCLEAR GENERATING STATION

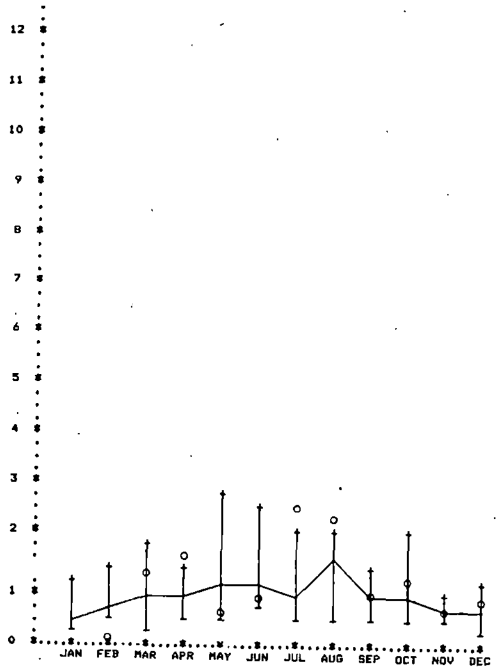
TOTAL ORGANIC CARBON AS TOC

(mg/l)

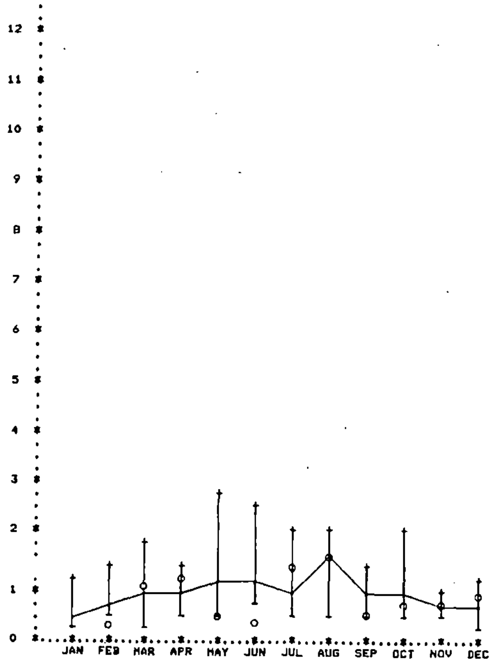
FIG. 3.1.1.4.4-3



REDUCING SUBSTANCES AS H2S...... INTAKE AREA



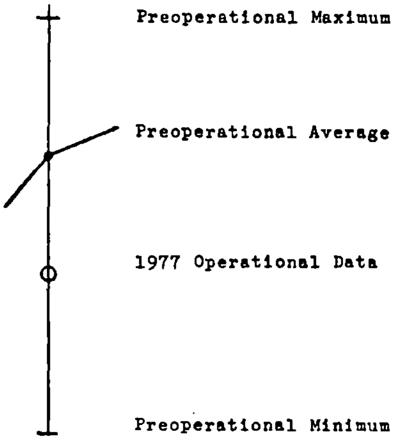
REDUCING SUBSTANCES AS H2S... DISCHARGE AREA



REDUCING SUBSTANCES AS H2S.......

OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

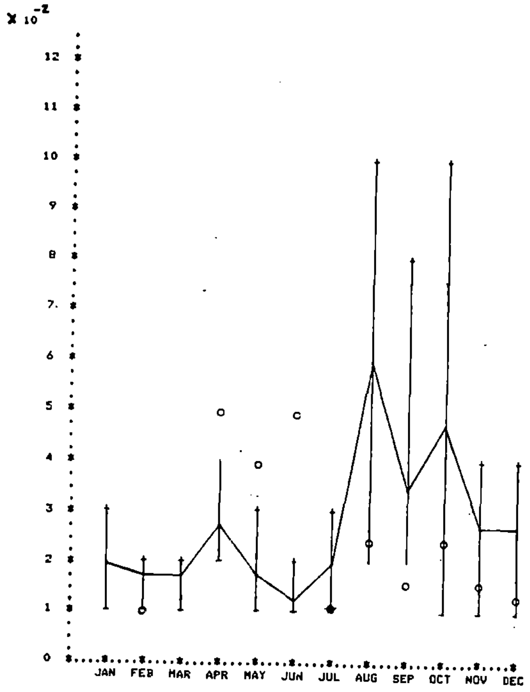
KEY TO GRAPHICAL SYMBOLS



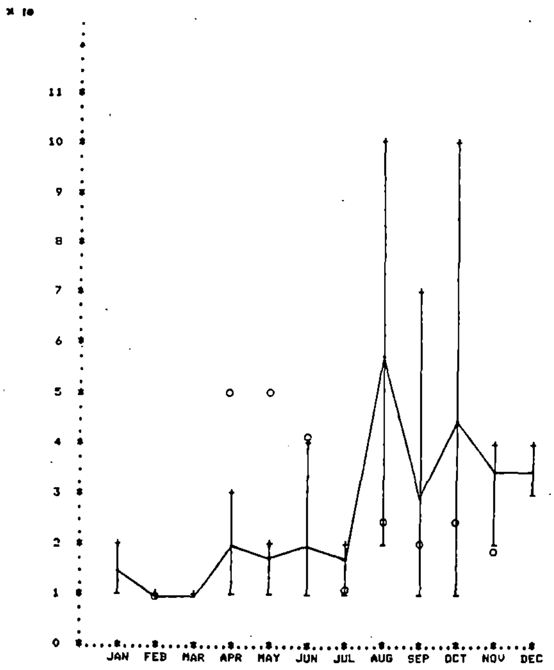
PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SALEM NUCLEAR GENERATING STATION

REDUCING SUBSTANCES AS H_2S
(mg/l)

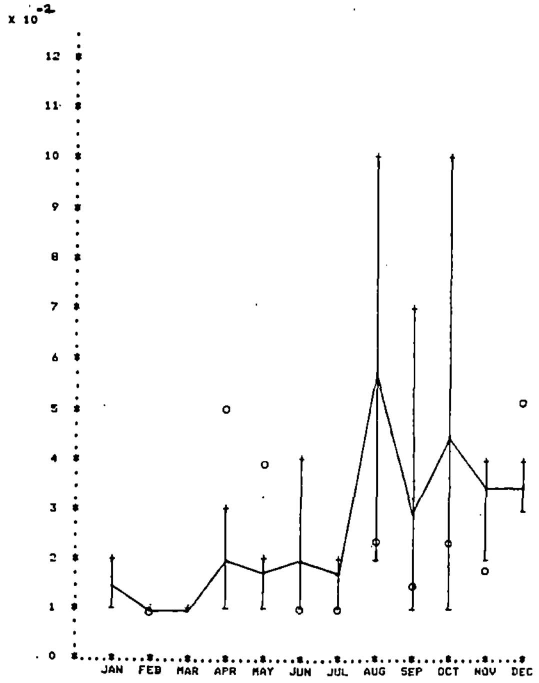
FIG. 3.1.1.4.4-4



SULFIDES AS S...... INTAKE AREA

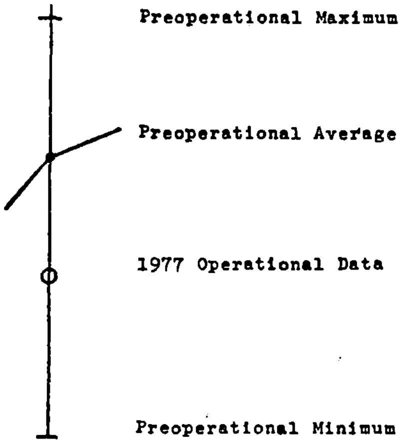


SULFIDES AS S..... DISCHARGE AREA



SULFIDES AS S.......
OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

KEY TO GRAPHICAL SYMBOLS



PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	SULFIDES AS S (mg/l)
	FIG. 3.1.1.4.4-5

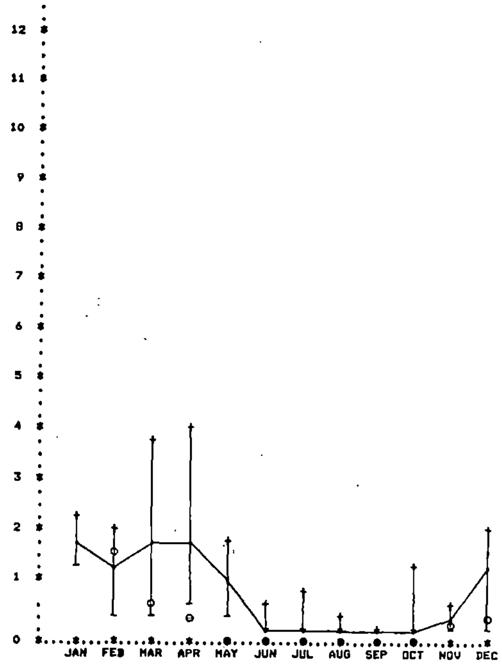
3.1.1.4.5 Nitrogen/Phosphorus Relationships (Figs. 3.1.1.4.5-1 through 3.1.1.4.5-4)

Nitrogen and phosphorus relationships may be strongly influenced by watershed agricultural practices. This should be borne in mind throughout the sections which follow:

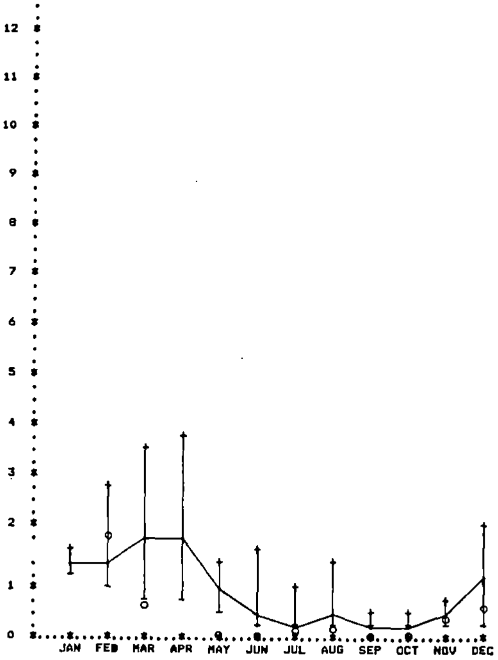
Ammonia as NH_3 ranged between 0.03 and 1.82 milligrams per liter in 1977 and followed a definite seasonal pattern with highest values in the early spring. Except for February, all ammonia values recorded were at or below preoperational monthly averages. This was noteworthy, particularly for the summer, since it probably contributed to the low 30-second and 3-minute chlorine demands observed (See Section 3.1.1.4.6).

Nitrate measured as NO_3 was always below preoperational monthly averages for all stations, and in many cases, fell below previously recorded minimums. A maximum of 7.53 milligrams per liter was recorded outside and downstream of the mixing zone on July 19. It did not appear to be related to plant operations since intake and discharge area concentrations were 5.76 and 5.45 milligrams per liter respectively on that date.

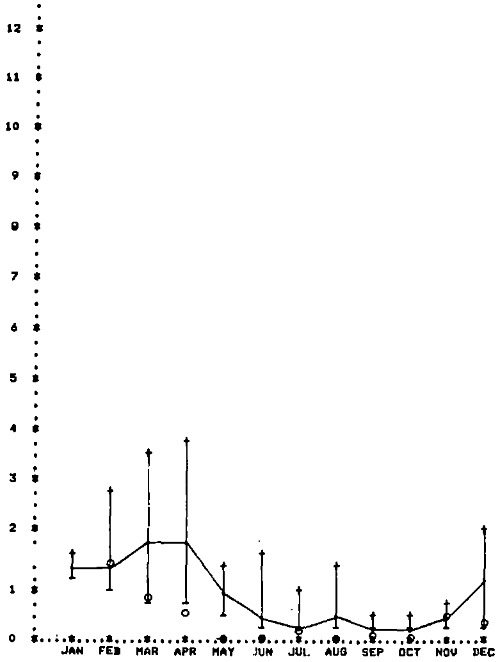
Kjeldahl Nitrogen is a measure of total nitrogen, including any nitrogen contained in suspended organic matter. Preoperational data are essentially limited to the location near Sunken Ship Cove (See Fig. 3.1.1-1). Also, Kjeldahl nitrogen determinations were not made for the intake area nor the area outside and downstream of the mixing zone nor were they made for the June and July 1977



AMMONIA AS NH3....... INTAKE AREA



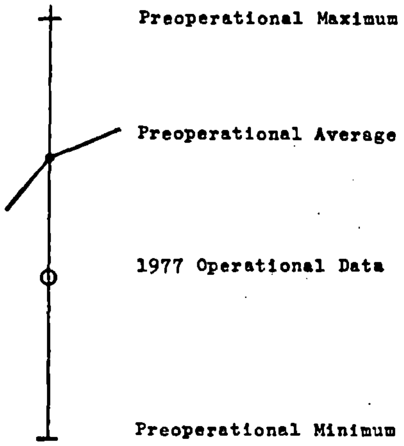
AMMONIA AS NH3....... DISCHARGE AREA



AMMONIA AS NH3.......

OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

KEY TO GRAPHICAL SYMBOLS



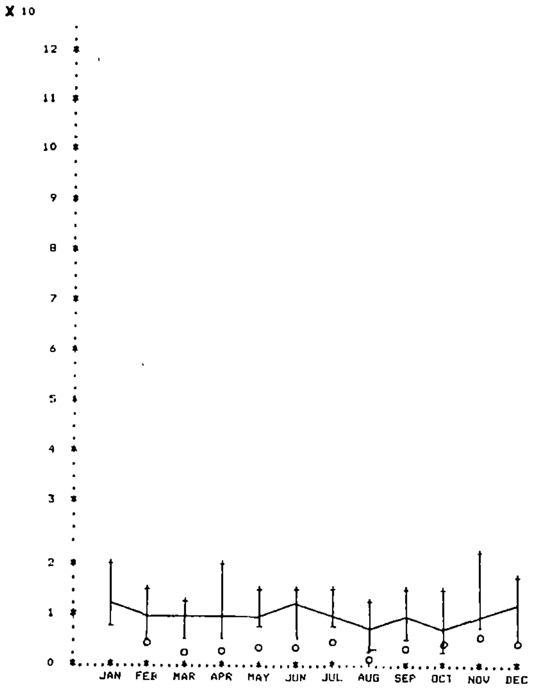
PUBLIC SERVICE ELECTRIC AND GAS COMPANY

SALEM NUCLEAR GENERATING STATION

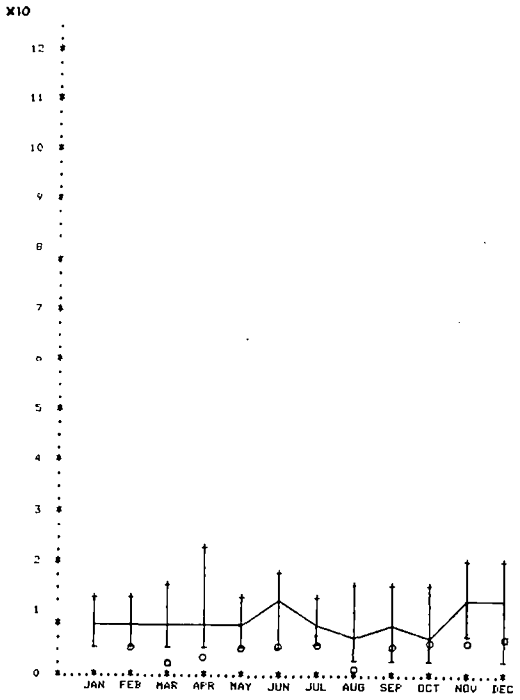
AMMONIA AS NH_3

(mg/l)

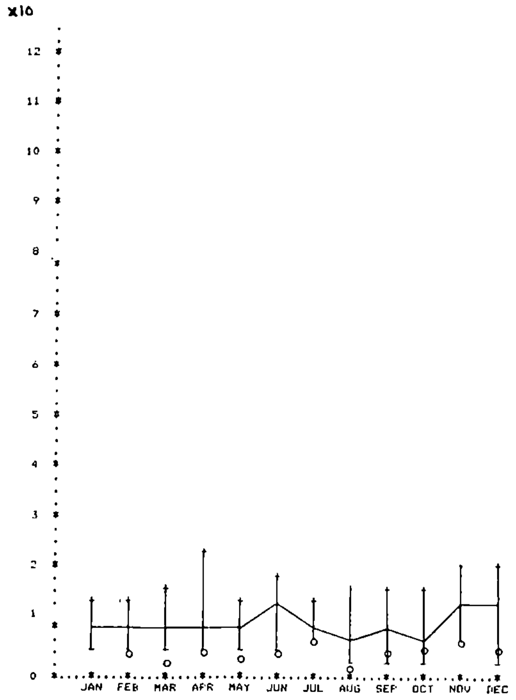
FIG. 3.1.1.4.5-1



NITRATE AS NO3... INTAKE AREA

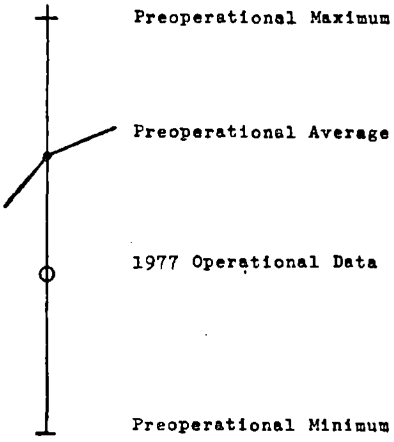


NITRATE AS NO3... DISCHARGE AREA

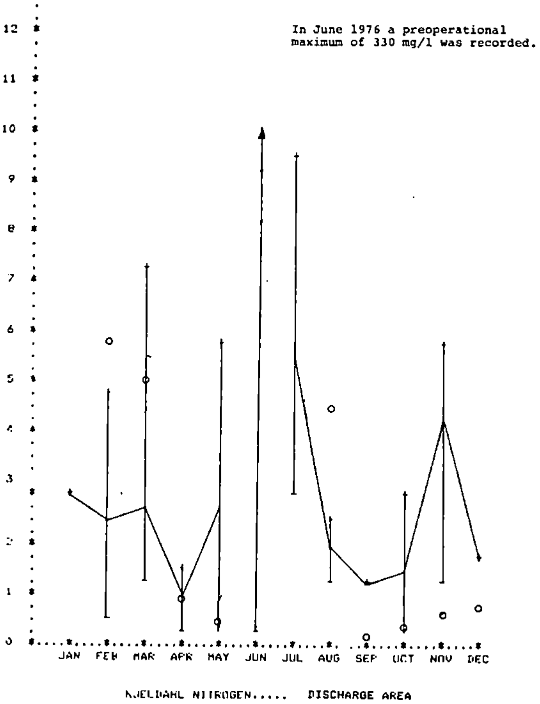


NITRATE AS NO3.....
OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

KEY TO GRAPHICAL SYMBOLS

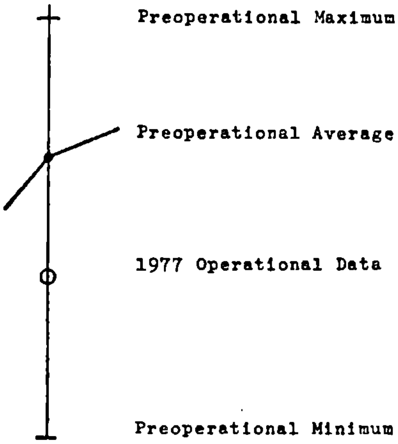


PUBLIC SERVICE ELECTRIC AND GAS COMPANY **SALEM NUCLEAR GENERATING STATION**	NITRATE AS NO_3 (mg/l)
	FIG. 3.1.1.4.5-2



In June 1976 a preoperational maximum of 330 mg/l was recorded.

KEY TO GRAPHICAL SYMBOLS



PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SALEM NUCLEAR GENERATING STATION

KJELDAHL NITROGEN AS N
(mg/l)

FIG. 3.1.1.4.5-3

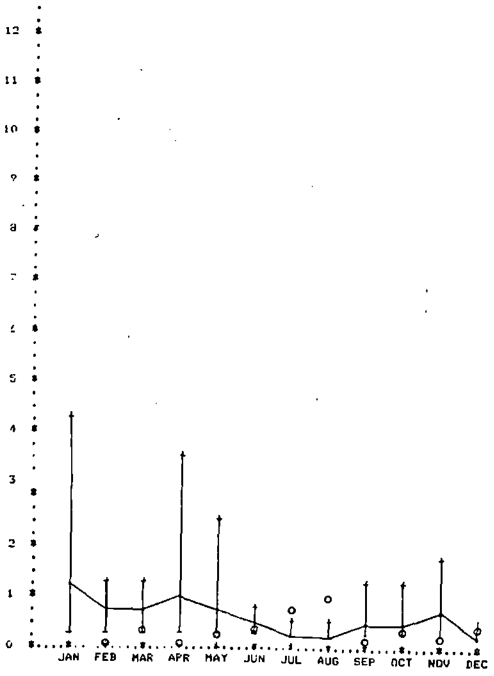
discharge area samples. This was reported to the NRC in Licensee Event Report 78-19/04L.

Results did show that the broad preoperational scatter of Kjeldahl nitrogen values (with no discernable seasonality) encompassed most of the 1977 values from the discharge area.

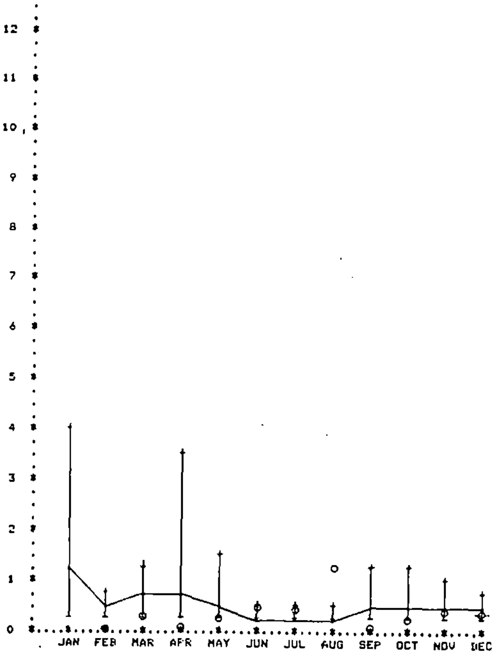
Phosphate as PO_4 varied between 0.013 and 1.28 milligrams per liter. Except for July 19 and August 30, the data remained within preoperational extremes and in most cases were below preoperational monthly average values. In July, phosphate at the intake only was higher than usual. In August, elevated phosphate values (1.02 milligrams per liter at the intake and 1.28 milligrams per liter at the discharge) appeared to result from natural variation.

As described in Section 3.1.1.5 the Station does not routinely use significant quantities of phosphate-containing chemicals. Special cleaning operations associated with Unit 2 are conducted only when properly authorized by an NPDES permit.

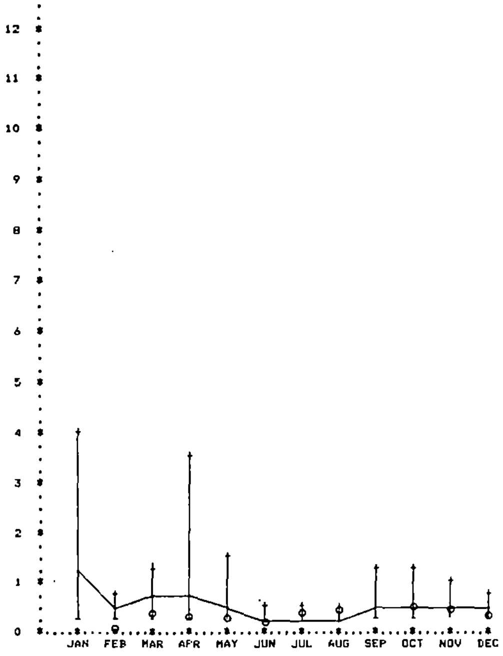
3.1.1.4.6 Chlorine Demand (Figs. 3.1.1.4.6-1 and 3.1.1.4.6-2) Chlorine demand exerted after 30 seconds and 3 minutes was determined for each monthly sample, except those for March when titrating equipment failure ocurred. The chief reason for this determination is to guide the rate of chlorine addition to the service water and circulating water systems. The missing samples were not environmentally significant because chlorination did not take place in March 1977.



PHOSPHATE AS PO4........ INTAKE AREA



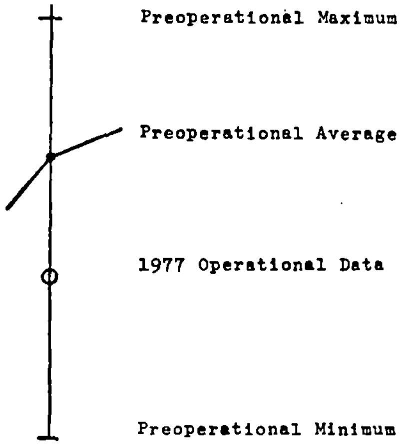
PHOSPHATE AS PO4..... DISCHARGE AREA



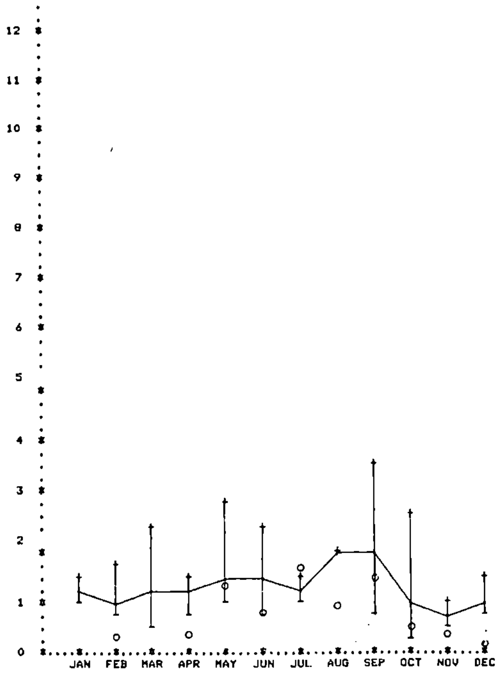
PHOSPHATE AS PO4........LOCATION 3

OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

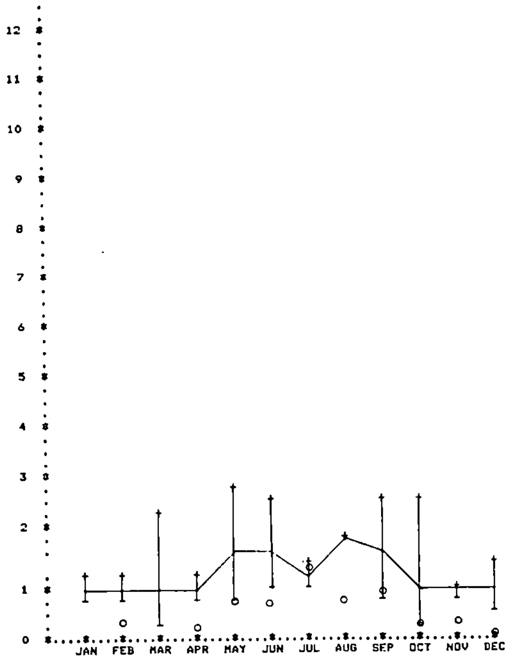
KEY TO GRAPHICAL SYMBOLS



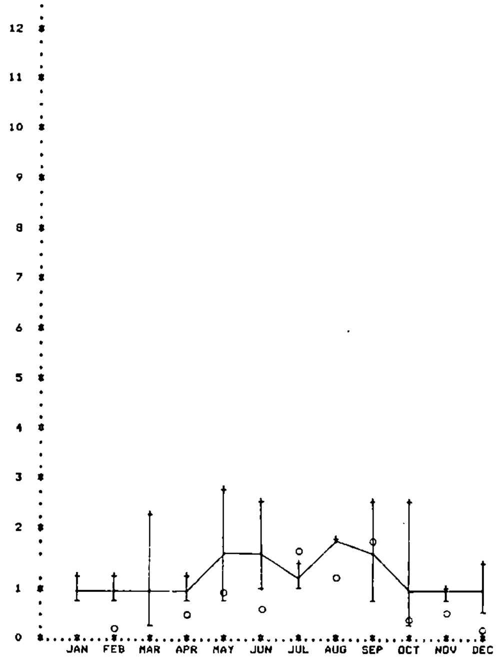
PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	PHOSPHATE AS PO_4 (mg/l)
	FIG. 3.1.1.4.5-4



CHLORINE DEMAND,30SEC, AS CL....... INTAKE AREA



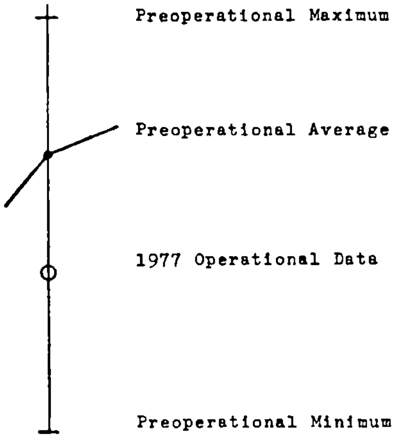
CHLORINE DEMAND,30SEC, AS CL..... DISCHARGE AREA



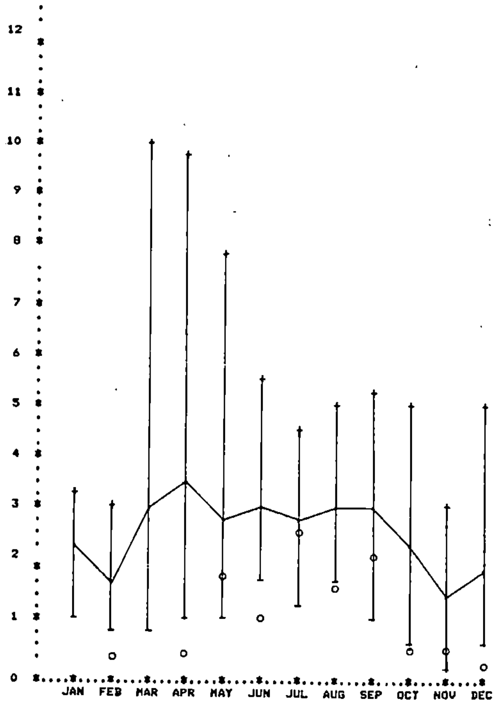
CHLORINE DEMAND,30SEC, AS CL........

OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

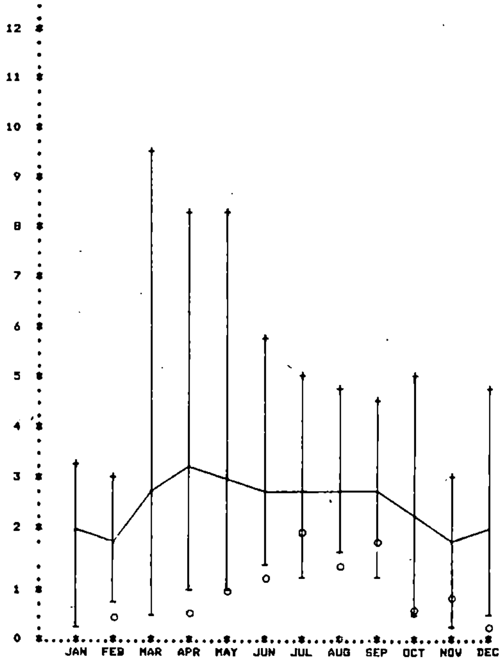
KEY TO GRAPHICAL SYMBOLS



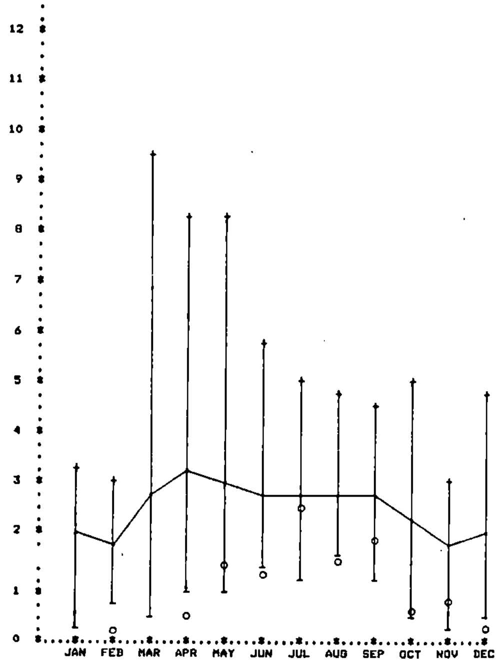
PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	30-SECOND CHLORINE DEMAND AS CL_2 (mg/l)
	FIG. 3.1.1.4.6-1



CHLORINE DEMAND, 3 MIN, AS CL...... INTAKE AREA



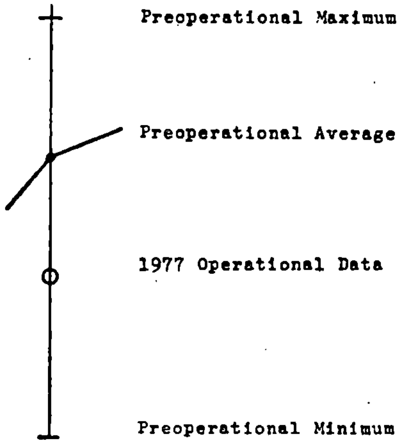
CHLORINE DEMAND, 3 MIN, AS CL.... DISCHARGE AREA



CHLORINE DEMAND, 3 MIN, AS CL....

OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

KEY TO GRAPHICAL SYMBOLS



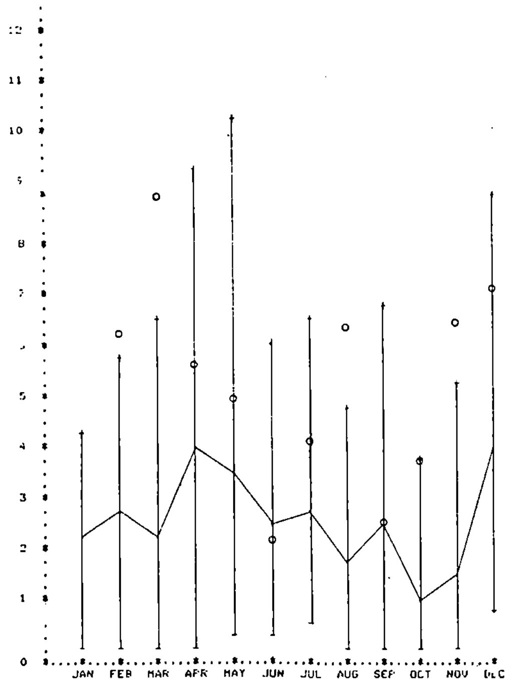
PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	3-MINUTE CHLORINE DEMAND AS CL_2 (mg/l)
	FIG. 3.1.1.4.6-2

Both 30 second and 3 minute chlorine demand values followed the typical preoperational seasonal trend with lower values in winter, spring and fall and higher values in summer, when higher temperatures prevail and more organic matter is present. However, chlorine demand was much lower, on the average, for each month than had been preoperationally observed. In many cases new minimums were established. Three minute chlorine demand exceeded 2 milligrams per liter only in July where preoperational values near 3 milligrams per liter had been typical in the summers of earlier years.

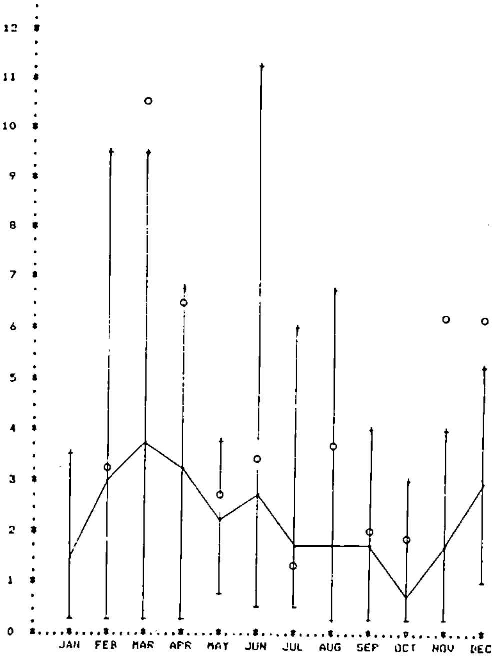
3.1.1.4.7 Metals (Figs. 3.1.1.4.7-1 Through 3.1.1.4.7-5).

Iron varied from 1.26 to 10.6 milligrams per liter during the 1977 monitoring period. At the discharge area, preoperational monthly maximums were exceeded during March, November, and December but correspondingly high values were also recorded near the intake and outside and downstream of the mixing zone.

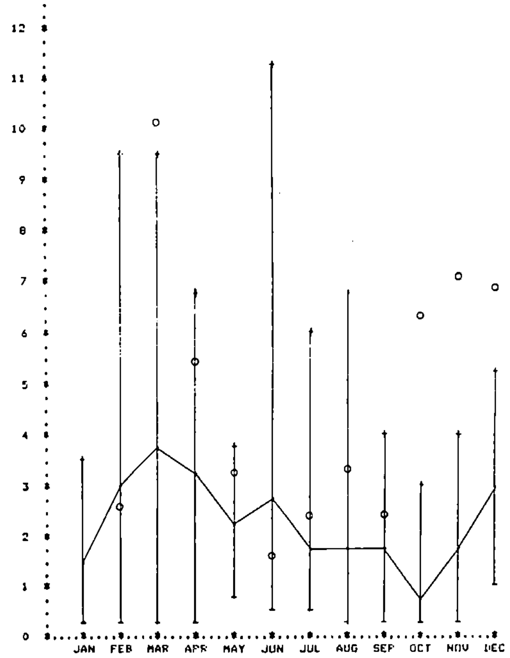
No consistent pattern of iron increase or decrease between intake and discharge areas was evident from the 1977 data. It is concluded that the Station did not influence ambient iron concentrations in the river.



IRON, TOTAL AS FE........INTAKE AREA

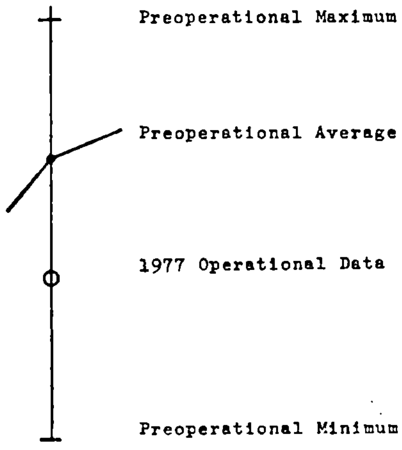


IRON, TOTAL AS FE...... DISCHARGE AREA



IRON, TOTAL AS FE.......
OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

KEY TO GRAPHICAL SYMBOLS



PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SALEM NUCLEAR GENERATING STATION

TOTAL IRON AS FE
(mg/l)

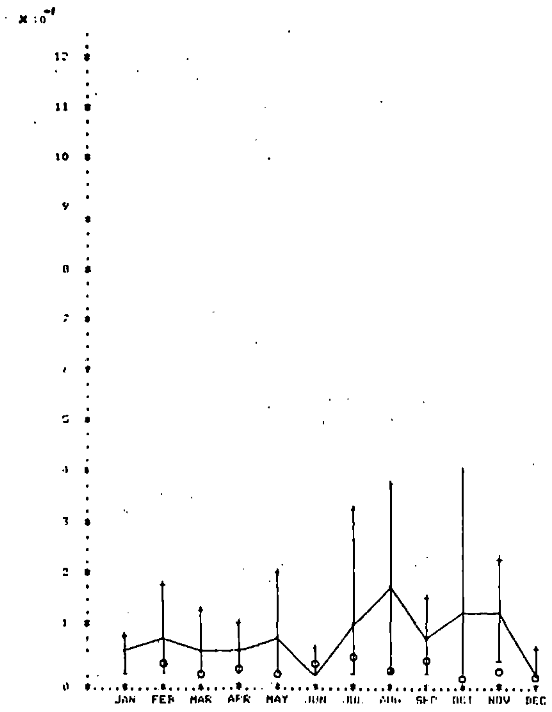
FIG. 3.1.1.4.7-1

Copper levels remained below preoperational maximums at all times during 1977 at all sampling stations. The highest value recorded was 0.07 milligrams per liter. A slight preoperational seasonal trend toward summer highs was not observed. Discharge area concentrations were generally higher than those measured outside and downstream of the mixing zone, but this could have been due to copper transported to the discharge area from the intake area where average concentration are higher via the circulating water system. No definite pattern of increase between the intake and discharge areas suggesting corrosion-related impacts was observed.

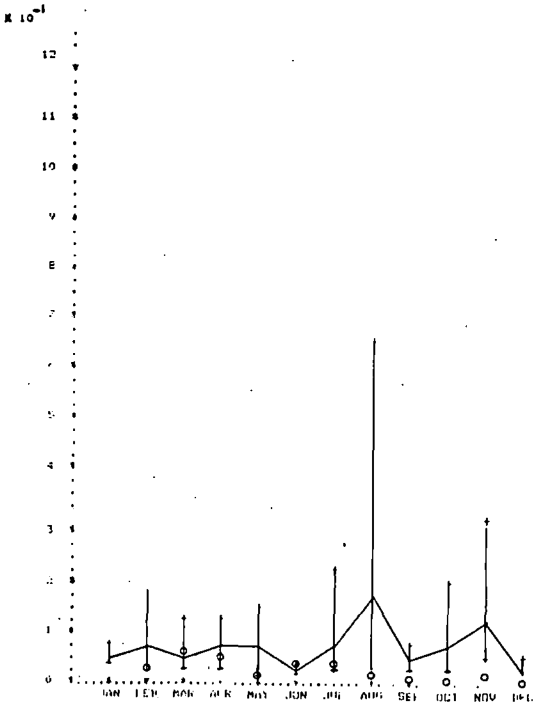
Zinc measurements were performed on samples from all locations, and concentrations ranged from 0.03 milligrams per liter to 1.25 milligrams per liter. With the exception of July and November, site area values of zinc remained below preoperational maximums and near the preoperational average.

In July zinc values of 0.47, 0.95, and 0.92 milligrams per liter were recorded at the intake area, discharge area, and the area outside and downstream of the mixing zone.

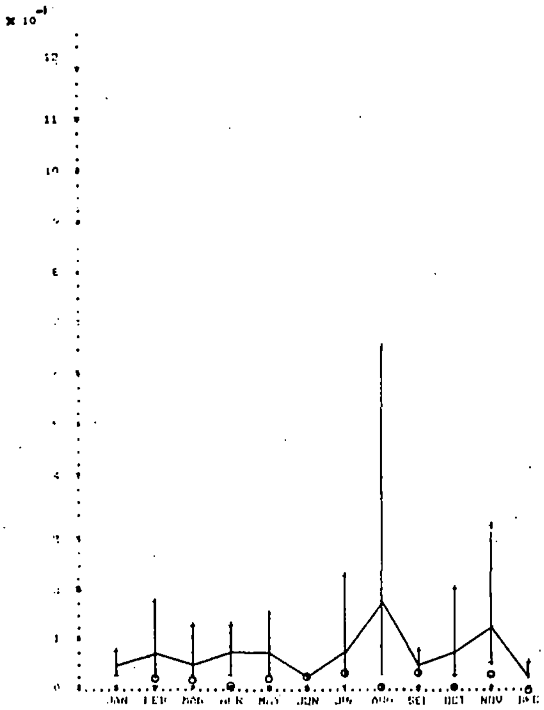
In November a zinc concentration of 1.25 milligrams per liter was mesured at the intake. Transport of zinc through the circulating water sytem may have caused the zinc concentration near the discharge to reach 0.475 milligrams per liter on that occassion.



COPPER, TOTAL AS CU... INTAKE AREA



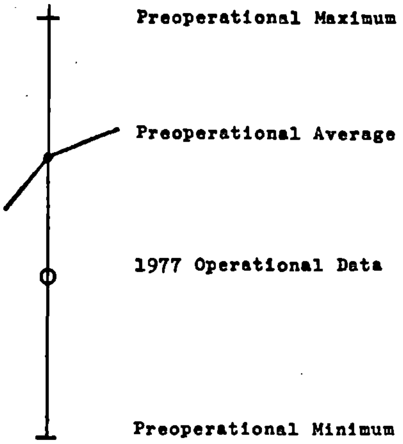
COPPER, TOTAL AS CU... DISCHARGE AREA



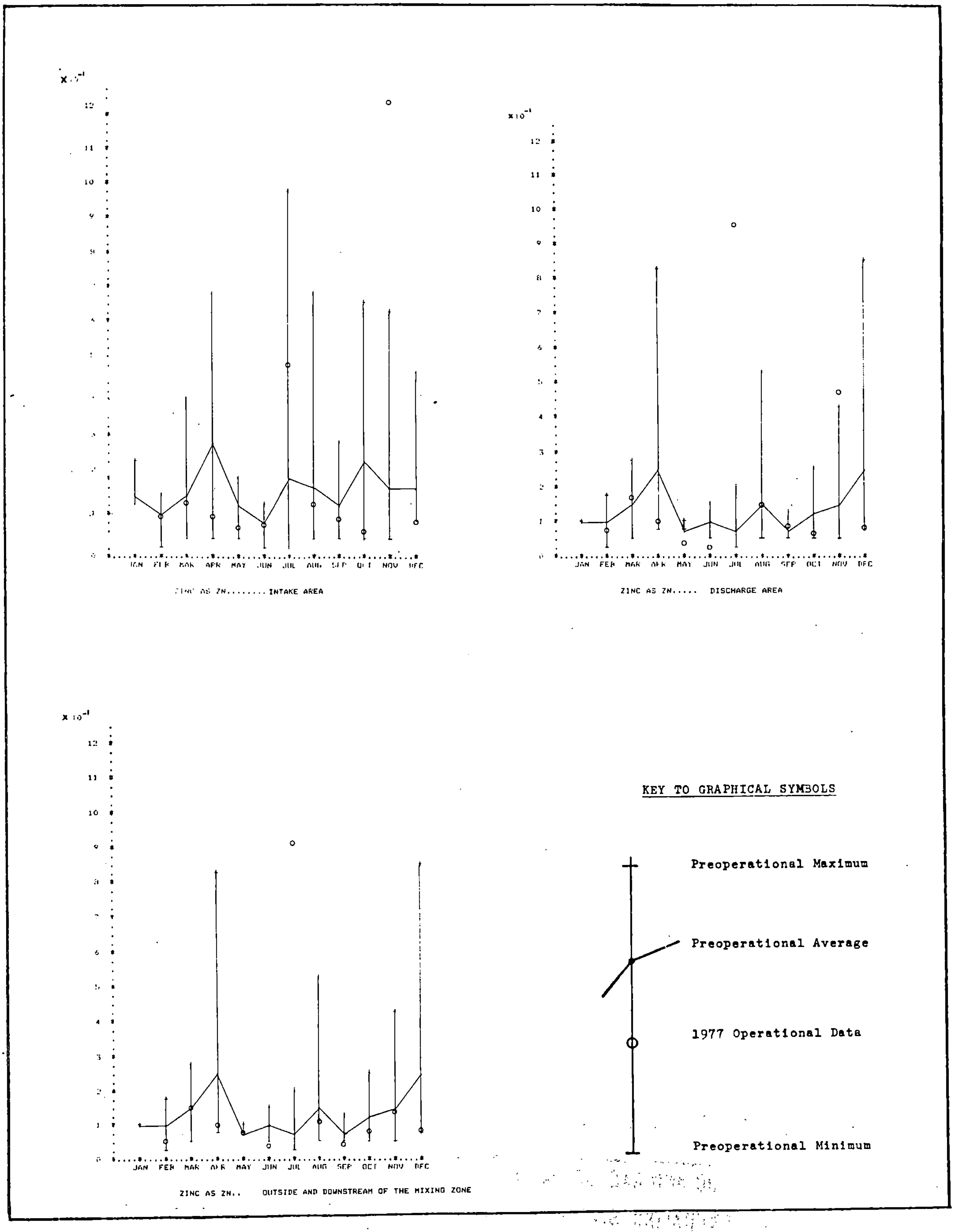
COPPER, TOTAL AS CU...

OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

KEY TO GRAPHICAL SYMBOLS



PUBLIC SERVICE ELECTRIC AND GAS COMPANY **SALEM NUCLEAR GENERATING STATION**	TOTAL COPPER AS CU (mg/l)
	FIG. 3.1.1.4.7-2



PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SALEM NUCLEAR GENERATING STATION

ZINC AS ZN
(mg/l)

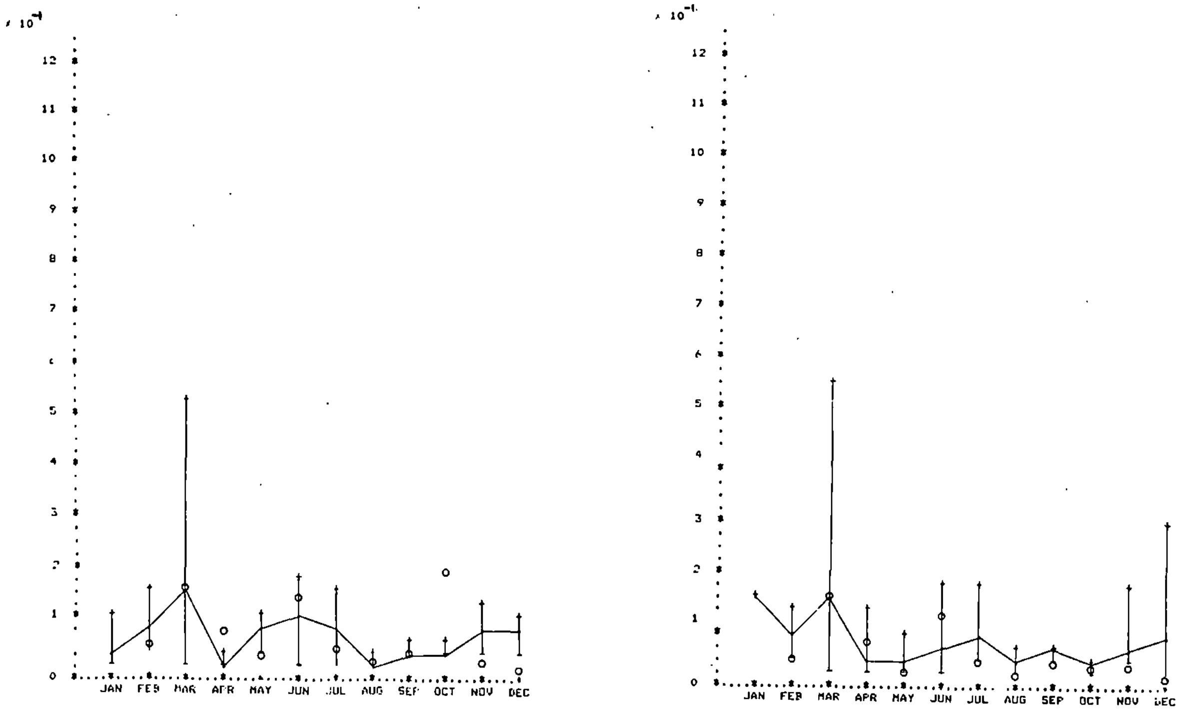
FIG. 3.1.1.4.7-3

Since no significant source of zinc addition or zinc corrosion products exists, these observations are not attributable to any Station operations other than the transport of ambient water nearshore to the offshore area via the circulating water system.

Chromium levels ranged between 0.025 and 0.301 milligrams per liter among the three locations sampled. Except for October, values did not vary significantly outside preoperational ranges. In October, unusually high values were recorded near the intake and also outside and downstream of the mixing zone, but not near the discharge.

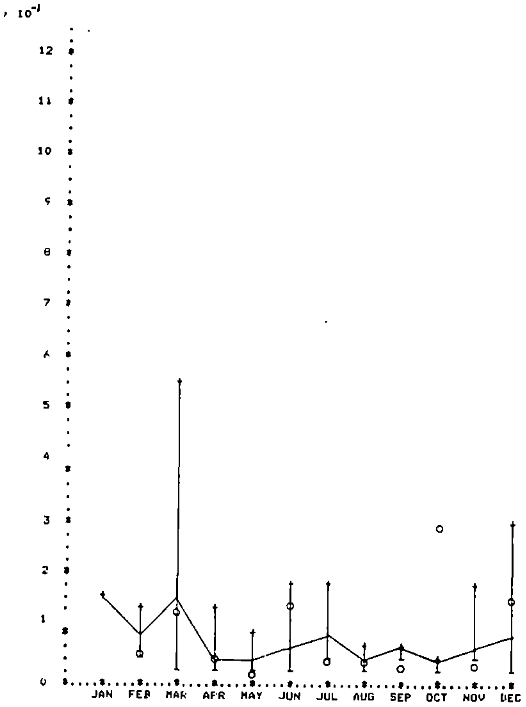
Salem does not discharge any significant quantities of chromium and no significant intake/discharge relationship is evident from the 1977 data. This indicates that the Station had no significant impact on ambient chromium levels in the Delaware Estuary.

Manganese levels varied between 0.08 and 0.50 milligrams per liter with both extremes observed in the discharge area samples. The preoperational trend of late spring maximums followed by a gradual decline through summer and fall was exhibited to some extent near the intake and discharge areas but less so in the samples obtained outside and downstream of the mixing zone.



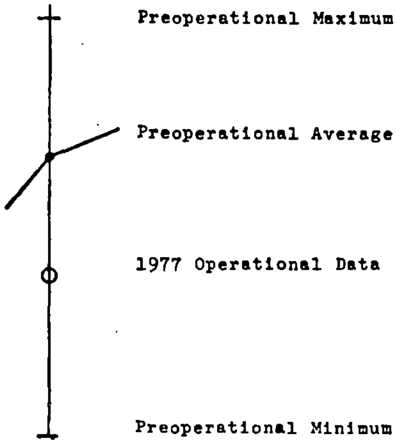
CHROMIUM AS CR...... INTAKE AREA

CHROMIUM AS CR...... DISCHARGE AREA

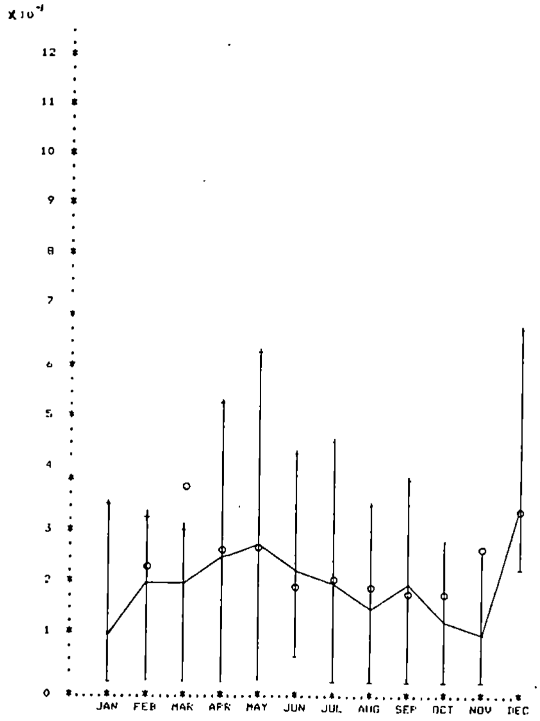


CHROMIUM AS CR......
OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

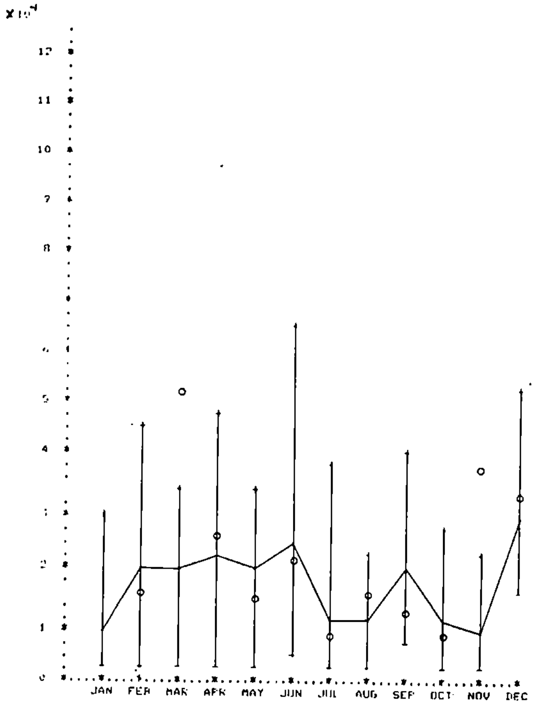
KEY TO GRAPHICAL SYMBOLS



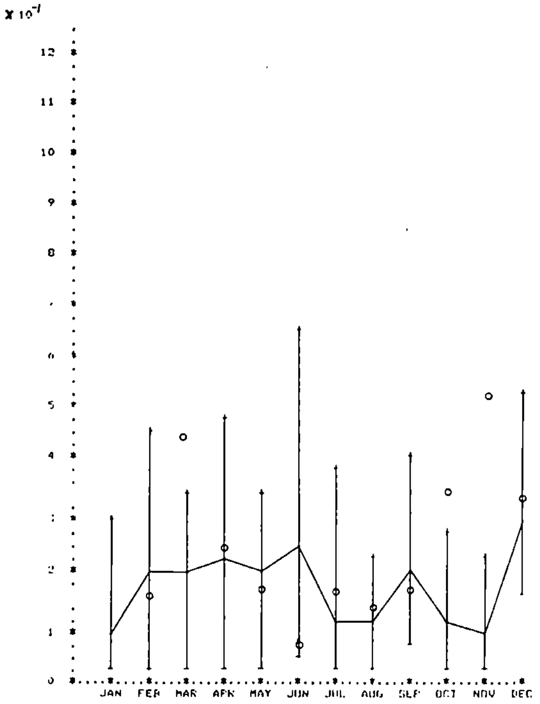
PUBLIC SERVICE ELECTRIC AND GAS COMPANY SALEM NUCLEAR GENERATING STATION	CHRONIUM AS CR (mg/l)
	FIG. 3.1.1.4.7-4



MANGANESE AS MN..... INTAKE AREA

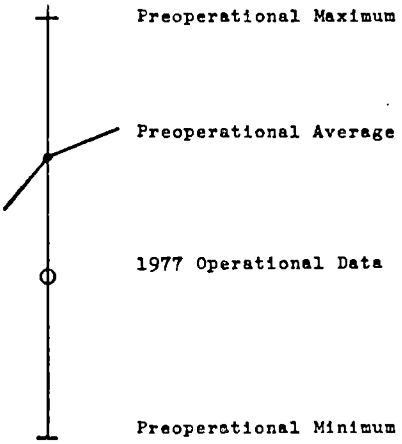


MANGANESE AS MN.... DISCHARGE AREA



MANGANESE AS MN.....
OUTSIDE AND DOWNSTREAM OF THE MIXING ZONE

KEY TO GRAPHICAL SYMBOLS



PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SALEM NUCLEAR GENERATING STATION

MANGANESE AS MN
(mg/l)

FIG. 3.1.1.4.7-5

Preoperational maximums were exceeded in March and November at all three locations and in October outside and downstream of the mixing zone only. The extremes recorded for other months in the preoperational program exceeded these particular postoperational maximums and permit the conclusion that 1977 observed variations in manganese levels were due to natural variations.

No significant source of manganese exists in any discharge from the Station.

3.1.1.4.8 Phenols

Phenols were detected at concentrations of 0.005 milligrams per liter and 0.006 milligrams per liter in February and November respectively in the vicinity of the discharge. Samples were not analyzed for phenols from the other two sampling stations. This is discussed in Licensee Event Report 78-19/04L. All other data were below the limits of detectability (0.001 milligrams per liter). Preoperational phenol data (from the station near Sunken Ship Cove - See Fig. 3.1.1-1) generally ranged between 0.001 and 0.004 milligrams per liter with late summer and fall excursions observed up to 0.130 milligrams per liter (October 1975).

The inventory of identifiable chemicals (See Section 3.1.1.5) did not indicate Station use of any chemical in large quantity which would contain phenolic compounds. Therefore, it is concluded that any variation in phenols detected in the ambient river is due to other pollution sources.

3.1.1.5 Chemical Releases

An inventory of identifiable chemicals used during the reporting period was made and the quantities discharged daily of each of the chemical constituents in ETS Table 3.1-3 was estimated. Since wells were used to supply certain systems which ultimately discharged to the non-radioactive chemical waste disposal system, the well water's chemical constituents were taken into account also in making the daily estimate.

During 1977 a total of 74.2 million gallons of non-radioactive chemical wastes were discharged from the waste basin. As discussed in Section 2.2.2, approximately one third of the total is steam generator blow-down quench water whose source is the Delaware River. Consequently, only approximately 49.5 million gallons were derived from the production wells at Salem Station. It was this volume that was used to determine the chemical releases given in Table 3.1.1.5-1.

Flow from the non-radioactive chemical liquid waste disposal basin occurred on 293 days in 1977. This value was used to calculate the average daily amount of chemical constituents discharged to the river. The biocide system for circulating and service water systems operated for a total of 220 days (Section 2.2.1) which yielded the average daily amount of chlorine (Cl_2) in Table 3.1.1.5-1.

Table 3.1.1.5-1

Chemical Release Estimates - 1977

Chemical Constituent	Anticipated Average Net Amount Discharged (lbs/day)	Estimated Average Net Amount Actually Discharged (lbs/day)
Chlorine (Cl_2)	870	1609.1
Calcium (Ca)	135	26.2 (1)
Magnesium (Mg)	56	11.8 (1)
Sodium (Na)	600	2723.6 (2)
Potassium (K)	55	16.9 (1)
Copper (Cu)	--	0.08 (3)
Sulfate (SO_4)	1590	3367.0
Chloride (Cl)	138	237.8
Nitrate (NO3)	2.4	7.0
Silica (SiO_2)	46	27.2
Phosphate (PO_4)	11	Not Available (4)
Volatile Amines	4.2	9.4
Hydrazine	0.04	17.3 (5)
Suspended Solids	1000	135.1 (6)

Note (1) Chemical analysis of the four production wells yielded a lower content of Calcium, Magnesium, and Potassium than anticipated. This resulted in lower discharges of the three chemicals from the waste basin to the river. There was no environmental impact.

Note (2) Startup conditions continued into 1977 that resulted in a higher than normal use of sodium hydroxide. This coupled with the circulating water biocide treatment (sodium hypochlorite) resulted in a higher total sodium discharge to the river than anticipated. Sodium at 2723.6 lbs/day is equivalent to an average daily concentration in the combined effluents of 1194 mg/liter of Na (2600 mg/liter as $CaCO_3$). This is at the low end of the natural range of background Na concentrations. Therefore, there was no environmental impact.

Note (3) Attributable to average copper concentrations in the four production wells of less than 0.08 mg/liter. This is nearly the same as the 0.07 mg/liter average natural copper concentration from the preoperational river water survey through 1977. There was no detectable environmental impact.

Note (4) Phosphate data for the well water were not available. No phosphate containing chemicals were used during the reporting period.

Note (5) Hydrazine is used for oxygen scavenging and, to a lesser degree, pH control.

In normal use hydrazine reacts with dissolved oxygen to form N_2 gas and water. Consequently, 17.3 lb/day of hydrazine were used at the station but not actually discharged as residual hydrazine in the steam generator blowdown. Except during startup the normal hydrazine level is below 0.02 ppm in the condensate. If, conservatively, the entire daily discharge from the non-radioactive chemical waste disposal system is assumed to have contained 0.02 mg/liter hydrazine, this was only 0.03 lb/day. The only environmental impact would have been a reaction with approximately 0.03 lb of dissolved oxygen in the estuary.

In reality little or no hydrazine is contained in the blowdown. It is volatile and either decomposes to NH_3 or continues to circulate in the system.

Note (6) The total suspended solids (TSS) discharge rate of 135.1 lbs/day was conservatively calculated by using the daily average of 63.9 mg/liter (Section 2.2.2) to the average waste basin flow of 253,320 gallons/day. A more representative determination of the total suspended discharged from Salem Station is found by comparing 17 mg/liter (Section 2.2.2) with a basin discharge of 168880 gallons/day. This would result in a TSS discharge of approximately 24 lbs/day.

This demonstrates that the ETS specification for the allowable average TSS of 25 mg/liter on an annual basis is inconsistent with the reporting requirements given in ETS Table 3.1-3. A change to the suspended solids specification will be requested which will take into account the contribution of the higher suspended solids content of the blowdown quench water. Regardless, the results of the TSS analysis for 1977 indicates that there was no environmental impact since the concentration is substantially lower than that found in the Delaware River.