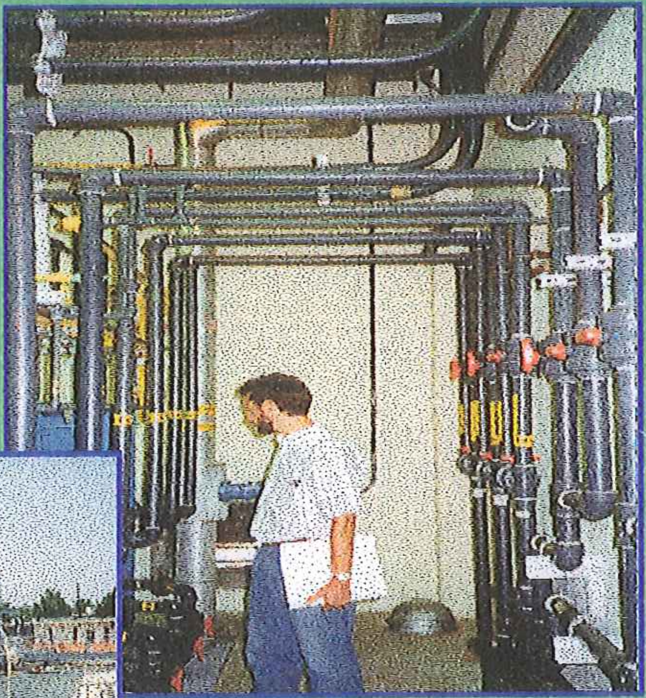
Water Quality Master Plan Update

Sewerage & Water Board *OF NEW ORLEANS*



April 1997

MALCOLM PIRNIE

100 YEARS

In association with:

Burk-Kleinpeter, Inc. and **C&S Consultants, Inc.**

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.
ENVIRONMENTAL ENGINEERS, SCIENTISTS & PLANNERS

April 2, 1997

Mr. G. Joseph Sullivan
General Superintendent
Sewerage and Water Board of New Orleans
625 St. Joseph Street
New Orleans, LA 70165

RE: Water Quality Master Plan Update

Dear Mr. Sullivan:

We are pleased to submit this Update to the 1992 Water Quality Master Plan for the water supply of the City of New Orleans on behalf of the consulting team of Malcolm Pirnie, Inc.; Burk-Kleinpeter, Inc.; and C & S Consultants, Inc. In accordance with the request of your staff, nine copies are being submitted for record purposes.

This document updates the information contained in the 1992 report, and summarizes recommendations for plant improvements based on this updated information and on information generated during our production of the Zebra Mussel Control Plan, the G and L Basin Upgrade Plan, and the Plant Performance Assessment.

We appreciate the assistance of the Board staff during the production of this report, and look forward to working with you to implement the recommendations of this report.

Very truly yours,

MALCOLM PIRNIE, INC.

for Thomas J. Lane, P.E.
Project Officer

c: Ray Rials, Malcolm Pirnie, Inc.
Timothy Brodeur, Malcolm Pirnie, Inc.
George Kleinpeter, Burk-Kleinpeter, Inc.
Lloyd Fitzpatrick, Burk-Kleinpeter, Inc.
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Enclosure

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EXECUTIVE SUMMARY

This document updates the 1992 Water Quality Master Plan for the New Orleans Sewerage and Water Board by Malcolm Pirnie, Inc.; in association with Burk-Kleinpeter, Inc.; and C&S Consultants, Inc.

This document presents an updated list of recommended phased capital improvements to assure that the Board's water treatment plants continue to provide a safe and reliable water supply to the Board's customers.

The recommendations are the result of an evaluation of the changes in raw water quality and in the quality of finished water produced by the plants, an evaluation of recently enacted and forthcoming water regulations, and a summary of data presented in three concurrent reports. The concurrent reports are as follows:

1. Zebra Mussel Control Plan
2. G and L Basin Upgrade Plan
3. Water Treatment Plant Performance Assessment

This update to the Water Quality Master Plan additionally provides guidance on steps necessary for the whole water treatment system (source, treatment and distribution of water) for the Board to consider in becoming a 'forward-looking utility." This will correlate with the Board's desire to participate in the American Water Works Association "Qual-Serve" program and utility peer reviews.

Planning level estimates of capital costs for Phase I and Phase II improvements are summarized below.

Plant	Phase I	Phase II
Carrollton WTP	$23,150,000	$62,000,000
Algiers WTP	$13,150,000	$ 3,000,000
TOTAL	$36,300,000	$65,000,000

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

Description **Page**

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 BACKGROUND AND PURPOSE

In 1991, the Sewerage and Water Board of New Orleans (Board) retained a consulting team consisting of Malcolm Pirnie, Inc.; in association with Burk-Kleinpeter, Inc.; and C&S Consultants, Inc. to develop a Water Quality Master Plan. The plan was completed in May 1992. In December of 1995, the consulting team was authorized to collect new information/data relating to plant water quality and to water quality regulations, and to update the Water Quality Master Plan.

1.2 REPORT

This report presents the results of the compilation of updates since the original Water Quality Master Plan was submitted.

1.2.1 Organization of Report

- Section 1 presents an introduction to the report.
- Section 2 presents an update of changes in regulations that affect the project.
- Section 3 presents a summary and analysis of plant performance data at each of the Board's water treatment plants.
- Section 4 presents recommendations drawn from the information included in the previous sections, and updates the Water Quality Master Plan.
- Section 5 presents a description of each phase of the improvements.
- Section 6 presents a revised schedule and estimated costs for the improvements described in the plan.

1.2.2 Related Documents

Some of the recommendations contained in this update are the result of information presented by the consulting team in other documents prepared for the Board. These documents are as follows:

- Zebra Mussel Control Plan
- G & L Basin Upgrade Plan
- Water Treatment Plant Performance Assessment

2.0 WATER QUALITY REQUIREMENTS UPDATE

2.1 INTRODUCTION

This section summarizes the changes in the Federal regulations since the 1992 Water Quality Master Plan (WQMP). No State regulations have been enacted which are more stringent than Federal regulations. The primary drinking water regulations that are discussed in this section include:

- Safe Drinking Water Act (SDWA)
- Clean Water Act (CWA)

Federal rules and regulations have also been published by EPA and OSHA regarding safety issues. These are discussed in Section 2.4. The SDWA and CWA are covered in Section 2.2 and 2.3, respectively. State requirements are covered in Section 2.5. Other water quality objectives are described in Section 2.6. Section 2.7 describes an update of the original proposed water quality goals, which the Board may wish to implement to define ideal levels of treatment.

2.2 SAFE DRINKING WATER ACT (SDWA)

The SDWA was signed into law (PL 93-523) in December 1974. Under the provisions of the SDWA, USEPA was required to establish the National Primary Drinking Water Regulations (NPDWR). Enforceable MCLs were promulgated in 1975 as part of the National Interim Primary Drinking Water Regulations (NPDWR). The NPDWR were amended in 1977 and 1979 to include Maximum Contaminant Levels (MCLs) for additional contaminants. In addition to the health-related primary drinking water regulations, SDWA also authorized USEPA to develop secondary regulations for contaminants which may adversely affect the aesthetic quality of drinking water. Non-enforceable secondary maximum contaminant levels (SMCLs) were promulgated in 1979.

In June 1986, the SDWA amendments were signed into law (PL 99-339) to strengthen the regulations to provide additional protection of groundwater. In 1986, MCLs were in place for 25 contaminants and SMCLs were in place for 13 contaminants. Under the 1986 amendments, USEPA is required to continually increase the number of contaminants regulated. In addition, the amendments required disinfection of all public water supplies (including groundwater) and authorized USEPA to develop filtration criteria for surface water supplies.

On August 6, 1996, the President signed the SDWA amendments into law (PL-104-182). The new amendments made sweeping changes to the existing SDWA, created new programs, and included a total authorization of more than $12 billion in federal funds for various programs.

The primary drinking water regulations include:

- Enhanced Surface Water Treatment Rule
- Disinfectant/Disinfection By-Products Rule
- Information Collection Rule
- Phase II SOCs, IOCs, VOCs
- Radionuclides
- Phase VIb SOCs, VOCs, IOCs
- Arsenic

2.2.1 Enhanced Surface Water Treatment Rule

The Surface Water Treatment Rule (SWTR) was finalized in June 1989, became effective in June 1993, and provided minimum disinfection requirements for systems using surface water or groundwater under the influence of surface water. The focus of the SWTR is on the removal and inactivation of *Giardia* cysts and viruses.

During the regulatory negotiation for the D/DBP Rule, all parties were concerned about the possible reduction in disinfection efficiency while attempting to reduce the formation of DBPs. In some instances, systems were providing removals greater than those required by the SWTR, but might reduce to "minimum" disinfection requirements to address DBP formation. This potential increase in microbial risk prompted discussions on requiring increased levels of disinfection for poorer quality source waters, rather than allow this to be guidance as in the SWTR.

In addition, the first major outbreak of waterborne disease caused by *Cryptosporidium* was reported in Milwaukee, WI in 1993. Lack of data on *Cryptosporidium* prevented it from being regulated in the SWTR, but there was considerable interest in including this pathogen as a target organism for disinfection. The ability of the SWTR to protect against *Cryptosporidium* was questioned during the regulatory negotiation, and the regulatory committee concluded that an Enhanced Surface Water Treatment Rule (ESWTR), addressing increased removal/inactivation for poorer quality source waters as well as potential treatment requirements for *Cryptosporidium*, was necessary. The ESWTR was proposed on June 13, 1994 and was published in the *Federal Register* on July 29, 1994.

2.2.1.1 Implementation Schedule

After data are collected as required by the Information Collection Rule (ICR), the final ESWTR will be developed. In the meantime, the USEPA proposed an interim ESWTR on June 13, 1994 that was published in the Federal Register on July 29, 1994. The expected implementation schedule for the ESWTR is:

Interim Rule Proposal .... June 1994

Interim Rule Final (Promulgation) .... November 1998

Interim Rule Effective .... May 2000

Final Rule Final (Promulgation) .... November 2000

Final Rule Effective .... May 2002

The Interim ESWTR is applicable only to surface water systems or groundwater systems under the direct influent of surface water that serve 10,000 or more people. The final ESWTR will apply to all surface water systems, including those serving less than

10,000 people. Both the interim and the final rules will apply to the Board's water treatment plants.

Because of the uncertainty relative to information on national occurrence of the contaminants, which will not be available until completion of monitoring under the ICR, the EPA has proposed five alternative treatment techniques for the ESWTR

2.2.1.2 Proposed Maximum Contaminant Level Goal (MCLG) for *Cryptosporidium*

Some strains of *Cryptosporidium parvum* appear to be highly infectious. Currently, there is no generally accepted practical means for distinguishing whether detected oocysts are viable, or for determining the infectious dose of any particular strain. For these reasons, EPA believes that consumption of one *Cryptosporidium* oocyst would be considered sufficient to initiate human infection as a possible consequence. Also, direct person-to-person spread of infection may readily occur, thus magnifying the significance of the original waterborne infection. Therefore, EPA proposes that the presence of this organism at any level in drinking water cannot be considered safe for human consumption. For these reasons and to be consistent with EPA drinking water standards for other microbiological contaminants, EPA proposed that the MCLG for *Cryptosporidium* oocysts in water be zero.

EPA proposes to amend the SWTR to require all systems that use surface water, or groundwater under the direct influent of surface water, to have a periodic sanitary survey, regardless of whether or not they filter. States would be required to review the results of each sanitary survey to determine whether the existing monitoring and treatment practices for that system are adequate, and if not, to determine the corrective measures needed to provide adequate drinking water quality. If EPA publishes a regulation that requires systems to treat their water on the basis of pathogen densities in the source water, the EPA with the State would require systems, as part of the sanitary survey, to assess quantitatively whether the source water quality has changed sufficiently since the previous sanitary survey to warrant changes in treatment practice.

Under this rule, the utility would be responsible for ensuring that the sanitary survey is accomplished. Only the State or an agent approved by the State would be able to conduct this sanitary survey (EPA is requesting comment on the method to generate a list of approved agents).

A sanitary survey is defined in the SWTR as "an on-site review of the water source, facilities, equipment, operation and maintenance of a public water system for the purpose of evaluating the adequacy of such sources, facilities, equipment, operation and maintenance for producing and distributing safe drinking water." Guidance for conducting a sanitary survey for unfiltered systems appears in the SWTR Guidance Manual (EPA, 1991), even though such a survey is not specifically required by the SWTR.

EPA is considering requiring sanitary surveys either every three years or every five years. The concern is that changes over time in watershed characteristics, such as those resulting from development or other changes in land use, may degrade surface source water quality significantly. Treatment facilities and distribution systems likewise may deteriorate over time. It is important to address such adverse changes as soon as possible. Consequently, more frequent sanitary surveys should result in safer and more reliable drinking water. This is the advantage of a three-year survey over a five-year survey.

Yet a survey every five years is less expensive and is more consistent with the provisions of the TCR. EPA considers a five-year frequency to be minimal for assessing watershed and system conditions associated with surface waters.

2.2.1.3 Possible Supplemental Requirements

EPA is also considering supplemental regulations to require:

- All finished water reservoirs to be covered.
- Cross-connection control programs.
- Immediate (as soon as possible) reporting to the State of violations of the SWTR's turbidity performance standards.

The EPA is accepting comments on each of these possible supplemental requirements.

2.2.1.4 Defining Pathogen Densities in Source Waters

The EPA proposes five alternative treatment requirements for removing *Giardia* and *Cryptosporidium*. The final rule might include one, or a combination of, these alternatives. These regulatory alternatives would require systems to remove a specified level of pathogen based upon its density in the raw water. The greater the pathogen density in raw water, the greater would be the pathogen reduction required by treatment.

EPA is considering four options for defining the raw water pathogen density that systems would use to determine their needed level of treatment. As part of this, EPA is considering both the technical and public health implications of these options. Each of the four options is discussed briefly below.

Arithmetic Mean of Data

The arithmetic mean is the sum of the pathogen densities from all collected samples divided by the number of samples. An arithmetic mean would be calculated for each pathogen. The arithmetic mean is most appropriate when the densities are relatively uniform, both spatially and temporally, and symmetrical about the mean, i.e., when the distribution of measured values approximates a normal distribution.

Geometric Mean of Data

The geometric mean is defined by the equation:

$$GM = \log^{-1} \left[\frac{\log x_1 + \log x_2 + \ldots + \log x_n}{n}\right]$$

Where n = number of samples and X_i is the measured density for each sample. For example, the geometric mean of the values 1, 10, and 100 would be 10. The geometric mean is more appropriate than the arithmetic mean for representing the central tendency for data that have a skewed distribution.

90th Percentile Value

Another alternative for defining pathogen density is to base this value on the 90th percentile of all data for a particular pathogen. This is the value below and above which are 90% and 10% of the data, respectively. This approach is more conservative in terms of risk than the arithmetic mean and geometric mean, because for sources where pathogen density varies significantly throughout the year, use of this value will be more representative of the elevated risk associated with peak contamination periods.

Maximum Measured Value

This approach would dictate the use of the highest density measured under the ICR for raw water. Since few systems have the resources for routine, frequent, and long-term sampling for pathogens such as *Giardia*, *Cryptosporidium* and viruses, it is clear that episodic periods of microbial contamination may escape detection. EPA is particularly concerned with the risks from unusually high level contamination events that might exceed the removal/inactivation capacity of a treatment system. While the maximum measured value may not be representative of the normal pathogen density in a source water, it would be more indicative of potential short-term risks.

2.2.1.5 Treatment Alternatives for Controlling Pathogens

To address the health risk associated with waterborne illness, EPA is proposing five treatment alternatives for controlling *Giardia*, *Cryptosporidium*, and/or viruses in the interim ESWTR. Within each alternative, several options are addressed. The EPA may promulgate one or more of these alternatives. Alternative A addresses enhanced treatment for *Giardia* only. Alternatives B and C address treatment for *Cryptosporidium* only. Alternative D addresses enhanced treatment for viruses only. Alternative E maintains existing level of treatment requirements for *Giardia* and viruses. In the proposal published in the *Federal Register*, EPA requested comment on which alternative(s) is most appropriate.

Alternative A: Enhanced Treatment for *Giardia*

This alternative bases the extent of treatment required on the *Giardia* density in the source water. The SWTR currently requires a 99.9 percent (3-log) removal/inactivation of *Giardia* for all surface waters, regardless of *Giardia* cyst concentration in the source water.

Under Alternative A, systems using source waters with higher *Giardia* densities would be required to meet higher levels of treatment to satisfy the desired acceptable risk levels (e.g., a 10^{-4} annual risk). Specifically, under one option of Alternative A, EPA is proposing that systems meet the level of treatment for *Giardia* associated with the *Giardia* concentrations in the source water to achieve a 10^{-4} annual risk level, as indicated in Table 2-1.

TABLE 2-1
Alternative A (Option 1):
Treatment Levels for *Giardia*

Source Water *Giardia* Concentration (cysts/100 L)	Removal/Inactivation Requirement
<1	3-log (99.9%)
1 to 9	4-log (99.99%)
10 to 99	5-log (99.999%)
>99	6-log (99.9999%)

The determination by utilities and States of removal and inactivation efficiencies for specific treatment strategies would be based on EPA guidance and information, as is currently done under the existing SWTR. EPA would revise the existing SWTR Guidance Manual based on data collected under the ICR and research to complement any criteria promulgated under the ESWTR. The Agency expects that data collected under the ICR will be used by States and utilities to define the source water concentration and consequently the appropriate level of treatment for individual systems. If a utility has not collected data on pathogen densities in source water under the ICR, it would be required to do so to define the appropriate level of treatment.

EPA is considering an alternative version of the above described treatment requirements that would instead require lesser *Giardia* reductions than Alternative A (Option 1), but still greater reductions that the current SWTR, for source waters beginning with *Giardia* concentrations of 10 or more cysts/100 liters, as indicated in Table 2-2.

TABLE 2-2
Alternative A (Option 2):
Treatment Levels for *Giardia*

No. *Giardia*/100L	Required treatment level (percent)
10 - 99	4-log (99.99)
100 - 999	5-log (99.999)
> 1000	6-log (99.9999)

Alternative B: Specific Treatment for *Cryptosporidium*

In Alternative B, EPA is proposing a treatment technique rather than an MCL for *Cryptosporidium*, because EPA believes that it is not currently economically or technologically feasible for a system to monitor for this organism in the finished water to determine whether it meets an acceptable risk level. EPA is proposing a wide variety of options. One sub-alternative would be to base the level of treatment on the *Cryptosporidium* densities found in the source water, as presented in Table 2-3.

TABLE 2-3 Alternative B (Option 1): Treatment Levels for *Cryptosporidium*	
Source Water *Cryptosporidium* Concentration (cysts/100 L)	**Removal/Inactivation Requirement**
< 1	3-log (99.9%)
1 to 9	4-log (99.99%)
10 to 99	5-log (99.999%)
>99	6-log (99.9999%)

EPA is concerned, however, that it may not be technologically or economically feasible to achieve the treatment levels above, given that *Cryptosporidium* is much more resistant to disinfection than is *Giardia*. Conventional treatment of coagulation, sedimentation, and filtration may not reliably achieve more than 2.5-log or 3-log *Cryptosporidium* oocyst reduction under typical operating conditions. Unless systems can feasibly achieve higher removal levels for *Cryptosporidium* by physical means, they would have to achieve this additional reduction by the use of disinfectants. However, uncertainties exist with respect to disinfection of *Cryptosporidium*. Current data suggest that chlorine and chlorine-based disinfectants are relatively ineffective in inactivating *Cryptosporidium*, and the EPA is not certain if alternative disinfectants, such as ozone, are more effective than chlorine to allow systems to comply with the removal/inactivation levels above.

For these reasons, EPA is also considering two other treatment sub-alternatives for *Cryptosporidium*, as indicated in Table 2-4 and Table 2-5.

TABLE 2-4 Alternative B (Option 2): Treatment Levels for *Cryptosporidium*	
No. *Cryptosporidium*/100 L	Required treatment level (percent)
<1	2-log (99)
1 - 9	3-log (99.9)
10 - 99	4-log (99.99)
>99	5-log (99.999)

TABLE 2-5 Alternative B (Option 3): Treatment Levels for *Cryptosporidium*	
No. *Cryptosporidium*/100 L	Required Treatment Level (percent)
< 10	2-log (99)
10 - 99	3-log (99.9)
> 99	4-log (99.99)

Alternative C: 99% (2-log) Removal of *Cryptosporidium*

Under this alternative, EPA would require systems to achieve at least 99% (2-log) removal of *Cryptosporidium* by filtration (including pretreatment) alone. EPA believes that a two-log removal of *Cryptosporidium* is feasible using current conventional treatment methods of coagulation, sedimentation, and filtration, as specified under the SWTR.

Under this treatment option, EPA would continue to assess new field and laboratory data to control *Cryptosporidium* by physical removal and disinfection. If these data indicate that proportionally higher levels of *Cryptosporidium* removal/inactivation can be achieved at a reasonable cost, then EPA would revise the ESWTR accordingly as part of the long-term ESWTR regulatory development.

Alternative D: Specific Disinfection Treatment for Viruses

The SWTR required systems to achieve a 4-log reduction/inactivation of viruses. This is to be achieved through a combination of filtration and disinfection or, for systems not required to filter their source waters, by disinfection alone.

The SWTR considered *Giardia* to be a surrogate for viruses, and assumed that if viruses were present in the source water, treatment requirements adequate to reduce *Giardia* by three logs would also reduce viruses to safe levels. This assumption may not be appropriate if a system were to achieve a 3-log removal of *Giardia* by physical means and provide little disinfection inactivation. Viruses may be present in substantial numbers even in the absence of detectable *Giardia* cysts.

Treatment designed to minimize *Giardia* may not be optimal for viruses. Viruses are substantially smaller than *Giardia* cysts or *Cryptosporidium* oocysts and may pass through certain filter media that will remove the larger protozoa. Therefore, use of data on *Giardia*, *Cryptosporidium*, or even coliform bacteria (intermediate in size between viruses and protozoa) in assessing treatment efficacy may not be adequate for virus control.

For the above reasons, particularly for strengthening the treatment barrier by disinfection, EPA is proposing to require that systems provide sufficient disinfection such that by disinfection alone it would achieve at least a 0.5-log inactivation of *Giardia* or, alternatively, a 4-log inactivation of viruses. This requirement would be independent of the level of physical removal, e.g., if filtration were able to remove three logs of *Giardia*, the system would still have to provide at least an additional 0.5-log inactivation of *Giardia* or 4-log inactivation of viruses by disinfection. Therefore, the system would provide 6 logs of virus removal/inactivation, assuming it is removing 2 logs of viruses by filtration alone. EPA would provide guidance to indicate the appropriate CT values to use with these two alternatives.

The SWTR assumed that a 0.5-log inactivation of *Giardia* would result in a 4-log inactivation of viruses. This assumption was based on a study (Sobsey M.D., F. Takashi, and

R.M. Hall, 1991, Inactivation of Cell-Associated and Dispersed Hepatitis A Virus in Water. Journal American Water Works) where the effect of free chlorine on the hepatitis A virus was examined. Subsequent investigations, however, have suggested that some viruses, such as the Norwalk agent, are substantially more resistant to disinfection by chlorine than is the hepatitis A agent. Additionally, use of disinfectants other than free chlorine to achieve the 0.5-log inactivation of *Giardia* may not yield a 4-log inactivation of viruses. Therefore, a requirement to provide sufficient disinfection to inactivate 4 logs of viruses may be more conservative than the alternative requirement of providing sufficient disinfection to inactivate 0.5 logs of *Giardia*.

Alternative E: No Change to Existing SWTR Treatment Requirements for *Giardia* and Viruses

Under this alternative, the existing SWTR requirements for treatment for *Giardia* and viruses would not change. For *Cryptosporidium* control, EPA could either regulate this organism directly (e.g., Alternative C above) or make a finding that *Cryptosporidium* is adequately controlled by filtration and disinfection requirements in the existing SWTR.

However, discussions are still on-going as to the regulatory options of the Interim Rule. The following is a summary evaluation of microbial and disinfection by-product options that were discussed as of the September 26, 1996 stakeholders meeting.

SUMMARY EVALUATION OF MICROBIAL AND DISINFECTION BY-PRODUCT OPTIONS(1)

OPTIONS	ELEMENTS
Microbial - Incremental	1. Individual filter turbidity monitoring
	2. Action levels for turbidity (0.5 NTU) trigger self-assessment. If chronic, a formal CCP w/report to State.
	3. High priority turbidity level: trigger CCP, corrective action, and publicly available report to State

OPTIONS	ELEMENTS
Microbial - CCP	1. Individual filter turbidity monitoring
	2. Turbidity action level for high priority facilities.
	3. External CCP and, if needed, remedial plan.
	4. Public availability of report to state
Microbial - Revise Turbidity Limits	1. Individual filter turbidity monitoring
	2. Lower 0.5 NTU standard
	3. Lower 5 NTU standard
Microbial - Supplemental Elements	1. *Cryptosporidium* MCLGs
	2. Cross-connection
	3. Filter backwash
DBP Action Level(2)	1. 80 μg/L/60 μg/L/10 μg/L for THM, HAA5, and bromate triggers study.
	2. Implement remedial steps within specific time frame.
Precursor Action Level(2)	1. If TOC > 2 mg/L, then enhanced coagulation.
DBP MCLs(2)	1. 80 μg/L/60 μg/L/10 μg/L for THM, HAA5, and bromate.
Finalize DBP Stage 1(2)	1. 80 μg/L/60 μg/L/10 μg/L/1 μg/L for THM, HAA5, bromate, and chlorite.
	2. Set maximum residual disinfectant concentrations.
	3. Enhanced coagulation
	4. No CT credit for pre-disinfection

Notes: (1) As of September 26, 1996 stakeholders meeting.
(2) Assumes filtration performance maintained.

2.2.2 Disinfectant/Disinfection By-products Rule

The requirements of the Disinfectant/Disinfection By-Product (D/DBP) Rule will apply to community water systems (CWS) and nontransient, non-community water systems (NTNCWS) that treat their water with a chemical disinfectant. Based upon a regulatory negotiation conducted in 1992 and 1993 between EPA and interested parties, the D/DBP Rule was developed in two stages. Stage 1 of the D/DBP Rule contains a revised Maximum Contaminant Level (MCL) for total trihalomethanes (TTHMs). New MCLs are proposed for the sum of five haloacetic acids (HAA5-monochloroacetic, dichloroacetic, trichloroaecetic, monobromoacetic, and dibromoacetic acids), bromate, and chlorite. The Rule also designates best available technology (BAT) for compliance, and specifies a treatment technique to reduce DBP precursors.

Since the date of the original WQMP, a new D/DBP rule was proposed on June 13, 1994. A final rule (promulgation) is expected following completion of the 18-month monitoring phase of the Information Collection Rule (ICR). The summary of the final ICR indicates that EPA will evaluate the first eight months of ICR data to determine whether to begin drafting the final Stage 1 D/DBP Rule. Later, EPA will also check the last 10 months of ICR data against the first eight months of data. If the data are similar, the EPA will probably move according to the following schedule:

ICR Monitoring Begins .... February 1997
ICR Monitoring Ends .... August 1998
Stage 1 D/DBP Rule Final .... November 1998
Stage 1 D/DBP Rule Effective .... May 2000

2.2.2.1 Stage 1 Monitoring Requirements

The Stage 1 D/DBP Rule is expected to include the following monitoring requirements for DBP precursors, DBPs, and disinfectants:

- TOC in 1) raw water and 2) before continuous disinfection (except ozone and chlorine dioxide). Monthly sampling is required.

- THMs in the distribution system (25 percent at maximum residence time and 75 percent at representative locations). Quarterly sampling is required. Four samples should be collected for each water treatment plant (WTP) in service.

- HAA5 in the distribution system (25 percent at a location representative of the maximum residence time and 75 percent at representative locations). Quarterly sampling is required. Four samples should be collected for each WTP in service.

- Chlorine residuals at the sample locations specified by the Total Coliform Rule for coliforms.

2.2.2.2 Disinfectant/Disinfection By-Product Rule - Stage 1 MCLs and MRDLs
The MCLs proposed as a part of the Stage 1 D/DBP rule are:

- Total THMs - 80 µg/L
- HAA5 - 60 µg/L
- Bromate - 10 µg/L
- Chlorite - 1.0 mg/L

In addition to the MCLs, the proposed D/DBP rule contains the following maximum residual disinfectant levels (MRDLs):

- Free Chlorine - 4.0 mg/L as free chlorine
- Chloramines - 4.0 mg/L as total chlorine
- Chlorine Dioxide - 0.80 mg/L

2.2.2.3 Reduced Monitoring

TTHMs and HAA5 monitoring may be reduced if all of the following conditions are met.

- At least one year of routine monitoring has been completed.
- The annual average for TTHMs is no more than 0.040 mg/L.

- The annual average for HAA5 is no more than 0.030 mg/L.
- Annual average source water Total Organic Carbon (TOC) level is no more than 4.0 mg/L prior to treatment.

Chlorine residual monitoring may not be reduced. Systems eligible for reduced monitoring may monitor for TTHMs and HAA5 on a one sample per quarter basis. Systems on a reduced monitoring schedule may remain on that reduced schedule as long as the average of all samples taken in the year is no more than 75 percent of each MCL. Systems must revert to routine monitoring if the annual average exceeds 75 percent of the MCL.

2.2.2.4 Compliance Determination

A public water system (PWS) is in compliance with the *MCL* when the running annual average of quarterly averages of all samples, computed quarterly, is less than or equal to the MCL. If the running annual average computed for any quarter exceeds the MCL, the system is out of compliance.

A PWS is in compliance with the *MRDL* when the running annual average of monthly averages of all samples, computed quarterly, is less than or equal to the MRDL. For emergency situations, however, operators may increase residual chlorine levels in the distribution system to a level and for a time necessary to protect public health (in spite of the MRDL) to address specific microbiological contamination problems (e.g., including distribution line breaks, storm runoff events, source water contamination, or cross-connections).

2.2.2.5 Treatment Technique

Surface water systems and groundwater systems under the direct influence of surface water that employ conventional treatment (including settling) will be required to use a specific treatment technique for the reduction of DBP precursors to minimize the formation of unknown DBPs. This treatment technique is termed "enhanced coagulation" and involves modification to the existing coagulation process to increase the removal of precursor material as measured by TOC. The purpose of the treatment technique for control of DBP precursors is to remove NOM that reacts with chlorine to produce halogenated DBPs.

Implementation of enhanced coagulation in difficult-to-treat waters may be costly and may introduce other water quality problems. Therefore, exception criteria have been proposed which allow systems to forego the treatment requirement. These criteria either recognize the low potential of certain waters to produce DBPs or account for types of water that contain TOC that is difficult to remove by enhanced coagulation. Three exceptions have been proposed for conventional, non-softening treatment systems. A system does not have to implement enhanced coagulation if any of the following are true:

- Treated water TOC (prior to continuously adding disinfectant for CT credit) less than 2.0 mg/L.
- Raw water TOC < 4.0 mg/L, raw water alkalinity > 60 mg/L as $CaCO_3$, distribution system TTHM and HAA5 concentrations are less than or equal to 40 μg/L and 30 μg/L, respectively.
- Distribution system TTHM and HAA5 concentrations are less than or equal to 40 μg/L and 30 μg/L, respectively, and the system uses only free chlorine for disinfection.

2.2.2.6 CT Credit

To limit DBP production prior to precursor removal, systems required to operate with enhanced coagulation may not take credit for compliance with CT requirements prior to sedimentation. However, there are four exceptions. The one exception that may apply to the Waterworks: CT credit may be taken prior to enhanced coagulation during periods when the water temperature is below 5°C and the TTHM and HAA5 quarterly averages are no greater than 40 μg/L and 30 μg/L, respectively. Compliance with these "exception" standards for CT must be demonstrated by monitoring.

2.2.2.7 Definition of Enhanced Coagulation

Precursor removal with alum and ferric chloride can be enhanced by increasing the coagulant dosage, reducing the pH at which coagulation occurs, or both. Removals must be achieved between the raw water and the point at which a disinfectant is added for CT credit. As an initial step for defining enhanced coagulation, the Stage 1 Rule establishes targets for additional precursor removals to be achieved based on raw water TOC and alkalinity.

If a utility can satisfy the TOC percent removals specified in Step 1, the enhanced coagulation criterion for Stage 1 is satisfied. If a utility does not achieve the target removals, bench-scale testing will be required to determine enhanced coagulation. Enhanced coagulation in Step 2 is defined as "diminishing returns", or the point at which an additional 10 mg/L increment of alum (or an equivalent amount of a ferric salt) produces less than a 0.3 mg/L reduction in TOC.

2.2.2.8 Disinfectant/Disinfection By-Product Rule Stage 2

The regulatory negotiation process produced an outline and key milestone dates for Stage 2 of the D/DBP Rule. USEPA plans to fully develop Stage 2 in another round of regulatory negotiations in 1998 following implementation of the ICR. An interim Stage 2 regulation was proposed with the Stage 1 proposal. As currently structured, Stage 2 will require further reductions in total THMs, HAA5, and TOC and may establish MCLs or treatment techniques for constituents not regulated under Stage 1. The tentative values for the MCLs presented here are goals and are subject to change based upon the results of the proposed second round of regulatory negotiations.

The following summarizes the rule-making schedule for Stage 2:

Interim Proposal . . . . June 1994

Final (Promulgation) . . . . May 2002
Effective . . . . November 2003

2.2.3 Information Collection Rule

The concept for the Information Collection Rule (ICR) was developed during the regulatory negotiation for the D/DBP Rule because an improved database is needed to support development of the Enhanced SWTR (ESWTR) and the Stage 2 D/DBP Rule. Various levels of monitoring are required depending on the source water type and system size. The most extensive monitoring requirements will be imposed on surface water systems and groundwater systems serving populations greater than 100,000. More limited monitoring will be required for systems serving between 10,000 and 99,999. A description of the requirements for information collection follows. The ICR was promulgated May 14, 1996 and public water system (PWS) must begin monitoring for DBPs and microbials in February, 1997 and continue through August, 1998.

2.2.3.1 Monitoring for DBPs and Related Parameters (PWSs serving at least 100,000 people and using surface water)

Monthly monitoring for DBPs, DBP precursors, and other chemical parameters must be conducted at each treatment plant and in the distribution system. These PWSs will also be required to characterize treatment processes (e.g., filtration and sedimentation) in the treatment plant on a monthly basis for 18 months. PWSs receiving all of their water from a supplier and not further disinfecting that water at the entrance to the distribution system are not required to conduct any DBP-related monitoring.

For each treatment plant that uses chloramines, hypochlorite solution, ozone, or chlorine dioxide for treatment or disinfection residual maintenance, an analysis of such parameters as cyanogen chloride, chlorate, pH, temperature, free residual chlorine, bromide, bromate, ammonia, and aldehydes is required. For consecutive systems (i.e., PWSs receiving finished water from another PWS), the receiving PWS must consult with the provider to ensure that all such additional analyses are completed.

2.2.3.2 Monitoring for Microorganisms and Microbial Indicators

Unless a PWS meets the requirements for reduced monitoring, the PWS must monitor:

- Source water at the intake of each treatment plant that treats surface water for *Cryptosporidium*, *Giardia*, total culturable viruses, total coliforms, and fecal coliforms or *Escherichia coli* (*E. coli*) for 18 months; and

- Finished water for these microorganisms at any treatment plant at which, during the first 12 months of source water monitoring, *Cryptosporidium* and *Giardia* exceed 10 per liter in the source water, or when total culturable virus levels exceed one per liter in the source water until the 18 months of source water monitoring are completed.

A PWS must arrange to submit samples of treatment plant influent and finished water to EPA for virus archiving each month until the 18 months of microbial monitoring are complete, if either:

- The PWS learns that viruses were detected in any previous sample for finished water, or

- The PWS learns that a density of at least 10 viruses per liter was detected in any previous treatment plant influent sample.

2.2.3.3 Treatment Study Applicability (Total Organic Carbon (TOC) Monitoring

Additionally, systems may be required to conduct DBP precursor removal studies (treatment studies) consisting of bench-scale or pilot-scale testing for granular activated carbon (GAC) or membrane treatment, based on monthly TOC monitoring of the source water supply for 12 months. Initial monitoring of raw water TOC to determine applicability for treatment study requirements began September 30, 1996.

A PWS operating multiple treatment plants using the same source is only required to conduct one treatment study for those treatment plants.

2.2.3.4. Treatment Study Requirements

To simulate the most likely treatment scenario, treatment studies will need to be conducted with the effluent from the treatment processes that are already in place to remove DBP precursors and TOC. Pilot-scale studies are required at treatment plants serving 500,000 people or more, and either bench- or pilot-scale studies may be conducted at those serving fewer than 500,000.

Bench-scale tests are continuous flow tests using the rapid small scale column test (RSSCT) for GAC and either flat sheet or single-element bench test apparatus for membranes. Water to be used in bench-scale tests must be representative of water which would be applied to the advanced treatment full-scale technology.

Pilot-scale tests must be continuous flow tests. For GAC, the PWS must use GAC of a particle size representative of that used in full-scale practice, a pilot GAC column with a minimum inner diameter of 2.0 inches, and hydraulic loading rate (volumetric flow rate/column cross-sectional area) representative of that used in full-scale practice. For membranes, the PWS must use a staged array to achieve a recovery of at least 75%.

2.2.3.5 Treatment Study Exceptions

PWSs that would otherwise be required to conduct a bench- and/or pilot-scale treatment study are exempt from treatment study requirements if they operate treatment plants that:

- Use chlorine as both the primary and residual disinfectant and have, as an annual average, levels less than 40 micrograms per liter (μg/L) for THM4 and less than 30 μg/L for HAA5. The quarterly average is calculated by averaging results from all individual distribution system samples taken during the quarter. The annual average is calculated by averaging the four quarterly averages.

- Use surface water that does not exceed a TOC level of 4.0 milligrams per liter (mg/L) in the treatment plant influent, when calculated by averaging the 12 monthly TOC samples.

- Use ground water not under the direct influence of surface water that does not exceed a TOC level of 2.0 mg/L in the finished water, when calculated by averaging the 12 monthly TOC samples.

- Already use full-scale GAC or membrane technology. These PWSs must submit full-scale plant data and data that show that the technology effectively removes DBP precursors and must monitor the full-scale process to comply with DBP and related monitoring requirements.

2.2.3.6 Analytical Requirements

For conducting the required analyses, PWSs are required to use the methods specifically approved for the ICR. With the exception of optional analyses for assimilable organic carbon (AOC) and biodegradable organic carbon (BDOC), only results from laboratories that have been approved by EPA to perform sample analyses for DBPs will be acceptable. Laboratories may apply to EPA for approval.

PWSs are also required to use the ICR-approved analytical methods for pathogens and indicator organisms. In addition, systems are required to use EPA-approved laboratories for analysis of *Giardia*, *Cryptosporidium*, and total culturable viruses. As proposed, a PWS must use laboratories certified for microbiology analyses under the EPA or State drinking water program for the analysis of total coliforms, fecal coliforms, and *E. coli*.

2.2.4 Phase II SOCs, IOCs, VOCs

Phase II of the rule became effective for 33 of the 38 contaminants on July 30, 1992, and for the last five of the 38 on January 1, 1993. However, the effective date of the MCLs for aldicarb, aldicarb sulfone, and aldicarb sulfoxide was postponed May 27, 1992 and is expected to be reproposed.

The final MCLs limit aldicarb concentrations to 3 μg/L, aldicarb sulone to 2 μg/L, and aldicarb sulfoxide to 4 μg/L. The agency is expected to propose revised MCLs of 7 μg/L for each compound, along with a 9 μg/L total.

2.2.5 Radionuclides

Radionuclides are radiological material which can enter a water supply naturally from some soils or from the leaching of radioactive wastes. Radionuclides are demonstrated human carcinogens. One of the most common radionuclides is radon, a naturally-occurring radioactive gas. The radionuclides now regulated that were included in the 1986 SDWA list of 83 contaminants include:

- Alpha emitters
- Beta and photon emitters
- Radium 226 and 228

USEPA's proposed rule for radionuclides was published July 18, 1991. However, Congress has deferred action on promulgation of the final rule of the entire radionuclides package for fiscal year 1996 because of the controversy over the proposed radon standard. The new rule would set MCLGs of zero for the currently regulated radionuclides and set new MCLs for Radium 226 and 228, radon, and Uranium. Table 2-6 summarizes the proposed rule.

TABLE 2-6
PROPOSED RADIONUCLIDES REGULATIONS

Radionuclide	Existing MCL (pCi/L)	Proposed MCL (pCi/L)	BAT (Percent Removal)
Radon-222	none	300	Air stripping (up to 99 percent)

TABLE 2-6 PROPOSED RADIONUCLIDES REGULATIONS			
Radionuclide	**Existing MCL (pCi/L)**	**Proposed MCL (pCi/L)**	**BAT (Percent Removal)**
Radium-226	5 [1]	20	Ion exchange (85-95 percent) Reverse osmosis (up to 98 percent)
Radium-228	5 [1]	20	Lime softening (75-85 percent) Ion exchange (85-95 percent)
Uranium	none	20	Reverse osmosis (up to 98 percent) Lime softening (75-85 percent) Coagulation-filtration (up to 75 percent)
Beta-particles and photon emitters	4 mrem [2] per year	4 mrem [2] per year	Reverse osmosis (up to 99 percent Anion exchange (up to 99 percent) Lime softening (up to 85 percent)
Alpha emitters	15	15	Reverse osmosis (up to 98 percent) Ion exchange (85-95 percent)

1 Existing MCL for radium-226 plus radium-228 is 5 pCi/L.
2 Mrem is a measurement of effective radiation dose to organs.

2.2.6 Phase VIb SOCs, VOCs, IOCs

The preliminary schedule for these regulations is as follows:

Proposal .... February 28, 1995
Promulgation .... February 28, 1997
Effective .... August 31, 1999

Table 2-7 summarizes a preliminary list of Phase VIb contaminants and MCLs.

TABLE 2-7 PRELIMINARY PHASE VIb CONTAMINANT AND MCL SELECTION			
IOCs	MCL (mg/L)	SOCs	MCL (mg/L)
Boron	0.6 - 1	Acifluorfen	0.002
Manganese	0.2	Acrylonitrile	0.003
Molybdenum	0.04	Bromomethane	0.01
Zinc	2	Cyanazine	0.001
		Dicamba	0.2
		Ethylene thiourea (ETU)	0.025
		Hexachlorobutadiene	0.001
		Methomyl	0.2
		Metolachlor	0.1
		Metribuzin	0.2
		Trifluralin	0.005
		1,1,1,2-Tetrachloroethane	0.07
		1,2,3-Trichloropropane	0.0008
		1,3-Dichloropropene	0.0006
		2,4- and 2,6-Dinitrotoluene (total mixture)	0.003

2.2.7 Arsenic

EPA is under a court-ordered deadline to propose revised regulations for arsenic no later than November 30, 1995. The regulation is scheduled to be final November 30, 1997 and effective May 31, 1999.

An MCL of 50 μg/L was established for arsenic as a part of the NIPDWR. The range of values currently being discussed for the revised arsenic MCL are 0.2 μg/L to 20 μg/L. Uncertainty concerning the health benefits of a substantially lower MCL may lead to further delay in development of the revised standard until additional studies can be conducted. Given that advanced analytical methods are required to measure a value of 2 μg/L and that many drinking water laboratories do not have this capability, 5 mg/L was selected as a conservative potential water quality goal. Health effects and other issues associated with arsenic have recently been reviewed. The American Water Works Association (AWWA) Arsenic Task Force and EPA recognize that significant technology implementation and costs will be associated with reducing the arsenic MCL. Consequently, both organizations have been evaluating the adequacy of available health effects data and have tentatively concluded that additional data are needed to more reliably establish a defensible revised MCL. It is possible that a new MCL for arsenic may be delayed for at least three years, pending additional health effects research.

2.3 CLEAN WATER ACT (CWA)

The CWA, passed by Congress into law as PL 92-500 in 1972 and currently pending review for re-authorization, covers pollution of the nation's waters and watersheds; (these national efforts are applicable to the Sewage and Water Board through the quality of water in the source - the Mississippi River). Significant improvements have been made to date by efforts from the CWA through end of pipe treatment technologies, technology-based standards, aggressive compliance schedules, and significant federal funding. These actions have worked together to foster an enormous reduction in the amount of pollution being discharged into the nation's waterways. (Hite, Robert W., President AMSA, Denver, CO; "Clean Water's Next Act," ENR, Sept. 1996.)

Current work efforts by EPA and the states continue on point sources, but significant water quality problems remain due to nonpoint sources. Efforts to control nonpoint sources such as Contained Sewer Overflows (CSOs), Sanitary Sewer (SS) overflow, urban storm water runoff and air deposition are well underway, but require enormous financial commitments over time. However, some feel that there will be limited success from these efforts because little progress is being made in controlling runoff from agricultural land.

For example, in the most recent inventory of national water quality trends by the USEPA in 1994, about 40% of bodies of water surveyed were too polluted for fishing/swimming. Agricultural runoff is the leading source for pollution of lakes/rivers, while urban runoff is the leading source for pollution of estuaries.

The American Metropolitan Sewerage Agencies (ASMSA) believe comprehensive watershed management will be the most cost-effective, environmentally sound approach to addressing remaining sources of water quality improvement without breaking the bank.

Robert Perciasepe, Director of Water, EPA, recently summarized EPA's efforts to enhance knowledge and availability of data. EPA is providing greater access to watershed data. The National 305(b) water quality report will be made available through the regions, states and in 1997, on the Internet. ("EPA Makes Watershed Management a Priority," ENR, Sept. 1996.)

EPA and the states are making transitions to a 5-year watershed monitoring and reporting cycle from a 2-year cycle. Each state will identify the water bodies and assess water quality conditions over a 5-year period. These reports will be electronically sent to EPA annually to be aggregated into a national report. The first 5-year report will begin in 1996 and the resulting national 305(b) report will be released on 2002.

Additionally, EPA is adding "Surf your Watershed" to their Water Channel on the Internet. Anyone can locate water quality and environmental information for a watershed using a state of stream name. (The Internet address is: http://www.epa.gov/surf.)

Agricultural Contribution to Pollution Control

Over the last 25 years, estimated continued investment of private industry and the government in controlling point source pollution approached $200 billion. Many believe a commitment of comparable magnitude will be needed to achieve similar results in managing nonpoint source pollution.

Nonpoint source pollution originates from many sources, but perhaps the most significant and problematic source is agriculture, because of the vast land areas involved.

The purposeful disturbance of the land and the use of fertilizers and chemical to control insects can lead to nonpoint source pollution problems through soil erosion and other forms of runoff.

The 1995 report by the US General Accounting Office (GAO) identified 618 watershed-based projects nationwide aimed at agricultural sources of pollution. Progress has been made; according to USDA, soil erosion was reduced by 1/3 in the 1980s. (Vanrsdall, Thomas R., "Nonpoint Source Pollution Tests, Watershed Approach," ENR, 1996.)

Other examples of progress include the Conservation Compliance Plans, which farmers have been required to develop under the 1987 Farm Act in order to remain qualified for commodity payments and other farm program benefits.

Pertinent actions under CWA regulations include:

Combined Sewer Overflow Control Policy - EPA is currently developing and issuing CSO Guidance documents. Final copies of Nine Minimum Controls, Long-Term Control Plans, Funding Options, Screening and Ranking, and Permit Writer's Guide have been issued. The nine minimum controls must be in place by January 1, 1997.

Phase I Storm Water Program - Cities over 100,000 population and industrial facilities are covered under the Stormwater Phase I rule. USEPA issued an Interim Approach on Water Quality-Based Effluent Limitations for Storm Water Discharges on August 1, 1996 which states that numeric effluent limits are not required for stormwater permits. EPA issued guidance on municipal stormwater Phase I re-applications on May 17, 1996 for municipalities that must reapply for their permits.

Phase II Storm Water Program - Cities under 100,000 population, commercial and some light industry are covered under the Stormwater Phase II Rule. This rule provides a 6 year extension for Phase II Stormwater permit applications, if Congress does not provide some sort of relief through legislative mean. Proposed new Stormwater Phase II regulations will be in effect by September 1997.

Sanitary Sewer Overflow Control Policy - EPA has established a SSO Advisory Committee consisting of approximately 10 organizations, including the Water

Environment Federation (WEF). A draft framework for SSO control has been developed by EPA. WEF's SSO Work Group developed an SSO Position Paper, which was approved by the Executive Committee January 25, 1996. EPA developed an additional chapter for its Enforcement Management System (EMS) guide specifically on SSOs. EPA expected to issue an outline of an SSO Control Approach by Nov 16, 1996.

Urban Wet Weather - EPA has established an Urban Wet Weather Advisory Committee to try to integrate the regulatory approaches to CSOs, SSOs, and Stormwater. The committee has developed papers on watershed planning and monitoring issues, and has expressed the desire to see the Phase I and Phase II Stormwater programs merged.

Water Quality Standards - EPA is developing an advanced notice of proposed rulemaking (ANPRM) to solicit ideas from the regulated community on issues, concerns and options for a possible revision of the existing water quality standards regulation.

Total Maximum Daily Loads (TMDL) - EPA is developing an advisory committee on Total Maximum Daily Loads (TMDL). Under section 303(d) of the Clean Water Act, states are required to develop TMDLs for their waters for which existing effluent limits are insufficient to meet water quality standards.

Effluent Trading in Watersheds - EPA issued a Policy Statement Feb 9, 1996 (61 FR 4994) that would allow effluent trading within watersheds, when covered by a TMDL or similar watershed-based analysis. Point sources would not be allowed to drop below technology-based limits. Pretreatment sources could not drop below categorical standards. Trading would be allowed for intraplant, pretreatment, point/point, point/nonpoint, and nonpoint/nonpoint trading. A Draft Framework for Watershed-Based Trading was released by EPA June 11, 1996.

Effluent Guidelines Program - The biennial Effluent Guidelines Plan was issued by EPA on July 3, 1996 (61 FR 35041-35054). EPA issued proposed regulations for the centralized waste treatment industry on Jan 27, 1995 (60 FR 5464). Guidelines for Coastal Oil and Gas Extraction were issued Feb. 17, 1995 (60 FR 9428). Proposed Guidelines for the Pharmaceutical Industry were issued May 2, 1995 (60 FR 21592). Metal Products and Machinery Guidelines were proposed May 30, 1995 (60 FR 29210-28278).

Significant improvements in watershed management and point-nonpoint pollution control can have profound effects on water quality in the River. Parameters such as dissolved organics (SOCs and VOCs), turbidity, and microbiological factors can be influenced greatly by pollution control efforts upstream. Many communities have found tremendous dividends in time and partnership investments in watershed controls.

2.4 NFPA AND OSHA

The National Fire Protection Agency (NFPA) has published rules requiring gas containment and scrubbing for facilities storing toxic chemicals including chlorine (May 1988 edition of Uniform Fire Code) as enforced locally by fire marshals and EPA/OSHA have published workers' safety guidelines. These rule are included in the OSHA PSM (29 CFR 1910.119) and the EPA 112(r)(40 CFR Part 68) Standards.

2.4.1 Compliance Deadlines

There are no specific deadlines for compliance with the NFPA regulations. Fire Marshals in most jurisdictions have been lenient in enforcing these requirements on existing facilities. However, nearly all Marshals enforce the requirements if upgrades are made to existing facilities.

The deadlines for completion of the OSHA process hazard analyses have been phased to allow companies ample opportunity to complete the significant work required. At least 25% of the initial PHAs (Process Hazard Analyses) should have been completed by May 26, 1994 and 50% of the PHAs should have been completed by May 26, 1995. The 75% and 100% completion dates are May 26, 1996 and 1997, respectively. Companies with fewer than four covered processes should complete one year starting with 1994.

The EPA required an owner or operator to submit a single RMP that includes the information required by §§68.155 through 68.185 for all covered processes. The RMP shall be submitted to a central point as yet to be specified by EPA prior to June 21, 1999. The owner or operator shall submit the first RMP no later than the latest of the following dates:

- June 21, 1999
- Three years after the date on which a new regulated substance is first listed under §68.130
- The date on which a regulated substance is first present above a threshold quantity in a process

2.5 STATE REGULATIONS

Since the Water Quality Master Plan was written in 1992, no regulations have been enacted in the State of Louisiana that are more restrictive than the Federal regulations discussed in the previous section.

2.6 OTHER WATER QUALITY OBJECTIVES

In addition to meeting all present and anticipated future water quality regulations, there are other water quality objectives which should be considered by the Board. These water quality objectives are not required by any regulatory agency, but are either specifically developed for a local need or provide a desired level of responsible water supply management. These additional objectives include softening and taste and odor control as local water quality objectives and reducing organics and limiting the effects from disinfectant residuals as public health related issues.

2.6.1 Softening

At the time of the original Water Quality Master Plan, it was the Board's policy to provide softened water to its customers. This policy is no longer in effect. Although lime is still added at the head of the L basis, its purpose is no longer for water softening.

2.6.2 Taste and Odor

For plants using the lower Mississippi River, taste and odor control is generally provided by use of oxidants or PAC at the raw water intakes. Currently, PAC can be added at the Algiers WTP river intake. This Master Plan Update recommends that PAC addition facilities be installed at the Carrollton WTP intake for intermittent control of taste and odor on a manual basis.

2.6.3 Health Risk Minimization

The potential health risk associated with DBPs, disinfectant residuals and SOCs are still under study by EPA before conclusions can be reached to define the extent of health risk involved with this broad range of contaminants. Because the New Orleans raw water supply from the Mississippi River contains a significant amount of disinfection-by-product precursors, a broad spectrum of synthetic organic chemicals in low concentrations and is subject to spills of higher concentrations of synthetic organic chemicals, these issues remain of importance in establishing drinking water objectives and selecting treatment processes as part of the development of a water quality master plan. However, better upstream watershed management has resulted in lower SOC and VOC levels in the raw water, thereby lessening the threat previously perceived from these chemicals.

Present health concerns are primarily focused on microbiological contaminants, primarily *cryptosporidium* and *Giardia*.

2.7 WATER QUALITY GOALS

Establishing internal goals for finished water quality, which in many cases exceed the requirements of regulatory agencies, is a step in the direction of encouraging optimization of operation of each plant process. While failure to meet a water quality goal on an intermittent basis would be a concern to operations staff, it would not be a deviation from regulatory requirements. Hence, establishing water quality goals would encourage an atmosphere wherein potential deviations from regulatory requirements would become noticeable long before a violation took place, and would therefore be more easily correctable.

Other intangible benefits of establishing water quality goals are as follows:

1. Establishment of such goals demonstrates a faith in the professional capabilities of the plant operators, thus encouraging operators to strive for excellence.

2. Regulatory agencies would perceive the focus of the water treatment and supply program as quality-based, rather than regulatory-driven.

3. Establishment of water quality goals would be a positive step in the direction of defining the Board as a forward-looking utility.

The recommended water quality goals are described in Table 2-8.

TABLE 2-8

RECOMMENDED WATER QUALITY GOALS		
Parameter	**Goal**	**Reasoning**
TOC	Provide TOC as low as possible ≤1 mg/L	Optimize coagulation/ sedimentation processes
THMs	Produce TTHMs as low as possible. Keep the brominated THM fractions <10 μg/L	Minimize health risk and be prepared to meet potential future regulations
DBPs	Keep as low as possible	Minimize health risk and be prepared to meet potential future regulations
Turbidity	Settled water goal of <0.5 NTU at all times and exceed future ESWTR requirements of 0.3 in finished water	Maintain ≤0.1 NTU in finished water at all times
pH	Range is 8.5 to 9.5	Consistent with Pb and Cu corrosion control strategy
Total Hardness	Annual range of 120-180 mg/L as $CaCO_3$	Discontinues softening
VOCs	Below MCLs at all times	Meet MCLGs when practicable; minimize health risk and be prepared to meet potential future regulations
SOCs	Below MCLs at all times	Meet MCLGs when practicable; minimize health risk and be prepared to meet potential future regulations
Taste and Odor	<3 TON at all times	Remove objectional T&O that affects consumer confidence

RECOMMENDED WATER QUALITY GOALS		
Parameter	**Goal**	**Reasoning**
IOCs	Not-to-exceed MCLs	Meet future regulations
RADs	Below detectable levels	Meet future regulations
Microbiological		
- Viruses	Provide 6-log removal/ inactivation through pretreatment, filtration and disinfection	Meet MCLG when practical to minimize health risks
- *Cryptosporidium*	Minimum 2-log removal based on 3-5 μ particles though existing pretreatment and filtration process	Meet MCLG of O organisms, when practical, in finished water
- *Giardia*	Maintain 3-6-log removal based on source water concentrations (to be determined via the ICR monitoring program)	Meet MCLG of O cysts in finished water, when practical

3.0 ASSESSMENT OF EXISTING PLANT PERFORMANCE

3.1 INTRODUCTION

This section presents an assessment of the performance and reliability of the existing plants' treatment processes and support facilities.

3.2 WATER QUALITY

3.2.1 Raw Water Quality

3.2.1.1 General

The Board continues to routinely collect and analyze daily river samples from the intake structures to monitor raw water quality.

Raw water quality data from 1991 through 1995 are summarized in Table 3-1. Finished water quality data from the Carrollton and Algiers WTPs and the Federal Drinking Water Standards are also presented for comparison with the raw water quality.

Data from 1993, 1994 and 1995 were obtained and reviewed for the raw water. Several constituents were reviewed: turbidity, pH, temperature, total hardness and total alkalinity. After manipulating the data into tables and bar charts for constituents of concern, the average value and the trends were considered. The 1992 WQMP used data for these constituents from the combination of the years 1984 to 1988.

3.2.1.2 Carrollton WTP

The majority of raw water turbidity levels for the years 1993, 1994 and 1995 was between 50 and 100 NTU. The average value listed for 1984-1988 was 168 NTU. The average turbidity level was 102 NTU for 1993, while the values for 1994 and 1995 were much lower, 58 and 61 NTU, respectively. Bar charts showing the trends graphically and a graph of the turbidity levels compared over the years are included as Figures 3 -1 through

FIGURE 3-1
CARROLLTON WATER TREATMENT PLANT
1993 RAW WATER TURBIDITY (NTU)

MAX.	295
MIN.	36
AVG.	102
COUNT (READINGS)	378
READINGS >= 200	7
READINGS BETWEEN 150 AND 200	42
READINGS BETWEEN 100 AND 149	111
READINGS BETWEEN 50 AND 99	208
READINGS LESS THAN 50	10

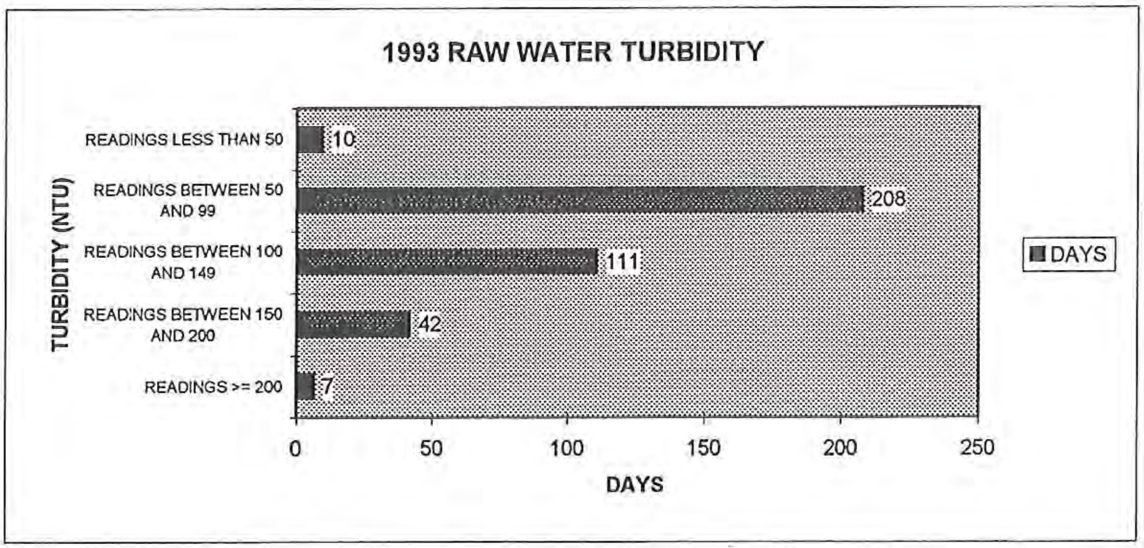


FIGURE 3-2
CARROLLTON WATER TREATMENT PLANT
1994 RAW WATER TURBIDITY (NTU)

MAX.	275
MIN.	7
AVG.	58
COUNT (READINGS)	381
READINGS >= 200	5
READINGS BETWEEN 150 AND 200	4
READINGS BETWEEN 100 AND 149	37
READINGS BETWEEN 50 AND 99	175
READINGS BETWEEN 25 AND 49	73
READINGS BETWEEN 10 AND 24	64
READINGS LESS THAN 10	23

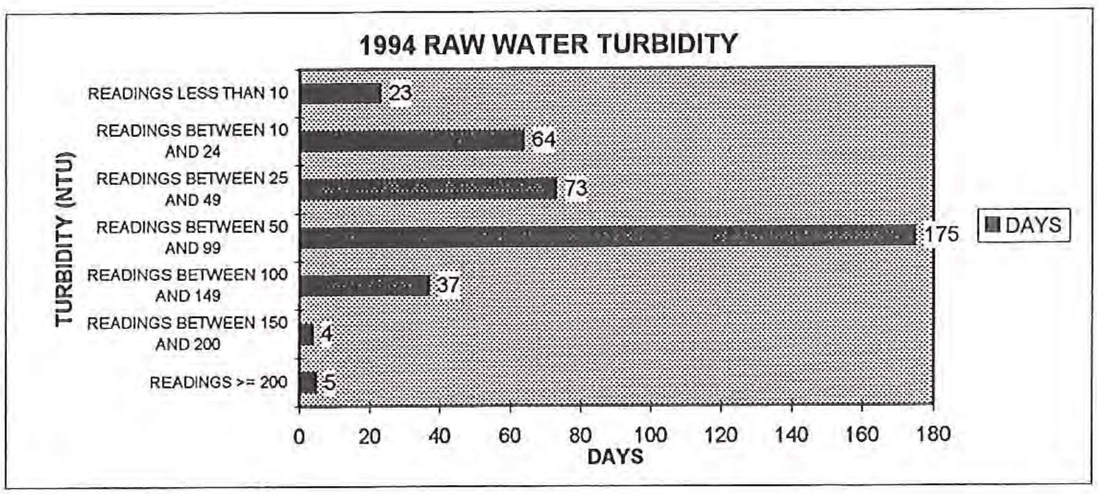
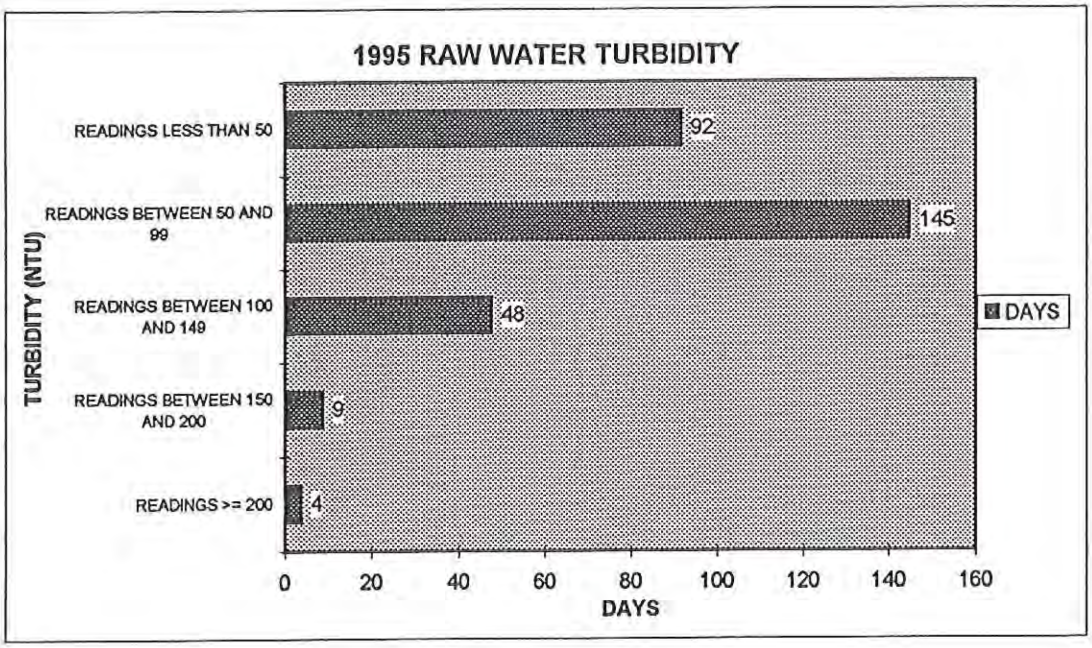


FIGURE 3-3
CARROLLTON WATER TREATMENT PLANT
1995 RAW WATER TURBIDITY (NTU)

MAX.	230
MIN.	8
AVG.	61
COUNT (READINGS)	381
READINGS >= 200	4
READINGS BETWEEN 150 AND 200	9
READINGS BETWEEN 100 AND 149	48
READINGS BETWEEN 50 AND 99	145
READINGS LESS THAN 50	92



3-3. Note that turbidity levels in the raw water have decreased since the writing of the WQMP.

Further review of the data statistically shows some improvements in raw water turbidity. Of the 378 readings represented in the 1993 data set, 42% of the time turbidity exceeds 100 NTU. 55% of the time the turbidity is between 50 and 100 NTU and for only 10 readings was turbidity <50 NTU. The years 1993 to 1995 are presented below.

Turbidity Range	1993	1994	1995
>100	42%	12%	15%
<100, >50	55%	46%	38%
<50	10 readings	160 readings	92 readings

The range of pH in the raw water was compared by bar graphs. The trends for the current years (1993, 1994 and 1995) were 7.75 and greater. The older data (1984-1988) list a pH of approximately 8.

The temperature of the raw water has remained consistent when comparing the average values over the years.

63°F 1984-1988
56°F 1993
58°F 1994
62°F 1995

Total hardness in the raw water over the last two years of data (1995 and 1994) has been very similar. Trends, reported as mg/L as $CaCO_3$, are 160 to 190, 160 to 180 and 125 to 200 for the years 1995, 1994 and 1993. The averages for these years are 159, 150 and 161, respectively. The average listed for 1984-1988 was 171.

Total alkalinity has remained consistent over the years in the raw water. The average for 1984-1988 was 107 to 117 mg/L as $CaCO_3$ were the range of average values for the years 1993 to 1995. The ranges for those years were:

95 to 130	1995
120 to 135	1994
90 to 120	1993

The bar charts for the pH, temperature, total hardness and total alkalinity in the raw water are included in the appendix.

VOCs and SOCs in the raw water were also compared for the years of 1993, 1994 and 1995 to the data used in the WQMP (1984 to 1988). For the contaminants of concern in the WQMP, the raw water has improved in quality as shown on the graphs of the VOC and SOC data shown on Figures 3-4 and 3-5. This may be a result of the additional environmental laws and regulations that have been put in place. Improved industry standards, tighter restrictions on pesticides and spill containment procedures reportedly have led to improved water quality in the nation and these limited data seem to reflect that trend.

3.2.1.3 Algiers WTP

Although the raw water intakes for each plant are near each other and theoretically should be of identical quality, raw water data was evaluated for each plant because of the possibility that the currents and eddys in the river could affect the raw water quality.

The average turbidity level was 98 NTU for 1993, while the values for 1994 and 1995 were much lower, 52 and 55 NTU, respectively. Bar charts showing the trends graphically and a graph of the turbidity levels compared over the years are included as Figures 3-6 through 3-8.

Total alkalinity has remained consistent over the years in the raw water. The averages for the years 1995, 1994, and 1993 were 118, 112, and 108, respectively. The trends for those years were 120 to 140 for 1995 and 120 to 150 for 1994 and 90 to 120 for 1993.

FIGURE 3-4

VOC Data Comparison

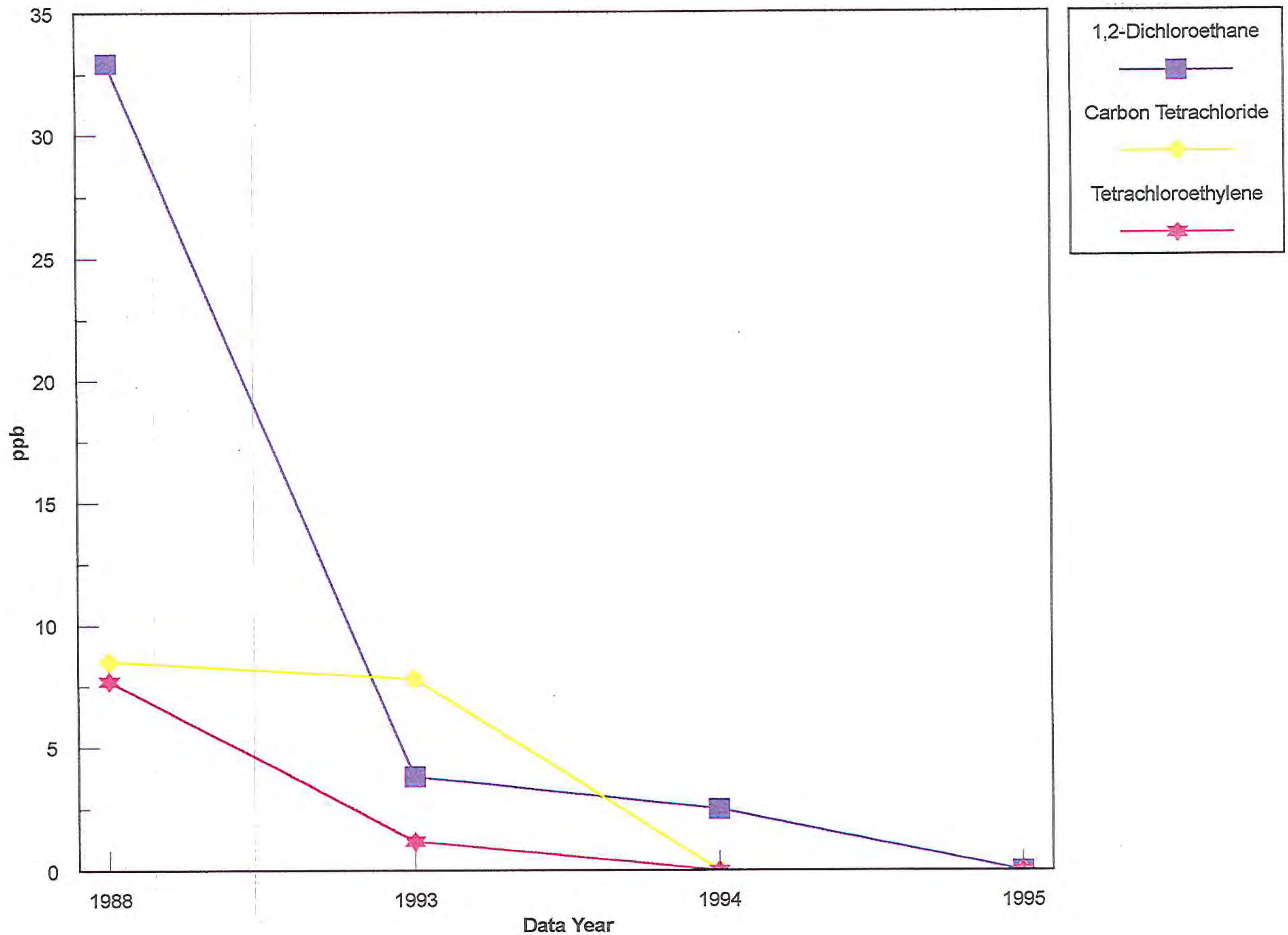


FIGURE 3-5

SOC Data Comparison

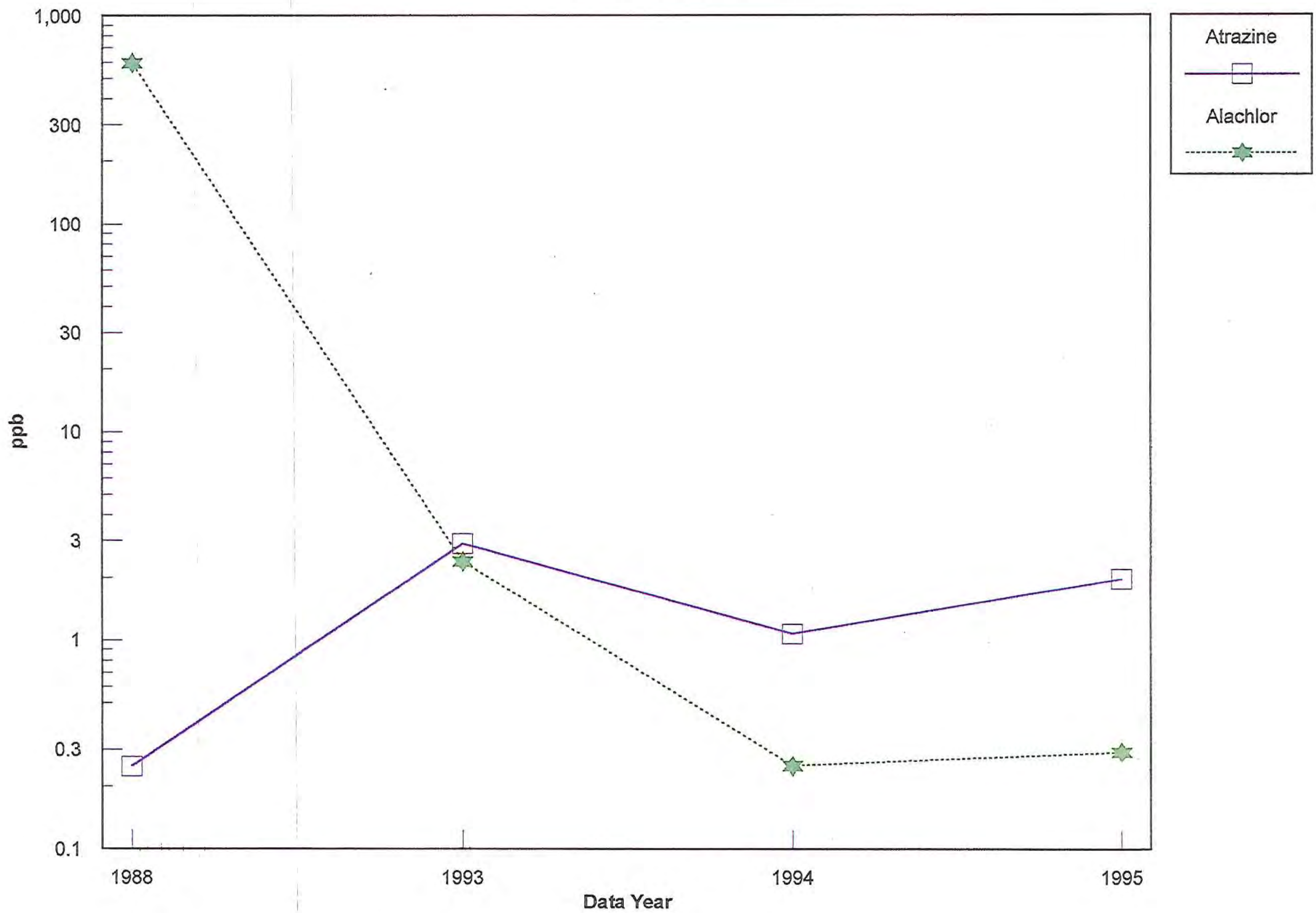


FIGURE 3-6
ALGIERS WATER TREATMENT PLANT
1993 RAW WATER TURBIDITY (NTU)

MAX.	231
MIN.	24
AVG.	98
COUNT (READINGS)	253
READINGS >= 200	4
READINGS BETWEEN 150 AND 200	20
READINGS BETWEEN 100 AND 149	65
READINGS BETWEEN 50 AND 99	154
READINGS LESS THAN 50	10

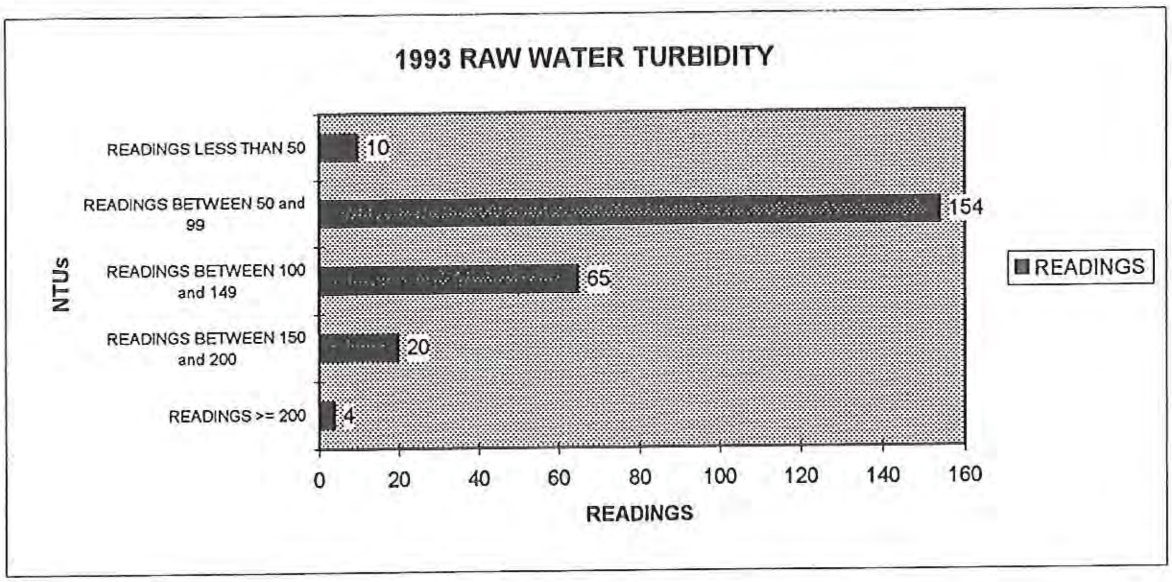


FIGURE 3-7
ALGIERS WATER TREATMENT PLANT
1994 RAW WATER TURBIDITY (NTU)

MAX.	277
MIN.	3.3
AVG.	52
COUNT (READINGS)	241
READINGS >= 200	3
READINGS BETWEEN 150 AND 200	2
READINGS BETWEEN 100 AND 149	17
READINGS BETWEEN 50 AND 99	93
READINGS LESS THAN 50	126

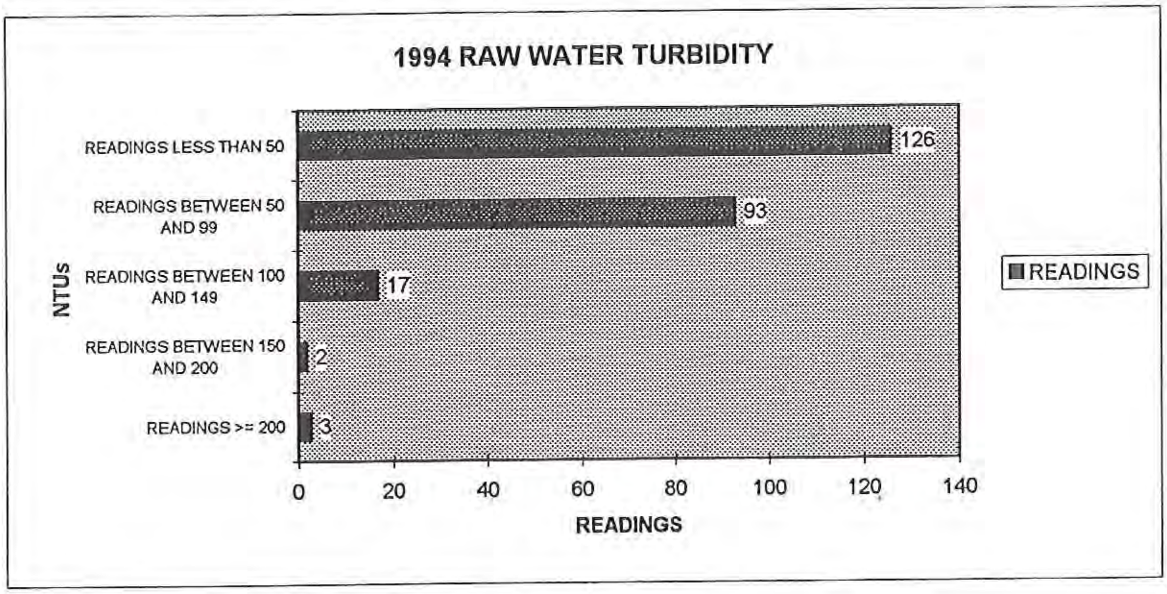
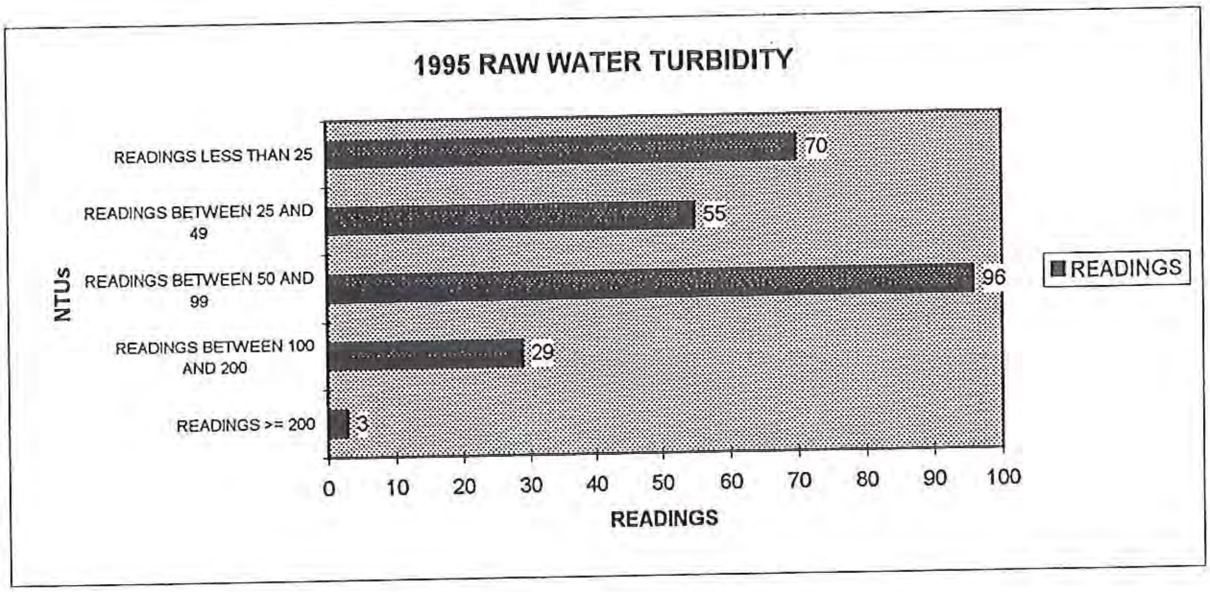


FIGURE 3-8

ALGIERS WATER TREATMENT PLANT

1995 RAW WATER TURBIDITY (NTU)

MAX.	222
MIN.	0.1
AVG.	55
COUNT (READINGS)	253
READINGS >= 200	3
READINGS BETWEEN 100 AND 200	29
READINGS BETWEEN 50 AND 99	96
READINGS BETWEEN 25 AND 49	55
READINGS LESS THAN 25	70



The bar charts for the total alkalinity in the raw water are included in the appendix.

3.2.2 Finished Water Quality

3.2.2.1 Carrollton Water Treatment Plant

Finished water quality at the Carrollton WTP was obtained from the tap at the Carrollton laboratory and reviewed for the same constituents as in the raw water.

Finished water turbidity levels were previously evaluated for the 1984-1988 period. The average was listed as 0.2 NTU. The more current data for 1993, 1994 and 1995 was evaluated. The range of the readings from the bar chart for 1993 was 0.1 to 0.4 NTU, while in 1994 and 1995 the range was from 0.1 to 0.2 NTU. The averages were 0.26, 0.13 and 0.12 NTU for 1993, 1994 and 1995 respectively. The maximum turbidity levels were compared over the three year period and found to decrease with each year. The maximum turbidity levels in the finished water for 1993, 1994 and 1995 were 1.5 NTU, 0.61 NTU and 0.39 NTU, respectively. This shows a dramatic increase in finished water quality, which demonstrates that the plant is now in compliance with the requirements of the Surface Water Treatment Rule. The bar charts and graphs for the finished water turbidity levels are shown on Figures 3-9 to 3-11. The decreasing turbidity levels are a result of the improvements which have been made at the plant to rehabilitate the filters.

In the finished water, comparisons to previous data can be made to understand performance and demonstrate improvement in water quality.

Range, NTU	1993-94	1994-95	1995-96
>1.0	1 reading	--	--
0.4 to 1.0	69 readings	3 readings	1 reading
<0.4	86%	17%	10%
<0.2	--	44%	59% (367)
<0.1	2% (11 readings)	38% (246 readings)	31% (191 readings)
Total Readings:	10 readings	639	624

FIGURE 3-9
CARROLLTON WATER TREATMENT PLANT
1993 FINISHED WATER TURBIDITY (NTU)

MAX.	1.5
MIN.	0.07
AVG.	0.26
COUNT (READINGS)	606
READINGS >= 1.0	1
READINGS BETWEEN 0.7 AND 1.0	7
READINGS BETWEEN 0.3 AND 0.7	62
READINGS LESS THAN 0.3	536

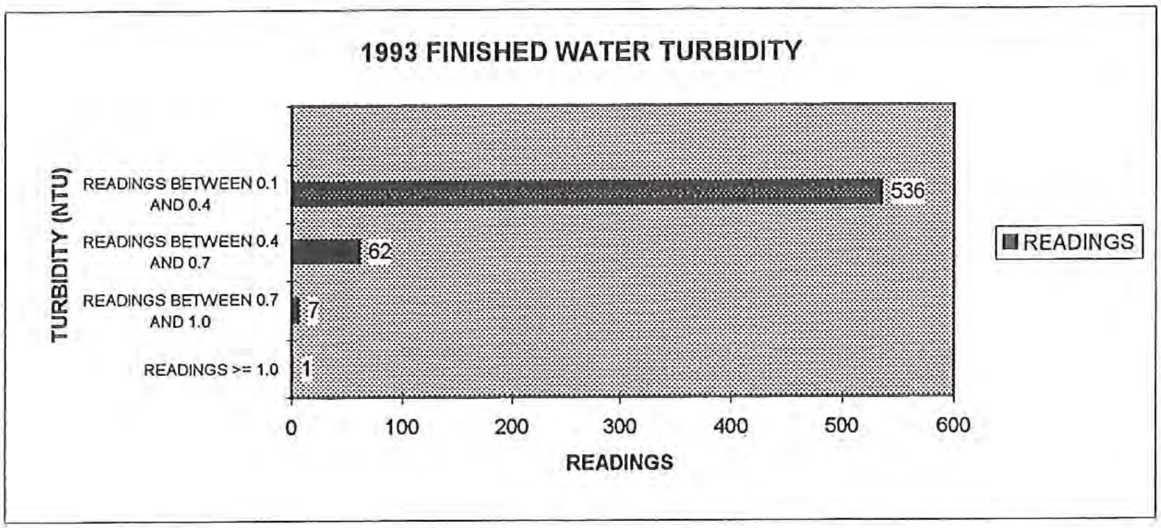


FIGURE 3-10
CARROLLTON WATER TREATMENT PLANT
1994 FINISHED WATER TURBIDITY (NTU)

MAX.	0.61
MIN.	0
AVG.	0.13
COUNT (READINGS)	639
READINGS >=0.5	3
READINGS BETWEEN 0.3 AND 0.5	21
READINGS LESS THAN 0.3	615

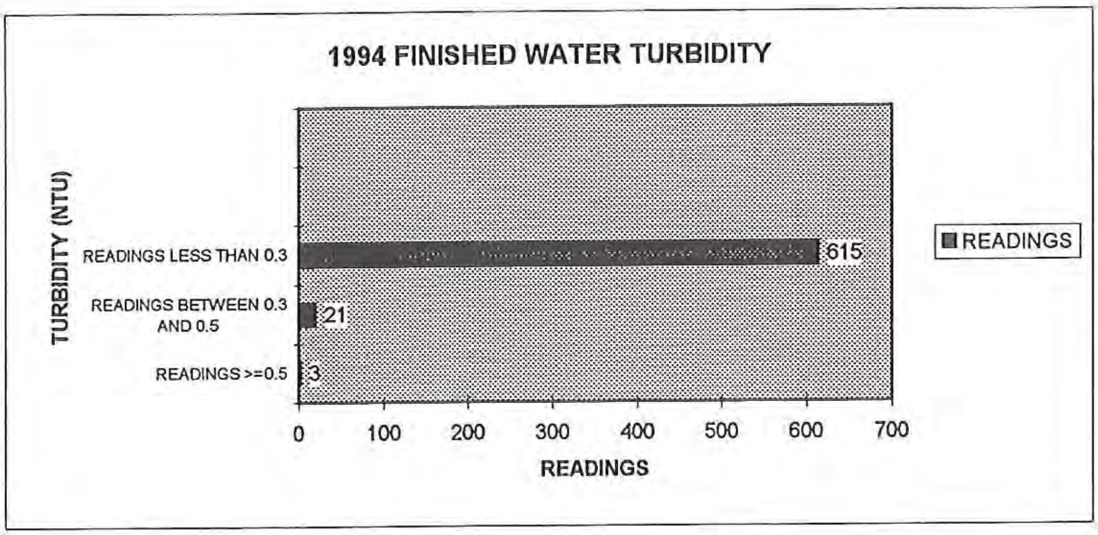
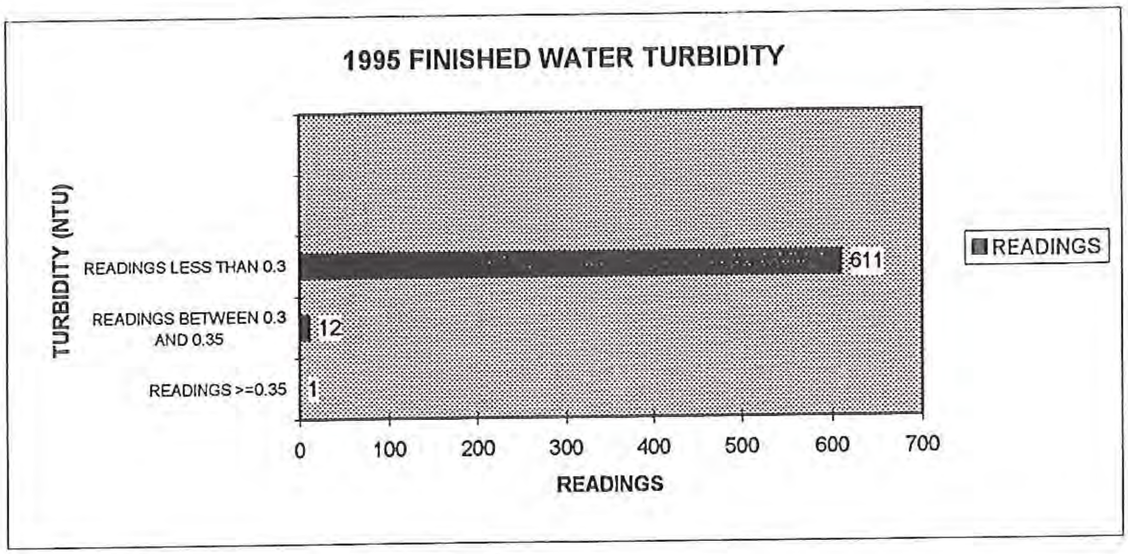


FIGURE 3-11
CARROLLTON WATER TREATMENT PLANT
1995 FINISHED WATER TURBIDITY (NTU)

MAX.	0.39
MIN.	0.02
AVG.	0.12
COUNT (READINGS)	624
READINGS >=0.35	1
READINGS BETWEEN 0.3 AND 0.35	12
READINGS LESS THAN 0.3	611



After 1993-94, there were no readings reported with turbidity >1.0 NTU. By 1994-95, about 90% of the readings show turbidity <0.2 NTU, where that frequency in 1993-94 was only 2%.

The pH of the finished water from the plant did show a difference from the raw water. The current data (1993-94, 1994-95 and 1995-96) showed a trend of 8.7 to 9.5. The 1984-1988 data show pH values of 10. This reflects the Sewerage and Water Board's policy, which was enacted after the WQMP was written, to lower the pH in the finished water to comply with the SDWA - Surface Water Treatment Rule's disinfection requirements with chloramines.

The temperature of the finished water averaged 71°F for 1984-1988 and remains similar in the more recent data: 67°F for 1993-94, 71°F for 1994-95 and 73°F for 1995-96. The trends for these three years have been between 65°F to 85°F.

Total hardness, reported as mg/L as $CaCO_3$, for the finished water was 114 (average) for 1984-1988. The averages for the recent years are higher 144, 131 and 135 for 1995, 1994 and 1993, respectively. Trends for 1994-95 and 1995-96 were between 120 and 160, while in 1993-94 the range was between 105 and 165 mg/L as $CaCO_3$,. The higher levels in the recent years are reflective of the lowering of the finished water pH to comply with the SDWA.

Total alkalinity in the finished water has increased since the WQMP was written. The average for 1984-1988 was 57 mg/L as $CaCO_3$, while the averages for 1995, 1994 and 1993 are 89, 82 and 80, reported as mg/L as $CaCO_3$,. The ranges for 1995 and 1994 was 70 to 95, and 35 to 130 for 1993.

Bar charts showing trends for pH, temperature, total hardness and total alkalinity in the finished water are included in the appendix.

3.3.2.2 Algiers WTP

Finished water quality at the Algiers WTP was obtained from the tap at the Algiers outlet and reviewed for the same constituents as in the raw water.

The data for 1993, 1994 and 1995 were available for the Algiers WTP. The trend of the readings from the bar chart for 1993, 1994 and 1995 was 0.08 to 0.3 NTU. The averages for the three years were 0.15, 0.12 and 0.11 NTU for 1993, 1994 and 1995. The maximum turbidity levels were compared over the three year period and found to decrease slightly from 1993 to 1995. The maximum turbidity levels in the finished water for 1993, 1994 and 1995 were 0.91 NTU, 2 NTU and 0.81 NTU, respectively. The bar charts and graphs for the finished water turbidity levels are shown on Figures 3-12 to 3-14.

The pH of the finished water from the plant did show a difference from the raw water. The current data trends are as follows: 9.5 to 10.1 for 1993, 9.0 to 9.5 for 1994, and 8.8 to 9.5 for 1995. Note that the Sewerage and Water Board's policy was to lower the pH in the finished water to comply with the SDWA.

Total hardness for the finished water was 134, 121 and 123 for 1995, 1994 and 1993, respectively. Trends for 1993 and 1994 were between 100 and 120, while 1995 was between 125 and 140. The higher levels in the recent years are reflective of the lowering of the finished water pH to comply with the SDWA.

Total alkalinity in the finished water has increased since the WQMP was written. The average for 1995, 1994 and 1993 are 72, 62 and 54. The trend for 1995 was 75 to 90, 55 to 70 for 1994, and 45 to 65 for 1993.

Bar charts showing trends for pH, total hardness and total alkalinity in the finished water are included in the appendix.

3.3.2.3 Water Plant Production Rates

The water treatment plants daily production rates are summarized in Table 3-1 and 3-2 for the years 1969 to 1995. In comparison the 1969-1988 time period with the more recent time period (1989 to 1995) since the 1992 WQMP, the changes in production rates of significance are shown below.

FIGURE 3-12
ALGIERS WATER TREATMENT PLANT
1993 FINISHED WATER TURBIDITY (NTU)

MAX.	0.91
MIN.	0.01
AVG.	0.15
COUNT (READINGS)	250
READINGS >= 0.7	1
READINGS BETWEEN 0.3 and 0.7	15
READINGS LESS THAN 0.3	234

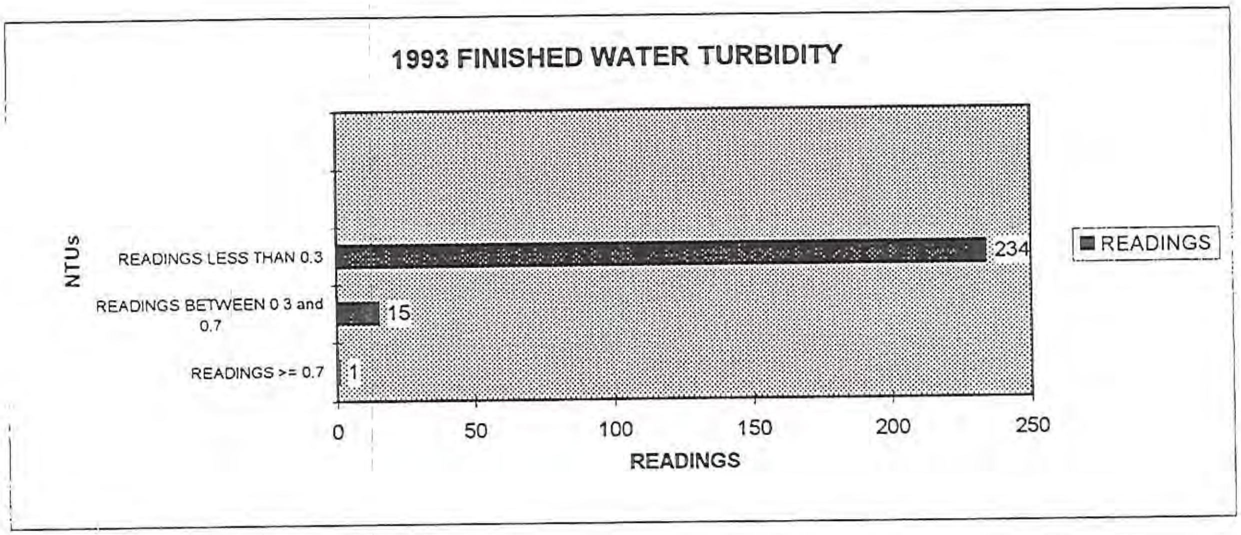


FIGURE 3-13
ALGIERS WATER TREATMENT PLANT
1994 FINISHED WATER TURBIDITY (NTU)

MAX.	2
MIN.	0
AVG.	0.12
COUNT (READINGS)	239
READINGS >=0.7	4
READINGS BETWEEN 0.3 & 0.7	4
READINGS LESS THAN 0.3	231

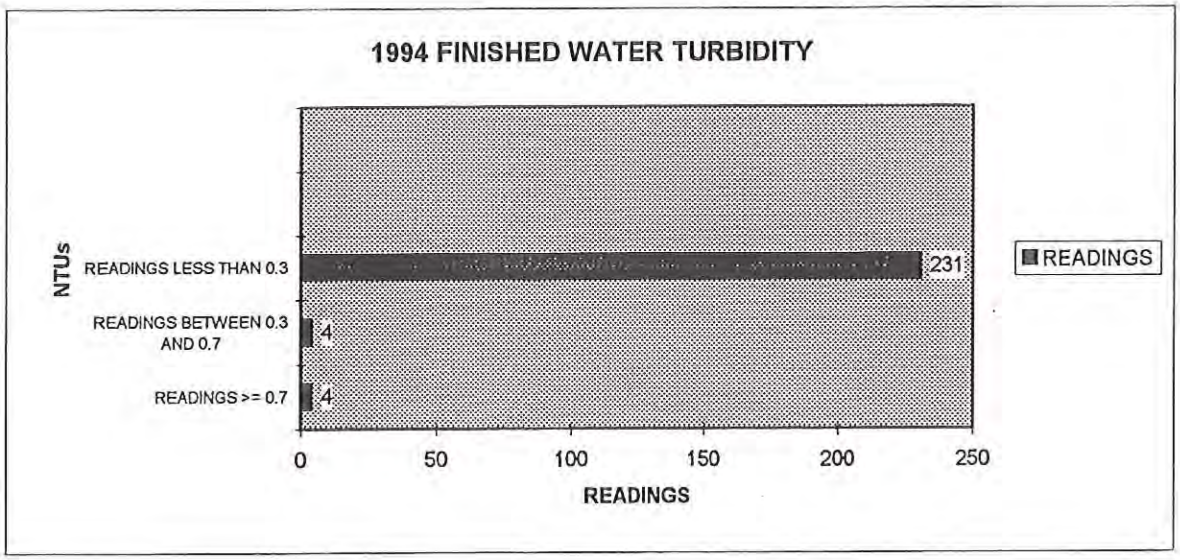


FIGURE 3-14
ALGIERS WATER TREATMENT PLANT
1995 FINISHED WATER TURBIDITY (NTU)

MAX.	0.81
MIN.	0.03
AVG.	0.11
COUNT (READINGS)	342
READINGS >= 0.7	1
READINGS BETWEEN 0.3 AND 0.7	5
READINGS LESS THAN 0.3	336

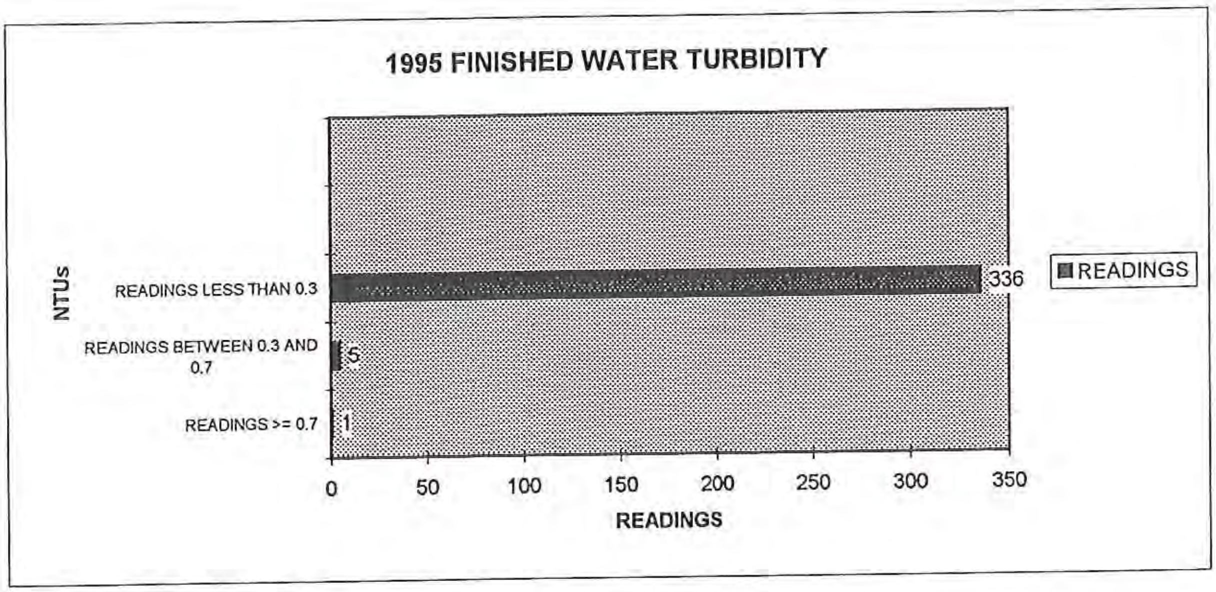


TABLE 3-1

WATER TREATMENT PLANT DAILY PRODUCTION RATES (MGD)						
	Carrollton			Algiers		
Year	Max	Min	Avg	Max	Min	Avg
1969	188.30	99.90	120.90	9.81	4.39	7.16
1970	229.50	97.90	122.70	10.00	4.00	6.73
1971	158.10	99.10	120.50	10.00	5.50	7.30
1972	150.00	94.30	124.20	11.00	6.00	7.68
1973	176.50	103.50	123.90	10.00	6.00	8.04
1974	139.30	101.20	122.00	11.00	6.00	8.46
1975	148.70	107.00	122.50	12.00	6.44	8.74
1976	144.50	98.20	122.70	12.21	7.00	9.38
1977	170.40	101.70	127.10	13.00	7.00	9.61
1978	144.90	108.10	126.30	12.08	8.00	9.86
1979	165.70	112.60	132.40	13.63	8.00	10.54
1980	166.80	118.30	137.10	13.50	8.00	10.09
1981	164.50	121.70	140.50	13.00	8.13	10.71
1982	216.40	118.30	133.80	15.68	9.25	11.07
1983	231.70	107.60	128.30	15.00	8.50	11.02
1984	166.71	113.08	130.37	15.42	9.50	11.07
1985	210.04	99.75	124.08	14.96	8.54	10.49
1986	175.77	89.12	121.50	13.71	8.04	10.29
1987	137.63	95.08	116.42	13.46	7.45	10.42
1988	146.38	94.71	118.38	13.71	8.34	10.19
1989	240.00	93.83	119.54	18.75	7.00	9.80
1990	162.50	100.46	119.61	14.78	8.00	10.46
1991	133.29	98.92	114.79	12.50	8.00	9.60
1992	139.00	97.00	115.22	13.88	8.00	9.88
1993	140.38	103.25	117.41	15.42	7.62	10.18
1994	128.88	103.88	113.71	17.00	8.00	11.47
1995	142.83	104.67	121.40	18.14	9.00	11.55

TABLE 3-2

Period	Range (min to max), MGD		Period Average MGD	
	Carrollton	Algiers	Carrollton	Algiers
1969 - 1988	89.12 to 231.70	4.00 to 15.68	125.73	9.44
1989 - 1995	93.83 to 240.00	7.00 to 18.75	117.38	10.42

3.3. Facility Improvements

3.3.1 General

Since production of the 1992 WQMP, various construction improvements have been undertaken at each water plant, and a number of operational improvements have been made at each plant. Some of these improvements were implemented as a result of the WQMP recommendations, while others reflect completion of projects which were on-going at the time the Master Plan was prepared.

Improvements implemented subsequent to production of the 1992 Water Quality Master Plan are summarized below.

3.3.2 Carrollton WTP

Improvements completed to date are as follows:

- Plant staff converted their coagulant storage and feed from powdered ferrous sulfate to liquid ferric. This eliminated the operational problems and dust hazards of the dry chemical feed system.
- Design of structural renovations to renovate and baffle the C basins is complete, and construction of the improvements is on-going. The completed project will result in a disinfection contact basin and will eliminate hydraulic restrictions upstream of the basins.
- Plant staff has discontinued the practice of water softening by reducing the amount of lime feed, using lime feed solely for pH adjustment.

- The Clairborne and Sycamore filters have been provided with dual media, providing more efficient filtration.

3.3.3 Algiers WTP

Improvements completed to date are as follows:

- The recent plant upgrade construction is complete. This upgrade provided the plant with new clarification and filtration capacity.
- Design of a new presedimentation facility for removal of organics is complete. However, due to the increased reliability of the raw water supply and the de-emphasis on regulating removal of organics in drinking water, the design documents for this project will not be issued for bid at this time.

3.4 Performance Assessment Summary

The water quality data and the regulatory updates provide a framework for developing the Master Planned Improvements. Beginning with the regulatory updates, we see the same degree of regulatory driving force as before, with renewed emphasis on the control of microbiological contaminants. This has become more prominent to the public since the Milwaukee Cryptosporidiosis outbreak in 1993 and the news media's extensive coverage of this outbreak. That outbreak has been followed by outbreaks in several other communities, most of which, including Milwaukee, have conventional surface water treatment plants practicing what each thought to be state-of-the art treatment and disinfection practices.

Consequently, the USEPA in recent rule making and Congress with the 1996 reauthorization of the SDWA have both focused debates on disinfection and the control of microscopic organisms versus the threat of carcinogens from disinfectant byproducts. The delays in some regulatory timetables and rule making processes have resulted from the ongoing concern for better microbiological data to support the design of more effective filtration and disinfection systems, i.e.,ozone.

The emphasis on coagulation has shifted somewhat from precursor removal (TOC removal by higher doses of ferric as primary coagulant) to increased particle removal.

Particles have become the new center of attention, shifting the emphasis from turbidity removals by coagulation to effectiveness in particle removal. Turbidity has become too broad a term when measuring the effectiveness of removal of discreet particles which may include microbiological cysts of organisms like *Giardia* and *Cryptosporidia,* which can be measured in the 3-5 micron range. From a DBP formation perspective, elements of the Stage 1 DBP Rule which are currently being evaluated in an "interim" rule include enhanced coagulation and enhanced precipitative softening, in some form, and some MCLs for DBPs.

Additionally, utilities have formed partnerships through the efforts of AWWA, AMWA, AWWARF, ASDWA and USEPA. The Partnership for Safe Water was formed to encourage U.S. water suppliers to survey their utilities to identify areas that will enhance the water system's ability to prevent entry of *Cryptosporidium, Giardia*, and other microbial contaminants into treated water and to voluntarily implement those actions which are appropriate for the system. Participation in the partnership is a sign of commitment by the utility to provide "the best possible treatment, focused particularly on pathogen reduction." The Board is considering joining this partnership.

Consequently, this Master Plan Update has several areas to address in the near and long term action plans for recommended improvements. The near term will by necessity focus on the particle removal and disinfection strategies needed to fulfill the Board's potential participation in the Partnership for Safe Water and produce consistently high quality water. The longer term strategies address the still valid long term alternatives to achieve high quality water with respect to other contaminants such as SOCs and VOCs, as well as to meet changing Clean Water Act requirements on discharges such as water plant solids residuals.

Parallel studies conducted by the project team that have application to this Master Plan Update include the Performance Assessment and the G&L Basin Upgrade Plan. The Performance Assessment of each plant addresses the review of critical unit processes which could impede the continuous production of high quality water with respect to particle removal. The G&L Basin Upgrade Plan uses and expands on the results of the Performance Assessment to recommend improvements to the coagulation and sedimentation system at the Carrollton WTP where known process and equipment upgrades will be necessary to meet the Partnership's goals of producing 3 or less NTU of turbidity in the settled water.

The results of the Performance Assessment indicate that:

- the weirs in the G&L Basins are overloaded;
- chemical addition and mixing facilities are less than optimal; and
- sludge removal facilities for the G&L Basins need improvements to reduce the frequency of manual removal of sludge from the basins.

The results of the Performance Assessment further indicate that, while the Algiers filtration units' effectiveness can be optimized through operational modifications, the Carrollton filters should be provided with a scour type of backwash to optimize the effectiveness of backwash operations, and that additional clearance between the media and the washwater troughs should be provided for the Sycamore filters.

There are near and long term improvements that have been identified as a result of these studies and the review of plant performance. The near term, operational improvements, are described in the Performance Assessment Report. The long term improvements are listed below by plant. These improvements are more fully described with cost estimates and phased improvements in Sections 4 and 5 of this report.

Long Term Suggested Improvements	
Algiers WTP	
Coagulation/Sedimentation	▸ Move ferric coagulant feed/storage system to plant. ▸ Move pH adjustment to post coagulation. ▸ Evaluate conversion to caustic soda for pH adjustment. ▸ Convert to ozone disinfection or provide more chlorine contact time for CT.
Filtration	▸ Upgrade Filter 1 - 8. Increase flow/ pressure to surface washwater; check media and height of backwash troughs. ▸ Check procedures for restoring a washed filter back into service. ▸ Install turbidimeters on each filter and consider on-line particle counters. ▸ Modify backwash recycle system.
Carrollton WTP	
Coagulation/Sedimentation	▸ Modify ferric/polymer coagulant feed system per G&L Report. ▸ Provide improved mechanical mixing in rapid mixing chamber. ▸ Reduce short circuiting at exit from flocculators and inlet to sedimentation basins. ▸ Lower chemfloc polymer feed to Zebra Mussel control dosages. ▸ Modify short circuiting in L Basins, which causes premature solids settling in flocculation zones. ▸ Increase weir length in G and L basins to conform with design standards. ▸ Replace or upgrade sludge pumps such that they can pump against mud pumps.
Filtration	▸ Increase number of filters in service to offset flow increase by taking filter off-line to clean. ▸ Filter to waste for a period subsequent to backwash. ▸ By-pass backwash return - waste to River. ▸ Alter backwash time of day to spread out so that backwashing of filters does not coincide with daily peak demands. ▸ Add filter wash sweeps to both banks of filters. ▸ Increase storage to offset flow changes in plant and provide finished water for daily peaks. ▸ Work toward goal of minimizing flow rate changes to minimize chemical feed adjustments and changes in filtration flow rates.

4.0 WATER QUALITY MASTER PLAN (REVISED)

4.1 INTRODUCTION

This section uses the conclusions from the preceding sections and from the G & L Basin Upgrade Plan, Plant Performance Assessment, and Zebra Mussel Control Plan to revise and update the long-term Water Quality Master Plan for the Board's water supply.

4.2 RECOMMENDED LONG-TERM PROCESS TRAIN

The 1992 Master Plan presented a long-term treatment process train to be applied to both plants. This recommended process train represented the best combination of practical treatment techniques to reliably treat the Mississippi River water to best address the regulatory requirements, health effects and aesthetic water quality concerns facing the Board.

This plan has been reviewed in view of updated information concerning raw water quality, treatment plant performance and new regulatory and health effects concerns as presented in Sections 2 and 3. It is concluded that the long-term treatment process train remains generally valid. However, the following changes are warranted:

1. Disinfection. At the Algiers WTP, it is proposed that an ozonation facility be added between the sedimentation units and the filters. This step will become the primary disinfection process. With this change, protection against microbiological contaminants will be greatly increased. In addition, chlorine storage and feed requirements will be decreased somewhat, and disinfection by-products levels will be reduced.

   Several regulatory initiatives are discussed in Section 2, which may require that this project be implemented in the near future. These include:

   - The Enhanced Surface Water Treatment Rule
   - The Disinfectant/Disinfection-By-Products Rule
   - Regulations concerning the handling and feeding of chlorine gas

Based on this, and on the need for a primary disinfection facility at Algiers, the Algiers Ozonation Facilities are proposed as a Phase I project.

As the on-going C basin modification at the Carrollton WTP will result in an appropriate CT at the plant, installation of ozonation at Carrollton should be deferred to Phase II. The final regulatory initiatives may increase or decrease the priority of ozonation at Carrollton.

2. Filtration. New concerns regarding turbidity and the potential for *Cryptosporidium* contamination have arisen that point to the need for very high performance from the filters at the plants. To best accomplish this over the long-term, it is recommended that the Board plan for the eventual replacement of the existing filters with new units. This change, which will be in the last phase of the Master Plan implementation, will involve either new state-of-the-art granular media filter units or adopting membrane technology.

3. GAC Adsorption. It is proposed, over the long term, that the existing filter units be renovated and converted to granular activated carbon (GAC) adsorption beds. Because of the improved quality of the raw water with respect to average concentrations of SOCs, it appears that frequent replacement/regeneration of the GAC media will not be required and that the beds should operate in a biologically activated manner. Therefore, the need should not exist for special provisions for transport and on-site regeneration of the GAC media.

   Note that the results of an ozonation study may dictate conversion of the filter beds to GAC adsorption beds in an earlier phase.

4. Storage. Provision of finished water storage remains an important concern at the Carrollton WTP. The 1992 Plan recommended that new finished water storage facilities be constructed at or near the plant. However, with the filtration/GAC changes described above it will be possible for the renovated "C" Basins to be used to fulfill this need. The "C" Basins will store water from the proposed new filters. Only the GAC adsorption units (existing filters) will need to carry peak hour system demands when extra flow is drawn from the "C" Basins. In addition, it is proposed to enlarge the piping to and from the existing finished water storage tanks. This will allow them to be used more regularly to help isolate the treatment plant from diurnal demand variations.

5. Spent Filter Backwash. The increased concerns for enhanced performance of the filters to maximize removal of *Cryptosporidium*-size particles have called into question the practice of recycling the water used to wash filters. It is now proposed that the practice of recycling the backwash be discontinued and that permits be obtained or modified for discharge of the wastewater to the river. Over the long-term, it may be desirable or required to provide a treatment step for the backwash prior to discharge or recycle. Provisions for this are included in the conceptual site plans presented in Section 5.

4.3 PROJECT PHASING

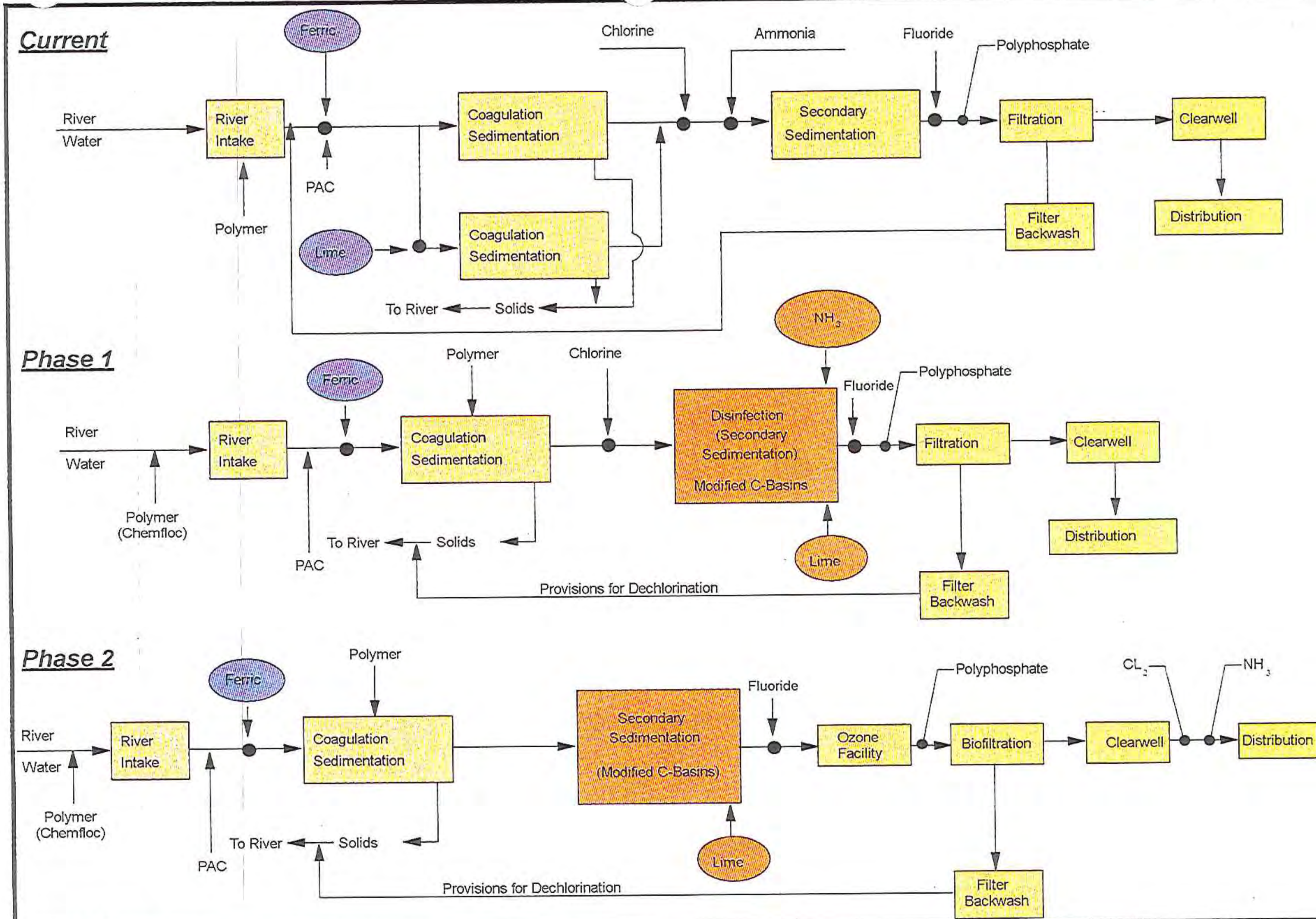
Figure 4-1 and Figure 4-2 present flow diagrams for the Carrollton and Algiers WTPs presenting in a simplified manner how the long-term process train can be implemented in four distinct phases. Tables 4-1 and 4-2 detail the proposed facility changes that will be made in each phase. The phases in these tables supersede and replace the phases presented in the 1992 Master Plan.

From the Baseline Conditions (proposed existing conditions, plus improvements already under construction), the following are the four improvement phases:

- Phase I. These are actions that should be implemented as soon as possible because they address immediate needs relating to regulations now in effect or to improved plant reliability and performance relating to turbidity and to particle removal.

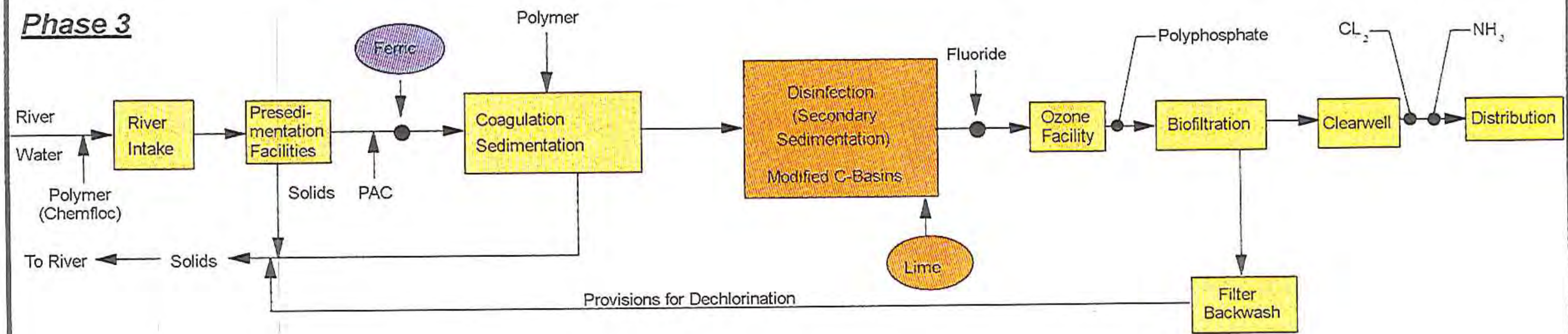
- Phase II. Improvements recommended under this phase are generally related to systems to improve the reliability and consistency of the plant's finished water. A notable exception is the recommendation for ozonation facilities at the Carrollton WTP, which are deferred to Phase II due to their cost and due to the fact that chlorine disinfection facilities with an appropriate CT will soon be available at the plant. The timing of this project will be impacted by the final result of upcoming regulatory initiatives.

  Recommendations for chemical feed and instrumentation improvements at each plant will be refined based on the results of the recommended Phase I Chemical Feed and Instrumentation and Operations Plan.

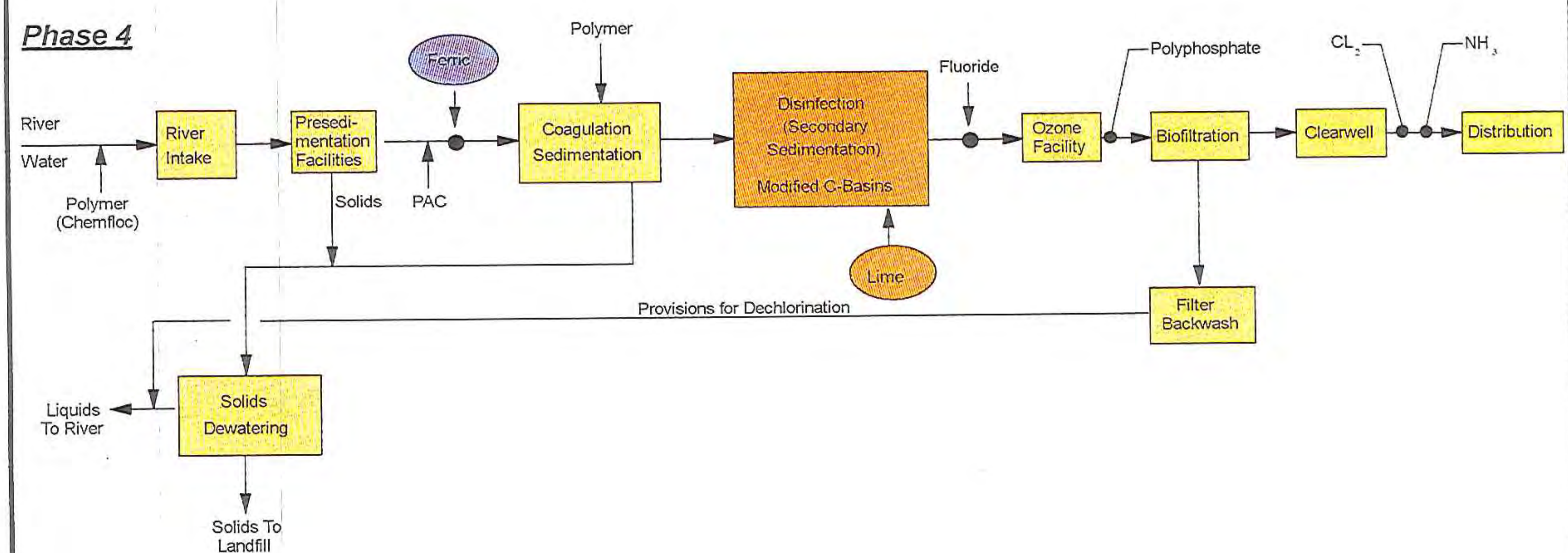


MALCOLM PIRNIE *IN ASSOCIATION WITH* BURK-KLEINPETER C & S CONSULTANTS	CARROLLTON WATER TREATMENT PLANT IMPLEMENTATION STEPS FOR UPDATED WATER QUALITY MASTER PLAN	FIGURE 4-1

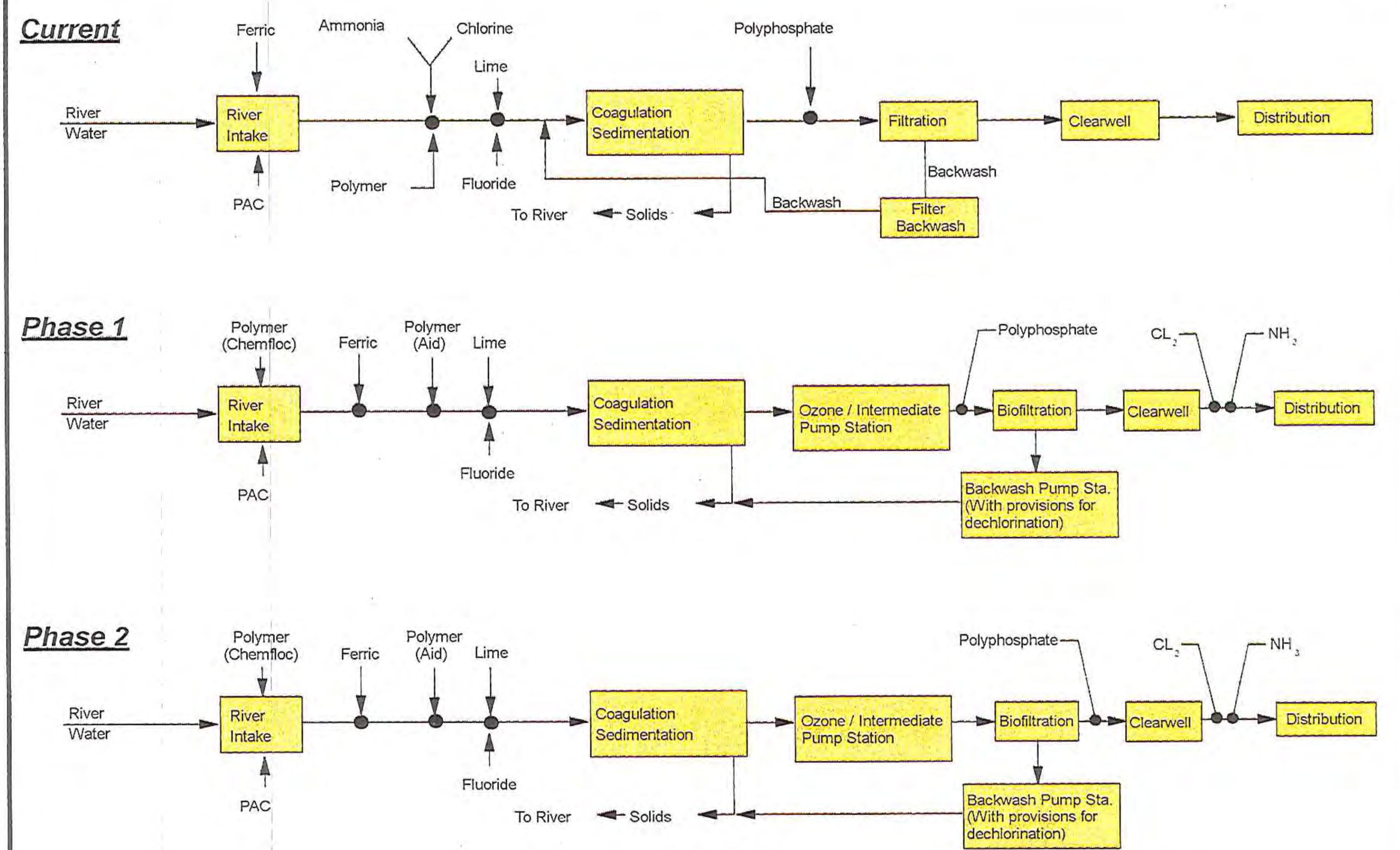
Phase 3



Phase 4



MALCOLM PIRNIE *IN ASSOCIATION WITH* BURK-KLEINPETER C & S CONSULTANTS	CARROLLTON WATER TREATMENT PLANT IMPLEMENTATION STEPS FOR UPDATED WATER QUALITY MASTER PLAN	FIGURE 4-1 Continued



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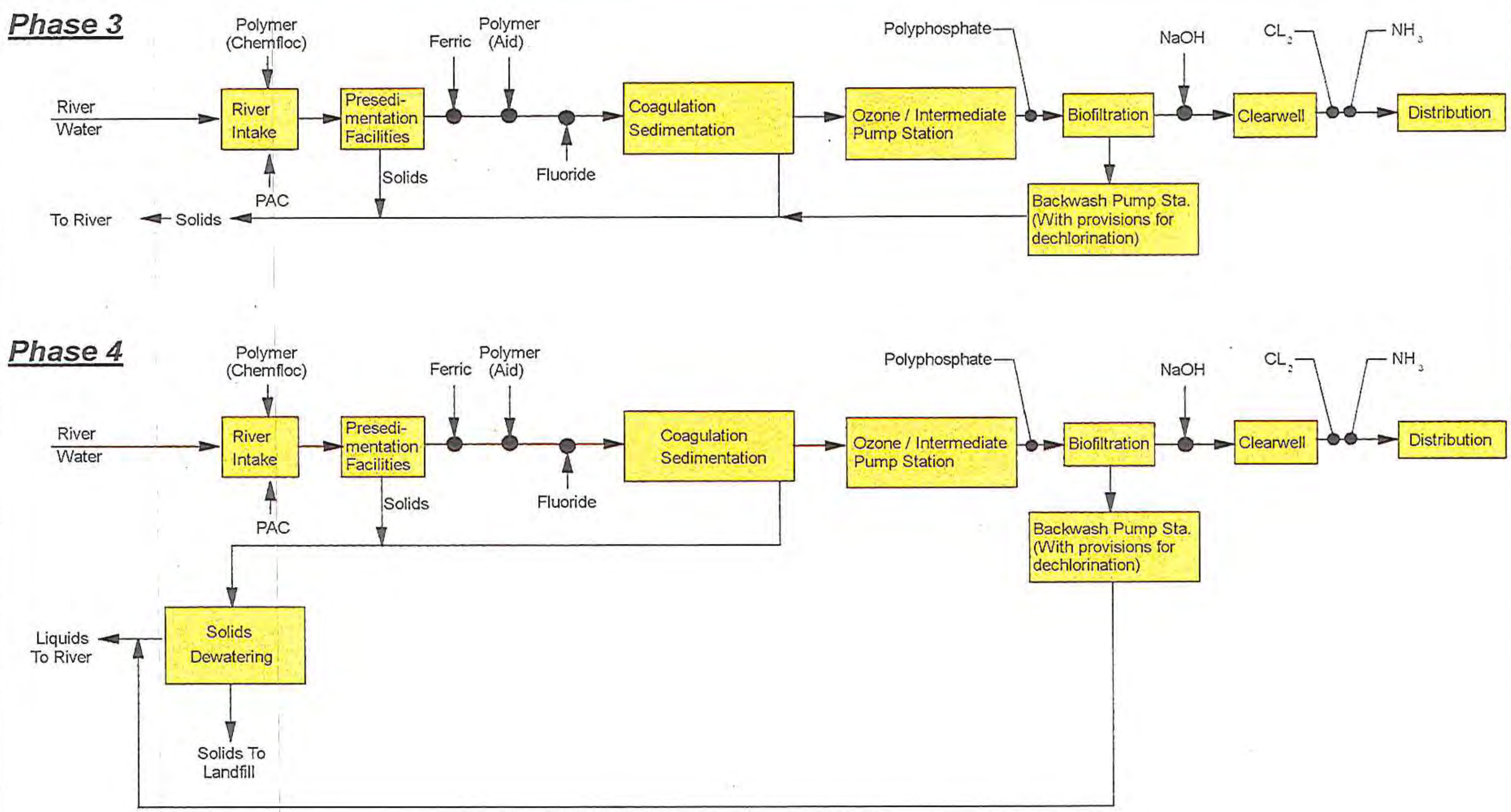
IN ASSOCIATION WITH
BURK-KLEINPETER
C & S CONSULTANTS

ALGIERS WATER TREATMENT PLANT

IMPLEMENTATION STEPS FOR UPDATED WATER QUALITY MASTER PLAN

FIGURE 4-2



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ALGIERS WATER TREATMENT PLANT

IMPLEMENTATION STEPS FOR UPDATED WATER QUALITY MASTER PLAN

FIGURE 4-2 Continued

TABLE 4-1
CARROLLTON WATER TREATMENT PLANT
PHASING OF IMPROVEMENTS

PHASE I	
Item	**Benefits**
A. Renovation of "G" and "L" Basins	• Improves plant performance for turbidity and particle removal by providing rapid mixing and control of flocculation. • Reduces O&M costs (chemical and labor). • Improves reliability by reducing short circuiting in floc/sed basin interface.
B. Filter Backwash Discharge Modifications	• Eliminates filter backwash recycle to improve performance for turbidity and particle removal.
C. Filter Improvements	• Improves filter backwashing system by raising washwater troughs, installing filter sweeps and automatic backwash operations. • Ensures consistency in filter operation and backwash through instrumentation.
D. Intake Chemical Feed Improvements	• Provides PAC feed capability for spill events on river. • Provides means to respond to potential Zebra Mussel infestation.
E. Chemical Feed, Instrumentation, and Operations Plan	• Addresses current safety concerns. • Addresses needs for optimization and improved reliability of plant performance and control.
PHASE II	
Item	**Benefits**
A. Ozonation Facilities	• Improves ability to meet Surface Water Treatment Rule. • Improves protection against microbiological contamination. • Reduces chlorine needs. • Reduces DBPs.
B. Finished Water Storage Piping Changes	• Allows existing finished water storage to be better utilized.

TABLE 4-1
CARROLLTON WATER TREATMENT PLANT
PHASING OF IMPROVEMENTS
(Continued)

C. Chemical Feed and instrumentation Improvements	• Implements recommendations of Phase I Plan • Allows for improved reliability and control and safety of chemical feed systems.
PHASE III	
Item	**Benefits**
A. Pretreatment Facilities	• Improves spill response capability. • Improves plant performance reliability. • Separates most river solids from coagulant sludge.
PHASE IV	
Item	**Benefits**
A. New Filter Units	• Improves particle removal. • Allows for renovation of existing filter units.
B. GAC Absorption System (in existing filter units)	• Provides additional DBP removal.
C. Sludge Dewatering System	• Allows elimination of discharge of coagulant sludge to river (if required).

TABLE 4-2
ALGIERS TREATMENT PLANT
PHASING OF IMPROVEMENTS

PHASE I	
Item	**Benefits**
A. Ozonation Disinfection Facilities	• Improves ability to meet Surface Water Treatment Rule. • Reduces DBPs over current raw water chlorination practice. • Improves protection against microbiological contamination. • Reduces chlorine needs.
B. Filter Backwash Discharge Modifications	• Eliminates filter backwash recycle to improve performance for turbidity and particle removal.
C. Chemical Feed Modifications	• Provides optimum point for coagulant feed. • Provides means to respond to potential Zebra Mussel infestation.
D. Chemical Feed, Instrumentation and Operations Plan	• Addresses current safety concerns. • Addresses needs for optimization and improved reliability of plant performance and control.
PHASE II	
Item	**Benefits**
A. Chemical Feed and Instrumentation Improvements	• Implements recommendation of Phase I Plan. • Allows for improved reliability and control of chemical feed systems.
PHASE III	
Item	**Benefits**
A. Pretreatment Facilities	• Improves spill response capability. • Improves plant performance reliability. • Separates most river solids from coagulant sludge.

TABLE 4-2
ALGIERS WATER TREATMENT PLANT
PHASING OF IMPROVEMENTS
(Continued)

PHASE IV	
Item	**Benefits**
A. New Filter Units	• Improves particle removal. • Allows for renovation of existing filter units.
B. GAC Absorption System (in existing filter units)	• Provides additional DBP removal.
C. Sludge Dewatering System	• Allows elimination of discharge of coagulant sludge to river (if required).

- Phase III. Under this phase presedimentation, aeration and powdered activated carbon (PAC) contact facilities will be added to treat the raw water before it reaches the main water treatment processes. These pretreatment facilities will:

  - Provide a more uniform raw water quality during high turbidity periods to improve particulate removal in the main treatment processes.

  - Provide the capability to remove most organic chemical compounds associated with river spill events and adverse water quality episodes without the need to shut the intakes or allow unacceptably poor water quality to be delivered to the distribution system.

  - Provide a means to separate the heavier river solids from the main coagulant sludge stream. In the future, if discharge of the coagulant sludge to the river were to become not permissible due to the potential new resolutions, this provision could reduce sludge dewatering and disposal costs significantly.

- Phase IV. Under this phase, new state-of-the-art filter units will be constructed and the existing filters converted to use as biologically-activated carbon adsorbers. Technology for the filters will be state-of-the-art at the time they are implemented and may utilize granular media or membranes. Also included would be facilities to thicken and dewater the plant coagulant sludge, should its discharge to the river be prohibited. The changes will offer:

  - Improved and more reliable filter performance for particle removal.

  - An opportunity to thoroughly renovate all components of the existing filters without the need to maintain filter operations during construction.

  - Improved removals of DBPs and SOCs through the action of the biologically activated carbon.

  - A means to discontinue sludge discharges to the Mississippi River if this becomes necessary in the future.

4.4 LONG-TERM WATER SUPPLY NEEDS

The 1992 Master Plan recommended that the Board work with other utilities in the region to develop a major long-term raw water supply project to bring Mississippi River water from north of Baton Rouge to the New Orleans area. Such a project would solve long-term salinity concerns from droughts, sea level rise and potential changing of the river's course. Also recommended was an additional regional initiative to develop an emergency supply using local aquifers.

No action toward these initiatives have been undertaken. However, the need remains, and the Board should begin to pursue these initiatives as soon as possible.

5.0 RECOMMENDED PHASED IMPROVEMENTS

5.1 INTRODUCTION

This section describes the specific facility improvements needed to implement the four phases of this updated Master Plan. This report is the result of a planning process and is not a preliminary engineering report. Thus, some of the recommended improvement may be modified or refined during the development of the preliminary design.

5.2 CARROLLTON WTP

5.2.1 General

Figure 5-1 shows a general layout of the phased improvements at the Carrollton WTP. Each of the improvements is briefly described in the following write-up.

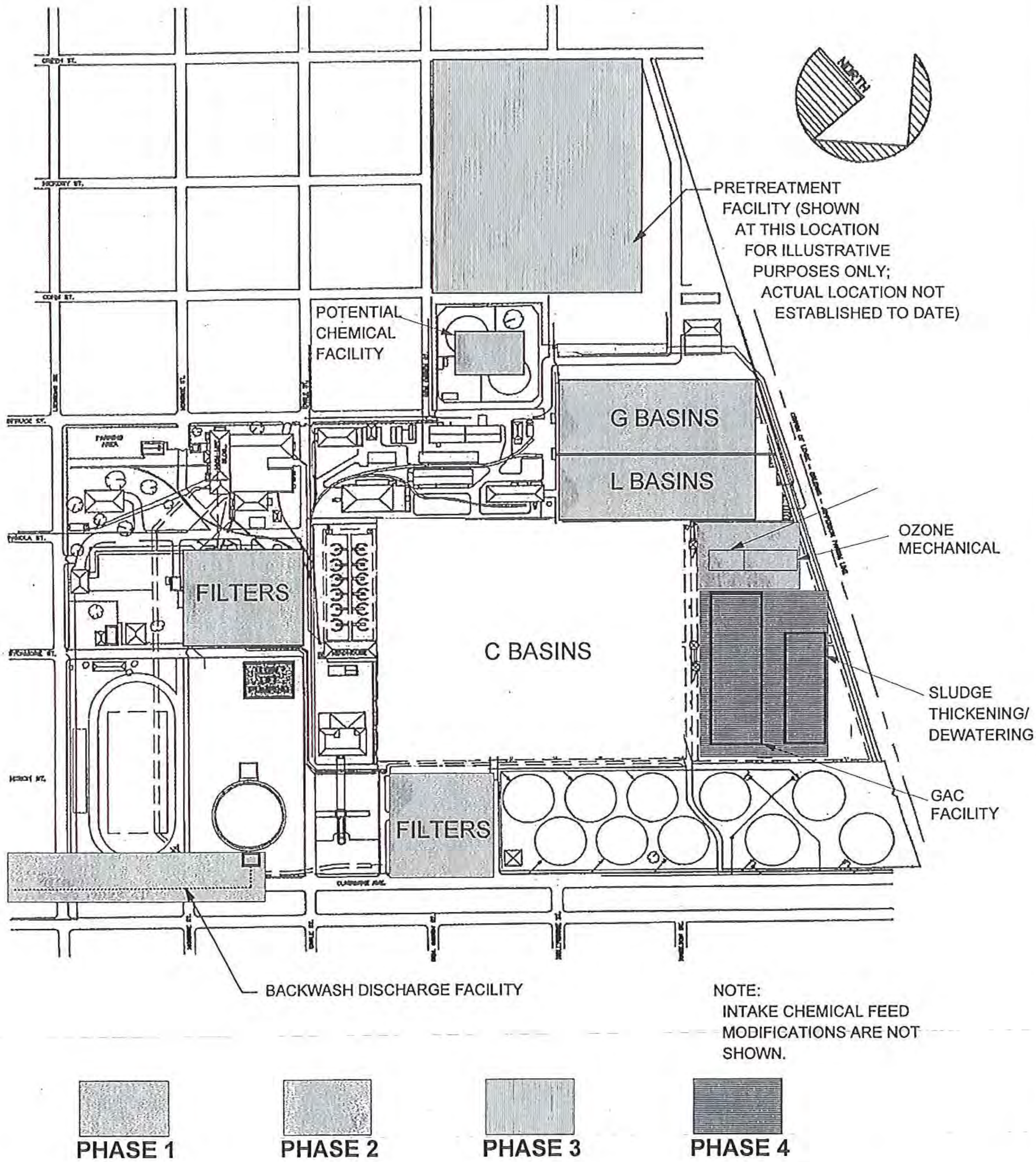
5.2.2 Phase I Improvements

- Renovation of G and L Basins: These upgrades are based on recommendations contained in the G and L Basin Upgrade Report. In general, the renovation includes improvements to the chemical mixing facilities, relocation of the lime feed point, and provisions of new ported baffle walls at the entrance to each basin for flow distribution.

  Solids collection and pumping will be modified mechanically, and new tube settlers will be installed to provide more efficient solids removal. In addition, new effluent weirs will be provided to reduce the load on the existing weirs.

  The renovated G and L Basins will improve the plant performance in terms of turbidity and particle removal, and will reduce chemical costs by maximizing chemical dosage and by providing more efficient chemical mixing. In addition, the improved removal of solids from the basins will greatly reduce the plant's labor costs.

- Filter Backwash Discharge Modifications: This upgrade will remove filter backwash water from the plant recycle, directing it to a disposal point at the River to reduce the potential for recycling particles through the plant. The



MALCOLM PIRNIE *IN ASSOCIATION WITH* BURK-KLEINPETER C & S CONSULTANTS	CITY OF NEW ORLEANS	MALCOM PIRNIE, INC.
	PLOT PLAN OF CARROLLTON WATER TREATMENT PLANT	FIGURE 5-1

improvements will consist of a new pipeline to the River, sized for a velocity of five feet per second, with a new pumping facility retrofitted at the existing backwash storage tank. The tank will be used to equalize the flow to the River, thereby allowing for a more efficient selection of pipe size and a lower motor horsepower. Pumps will be vertical turbine and will operate off of tank level.

In anticipation of future regulations regarding discharges to the River, provisions will be made for future installation of a backwash water treatment facility.

- <u>Filter Improvements:</u> The major components of the filter improvements are:

  - Raise the filter backwash troughs on the Sycamore filters to allow for proper bed expansion during backwash. This provides the ability to expand the filter media for particle removal as well as preventing media loss which can result from siphoning the media during backwash when the height of the takeoff is lower than the bed rise or expansion to the backwash pumping velocities. More detailed evaluation may show that lowering the filter underdrain is possible, and is a feasible method of attaining the intended result.

  - Provide filter sweeps to aid in the proper backwash by providing a horizontal velocity to wash particles from the media while the normal backwash provides the vertical agitation. Filter sweeps are classically recognized as the most effective way to prevent mudball formation in the filter media.

  - Automating the backwash procedure is a way to ensure consistency in the backwash of each filter. This ensures uniformity in procedures to achieve plant goals and can be adjusted seasonally for different water quality conditions. Additionally the filters can be washed any time of day since the method will be the same and the knowledge required will transfer to how to initiate the sequence rather than the backwash itself.

- <u>Intake Chemical Feed Modifications:</u> The major components include modifying the chemfloc polymer feed point and moving PAC storage and addition to the River. The chemfloc feed point will be adjusted from the raw water pipeline to the intake screens as recommended in the Zebra Mussel control report. Moving the point of addition to the screens controls a potential nuisance problem. Moving the point of addition involves piping changes only.

PAC is currently stored and dosed at the Carrollton plant site. At Algiers the PAC is stored and dosed near the River intake facilities. PAC is added to the raw water in the Algiers pipeline affording some contact before coagulation and settling.

This is not the case at Carrollton. Currently the PAC is added to the G or L Basins. The coagulating chemicals can coat the adsorption sites on the carbon particles, settling the PAC and taking the carbon out of the water stream, rendering the carbon inefficient to adsorb dissolved organic molecules. By moving PAC to the intake structure area and adding PAC to the raw water line, the PAC will have the detention time in the pipeline to adsorb organics prior to the coagulation process. Tests from the previous WQMP showed this contact time before coagulation to be beneficial for SOC removal. Similarly, we expect an improvement in the adsorption of taste and odor compounds.

- <u>Chemical Feed, Instrumentation and Operations Plan:</u> This plan will consist of an engineering report which will identify deficiencies and needs (from a process control and reliability standpoint) of the existing chemical storage and feed systems at the plant, and will address regulatory and "good practice" concerns associated with the storage and handling of dangerous chemicals (bulk chlorine and ammonia).

  The plan will recommend steps for achieving O&M cost reductions through energy and chemical efficiencies. The plan will also assess existing plant instrumentation and control system against ideal operations plan for 21st century, and will plan for interfacing/investigation of plant operations with other Board operations including:

  - River water quality monitoring (early warning systems)
  - Distribution system water quality monitoring
  - Water demand monitoring
  - Electric power generation operations

5.2.3 Phase II Improvements

- <u>Ozonation Facilities:</u> Ozone generation and contactors for ozonating the water will be provided for primary disinfection, replacing chloramines. Additionally the ozone will convert the dissolved TOC in the settled water to BDOC (Biodegradable dissolved organic carbon) and aid in the chemical alteration of some of the SOCs. The BDOC may require GAC filtration to lower the concentration to prevent biofilm growths in the distribution system.

Once the ozone facilities are constructed the filters will become biologically active and the bacteria which will be allowed to grow on the filter media will lower the concentration of the TOC and the SOCs, thereby reducing the formation of DBPs and other organic compounds in the finished water. Enhancing the filters by adding post GAC adsorbers will depend on field evaluations to be conducted at Algiers WTP. Chloramines will continue to be used for secondary disinfection. The chloramination point will be relocated to downstream of the filters, to allow the filters to operate biologically.

- <u>Finished Water Storage Piping Changes:</u> This improvement to the finished water piping will reduce or eliminate hydraulic restrictions in the piping to the finished water tanks. Piping runs will be replaced with larger diameter piping to decrease pipe friction loss, and new connections will be made at the high-lift pump station.

  The project will reduce power costs and will allow staff to fully utilize the capacity of the existing storage tanks.

- <u>Chemical Feed and Instrumentation Improvements:</u> The results of the Phase I Chemical Feed, Instrumentation, and Operations Plan will set the stage for this project. Minimum improvements should include flow level monitoring and flow pacing of chemical feeds. Additionally, a plant information management system should be considered.

5.2.4 Phase III Improvements

- <u>Pretreatment Facilities:</u> Should land become available for this project in the future, pretreatment facilities would be installed to separate river solids (mud) from the plant influent prior to its reaching the chemical mixing and flocculation facilities, and to provide for removal of VOCs and SOCs from the raw water.

  The facility will be a concrete structure consisting of a sedimentation chamber, a mud pump station, and a shallow aeration basin. The sedimentation chamber will contain flight and chain sludge collectors, tube settlers for removal of fine sludge particles, and weirs troughs for removal of settled water. The aeration basin will use compressors, which provide an energetic mixing reaction for removal of organics.

5.2.5 Phase IV Improvements

- New State-of-the-Art Filter Units and GAC Adsorption System: State-of-the-art filters will be provided by renovating the existing filters and adding new filters to provide for additional capacity for continued maintenance of high quality water with acceptable allowances for filters to be out of service for backwash or maintenance. The renovation of filters will be accomplished by adding to the anthracite media to bring up to full bed (at least 24 to 36 inches). This effectively increases the surface depth and area of the media to accommodate better particle removal. Removal of BDOC may only occur at levels of 10 to 20% in these filters. Further BDOC removal would require post carbon contactors to provide enough EBCT (empty bed contact time) for cold water months. The empty filter beds are too shallow for conversion to filter adsorbers.

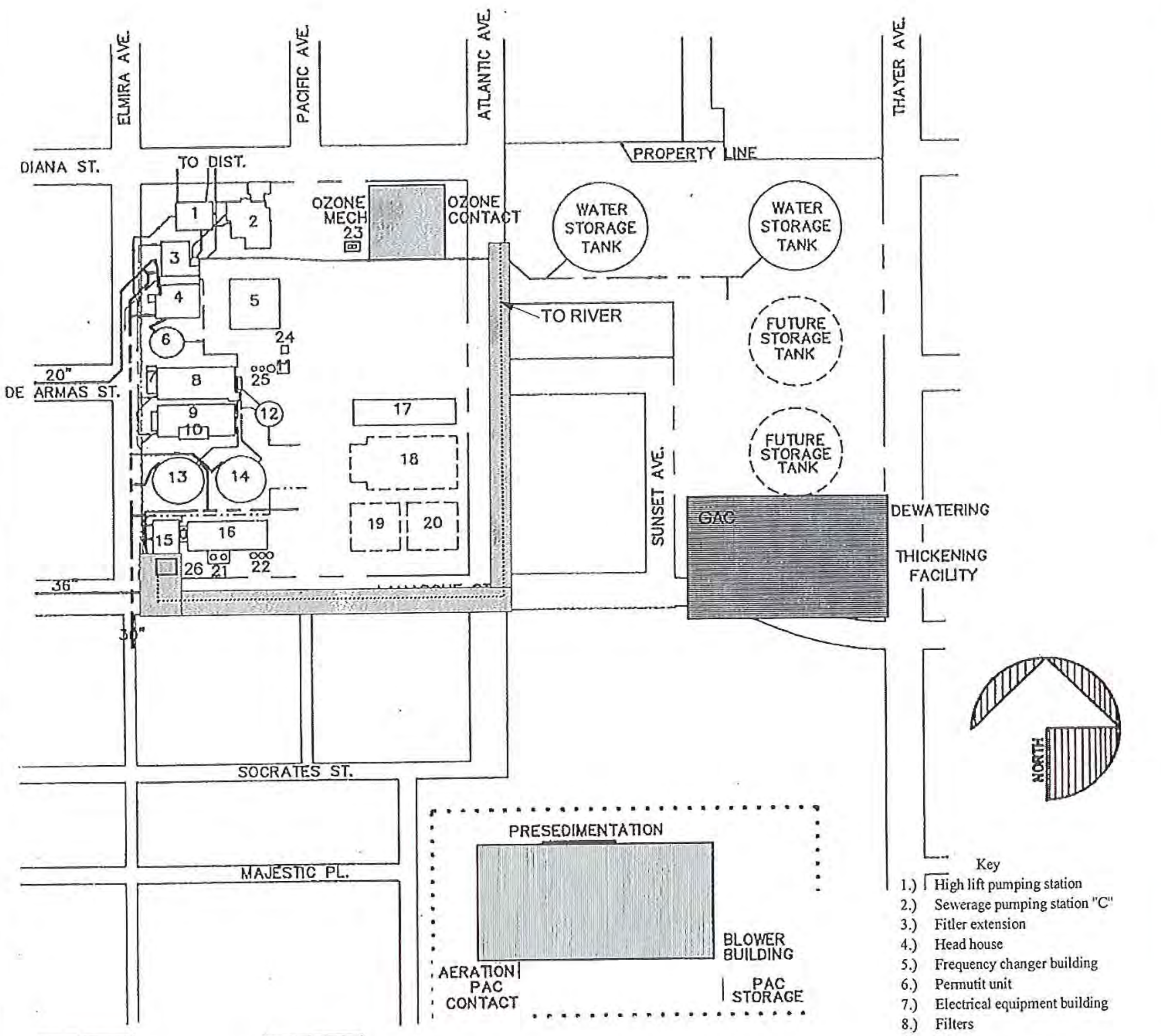
  Note that the results of the ozonation study may dictate that GAC filters be installed under Phase II.

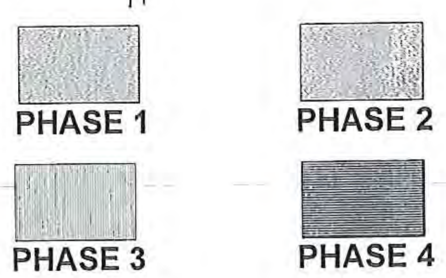
- Sludge Dewatering System: In the event of regulations preventing discharge of coagulated solids directly into the River, sludge dewatering for land disposal would be provided. Land disposal options include sanitary landfill and/or agricultural land spreading. To haul solids for such disposal will require dewatering facilities consisting of sludge holding tanks, thickening units and dewatering equipment such as centrifuges, belt presses, or plate and frame filter units. Additionally, the facilities will include buildings to house the dewatering equipment and dewatered-sludge conveyors and truck loading areas.

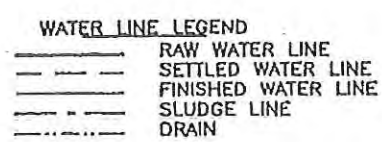
5.3 ALGIERS WTP

5.3.1 General

Figure 5-2 shows a general layout of the phased improvements at the Algiers WTP. Each of the improvements is briefly described in the following write-up.







Key

1.) High lift pumping station
2.) Sewerage pumping station "C"
3.) Fitler extension
4.) Head house
5.) Frequency changer building
6.) Permutit unit
7.) Electrical equipment building
8.) Filters
9.) Filters
10.) Control building
11.) Sludge control building
12.) Fitler wash water tank
13.) Upflow treatment unit
14.) Upflow treatment unit
15.) New recycle basin
16.) New chemical building
17.) New high lift pumping station
18.) Filters
19.) Upflow unit
20.) Upflow unit
21.) Future polytelectrolyte tanks
22.) Future lime storage silos
23.) Fuel storage tank
24.) Mud pump station
25.) Existing lime storage
26.) Backwash disposal

NOTES:

1. Intake Chemical Feed Modifications are not shown.
2. Phase II improvements are not shown.

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5.3.2 Phase I Improvements

- Ozonation Facilities: Ozone generation and contactors for ozonating the water will be provided for primary disinfection, replacing chloramines. Additionally the ozone will reduce the dissolved TOC in the settled water and aid in the chemical alteration of some of the SOCs. Once the ozone facilities are constructed, the filters will become biologically active and the bacteria which will be allowed to grow on the filter media will lower the concentration of the TOC and the SOCs, thereby reducing the formation of DBPs and other organic compounds in the finished water. Chloramines will continue to be used for secondary disinfection. The chloramination point will be relocated to downstream of the filters, to allow the filters to operate bilogically.

  Normal anthracite filters operated biologically may only remove 10-20% of the BDOC - not enough to prevent biofilm growths in the distribution system. Hence, the filters should be modified to increase the surface area of the media to support more bacteria for substrate BDOC - removal. This can sometimes be done by replacing the antracite media with GAC as the GAC particles have much greater surface area to grow bacteria than does anthracite.

  The operation of these converted filters to filter absorbers is affected more by the EBCT - empty bed contact time - in the cell rather than by the usual loading rates of gpm/ft^2. At colder water temperature conditions, more EBCT is required. At this time we believe the existing new filters would have adequate EBCT.

  An ozonation study is recommended prior to commencement of preliminary design, which would determine whether GAC would be required, based on the estimated amount of BDOC resulting from the ozonation process. The study will also evaluate the ozone demand and other issues.

- Filter Backwash Discharge Modifications: This upgrade will remove filter backwash water from the plant recycle, directing it to a disposal point at the River to reduce the potential for recycling particles through the plant. The improvements will consist of a new pipeline to the River, sized for a velocity of five feet per second, with a new pumping facility retrofitted at the existing backwash storage tank. The tank will be used to equalize the flow to the River, thereby allowing for a more efficient selection of pipe size and a lower motor horsepower. Pumps will be vertical turbine and will operate off of tank level.

In anticipation of future regulations regarding discharges to the River, provisions will be made for future installation of a backwash water treatment facility.

- Intake Chemical Feed Improvements: The major components include modifying the chemfloc polymer feed point. The chemfloc feed point will be adjusted from the raw water pipeline to the intake screens as recommended in the Zebra Mussel Control Report. Addition of the polymer at the River continues to be a process coagulant chemical. Moving the polymer point of addition to the screens controls a potential nuisance problem. This modification involves piping changes only.

  PAC is currently stored and dosed near the River intake facilities. PAC is added to the raw water in the pipeline affording some contact before coagulation and settling; however, ferric is currently added to the raw water pipeline and will impede the PAC adsorption by coagulating the PAC with other river particles. By moving ferric to the plant the addition of PAC to the raw water pipeline will provide the detention time necessary to adsorb organics prior to the coagulation process. Tests from the previous WQMP showed this contact time before coagulation to be beneficial for SOC removal. Similarly, we expect an improvement in the adsorption of taste and odor compounds.

- Chemical Feed, Instrumentation and Operations Plan: This plan will consist of an engineering report which will identify deficiencies and needs (from a process control and reliability standpoint) of the existing chemical storage and feed systems at the plant, and will address regulatory and "good practice" concerns associated with the storage and handling of dangerous chemicals (bulk chlorine and ammonia).

  The plan will recommend steps for achieving O&M cost reductions through energy and chemical efficiencies. The plan will also assess existing plant instrumentation and control system against ideal operations plan for 21st century, and will plan for interfacing/investigation of plant operations with other Board operations including:

  - River water quality monitoring (early warning systems)
  - Distribution system water quality monitoring
  - Water demand monitoring
  - Electric power generation operations

5.3.3 Phase II Improvements

- Chemical Feed and Instrumentation Improvements: The results of the Phase I Chemical Feed, Instrumentation, and Operations Plan will set the stage for this project. Minimum improvements should include flow level monitoring and flow pacing of chemical feeds. Additionally, a plant information management system should be considered.

5.3.4 Phase III Improvements

- Pretreatment Facilities: Design of these facilities is complete, and the facilities can be installed once the need arrives. Pretreatment facilities would be installed to separate river solids (mud) from the plant influent prior to its reaching the chemical mixing and flocculation facilities, and to provide for removal of VOCs and SOCs from the raw water.

  The facility will be a concrete structure consisting of a sedimentation chamber, a mud pump station, and a shallow aeration basin. The sedimentation chamber will contain flight and chain sludge collectors, tube settlers for removal of fine sludge particles, and weirs troughs for removal of settled water. The aeration basin will use compressors, which provide an energetic mixing reaction for removal of organics.

5.3.5 Phase IV Improvements

- New State-of-the-Art Filter Units and GAC Adsorption System: State-of-the-art filters will be provided by renovating the existing filters and adding new filters to provide for additional capacity for continued maintenance of high quality water with acceptable allowances for filters to be out of service for backwash or maintenance. The renovation of filters will be accomplished by replacing the anthracite media with GAC. This effectively increases the surface area of the media to accommodate bacteria to operate the filter biologically. These "filter absorbers" will not only remove particles but will also adsorb TOC, particularly, the Biological Dissolved Organic Carbon (BDOC) created by ozone chemically altering the natural TOC molecules to carbon compounds which are more easily assimilated by the bacteria.

  Installation of GAC may be required in Phase I, depending on the results of the ozonation study.

- Sludge Dewatering System: In the event of regulations preventing discharge of coagulated solids directly into the River, sludge dewatering for land disposal would be provided. Land disposal options include sanitary landfill and/or agricultural land spreading. To haul solids for such disposal will require dewatering facilities consisting of sludge holding tanks, thickening units and dewatering equipment such as centrifuges, belt presses, or plate and frame filter units. Additionally, the facilities will include buildings to house the dewatering equipment and dewatered-sludge conveyors and truck loading areas.

6.0 COST ESTIMATES AND IMPLEMENTATION SCHEDULE

6.1 INTRODUCTION

This section presents a revised cost estimate for the phased implementation and a revised implementation schedule.

6.2 ESTIMATED COSTS (UPDATE)

6.2.1 Capital Costs

The opinion of probable capital costs associated with the recommended improvements to the Carrollton and Algiers WTPs are shown in Tables 6-1 and 6-2.

These costs are in 1996 dollars and include Contractor's overhead and profit plus contingencies. Brief descriptions of the work included in Phase I through Phase II are also shown in these tables.

Please note that the costs presented for the chemical feed and instrumentation improvements at each plant cannot be fully defined until the Chemical Feed, Instrumentation and Operations Plan is finished, and are therefore presented as an allowance.

The listed costs do not include any right-of-way acquisitions.

6.2.2 Operation and Maintenance Costs

General evaluations of the impact of the Water Quality Master Plan Update on operation and maintenance were made, considering the following:

- Chemicals
- Power
- Labor

The impact of each recommended improvement is discussed below.

TABLE 6-1
CARROLLTON WATER TREATMENT PLANT
PHASED IMPROVEMENTS

PHASE I	
Description	**Cost**
A. Renovation of "G" and "L" Basins	$9,500,000
B. Filter Backwash Discharge Modifications	$1,675,000
C. Filter Improvements	$8,350,000
D. Intake Chemical Feed Improvements	$3,325,000
E. Chemical Feed, Instrumentation, and Operations Plan	$300,000 (engineering fee)
TOTAL PHASE I	**$23,150,000**
PHASE II	
A. Ozonation Facilities	$48,000,000
B. Finished Water Storage Piping Changes	$6,000,000
C. Chemical Feed and instrumentation Improvements (allowance)	$8,000,000
TOTAL PHASE II	**$62,000,000**

TABLE 6-2
ALGIERS WATER TREATMENT PLANT
PHASED IMPROVEMENTS

PHASE I	
Description	**Cost**
A. Ozonation Disinfection Facilities	$11,250,000
B. Filter Backwash Discharge Modifications	$990,000
C. Chemical Feed Modifications	$910,000
D. Chemical Feed, Instrumentation, and Operations Plan	(Included under costs for Carrollton WTP)
TOTAL PHASE I	**$13,150,000**
PHASE II	
A. Chemical Feed and Instrumentation Improvements (allowance)	$3,000,000
TOTAL PHASE II	**$3,000,000**

6.2.2.1 Carrollton WTP

- Renovation of "G" and "L" Basins: These improvements should result in decreased labor costs for removal of sludge from the basins. Power costs for rapid mixing will increase slightly, while power costs for flocculation will decrease slightly. Overall power costs should not change. Chemical costs will decrease slightly due to more efficient mixing. Overall costs should decrease slightly.

- Filter Backwash Discharge Modifications: These improvements will not impact chemical costs, but will increase power costs, both for disposal of backwash water and for pumping of additional water from the river to make up for the loss of the backwash water in the plant flow. Labor costs will increase slightly as the result of operation and maintenance of the backwash disposal pumps. Overall costs will increase.

- Filter Improvements: These improvements will not impact chemical costs. Additional power costs will be minimal. Substantial savings on labor should be realized due to more efficient and consistent backwash operations. Overall costs will decrease.

- Intake Chemical Feed Improvements: This project will result in increased power and chemical costs for polymer for Zebra Mussel control, but will reduce or make more efficient the PAC. There will be no increase in labor costs due to moving existing chemical feeds.

- Ozonation Facilities: Ozonation facilities will reduce chlorine needs slightly, but will result in a substantial increase in power costs for ozone generation. The difference in labor costs is difficult to quantify, but labor costs may increase initially while plant operators familiarize themselves with the ozonation process. Overall costs are projected to increase.

- Finished Water Storage Piping Changes: This project will lower chemical, labor, and power costs.

- Chemical Feed and Instrumentation Improvements: Although the project cannot be fully defined until the results of the Chemical Feed and Instrumentation Operations Plan are available, this project should result in more efficient use of chemicals and on more efficient facility operation, thus reducing both chemical and labor costs.

6.2.2.2 Algiers WTP

- Ozonation Facilities: Ozonation facilities will reduce chlorine needs slightly, but will result in a substantial increase in power costs for ozone generation. The difference in labor costs is difficult to quantify, but labor costs may increase initially while plant operators familiarize themselves with the ozonation process. Overall costs are projected to increase.

- Filter Backwash Discharge Modifications: These improvements will not impact chemical costs, but will increase power costs, both for disposal of backwash water and for pumping of additional water from the river to make up for the loss of the backwash water in the plant flow. Labor costs will increase slightly as the result of operation and maintenance of the backwash disposal pumps. Overall costs will increase.

- Intake Chemical Feed Improvements: This project will result in increased power and chemical costs for polymer for Zebra Mussel control, but will reduce or make more efficient the PAC. There will be no increase in labor costs due to moving existing chemical feeds.

- Chemical Feed and Instrumentation Improvements: Although the project cannot be fully defined until the results of the Chemical Feed and Instrumentation Operations Plan are available, this project should result in more efficient use of chemicals and on more efficient facility operation, thus reducing both chemical and labor costs.

6.3 IMPLEMENTATION SCHEDULE (UPDATE)

6.3.1 Schedule of Construction

Figure 6-1 shows the recommended implementation schedule for the Carrollton and the Algiers WTPs. This schedule reflects the phased development of improvements per Section 4. The physical components associated with each phase are shown on the site plans in Section 5.

As can be seen from Figure 6-1, Phase I is estimated to be on line by the middle of 2002 at each plant, assuming an April 1997 project approval date.

Design of Phase II improvements is contingent upon completion of the recommended Phase I Chemical Feed Instrumentation and Operations Plan, and upon implementation of

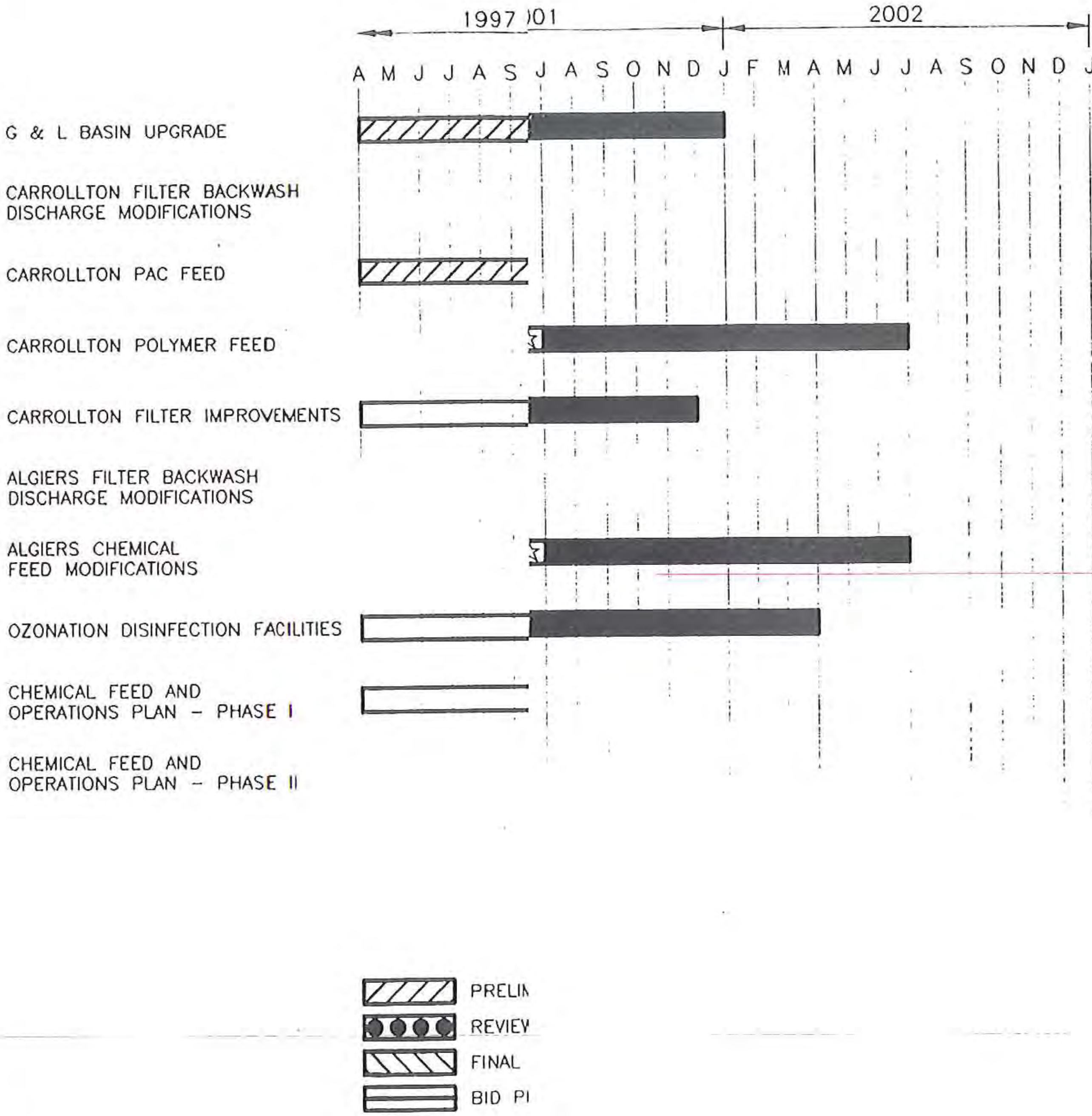


FIGURE 6-1

MALCOLM PIRNIE

IN ASSOCIATION WITH

BURK – KLEINPETER

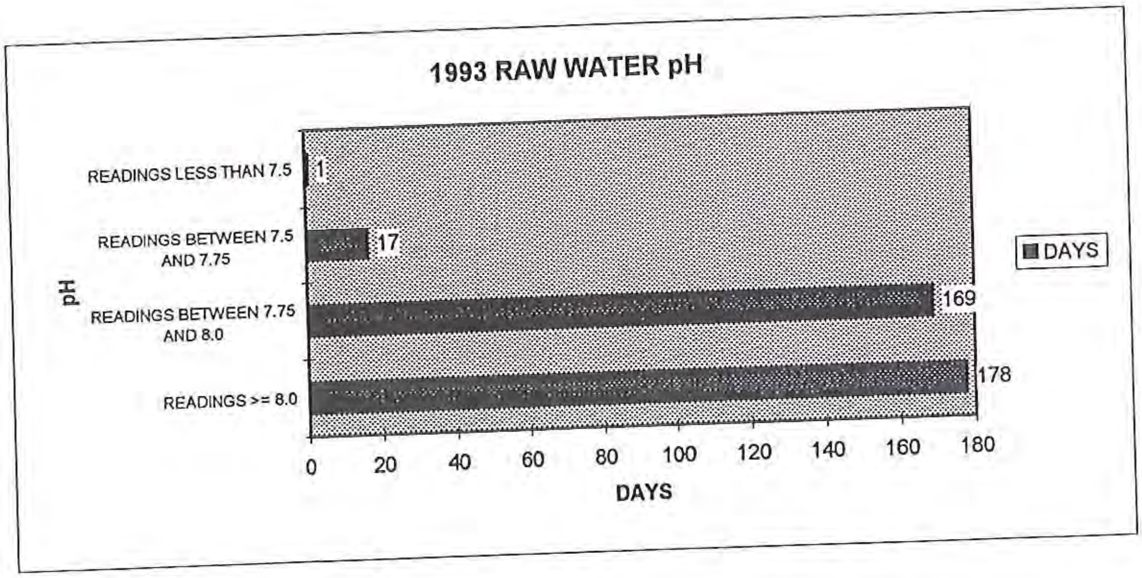
C & S CONSULTANTS

regulations related to disinfection. It is projected that construction of these improvements will be complete by early 2007.

CARROLLTON WATER TREATMENT PLANT
RAW WATER QUALITY DATA
1993 - 1995

CARROLLTON WATER TREATMENT PLANT
1993 RAW WATER pH

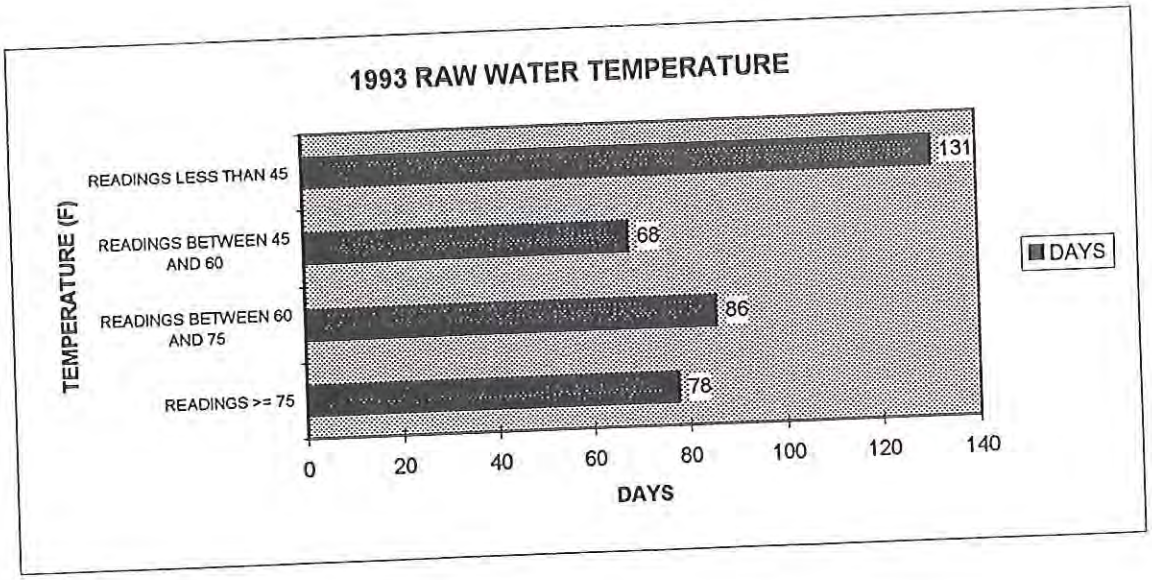
MAX.	8.4
MIN.	7.3
AVG.	7.9
COUNT (READINGS)	365
READINGS >= 8.0	178
READINGS BETWEEN 7.75 AND 8.0	169
READINGS BETWEEN 7.5 AND 7.75	17
READINGS LESS THAN 7.5	1



CARROLLTON WATER TREATMENT PLANT

1993 RAW WATER TEMPERATURE

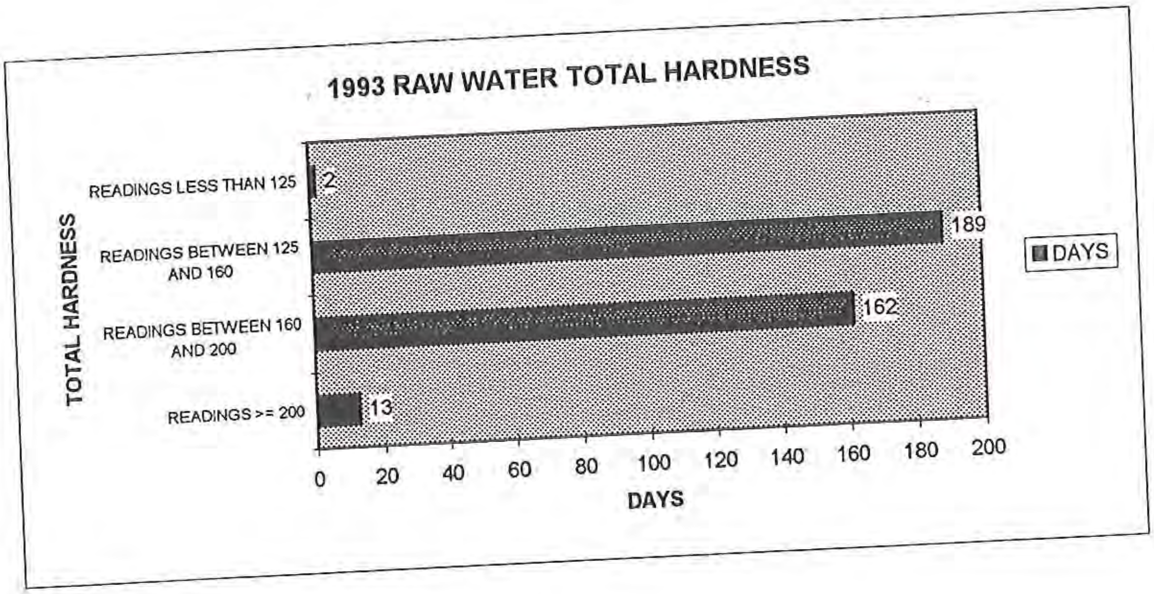
MAX.	80
MIN.	35
AVG.	56
COUNT (READINGS)	363
READINGS >= 75	78
READINGS BETWEEN 60 AND 75	86
READINGS BETWEEN 45 AND 60	68
READINGS LESS THAN 45	131



CARROLLTON WATER TREATMENT PLANT

1993 RAW WATER TOTAL HARDNESS

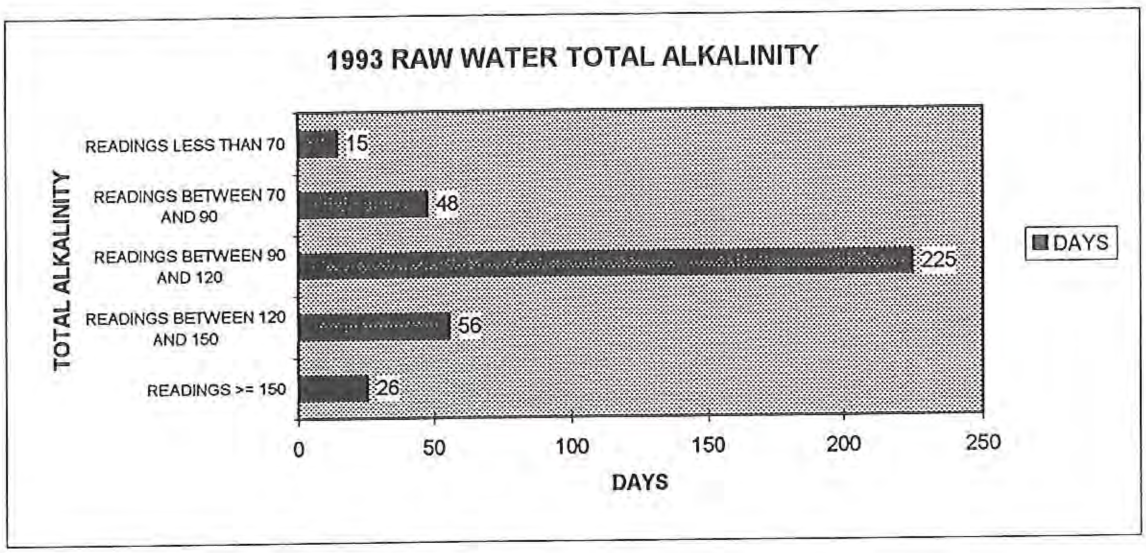
MAX.	216
MIN.	122
AVG.	161
COUNT (READINGS)	366
READINGS >= 200	13
READINGS BETWEEN 160 AND 200	162
READINGS BETWEEN 125 AND 160	189
READINGS LESS THAN 125	2



CARROLLTON WATER TREATMENT PLANT

1993 RAW WATER TOTAL ALKALINITY

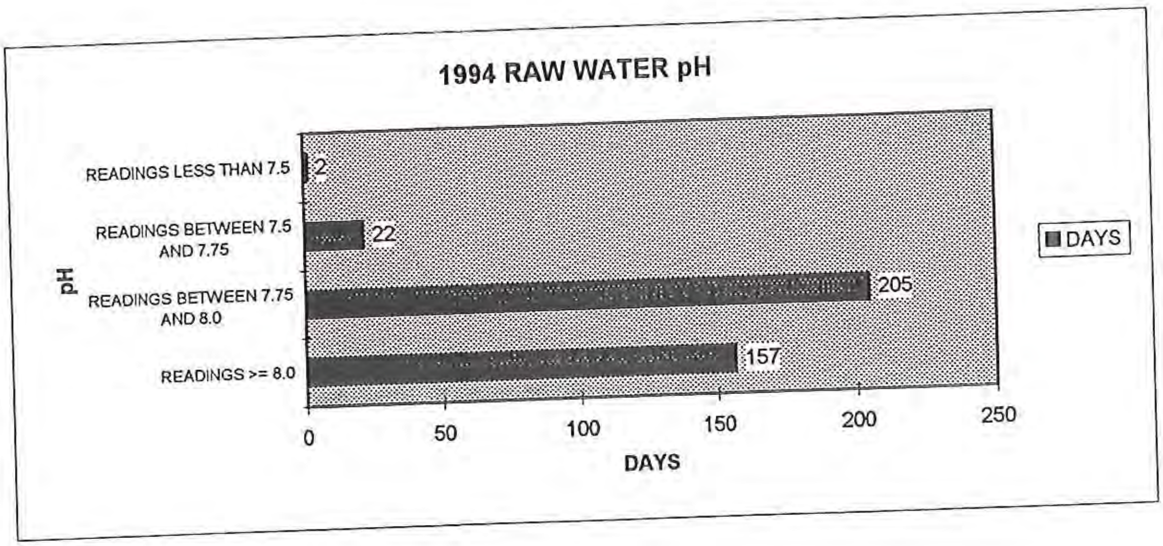
MAX.	162
MIN.	62
AVG.	107
COUNT (READINGS)	370
READINGS >= 150	26
READINGS BETWEEN 120 AND 150	56
READINGS BETWEEN 90 AND 120	225
READINGS BETWEEN 70 AND 90	48
READINGS LESS THAN 70	15



CARROLLTON WATER TREATMENT PLANT

1994 RAW WATER pH

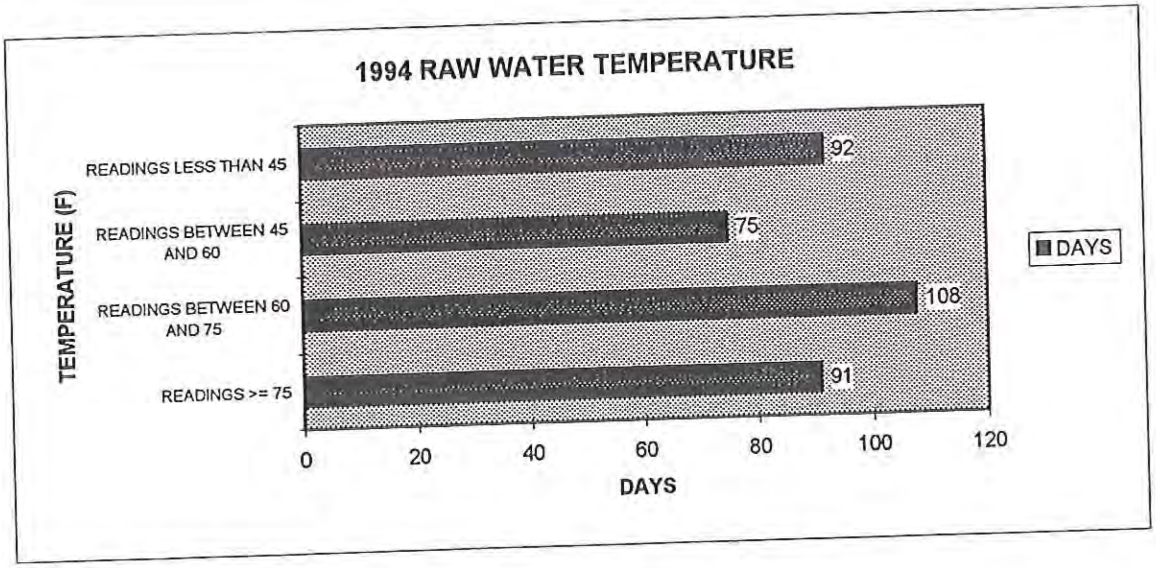
MAX.	8.3
MIN.	7.4
AVG.	7.9
COUNT (READINGS)	386
READINGS >= 8.0	157
READINGS BETWEEN 7.75 AND 8.0	205
READINGS BETWEEN 7.5 AND 7.75	22
READINGS LESS THAN 7.5	2



CARROLLTON WATER TREATMENT PLANT

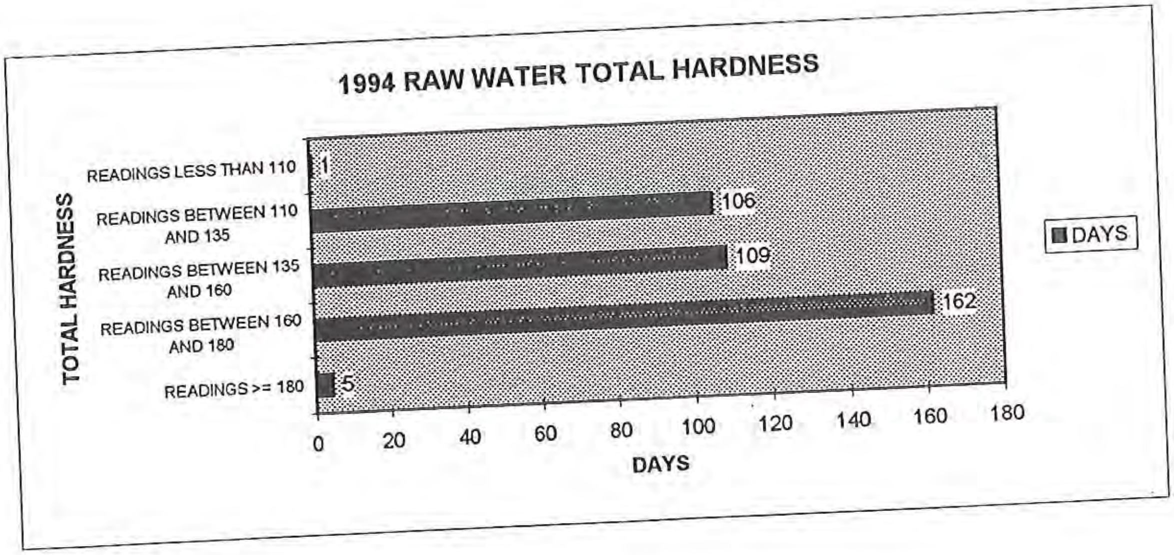
1994 RAW WATER TEMPERATURE

MAX.	80
MIN.	32
AVG.	58
COUNT (READINGS)	366
READINGS >= 75	91
READINGS BETWEEN 60 AND 75	108
READINGS BETWEEN 45 AND 60	75
READINGS LESS THAN 45	92



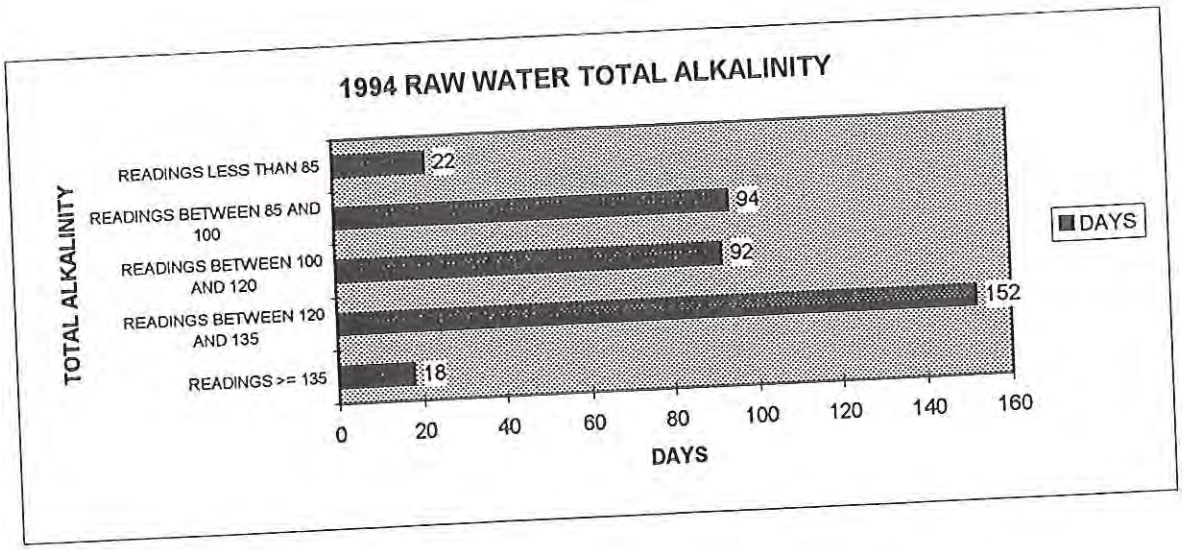
CARROLLTON WATER TREATMENT PLANT
1994 RAW WATER TOTAL HARDNESS

MAX.	182
MIN.	106
AVG.	150
COUNT (READINGS)	383
READINGS >= 180	5
READINGS BETWEEN 160 AND 180	162
READINGS BETWEEN 135 AND 160	109
READINGS BETWEEN 110 AND 135	106
READINGS LESS THAN 110	1



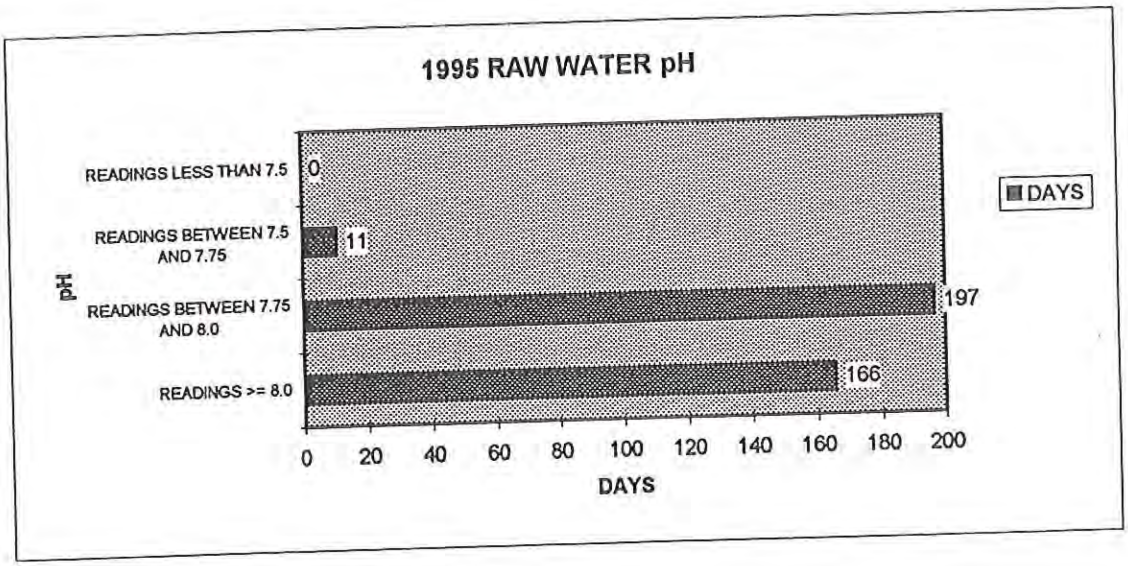
CARROLLTON WATER TREATMENT PLANT
1994 RAW WATER TOTAL ALKALINITY

MAX.	142
MIN.	77
AVG.	111
COUNT (READINGS)	378
READINGS >= 135	18
READINGS BETWEEN 120 AND 135	152
READINGS BETWEEN 100 AND 120	92
READINGS BETWEEN 85 AND 100	94
READINGS LESS THAN 85	22



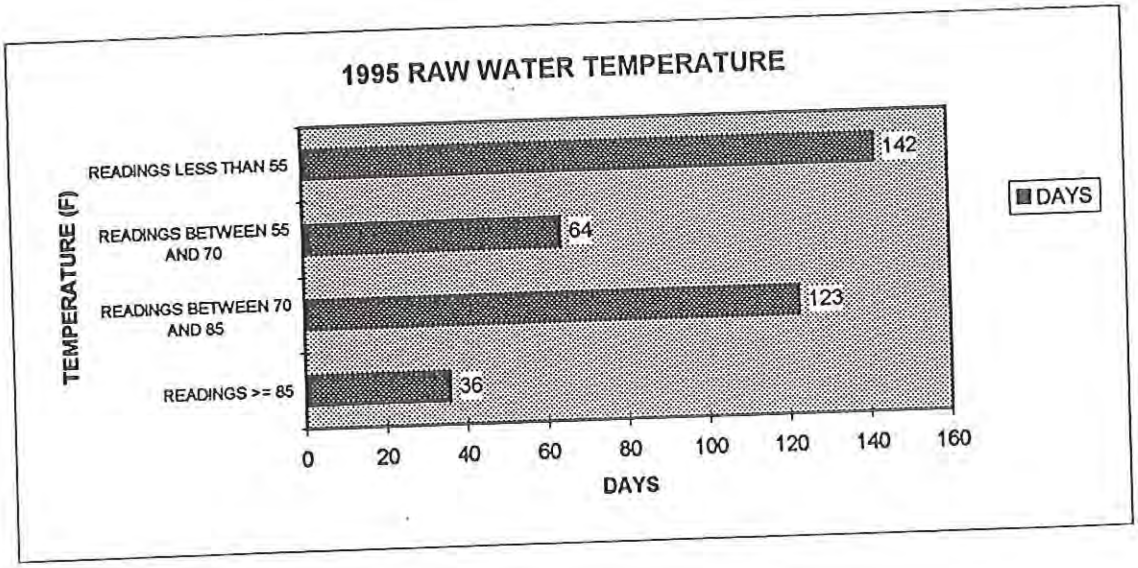
CARROLLTON WATER TREATMENT PLANT
1995 RAW WATER pH

MAX.	8.32
MIN.	7.67
AVG.	8
COUNT (READINGS)	374
READINGS >= 8.0	166
READINGS BETWEEN 7.75 AND 8.0	197
READINGS BETWEEN 7.5 AND 7.75	11
READINGS LESS THAN 7.5	0



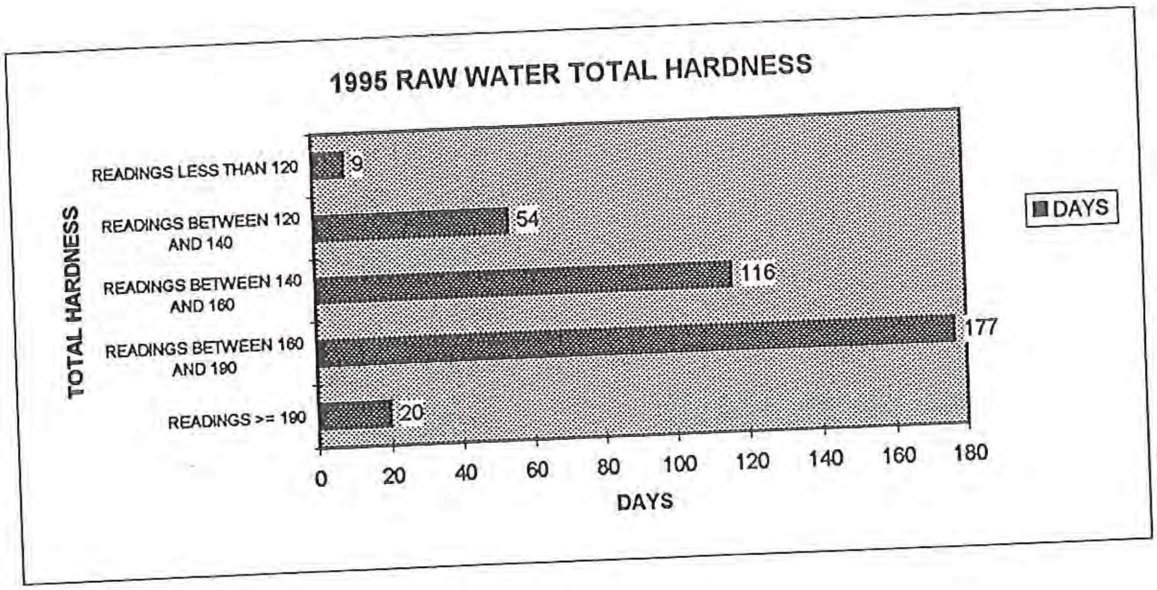
CARROLLTON WATER TREATMENT PLANT
1995 RAW WATER TEMPERATURE

MAX.	88
MIN.	36
AVG.	62
COUNT (READINGS)	365
READINGS >= 85	36
READINGS BETWEEN 70 AND 85	123
READINGS BETWEEN 55 AND 70	64
READINGS LESS THAN 55	142



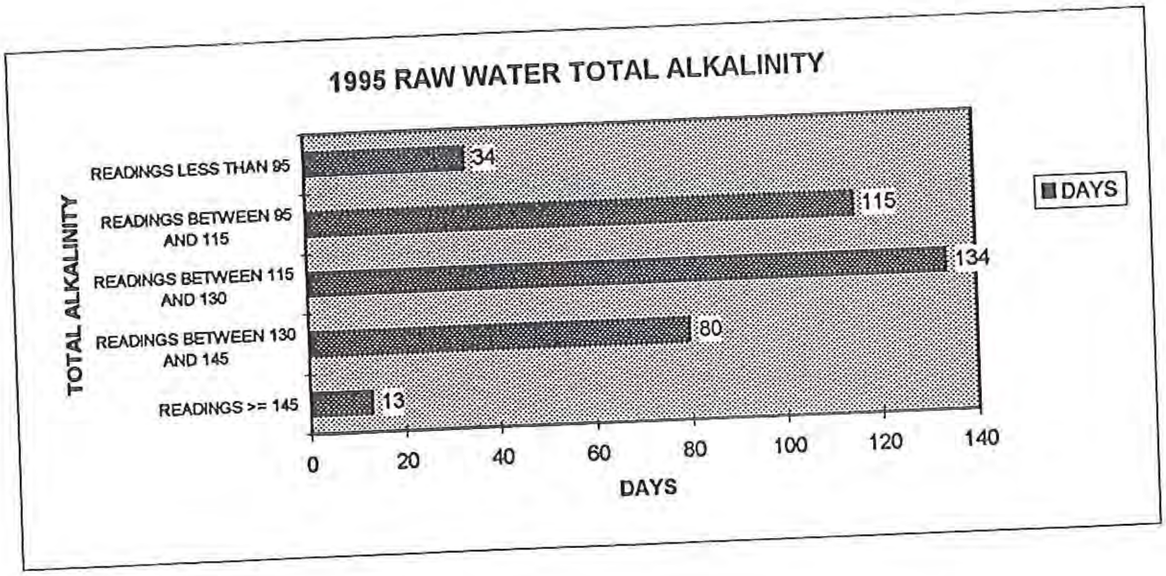
CARROLLTON WATER TREATMENT PLANT
1995 RAW WATER TOTAL HARDNESS

MAX.	203
MIN.	115
AVG.	159
COUNT (READINGS)	376
READINGS >= 190	20
READINGS BETWEEN 160 AND 190	177
READINGS BETWEEN 140 AND 160	116
READINGS BETWEEN 120 AND 140	54
READINGS LESS THAN 120	9



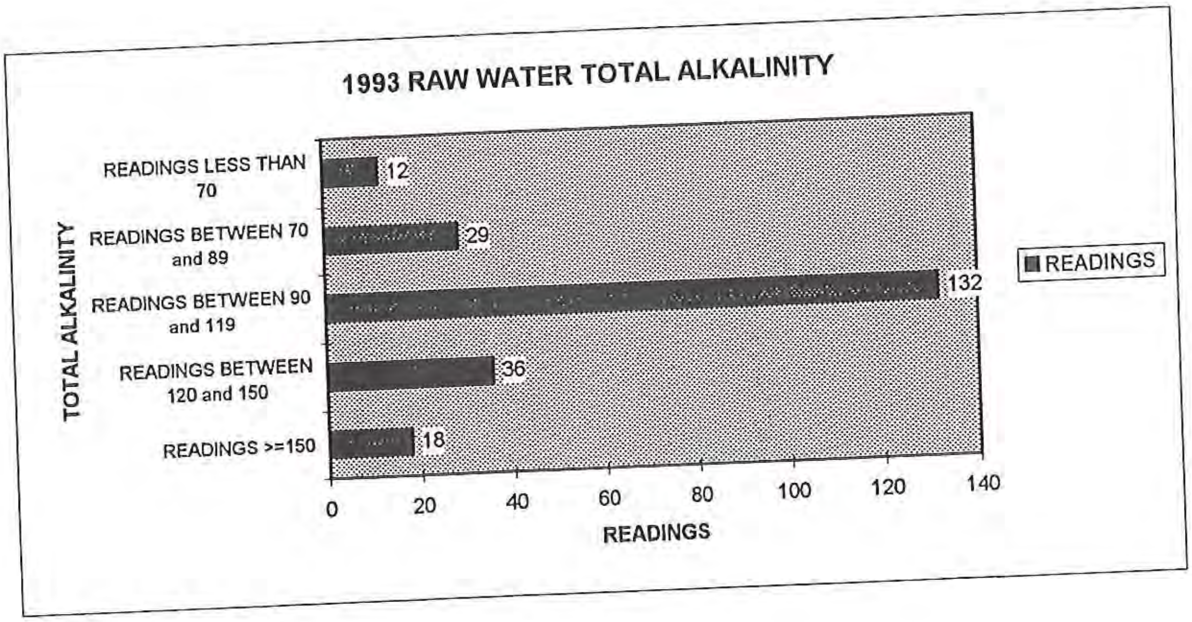
CARROLLTON WATER TREATMENT PLANT
1995 RAW WATER TOTAL ALKALINITY

MAX.	156
MIN.	82
AVG.	117
COUNT (READINGS)	376
READINGS >= 145	13
READINGS BETWEEN 130 AND 145	80
READINGS BETWEEN 115 AND 130	134
READINGS BETWEEN 95 AND 115	115
READINGS LESS THAN 95	34



ALGIERS WATER TREATMENT PLANT
1993 RAW WATER TOTAL ALKALINITY

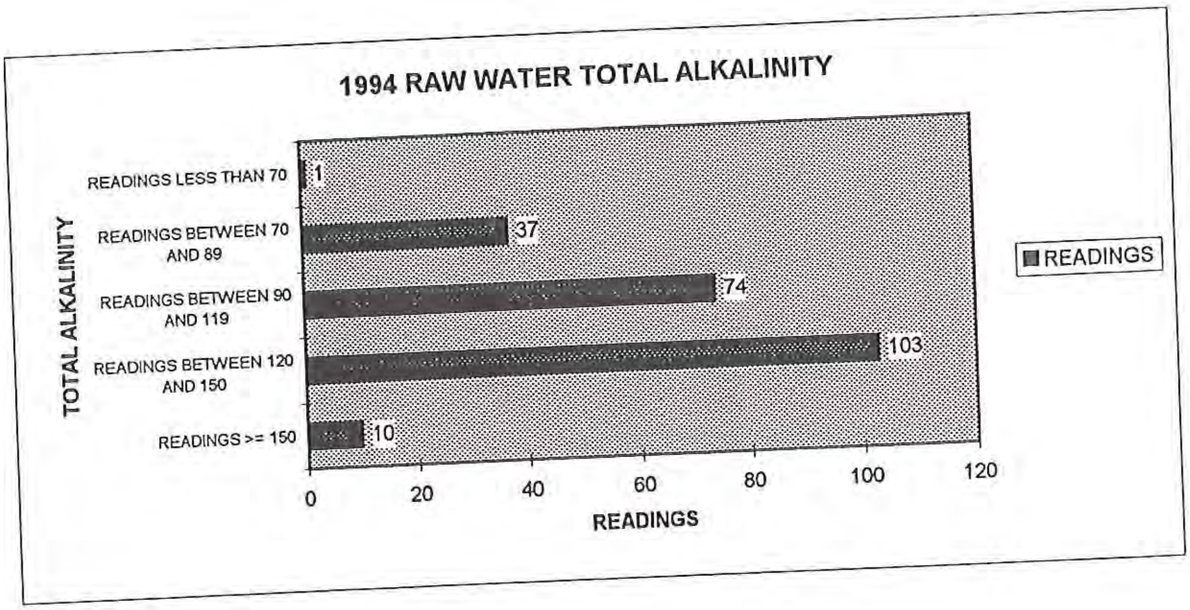
MAX.	164
MIN.	63
AVG.	108
COUNT (READINGS)	227
READING >= 150	18
READINGS BETWEEN 120 AND 150	36
READINGS BETWEEN 90 AND 119	132
READINGS BETWEEN 70 AND 89	29
READING LESS THAN 70	12



ALGIERS WATER TREATMENT PLANT

1994 RAW WATER TOTAL ALKALINITY

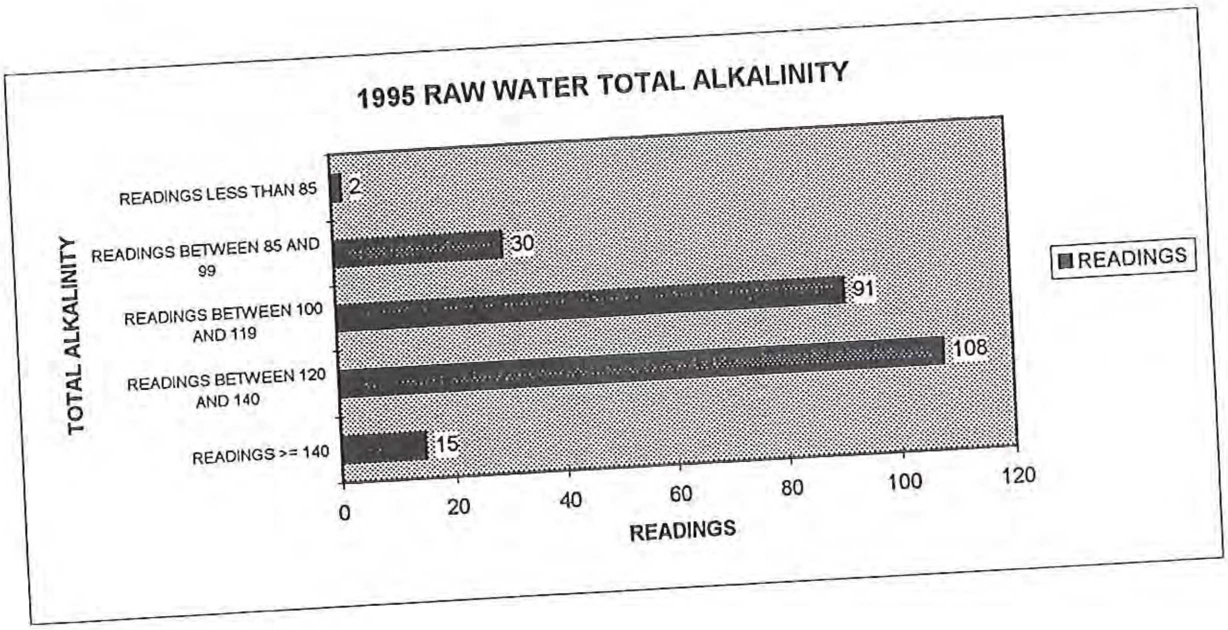
MAX.	141
MIN.	72
AVG.	112
COUNT (READINGS)	225
READINGS >= 150	10
READINGS BETWEEN 120 AND 150	103
READINGS BETWEEN 90 AND 119	74
READINGS BETWEEN 70 AND 89	37
READINGS LESS THAN 70	1



ALGIERS WATER TREATMENT PLANT

1995 RAW WATER TOTAL ALKALINITY

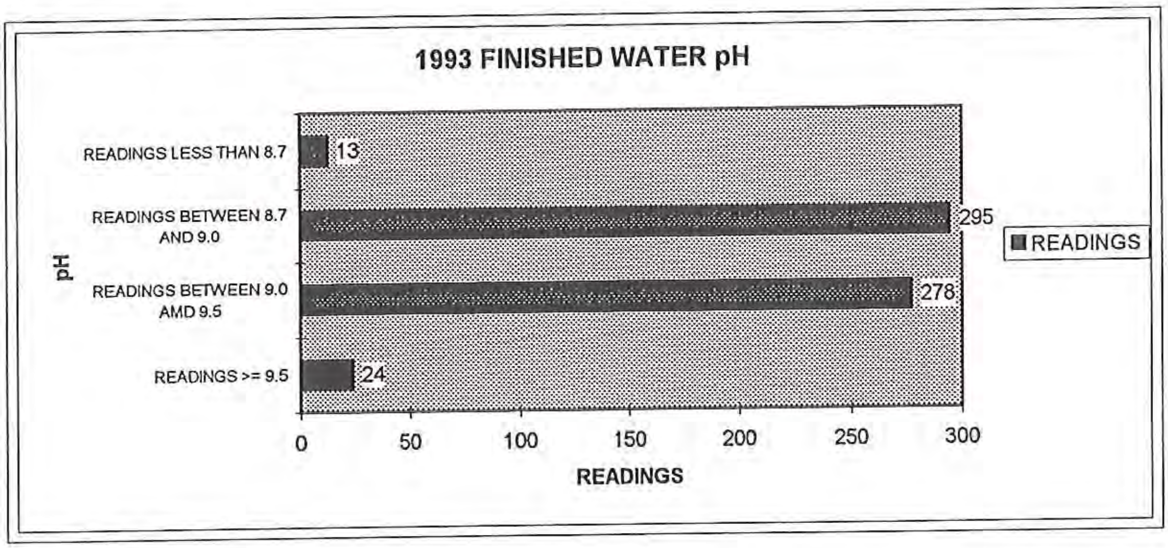
MAX.	155
MIN.	83
AVG.	118
COUNT (READINGS)	246
READINGS >= 140	15
READINGS BETWEEN 120 AND 140	108
READINGS BETWEEN 100 AND 119	91
READINGS BETWEEN 85 AND 99	30
READINGS LESS THAN 85	2



CARROLLTON WATER TREATMENT PLANT

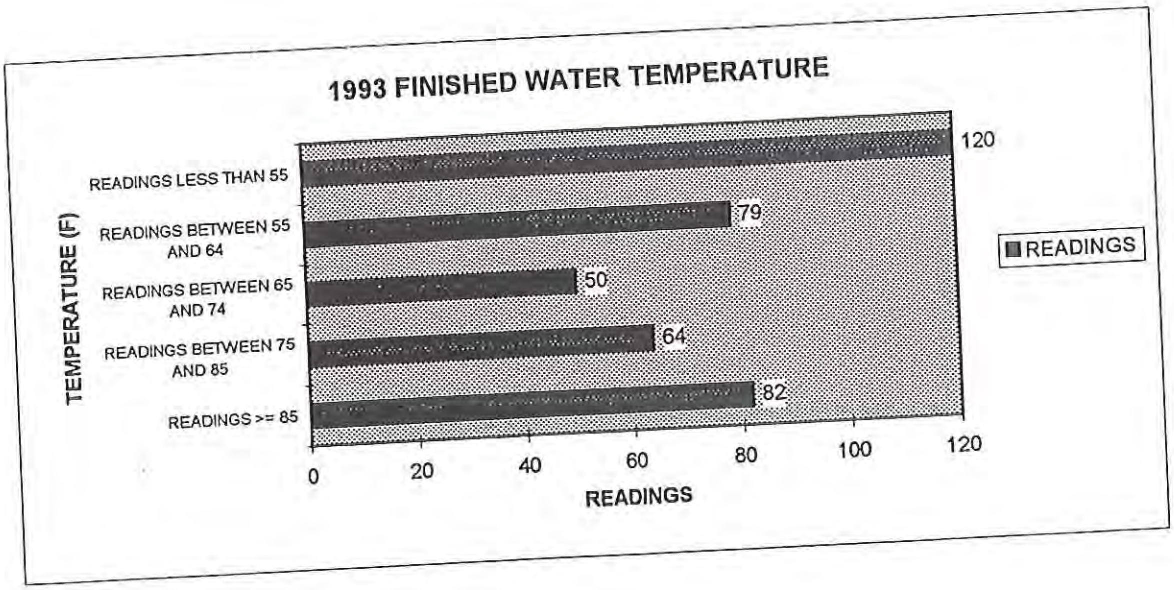
1993 FINISHED WATER pH

MAX.	9.9
MIN.	8.1
AVG.	9
COUNT (READINGS)	610
READINGS >= 9.5	24
READINGS BETWEEN 9.0 AMD 9.5	278
READINGS BETWEEN 8.7 AND 9.0	295
READINGS LESS THAN 8.7	13



CARROLLTON WATER TREATMENT PLANT
1993 FINISHED WATER TEMPERATURE

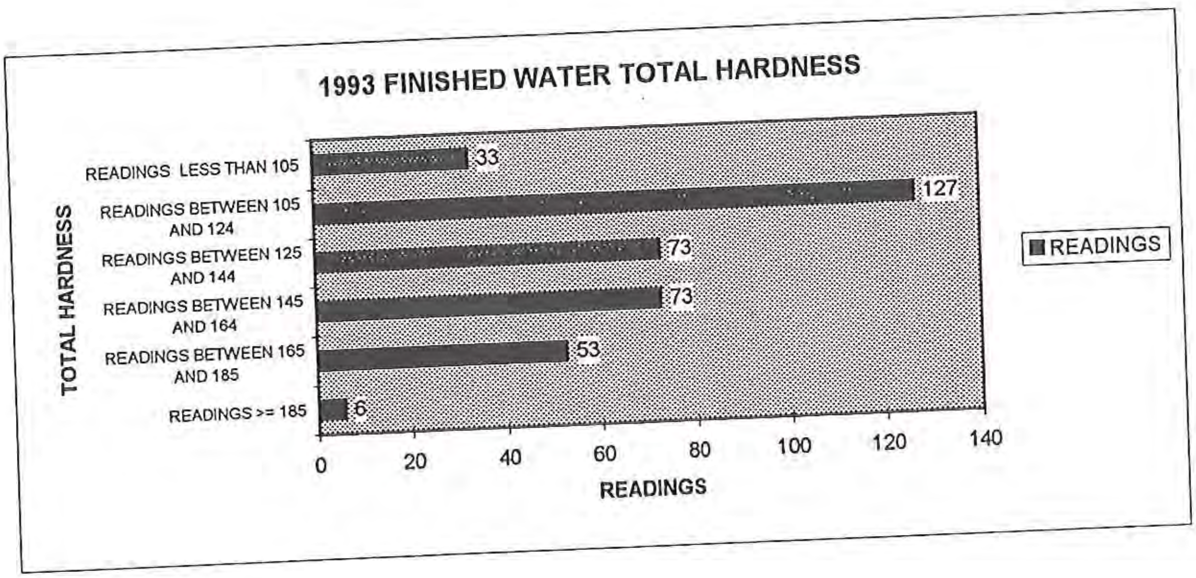
MAX.	91
MIN.	48
AVG.	67
COUNT (READINGS)	395
READINGS >= 85	82
READINGS BETWEEN 75 AND 85	64
READINGS BETWEEN 65 AND 74	50
READINGS BETWEEN 55 AND 64	79
READINGS LESS THAN 55	120



CARROLLTON WATER TREATMENT PLANT

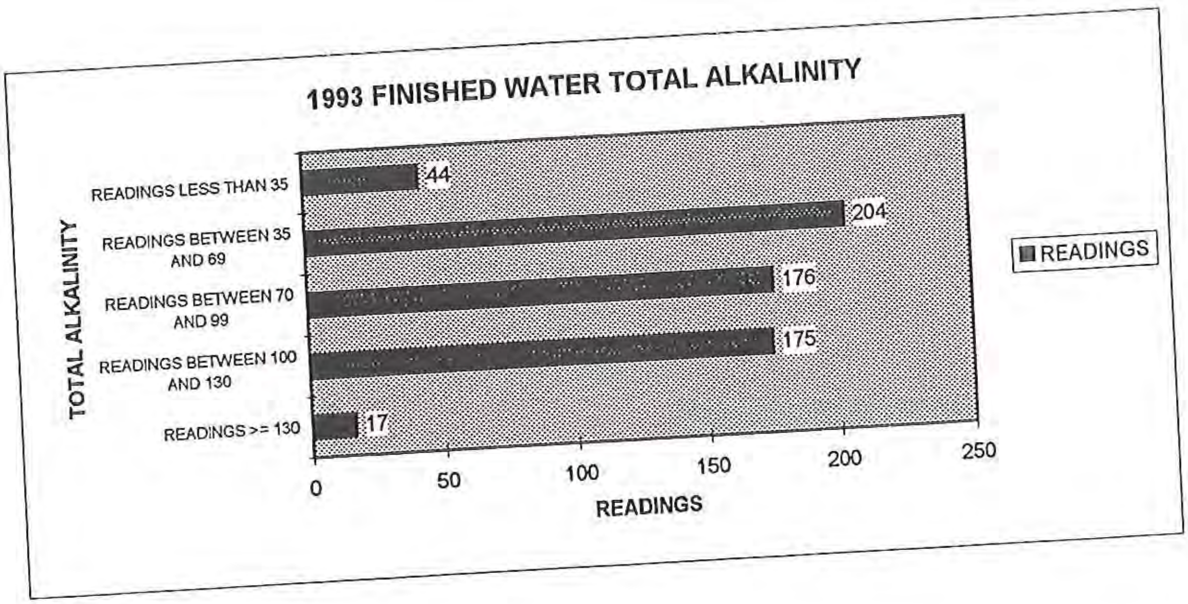
1993 FINISHED WATER TOTAL HARDNESS

MAX.	193
MIN.	96
AVG.	135
COUNT (READINGS)	365
READINGS >= 185	6
READINGS BETWEEN 165 AND 185	53
READINGS BETWEEN 145 AND 164	73
READINGS BETWEEN 125 AND 144	73
READINGS BETWEEN 105 AND 124	127
READINGS LESS THAN 105	33



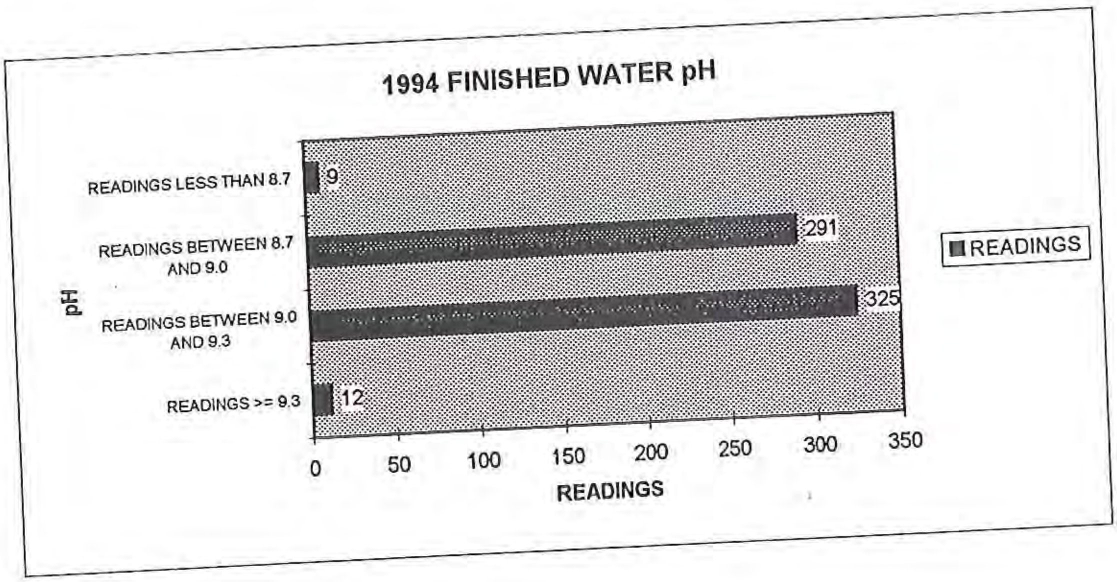
CARROLLTON WATER TREATMENT PLANT
1993 FINISHED WATER TOTAL ALKALINITY

MAX.	138
MIN.	29
AVG.	80
COUNT (READINGS)	616
READINGS >= 130	17
READINGS BETWEEN 100 AND 130	175
READINGS BETWEEN 70 AND 99	176
READINGS BETWEEN 35 AND 69	204
READINGS LESS THAN 35	44



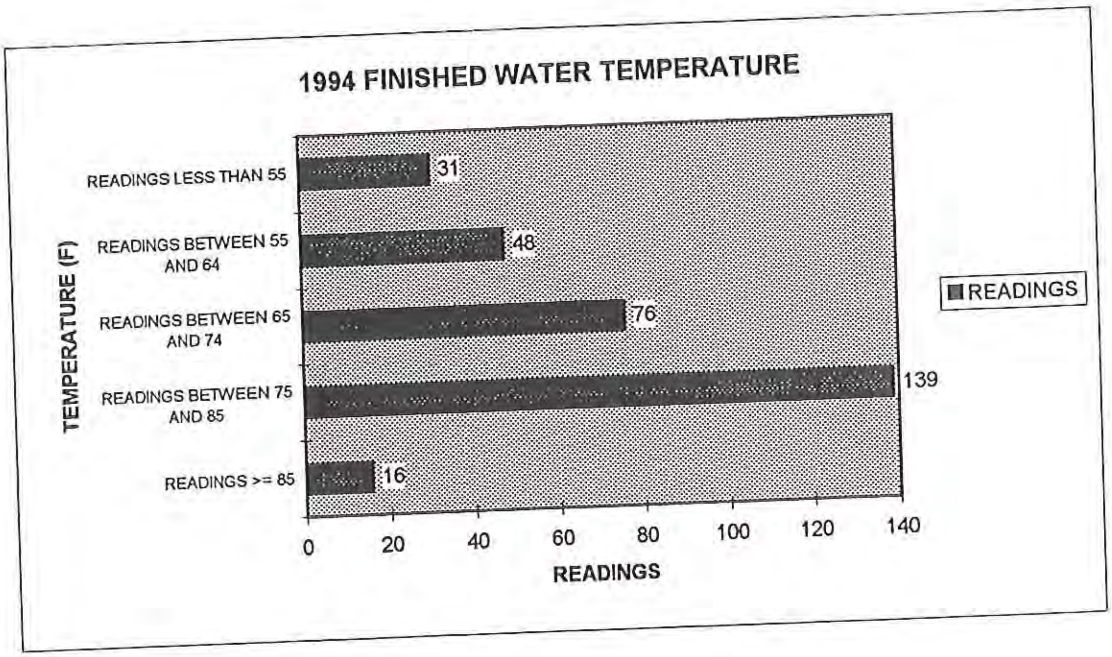
CARROLLTON WATER TREATMENT PLANT
1994 FINISHED WATER pH

MAX.	9.5
MIN.	8.1
AVG.	9.0
COUNT (READINGS)	637
READINGS >= 9.3	12
READINGS BETWEEN 9.0 AND 9.3	325
READINGS BETWEEN 8.7 AND 9.0	291
READINGS LESS THAN 8.7	9



CARROLLTON WATER TREATMENT PLANT
1994 FINISHED WATER TEMPERATURE

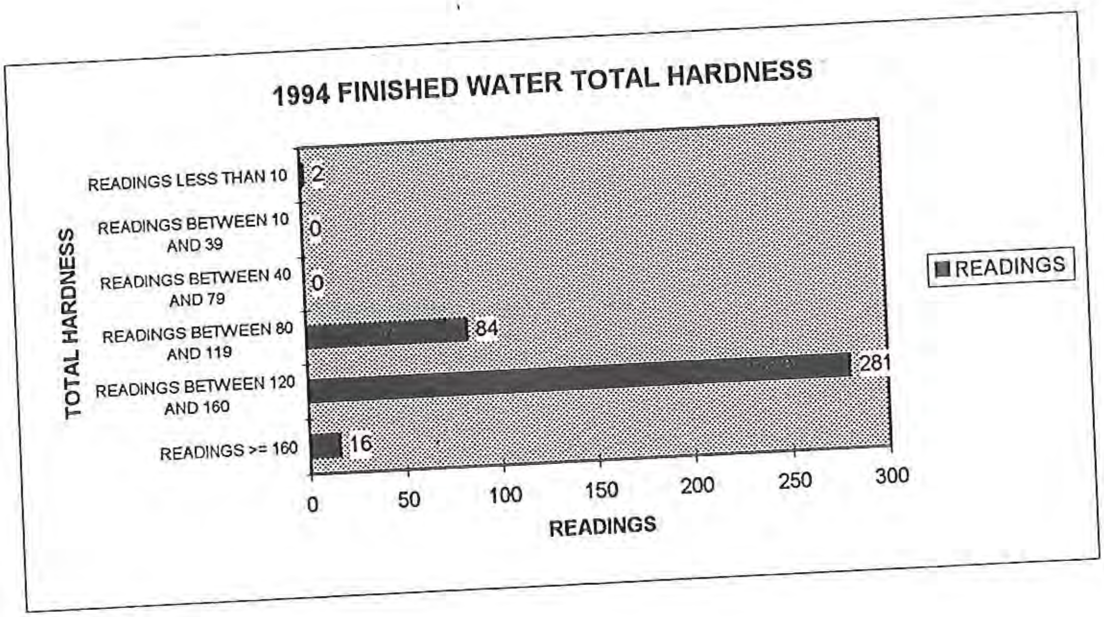
MAX.	90
MIN.	44
AVG.	71
COUNT (READINGS)	310
READINGS >= 85	16
READINGS BETWEEN 75 AND 85	139
READINGS BETWEEN 65 AND 74	76
READINGS BETWEEN 55 AND 64	48
READINGS LESS THAN 55	31



CARROLLTON WATER TREATMENT PLANT

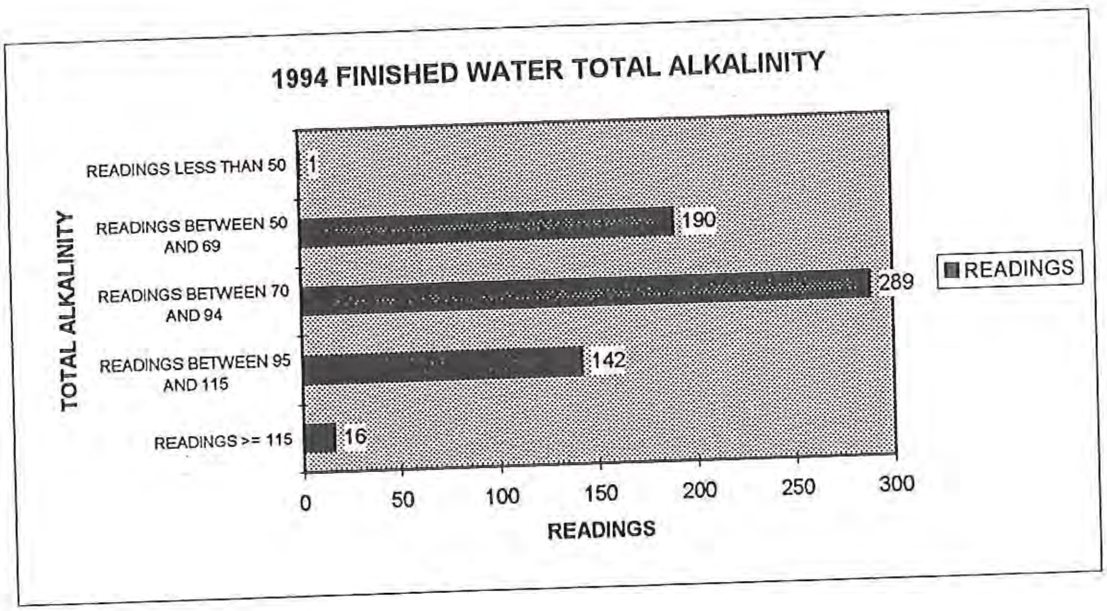
1994 FINISHED WATER TOTAL HARDNESS

MAX.	168
MIN.	3
AVG.	131
COUNT (READINGS)	383
READINGS >= 160	16
READINGS BETWEEN 120 AND 16	281
READINGS BETWEEN 80 AND 119	84
READINGS BETWEEN 40 AND 79	0
READINGS BETWEEN 10 AND 39	0
READINGS LESS THAN 10	2



CARROLLTON WATER TREATMENT PLANT
1994 FINISHED WATER TOTAL ALKALINITY

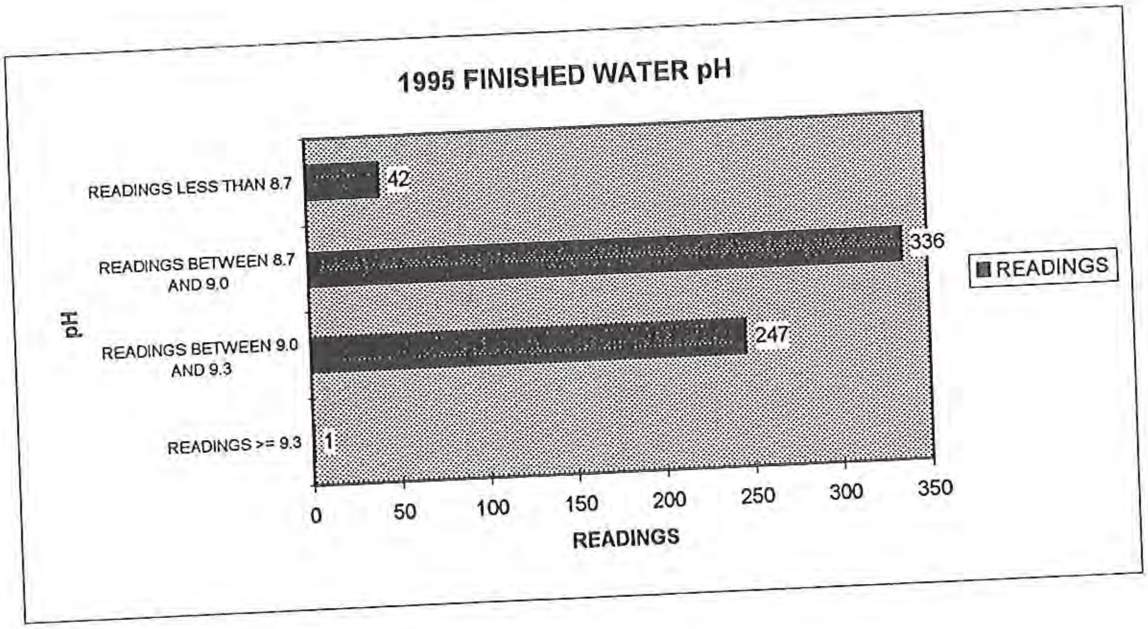
MAX.	120
MIN.	15
AVG.	82
COUNT (READINGS)	638
READINGS >= 115	16
READINGS BETWEEN 95 AND 115	142
READINGS BETWEEN 70 AND 94	289
READINGS BETWEEN 50 AND 69	190
READINGS LESS THAN 50	1



CARROLLTON WATER TREATMENT PLANT

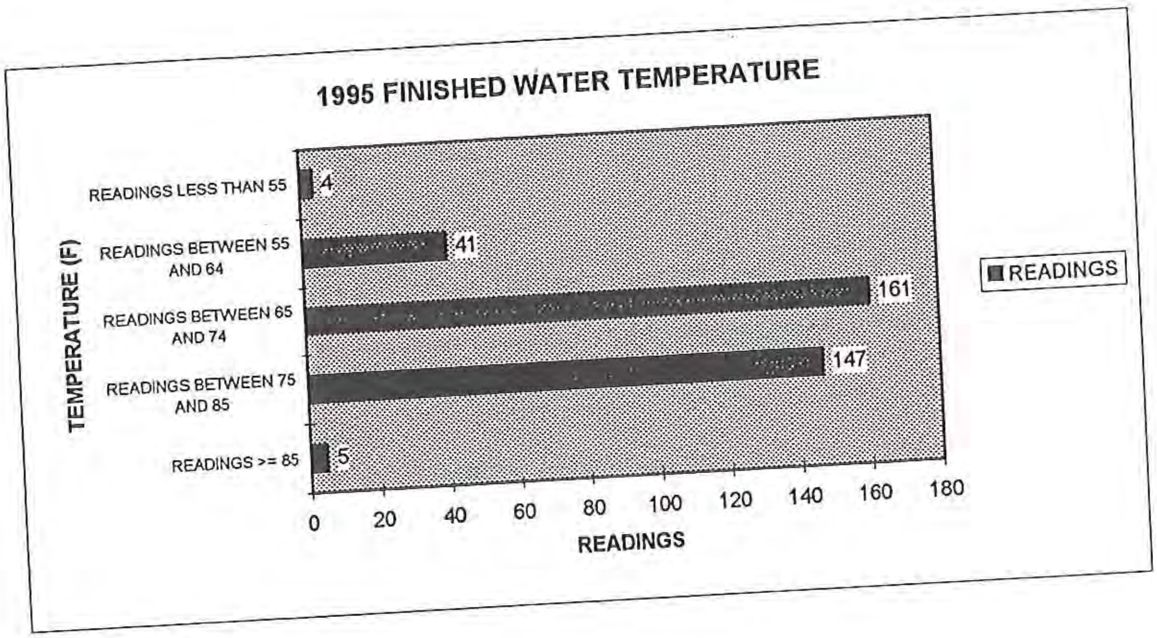
1995 FINISHED WATER pH

MAX.	9.3
MIN.	8.0
AVG.	9.0
COUNT (READINGS)	626
READINGS >= 9.3	1
READINGS BETWEEN 9.0 AND 9.3	247
READINGS BETWEEN 8.7 AND 9.0	336
READINGS LESS THAN 8.7	42



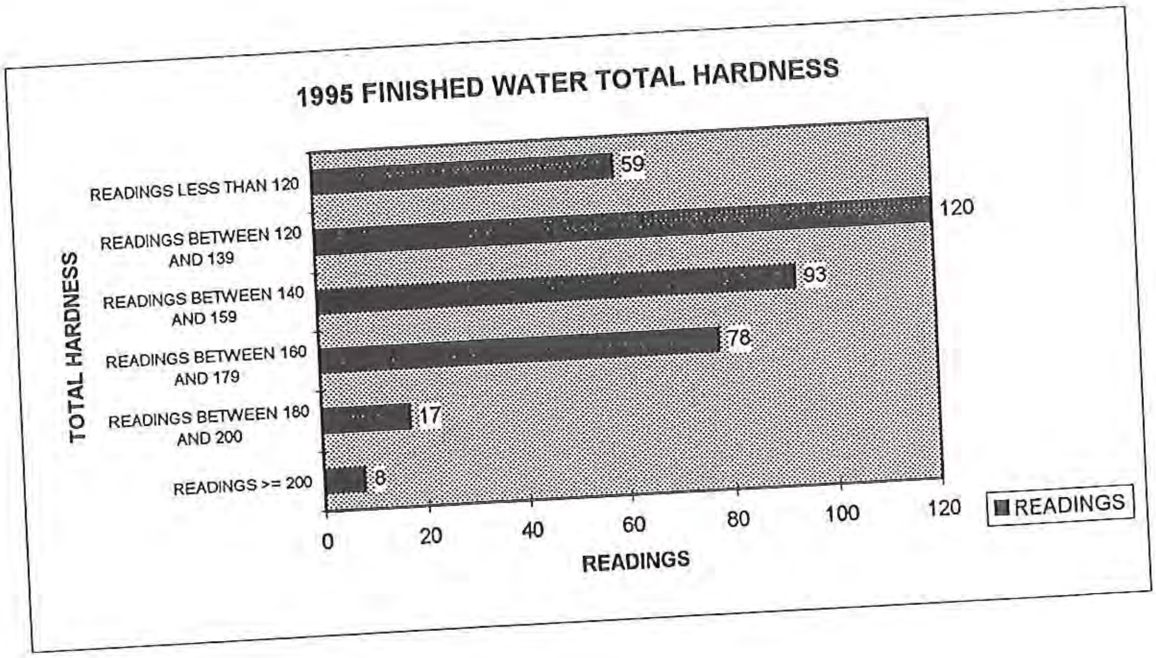
CARROLLTON WATER TREATMENT PLANT
1995 FINISHED WATER TEMPERATURE

	88
MAX.	44
MIN.	73
AVG.	358
COUNT (READINGS)	5
READINGS >= 85	147
READINGS BETWEEN 75 AND 85	161
READINGS BETWEEN 65 AND 74	41
READINGS BETWEEN 55 AND 64	4
READINGS LESS THAN 55	



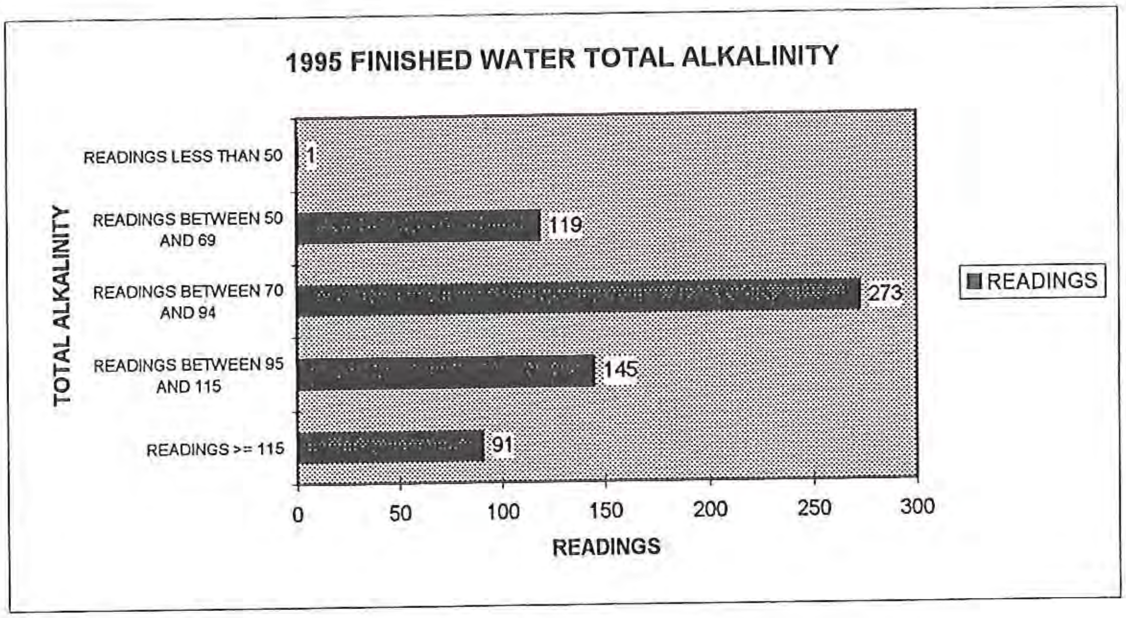
CARROLLTON WATER TREATMENT PLANT
1995 FINISHED WATER TOTAL HARDNESS

MAX.	213
MIN.	100
AVG.	144
COUNT (READINGS)	375
READINGS >= 200	8
READINGS BETWEEN 180 AND 200	17
READINGS BETWEEN 160 AND 179	78
READINGS BETWEEN 140 AND 159	93
READINGS BETWEEN 120 AND 139	120
READINGS LESS THAN 120	59



CARROLLTON WATER TREATMENT PLANT
1995 FINISHED WATER TOTAL ALKALINITY

MAX.	147
MIN.	49
AVG.	89
COUNT (READINGS)	629
READINGS >= 115	91
READINGS BETWEEN 95 AND 115	145
READINGS BETWEEN 70 AND 94	273
READINGS BETWEEN 50 AND 69	119
READINGS LESS THAN 50	1

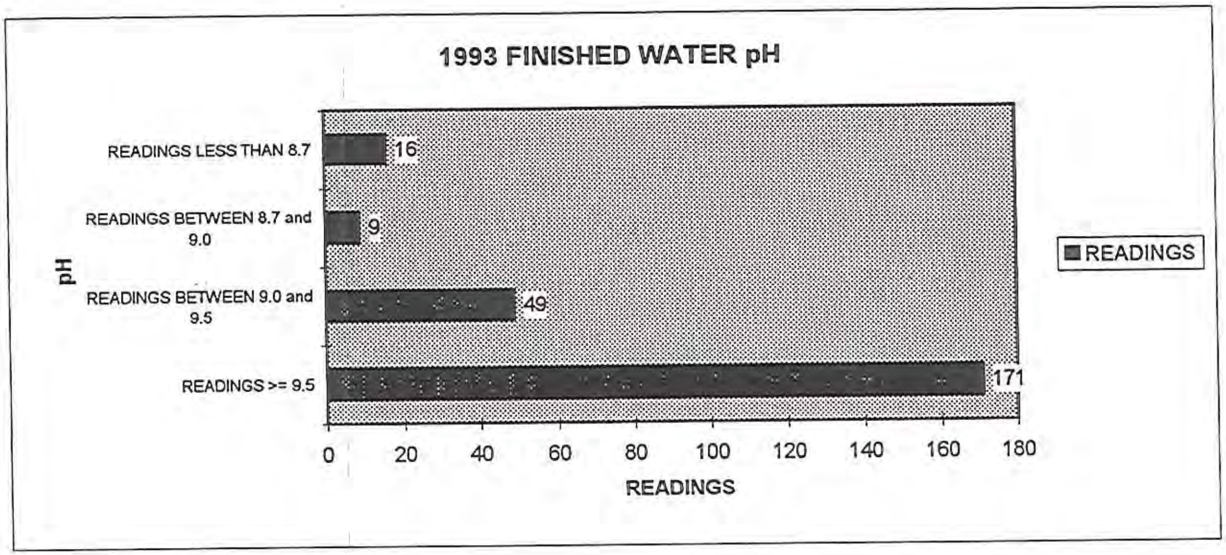


ALGIERS WATER TREATMENT PLANT
RAW WATER QUALITY DATA
1993 - 1995

ALGIERS WATER TREATMENT PLANT

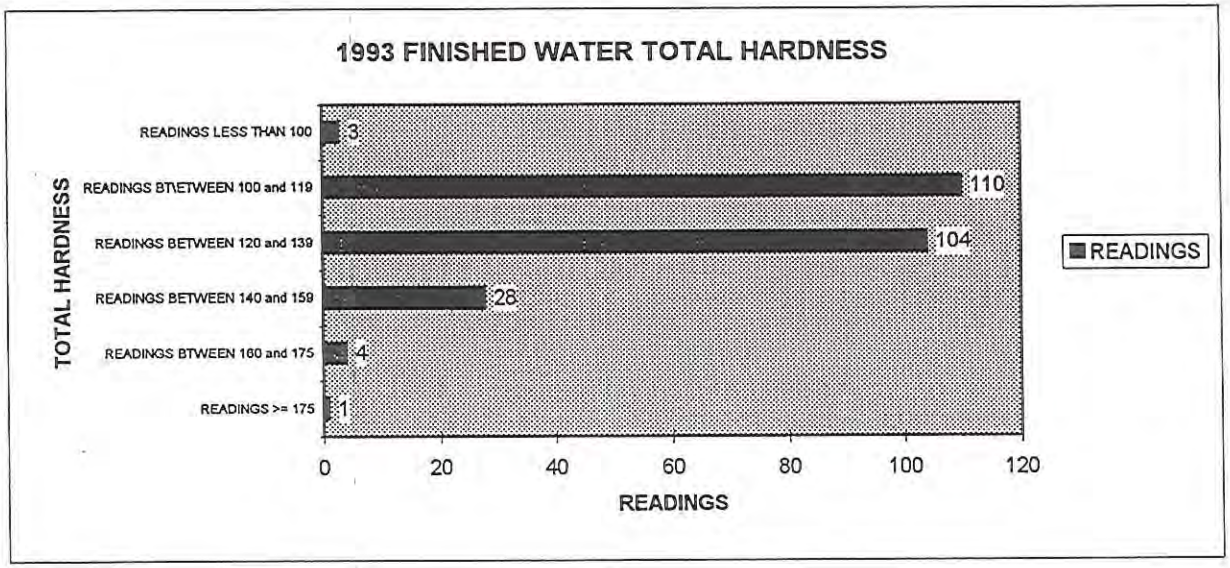
1993 FINISHED WATER pH

MAX.	10.1
MIN.	8.4
AVG.	9.5
COUNT (READINGS)	245
READINGS >= 9.5	171
READINGS BETWEEN 9.0 and 9.5	49
READINGS BETWEEN 8.7 and 9.0	9
READINGS LESS THAN 8.7	16



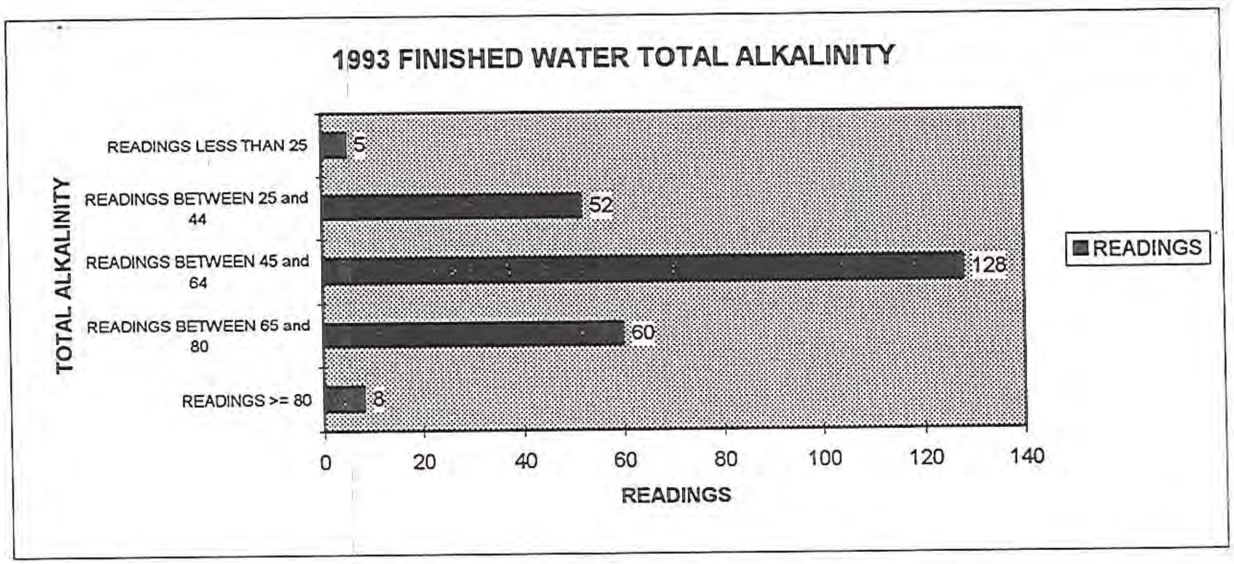
ALGIERS WATER TREATMENT PLANT
1993 FINISHED WATER TOTAL HARDNESS

MAX.	180
MIN.	94
AVG.	123
COUNT (READINGS)	250
READINGS >= 175	1
READINGS BETWEEN 160 AND 17	4
READINGS BETWEEN 140 AND 15	28
READINGS BETWEEN 120 AND 13	104
READINGS BETWEEN 100 AND 11	110
READINGS < 100	3



ALGIERS WATER TREATMENT PLANT
1993 FINISHED WATER TOTAL ALKALINITY

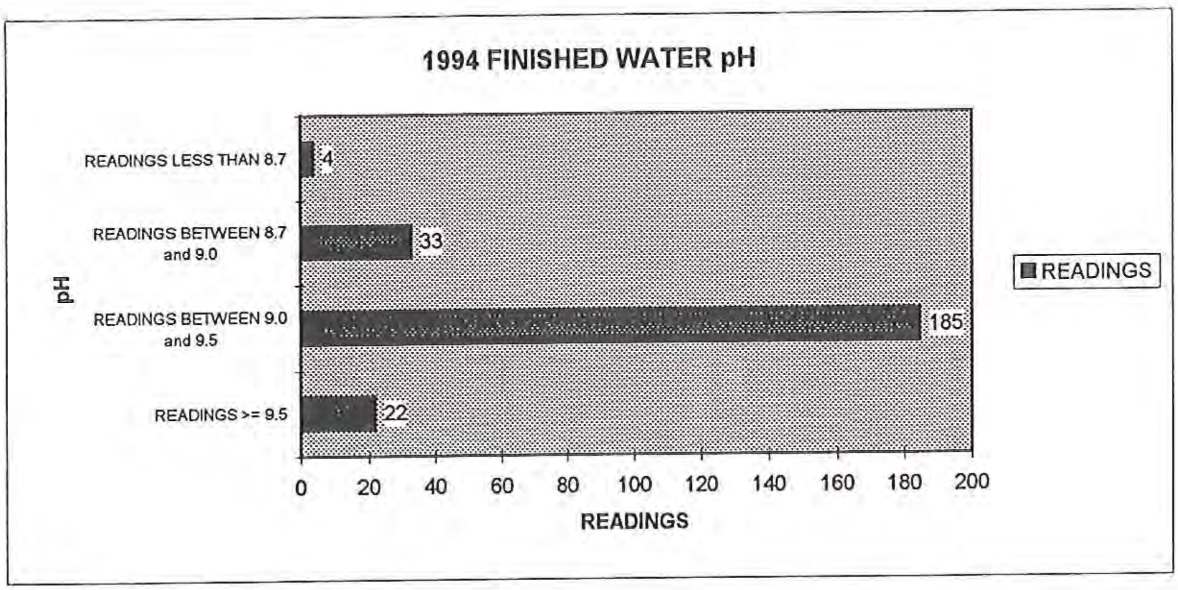
MAX.	90
MIN.	22
AVG.	54
COUNT (READINGS)	253
READINGS >= 80	8
READINGS BETWEEN 65 AND 80	60
READINGS BETWEEN 45 AND 64	128
READINGS BETWEEN 25 AND 44	52
READINGS LESS THAN 25	5



ALGIERS WATER TREATMENT PLANT

1994 FINISHED WATER pH

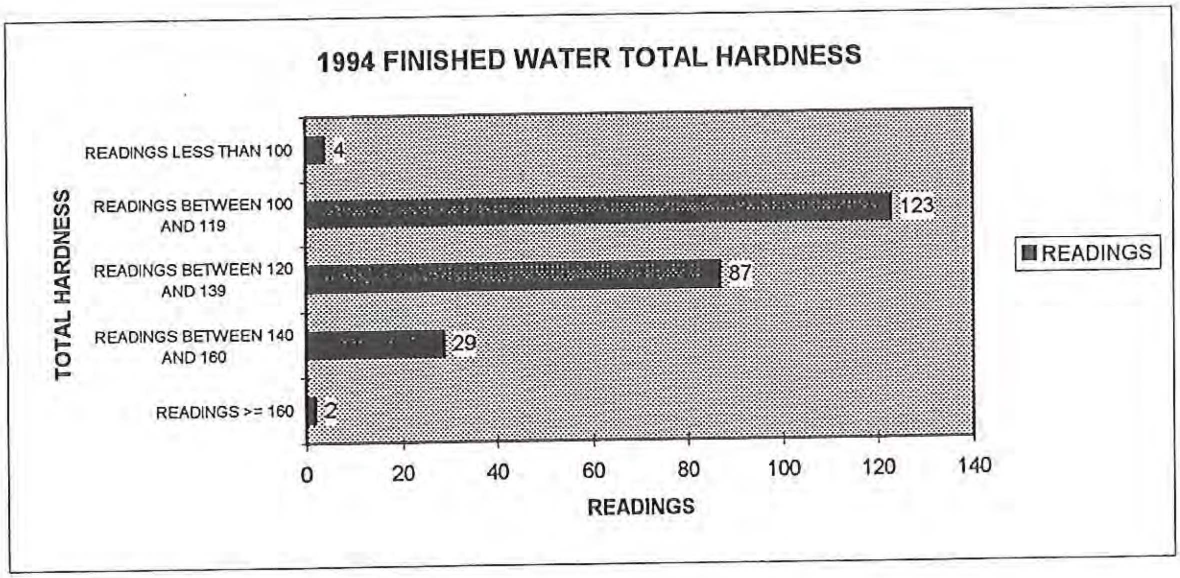
MAX.	10.9
MIN.	8.4
AVG.	9.2
COUNT (READINGS)	244
READINGS >= 9.5	22
READINGS BETWEEN 9.0 and 9.5	185
READINGS BETWEEN 8.7 and 9.0	33
READINGS LESS THAN 8.7	4



ALGIERS WATER TREATMENT PLANT

1994 FINISHED WATER TOTAL HARDNESS

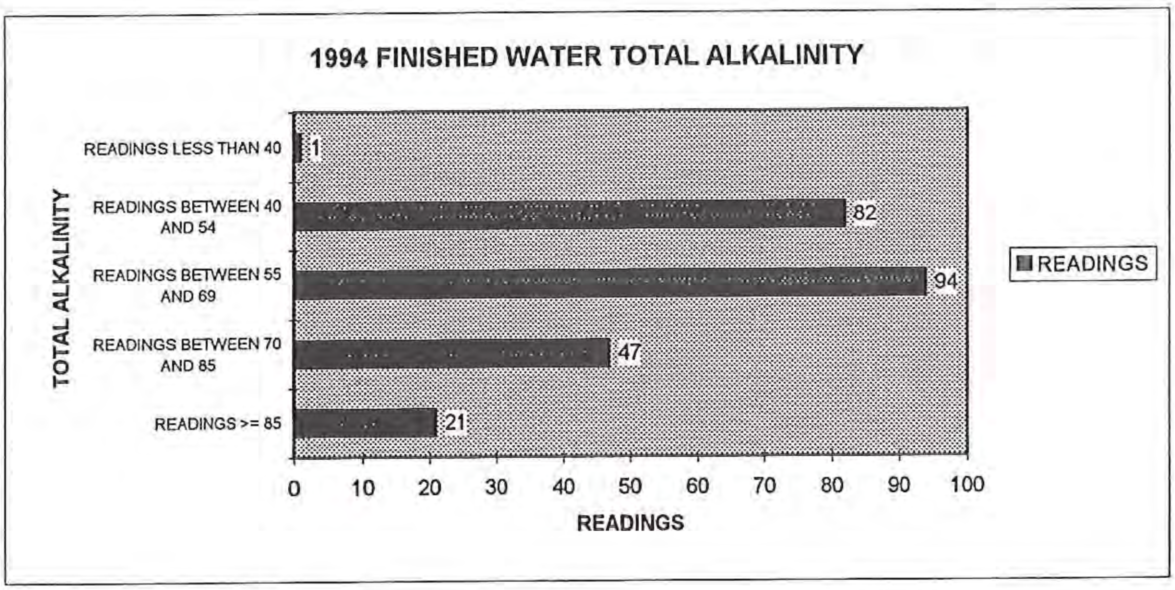
MAX.	162
MIN.	2
AVG.	121
COUNT (READINGS)	245
READINGS >= 160	2
READINGS BETWEEN 140 AND 16	29
READINGS BETWEEN 120 and 139	87
READINGS BETWEEN 100 and 119	123
READINGS LESS THAN 100	4



ALGIERS WATER TREATMENT PLANT

1994 FINISHED WATER TOTAL ALKALINITY

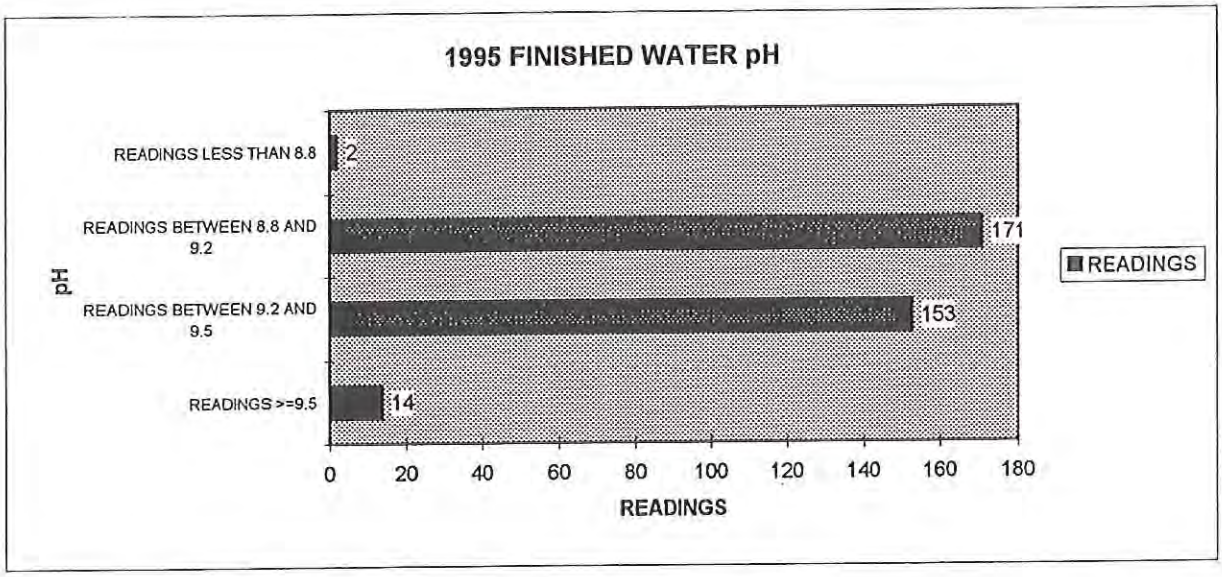
MAX.	97
MIN.	33
AVG.	62
COUNT (READINGS)	245
READINGS >= 85	21
READINGS BETWEEN 70 AND 85	47
READINGS BETWEEN 55 AND 69	94
READINGS BETWEEN 40 AND 54	82
READINGS LESS THAN 40	1



ALGIERS WATER TREATMENT PLANT

1995 FINISHED WATER pH

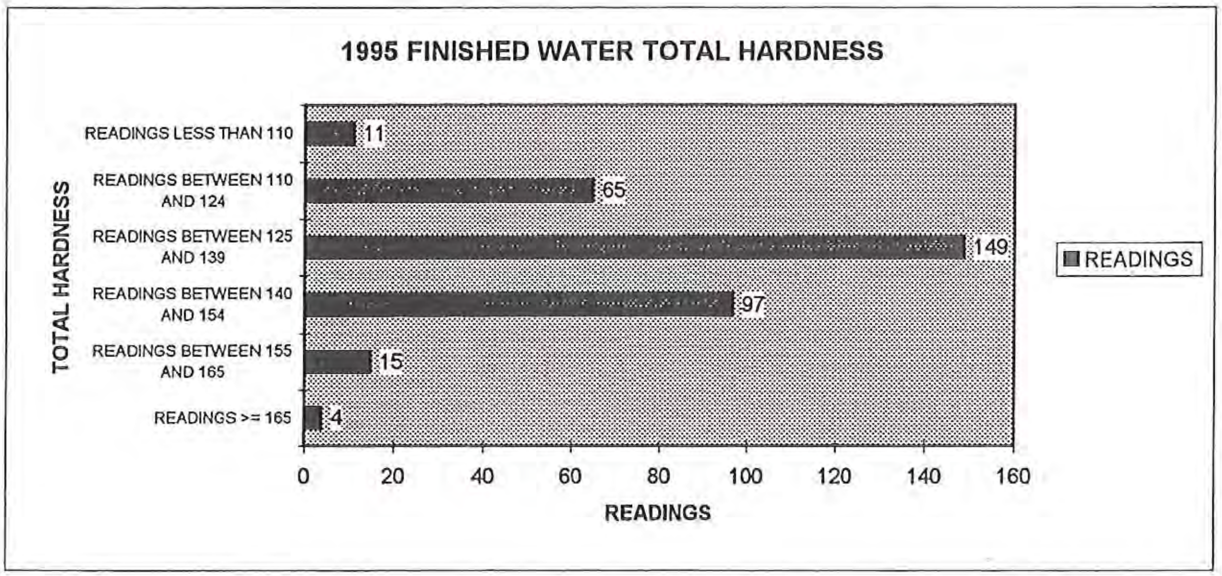
MAX.	10.4
MIN.	8.7
AVG.	9.2
COUNT (READINGS)	340
READINGS >=9.5	14
READINGS BETWEEN 9.2 AND 9.5	153
READINGS BETWEEN 8.8 AND 9.2	171
READINGS LESS THAN 8.8	2



ALGIERS WATER TREATMENT PLANT

1995 FINISHED WATER TOTAL HARDNESS

MAX.	170
MIN.	101
AVG.	134
COUNT (READINGS)	341
READINGS >= 165	4
READINGS BETWEEN 155 AND 165	15
READINGS BETWEEN 140 AND 154	97
READINGS BETWEEN 125 AND 139	149
READINGS BETWEEN 110 AND 124	65
READINGS LESS THAN 110	11



ALGIERS WATER TREATMENT PLANT
1995 FINISHED WATER TOTAL ALKALINITY

MAX.	100
MIN.	41
AVG.	72
COUNT (READINGS)	345
READINGS >= 90	8
READINGS BETWEEN 74 AND 90	150
READINGS BETWEEN 60 AND 74	137
READINGS BETWEEN 45 AND 59	48
READINGS LESS THAN 45	2