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MARTIN MARIETTA

An Evaluation of the Use of a Combination of Ozone, Ultraviolet Radiation, and Hydrogen Peroxide to Remove Chlorinated Hydrocarbons from Groundwater at the Department of Energy Kansas City Plant

Fiscal Year 1988 Annual Report

Sidney B. Garland II

ENVIRONMENTAL SCIENCES DIVISION
PUBLICATION NO. 3322

OPERATED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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ENVIRONMENTAL SCIENCES DIVISION

AN EVALUATION OF THE USE OF A COMBINATION OF OZONE, ULTRAVIOLET RADIATION, AND HYDROGEN PEROXIDE TO REMOVE CHLORINATED HYDROCARBONS FROM GROUNDWATER AT THE DEPARTMENT OF ENERGY KANSAS CITY PLANT*

FISCAL YEAR 1988
ANNUAL REPORT

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The Hazardous Waste Remedial Action Program assisted in the funding for this evaluation.

Thanks are given to Langston Laboratories for collecting and analyzing the samples. Nic Korte's assistance in reviewing the data and the manuscript is greatly appreciated. The staff at the Department of Energy Kansas City Plant, particularly Dave Brown, Jim Fredericks, and Larry Rice, also provided much support.

EXECUTIVE SUMMARY

The Department of Energy Kansas City Plant selected a treatment process that uses ozone, ultraviolet radiation, and hydrogen peroxide for the removal of trichloroethene from the underlying groundwater. Since the use of this process is not well-documented in the literature, this evaluation was initiated to determine its performance, costs, and operating history.

During the first year of the study, the flow rate remained at approximately 27% of the design flow rate, while the operating parameters varied from 50% to full treatment capacity. Consequently, it was difficult to evaluate the true performance of the plant. Throughout the 6 months of operation, all effluent standards were met, and all volatile organic compounds (VOCs) were reduced below detectable limits; but two problems were seen. First, despite the apparent overtreatment, neither the removal of total organic carbon and total organic halogens (TOX) nor the oxidation of iron and manganese were as great as expected, which indicates a potential problem in the utilization of ozone. Second, the TOX concentrations in the plant effluent were always greater than the concentrations in the final stage of the ozone reaction chamber and sometimes approached the effluent standard. There may be an inherent limitation in the use of TOX as a control parameter, and its replacement with one or more individual VOCs should be considered.

The cost of operation and maintenance for the treatment process appears to be in the range predicted. However, the costs are actually greater because of the process control and regulatory compliance monitoring that must be performed. Precipitation in the reaction chamber, coating of the ultraviolet lamps, and frequent replacement of the prefilter increased the operations and maintenance time over that expected. The plant was out of operation 30% of the time.

In fiscal year 1989, the study will emphasize optimizing the operating parameters, explaining the anomalies in the results, predicting the capability of the plant, and preparing a comparative cost evaluation with competing treatment technologies.

LIST OF ACRONYMS

AOPs	advanced oxidation processes
BATs	best available technologies
BOD	biochemical oxygen demand
DCA	1,1-dichloroethane
DCE	1,2-transdichloroethene
EFF	plant effluent
IAF	influent after the filter
IBF	influent before the filter
LADWP	Los Angeles Department of Water and Power
O&G	oil and grease
O&M	operation and maintenance
TCA	1,1,1-trichloroethane
TCE	trichloroethene
TOC	total organic carbon
TOX	total organic halogen
TSS	total suspended solids
UV	ultraviolet
VOCs	volatile organic compounds

1. INTRODUCTION

Allied-Signal Inc. currently operates a production facility in Kansas City, Missouri, under contract with the Department of Energy (DOE). Over the years, the operation of this facility has resulted in the contamination of groundwater with chlorinated hydrocarbons, including trichloroethene (TCE). One of the plumes of contaminated groundwater, the tank farm plume, was selected for remediation using ozone (O_3), ultraviolet (UV) radiation, and hydrogen peroxide (H_2O_2). Since this process is new and information on its performance, costs, and operating experience is not documented in the literature, the Oak Ridge National Laboratory was requested to evaluate the treatment process.

This report documents the work performed during FY 1988; the project will continue into FY 1990. The report first explains the mechanisms of the treatment process, and then the treatment plant is described. Next, the methodology for the evaluation is discussed, and the results are evaluated. The report ends with conclusions and recommendations.

2. BACKGROUND

2.1 INTRODUCTION

Groundwater contamination by halogenated organic compounds (TOX), including TCE, is a major concern. The Environmental Protection Agency has proposed a maximum contaminant level for certain TOX in drinking water and has specified two best available technologies (BATs) for treatment: packed-tower aeration and granular activated carbon filtration.[1] An objection to these BATs is that they transfer the contaminant from the water medium to the air or the carbon medium, respectively. Other treatment processes that should destroy organic contaminants are biological and chemical oxidation. Chemical oxidation with O_3 and H_2O_2 is being considered for the treatment of organics, but they are not yet proven as BATs. Therefore, various modifications to the use of O_3 and H_2O_2, known as advanced oxidation processes (AOPs)[2], are being developed as additional BATs:

1. O_3 at high pH values,
2. O_3 with H_2O_2,
3. O_3 with UV radiation,
4. H_2O_2 with UV radiation, and
5. O_3 with UV radiation and H_2O_2.

The remainder of this section describes the process mechanisms of the AOPs, with an emphasis on O_3 and H_2O_2 with UV radiation; relates performance experience; and describes competing treatment processes.

2.2 PROCESS MECHANISMS OF PHOTOLYTIC OXIDATION

2.2.1 Oxidation with O_3 and H_2O_2

O_3 and H_2O_2 have long been recognized as chemical oxidants in many water treatment applications. O_3 is a powerful oxidant that can be used to remove iron and manganese, color, and organics; to oxidize ammonia to nitrate; and to eliminate taste and odor. Organic molecules with carbon-carbon double bonds are particularly susceptible to an attack by O_3, in which the reaction causes a cleavage of the double bond. If the original compound is aliphatic, then two new molecules are formed. In compounds, such as phenol, with aromatic rings, O_3 ruptures the ring and yields aliphatic acids. Saturated organic compounds react more slowly and generally are not converted to CO_2 and H_2O but instead are converted to other organic compounds such as carboxylic acids, aldehydes, and ketones. Complete removal of these compounds requires adsorption or biological degradation.[3] O_3 and H_2O_2 have been shown to be effective for the removal of chlorinated hydrocarbons.[2,4,5]

In the destruction of organics, O_3 reacts through two pathways.[6] First, at low pH (<9) there is a direct electrophilic reaction between molecular O_3 and the organic; second, at higher pH (>9) there is an free radicals such as hydroxyl (OH^-), peroxy (HO_2^-), oxide (O^-), ozonide (O_3^-), and superoxide (O_2^-) at pH >9. These represent more potent oxidants than O_3 for some organics. H_2O_2 decomposes similarly.

An H_2O_2/O_3 system was shown to improve the oxidation efficiency of O_3 for several organic compounds and to increase the rate of O_3 transfer.[2,7] This enhanced destruction of organics is due to the hydroxyl radical, as in high pH ozonation, as well as all of the other AOPs.

Both O_3 and H_2O_2 are effective on many organic compounds, but their use must be based on several practical considerations.[5] Costs for O_3 generation are high; the substance cannot be stored for peak loads; and O_3 gas must be transferred into the water by mass transfer. However, because O_3 is generated immediately before use, there is no chemical handling or storage. Costs for H_2O_2 are lower; the substance can be stored; and it is readily mixed with water. As with O_3 chemical handling is necessary.

2.2.2 Photolytic Oxidation

In theory, O_3 and H_2O_2 should be able to oxidize inorganics to their highest stable oxidation states and organics to CO_2 and H_2O. But O_3 and H_2O_2 are selective, and their oxidation rates may be slow. Therefore, O_3 and/or H_2O_2 are now used in combination with UV radiation (photolytic oxidation), which has been shown to be more effective for the destruction of some organics than chemical oxidation alone (Fig. 1). The UV/O_3 treatment system first was used to enhance the degradation of complex cyanides[8] and then the degradation of chlorinated solvents.[9]

The UV radiation is believed to play a dual role in the UV/O_3 treatment system: both as a reactant and as a catalyst.[10] As a reactant the UV radiation dissociates the C-Cl bond,[10] and as a catalyst the UV radiation accelerates the destruction of organic compounds by O_3.[11] The UV radiation also may activate the organic compound, making it more amenable to reaction with hydroxyl radicals.

Until recently, the enhanced effectiveness of O_3 and/or H_2O_2 to destroy organic compounds when used with UV radiation was believed to be due to hydroxyl or other free radicals, but the mechanism for this was not supported by laboratory data. It was suggested that the UV/O_3 treatment process produced the hydroxyl radical directly [12, 13] or produced H_2O_2.[14] In 1988 the mechanisms were determined in a laboratory study.[15] Figure 2 shows the mechanisms for the UV/O_3 process. Reaction 1 in Fig. 2 in a UV/O_3 treatment system is the photolytic production of H_2O_2 from aqueous O_3. Then, in Reaction 2, a secondary reaction produces the hydroxyl radical. Reaction 3 is the photolytic production of the hydroxyl radical from H_2O_2. In the presence of oxygen, many organic compounds react with the hydroxyl radical in Reaction 4, forming superoxide (O_2^-) in Reaction 5 and/or H_2O_2 in Reaction 7. Both superoxide (Reaction 6) and H_2O_2 (Reaction 2) react further with O_3^- to produce more hydroxyl radicals, which are the active species for the destruction of organic compounds. This existence of multiple pathways for the generation of the hydroxyl

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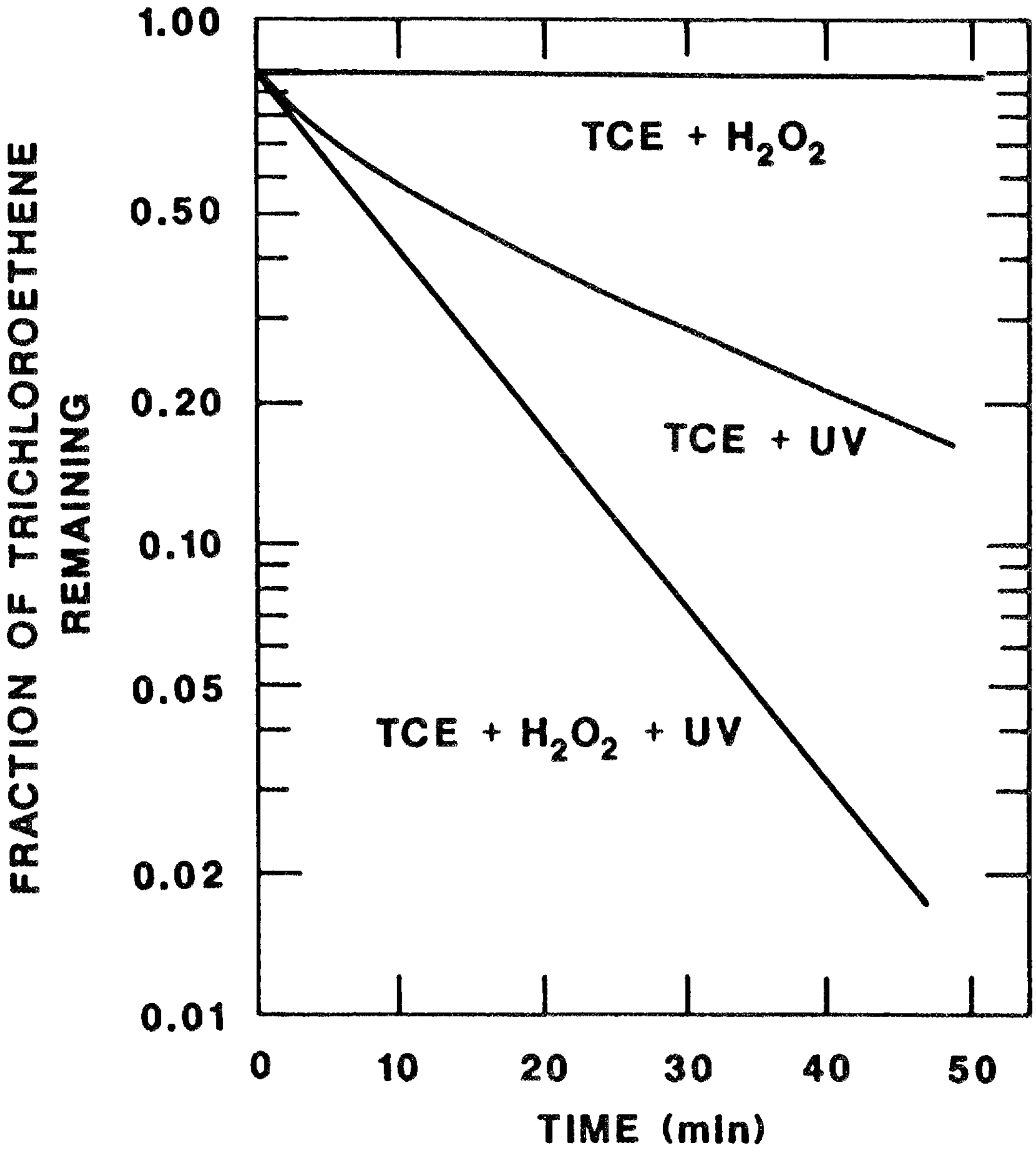

Fig. 1. Comparison of trichloroethene removal efficiency for several advanced oxidation processes. Source: D. W. Sundstrom, H. E. Klei; T. A. Nalette, D. J. Reidy, and B. A. Weir, "Destruction of Halogenated Aliphatics by UV Catalyzed Oxidation with H_2O_2," *Hazard. Wastes Hazard. Mater.*, 3(1), 101-110 (1986).

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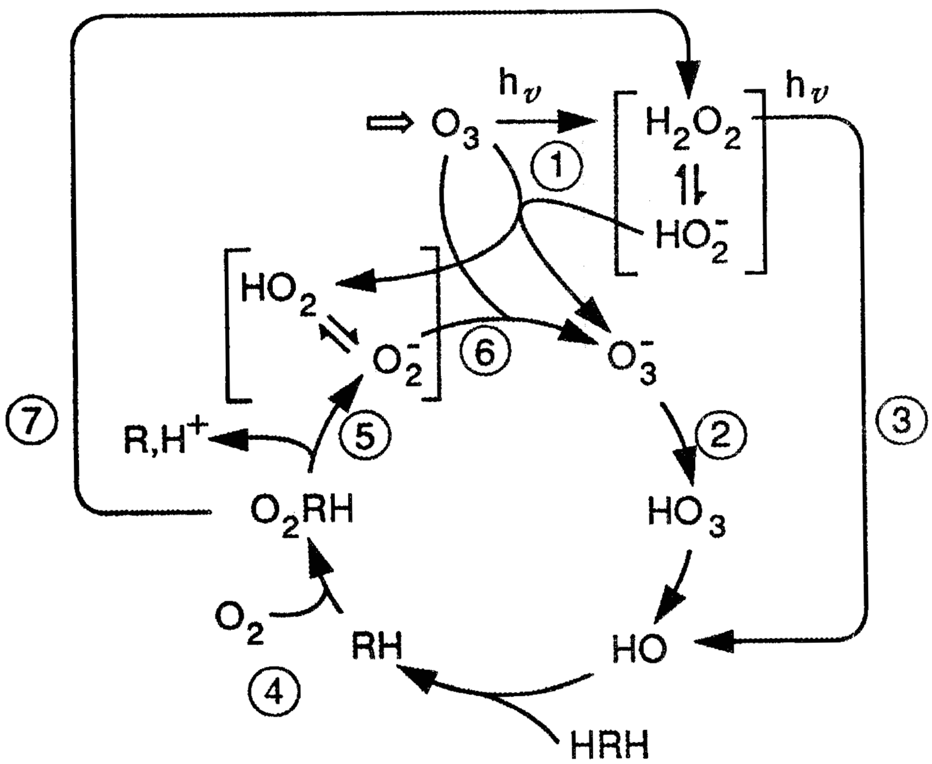

Fig. 2. Reaction cycles in photolytic ozonation. Numbered reactions are explained in text. Source: G. R. Peyton and William H. Glaze, "Destruction of Pollutants in Water with Ozone in Combination with UV Radiation, 3. Protolysis of Aqueous Ozone," ***Environ. Sci. Technol.*****, 22, 761-767 (1988).**

radical is a major advantage of the UV/O_3 and/or the H_2O_2 treatment system because the reaction mechanics can adjust to fit the situation.

When O_3 reacts with substances in water, the reaction is a combination of direct reaction with O_3 as well as with the hydroxyl radical. Therefore, the UV/O_3 treatment system employs both oxidation and photolysis and includes direct ozonation, decomposition of O_3 to the hydroxyl radical, direct photolysis of the organic compound, and the photolysis of H_2O_2.[16] The relative importance of each of these reactions depends on factors such as the intensity and wavelength of the UV radiation, the ratio of $UV:O_3$ doses, the concentration of the organic compound, and the concentrations of other scavengers of O_3.

2.2.3 Process Characteristics

Experiments with a H_2O_2/UV system for the removal of TCE were performed to determine what factors affect the process.[5] It was found that, as the initial TCE concentration increased, the rate of oxidation decreased; and, as the initial H_2O_2 concentration increased, the rate of oxidation increased. Higher temperatures doubled the rate of TCE degradation for every 10°C increase in temperature. For pH values between 5.5 and 7.9, reaction rates increased slightly as pH was increased. Similar effects are expected with O_3.

Water also contains other compounds, such as carbonates, bicarbonates, ammonia, iron, manganese, sulfides, and humic materials, that react with O_3 and the hydroxyl radical, exert a competing demand, and may preferentially consume the oxidants. Studies have shown that AOPs are less efficient when the water being treated is high in alkalinity because carbonates and bicarbonates act as radical scavengers,[2] and the radicals are unavailable for oxidation of organic contaminants.

One issue of concern with the oxidation of organics is the potential for the formation of other chlorinated organics as by-products that are health concerns themselves. Studies using H_2O_2 and UV for the photolytic oxidation of TCE found that all chlorinated structures were destroyed.[5] This also has been shown for O_3[7] and O_3/H_2O_2.[2]

2.2.4 Process Selection

The decision to use O_3, UV radiation, H_2O_2, or a combination is specific to the site and must be based on the contaminant and the water quality. For organic compounds that absorb UV radiation, its use is advantageous because direct photolysis plays a major role in the destruction of the organic compound. This is the case for compounds such as tetrachloroethene (PCE) and aromatic halides.[16] For other organics such as pesticides, O_3 is of little value because of the effectiveness of UV radiation alone.[16] For compounds that are not photolyzed well, the use of UV radiation to generate H_2O_2 may not make sense. It may be just as effective and less expensive to add H_2O_2 directly. Experiments on TCE[16] show that its oxidation is enhanced with the use of UV radiation[5] but that this oxidation is weakly related to UV radiation flux. Therefore, in general an O_3/H_2O_2 treatment system has a high yield of hydroxyl radicals, is cost effective, and is easier to maintain than UV radiation. A UV/O_3 or UV/H_2O_2 treatment system may be difficult to justify unless the organic compound is a strong absorber of UV radiation. Based upon plant size and operating costs, the decision to use O_3, H_2O_2, UV radiation, or a combination of the three is primarily one of economics, assuming all processes destroy the organic contaminant.

Because of the complicated and interrelated reactions described above, a model is needed to predict the optimum treatment system in terms of removal efficiency and cost. While such a model currently is not operational, one has been developed and verified in the laboratory and is ready to be tested in the field.[17, 18]

2.3 PROCESS PERFORMANCE HISTORY

The performance of AOPs in destroying organics, particularly TCE, is not well-documented in the literature for full-scale plants. Therefore, much of the following information comes from pilot plants and manufacturers' literature.

A bench scale study in Los Angeles[2] found high percentage removals of TCE and PCE with the use of O_3 and H_2O_2. Based on these results, the Los Angeles Department of Water and Power (LADWP) initiated a pilot plant study of the O_3/H_2O_2 treatment system on groundwater contaminated with TCE and PCE. Based on the results of 200 experiments, the removal efficiency for TCE ranged from 87-99%, and the removal efficiency for PCE ranged from 61-88%.[4]

Ultrox International reported that TCE concentrations of 470 μg/L in groundwater were reduced to drinking water standards with an O_3/UV pilot plant.[19]

The costs of AOPs, particularly for the removal of TCE, are not well-documented in the literature either. From the LADWP pilot plant discussed previously, annualized treatment costs for the O_3/H_2O_2 process are predicted to be \$0.024/m^3 (\$0.094/1000 gal).[4] Estimates for the cost of the H_2O_2/UV treatment process are \$0.01-0.045/m^3 (\$0.04-0.18/1000 gal)[20] and \$0.113-1.34/m^3 (\$0.45-5.35/1000 gal)[21, 22, 23], and the costs of treating groundwater contaminated with chlorinated solvents is estimated to be \$0.05-0.06/m^3 (\$0.20-0.25/1000 gal) with an O_3/UV treatment process.[19] Ultrox International estimated the treatment costs at the DOE Kansas City Plant to be \$0.23-0.38/m^3 (\$0.90-1.52/1000 gal) for a treatment process that uses O_3, UV, and H_2O_2. These costs, along with the costs of competing processes, are contained in Table 1.

2.4 COMPETING TREATMENT PROCESSES

The competing treatment processes for volatile organic compounds (VOCs) are air stripping, carbon absorption, and biodegradation. A

Table 1. Comparison of treatment costs for removal of trichloroethene and tetrachloroethene

Treatment process	Cost ($/m^3)	Cost ($/1000 gal)	Reference
Air stripping	0.005-0.025	0.02-0.10	4, 20, 24
Air stripping with GAC[a] adsorption of off-gas	0.069	0.277	4
Liquid-phase GAS adsorption	0.099	0.397	4
Aboveground biological treatment	0.075-0.2	0.30-0.80	20
Packed towers	0.005-0.025	0.02-0.10	20
Carbon adsorption	0.05-0.0225	0.20-0.90	20
H_2O_2/O_3	0.024	0.094	4
H_2O_2/UV[b]	0.01-0.45	0.04-0.18	20
	0.113-1.34	0.45-5.35	21, 22, 23
O_3/UV	0.05-0.06	0.20-0.25	19
O_3/H_2O_2/UV	0.225-0.38	0.90-1.52	25, 26

[a]GAC = Granular activiated carbon.
[b]UV = Ultraviolet radiation.

comparison of the advantages and disadvantages of these processes, along with the process using UV, O_3, and H_2O_2, are shown in Table 2.

Table 2. Comparison of technologies for treating volatile organic carbon compounds (VOCs) in water

Technology	Advantages	Disadvantages
Air stripping	Effective at all concentrations; mechanically simple; relatively inexpensive	VOCs discharged to air
Air stripping with carbon adsorption from vapor	Lower local air discharge; effective at high concentrations	Inefficient at low concentrations; does not destroy VOCs; requires disposal or regeneration
Air stripping with with regeneration	No carbon disposal cost; can reclaim product	High power consumption; product disposal required
Carbon absorption from groundwater	Low air emissions; effective at high concentrations	Inefficient at low concentrations; does not destroy VOCs; requires disposal or regeneration; comparatively expensive
Hydrogen peroxide and ozone with ultraviolet radiation	No air emissions; effective at all concentrations; available off shelf	High power consumption; process mechanisms not well-understood
In situ biodegradation	No air emissions; destroys VOCs	Difficulty in controlling extent and rate of process

3. PLANT DESCRIPTION

3.1 INTRODUCTION

The groundwater treatment plant under investigation uses the AOP of O_3, UV radiation, and H_2O_2 for the removal of TCE, 1,2-transdichloroethene (DCE), and vinyl chloride. This section discusses the bench scale and pilot plant studies that were conducted on the groundwater and describes the full-scale plant that was built and is being operated.

3.2 BENCH SCALE/PILOT PLANT STUDIES

A bench scale study was conducted on the groundwater by Ultrox International to evaluate the removal of TCE, DCE, 1,1-dichloroethane (DCA), 1,1,1-trichloroethane (TCA), vinyl chloride, and methylene chloride (CH_2Cl_2) and to predict the removal of various other organic contaminants. The bench scale study evaluated the UV/O_3 and UV/H_2O_2 processes. Details of the bench scale study are contained in the report prepared by Ultrox International.[25]

The results showed the UV/O_3 process to be unsuccessful.[25] After 30 min of contact time, there were still 100 ppb of TCE remaining, which was significantly higher than the required 5 ppb. The poor results were attributed to the oxidation of metals (primarily iron) to their oxides (e.g., Fe_2O_3), which left insufficient O_3 for oxidation of the organics. This was indicated by a large quantity of an orange-brown inorganic precipitate being formed.[25]

The UV/H_2O_2 process reduced all organic contaminants below detectable limits within 20 min.[25] During one UV/H_2O_2 treatment run, O_3 was added after 20 min for the final 10 min of the run. In this case, since all organic contaminants were also below detectable limits within 20 min, the utility of O_3 was not demonstrated.

Based upon the results of the bench scale study, Ultrox International recommended a UV/H_2O_2 process and estimated the costs in Table 3 for a full-scale plant.

Following the bench scale study, Ultrox International conducted pilot plant studies on UV/H_2O_2, UV/O_3, and UV/O_3/H_2O_2 processes. Details of the pilot plant study are contained in a report prepared by Ultrox International. Based on the results, Ultrox International concluded that the above processes can reduce the organic contaminants adequately and recommended a UV/O_3/H_2O_2 process.[26] The equipment cost for a 25-gal/min plant was estimated to be $123,000, and operation and maintenance (O&M) costs were estimated to be $1.25-$1.52/1000 gal.

A review of the data from the pilot plant study indicates that any of the three systems evaluated can reduce the organic contaminants adequately, which confirms the information obtained from the literature

Table 3. Ultraviolet radiation/hydrogen peroxide process costs estimated from bench scale studies

System size	Equipment cost ($)	Operation and maintenance cost per volume
25 gal/min	92,000	$0.23/m^3$ ($0.90/1000 gal)
50 gal/min	180,000	$0.23/m^3$ ($0.90/1000 gal)

Source: David B. Fletcher, Ultrox International, letter, subject: Analysis Results and Recommendations, November 17, 1986.

described previously. Because of this, any expansion of the existing plant should include an evaluation of economics, flexibility, and ease of operation of the three systems before the final design is selected.

3.3 PLANT DESCRIPTION

Following the recommendation of Ultrox International,[26] a 0.1-m^3/min (25-gal/min) plant was constructed[27] that employs a UV/O_3/H_2O_2 process (Fig. 3) to treat groundwater contaminated with organics. The reaction chamber has a volume of 2.9 m^3 (90 ft^3 or 725 gal) and is divided by baffles into six stages. The baffles cause a labyrinthine flowpath for the water. O_3 is introduced to the reactor through porous diffusers located in each of the six stages. The O_3 is supplied by a generator capable of producing 21 lbs of O_3 per day at 2% O_3 by weight. The air dryer supplies clean, dry air (-60°F dew point) to the O_3 generator at 12-15 psig.

There are 72 quartz-sheathed, low-pressure 65-W UV lamps located along the top of the reaction chamber. The lamps are installed in rows of six, with twelve lamps in each stage. Sight glasses and sample ports are located in each stage.

The H_2O_2 feed system can supply up to 50 lbs per day from either of the two 0.22-m^3 (55-gal) H_2O_2 storage drums. The H_2O_2 is mixed with the influent groundwater with an in-line static mixer.

The reaction tank and UV lights were manufactured by Ultrox International, and the O_3 generator was supplied by Pollution Control Industries. Details on all of the equipment are contained in the Operation and Maintenance Manual.[27]

The influent groundwater comes from three wells that extract contaminated groundwater from the tank farm plume at a rate of approximately 6 gal/min. To protect the downstream equipment, an in-line cartridge filter is located on the influent line. Following treatment, the plant effluent is discharged into Kansas City's municipal sewer system. The standards for the plant in terms of effluent quality are contained in Table 4.

Section 5 describes the actual operating conditions of the plant.

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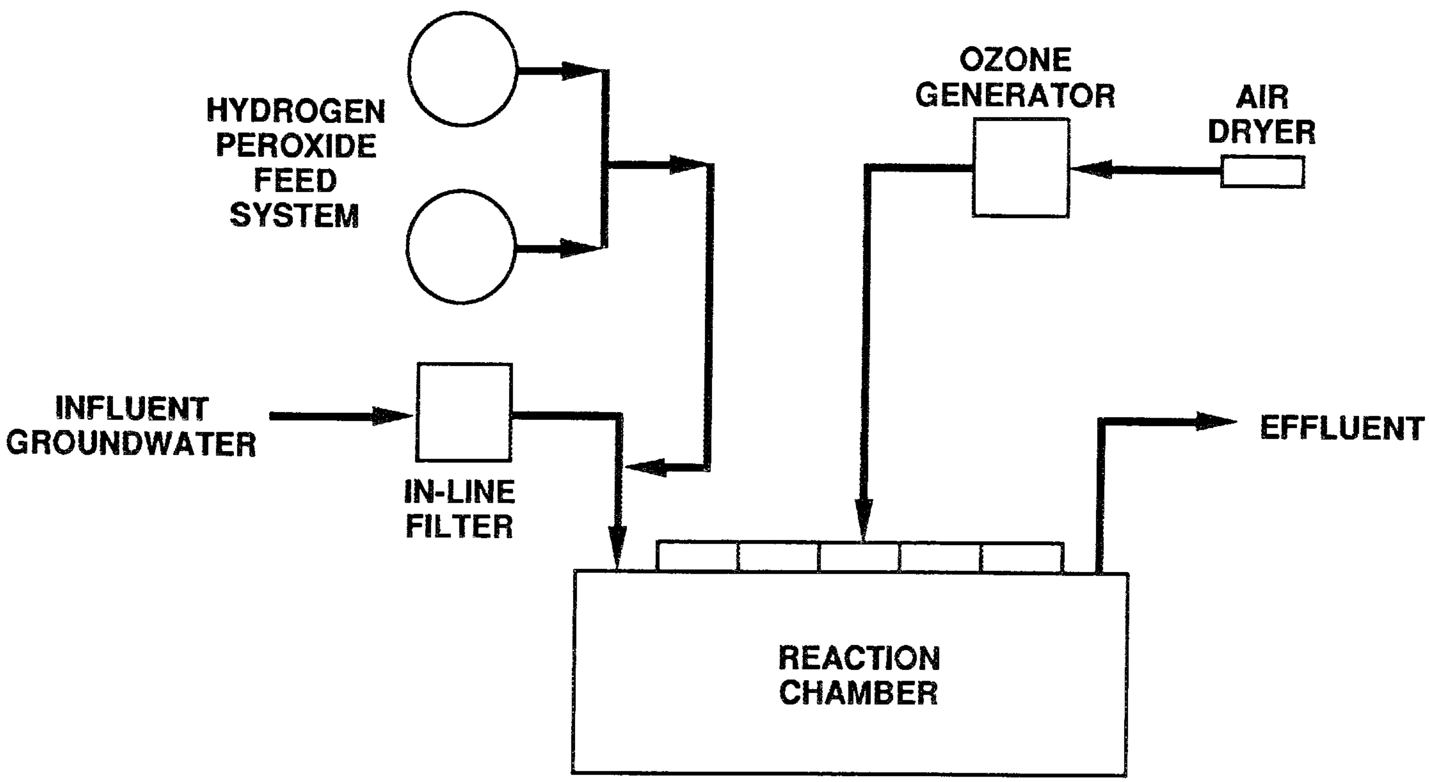

Fig. 3. Ultraviolet radiation/ozone/hydrogen peroxide groundwater treatment plant, Allied-Signal Aerospace Company, Kansas City Division.

Table 4. Groundwater treatment plant effluent water quality standards (mg/L unless otherwise noted)

Parameters[a]	Maximum discharge limit	Monitoring frequency
Cadmium	0.69	Monthly
Chromium	2.77	Monthly
Copper	3.38	Monthly
Lead	0.69	Monthly
Nickel	3.98	Monthly
Zinc	2.61	Monthly
Iron	100.	Monthly
Manganese	20.	Monthly
Boron	1.	Monthly
BOD[b]	-	Daily
TSS[c]	-	Daily
Flow (gal/d)	10,000.	Continuous
pH (units)	6-10	Continuous
Arsenic	0.25	Monthly
TOX[d]	0.16	Monthly
Sulfides	10.	Monthly
Oil and grease	100.	Monthly
Cyanide	2.	Monthly

[a]Parameters refer to total where applicable.
[b]Biochemical oxygen demand.
[c]Total suspended solids.
[d]Total organic halogens.

4. METHODOLOGY

The evaluation methodology described in the Study Plan includes monitoring the performance of the plant, determining O&M costs for the plant, comparing the costs with other technologies, evaluating contaminant removal mechanisms, and assisting in optimization of the process.[28] The Study Plan is found in App. A. Prior to continuous operation, the treatment plant was operated in a batch mode so that all of the effluent could be contained and analyzed prior to release. The parameters listed in Table 5 were determined on four batch tests at various time intervals to demonstrate that the effluent standards can be met. Following the batch operation, the treatment plant was operated in a continuous, flow-through mode. The monitoring plan used during the flow-through mode is outlined in Table 6.

In FY 1989, two changes to the Study Plan are recommended. First, a performance model should be used to evaluate the actual capacity of the plant, to predict optimum O_3 and H_2O_2 requirements, and to estimate the plant size needed for additional contaminated groundwater plumes. Second, the following monitoring changes should be initiated:

- The off-gases should be monitored for O_3 prior to the catalyst. A continuous monitor should be installed for this purpose.

- UV absorbance at 240 nm of H_2O_2 and O_3 should be determined at all sampling locations, except prior to the filter, on a daily basis during the optimization studies and then monthly thereafter.

- Carbonate and bicarbonate should be determined at all sampling locations, except prior to the filter and in the effluent, on a daily basis during the optimization studies and then monthly thereafter.

- The particulate matter retained by the in-line filter and the sediment in the reaction chamber should be analyzed quarterly. The sediment in the reaction chamber will be analyzed whenever the opportunity arises since it is not reasonable to shut down the plant for sampling.

- The O_3 content of the air flow out of the O_3 generator should be determined periodically as a check on the efficiency and effectiveness of the generator.

Table 5. Groundwater treatment plant parameters monitored during batch operations

Inorganics	
Arsenic	Iron
Barium	Lead
Boron	Manganese
Cadmium	Nickel
Chloride	Sulfide
Copper	Zinc
Cyanide	
Physical	
pH	Total suspended solids
Organics	
Biochemical oxygen demand	Oil and grease
Priority pollutant volatiles	
Chloromethane	Trichloroethene
Bromomethane	Dibromochloromethane
Vinyl chloride	1,1,2-Trichloroethane
Chloroethane	Benzene
Methylene chloride	*trans*-1,3-Dichloropropane
Acetone	Bromoform
Carbon disulfide	4-Methyl-2-pentanone
1,1-Dichloroethene	2-Hexanone
1,1-Dichloroethane	Tetrachloroethene
1,2-Dichloroethene (total)	1,1,2,2-Tetrachloroethane
Chloroform	Toluene
2-Butanone	Chlorobenzene
1,2-Dichloroethane	Ethylbenzene
1,1-Trichloroethane	Styrene
Carbon tetrachloride	Xylene (total)
Vinyl acetate	Total organic halogens
Bromodichloromethane	
1,2-Dichloropropene	
cis-1,3-Dichloropropane	

Table 6. Groundwater treatment plant monitoring plan, flow-through mode

Frequency	Parameter	Location[a]
Continuous	pH	E
	Flow	IBF
Daily	BOD[b]	IBF, IAF, E
	TSS[b]	IBF, IAF, E
Weekly	Sulfite	IBF, IAF, E
	Sulfite	IBF, IAF, E
	Nitrite	IBF, IAF, E
	Nitrite	IBF, IAF, E
	Ammonia	IBF, IAF, E
	Ferrous ion	IBF, IAF, E
	Manganous ion	IBF, IAF, E
	TOX[b]	IBF, IAF, E, RC
	VOC[b]	IBF, IAF, E, RC
	TOC[b]	IBF, IAF, E, RC
	Iron	IBF, IAF, E
	Manganese	IBF, IAF, E
	Sulfides	IBF, IAF, E
Monthly	Cadmium	IBF, IAF, E
	Chromium	IBF, IAF, E
	Copper	IBF, IAF, E
	Lead	IBF, IAF, E
	Nickel	IBF, IAF, E
	Zinc	IBF, IAF, E
	Boron	IBF, IAF, E
	Arsenic	IBF, IAF, E
	Oil and grease	IBF, IAF, E
	Total cyanide	IBF, IAF, E
	Total plate count	IBF, IAF, E
	Off-gas TOX	Tap
One time	Calcium	IBF, IAF, E
	Magnesium	IBF, IAF, E
	Sodium	IBF, IAF, E
	Potassium	IBF, IAF, E
	Chloride	IBF, IAF, E
	Fluoride	IBF, IAF, E
	Phosphate	IBF, IAF, E
	Carbonate	IBF, IAF, E
	Bicarbonate	IBF, IAF, E

[a]E = effluent; IBF = influent before filter; IAF = influent after filter; Tap = gas vent from reaction chamber; RC = all six stages in reaction chamber.

[b]BOD = biochemical oxygen demand; TSS = total suspended solids; TOX = total ogranic halogens; VOC = volatile organic compounds; TOC = total organic carbon.

5. RESULTS

5.1 BATCH OPERATION

The results from the batch operations for TOX and VOCs are contained in Tables 7 and 8, respectively. All of the VOCs in Table 9 were analyzed, but only those above detectable limits are reported in Table 8. For the effluent results for both TOX and VOCs, the duration of batch treatment is indicated. Table 10 contains the average results from all four batch tests for a variety of parameters that are listed in the plant's discharge permit.

5.2 FLOW-THROUGH OPERATIONS

5.2.1 Performance

The flow-through performance assessment started in May 1988, and the results reported here continue through September 1988. All of the data is contained in App. B, while summaries are contained in this section as discussed below. The flow data for the groundwater treatment plant for each month are contained in Table 11. Total suspended solids (TSS) and pH data are reported in Tables 12 and 13, respectively. These data were obtained with weekly grab samples of the influent before the filter (IBF), the influent after the filter (IAF), and the plant effluent (EFF) as well as with a single 24-h composite EFF sample once per month.

Sulfite, sulfide, and sulfate results for the IBF, IAF, and EFF are shown in Table 14. All results are based on weekly grab samples that are averaged for each month except for a single 24-h composite sample taken once each month. Nitrite, nitrate, and ammonia results are provided in Table 15. The results are all based on weekly grab samples averaged for each month.

The results of the iron and manganese sampling are listed in Tables 16 and 17, respectively. Weekly grab samples of the IBF, IAF, and EFF were collected and averaged for each month. In addition, a single 24-h composite sample was collected once per month for both iron and manganese at the EFF.

Trace metals were sampled once a month with grab samples at the IBF, IAF, and EFF, as well as once a month at the EFF with a 24-h composite sample. The results in Table 18 are averaged for all samples collected.

Oil and grease (O&G) results are in Table 19. Values are for single monthly grab samples at the IBF, IAF, and EFF, and a single monthly 24-h composite sample at the EFF.

Biochemical oxygen demand (BOD) and total organic carbon (TOC) results are contained in Tables 20 and 21, respectively. All BOD samples were daily grab samples, except for the daily 24-h composite effluent

Table 7. **Groundwater treatment plant batch operations, total organic halogen results (mg/L)**

Sample Location	(Batch 1) (2/23/88)		(Batch 2) (3/02/88)		(Batch 3) (3/09/88)		(Batch 4) (3/29/88)		Standard
Unfiltered influent	0.147		0.382		0.292		0.254		-
Filtered influent	0.113								-
Effluent (Stage 1)	0.248	(40)[a]	0.068	(50)	0.077	(24)	0.049	(48)	-
	0.109	(50)	0.061	(60)	0.063	(24)	0.019	(200)	-
	0.055	(60)	0.061	(70)	0.097	(100)			
	0.036	(70)	0.065	(80)	0.059	(100)			
	0.070	(80)	0.071	(90)					
	0.069	(90)	0.048	(100)					
	0.051	(100)							
Effluent (Stage 6)	0.043		0.043	(110)					0.16

[a]Numbers in parentheses indicate time of sample collection in minutes after treatment was initiated.

Table 8. Groundwater treatment plant batch operations, volatile organic compounds results[a]

Compounds	Batch 1 (2/23/88)			Batch 2 (3/02/88)		Batch 3 (UI only) (3/09/88)	Batch 4 (UI only) (2/29/88)
	UI[b]	FI[b]	E[b]	UI	E		
Methylene chloride	0.009	0.006	0.011 (40)[c] 0.011 (50) 0.010 (60) 0.014 (70)				
1,1,1-Trichloroethane			0.0079 (40)	0.0078 0.010		0.008	
Trichloroethene	0.0055	0.0056	0.300 (40)	0.280 0.320		0.300	0.700
Tetrachloroethene			0.033 (40)	0.029 0.037		0.025	0.050
1,2-Dichloethene	0.055	0.066	0.250 (40)	0.270		0.320	0.680
1,1-Dichloroethane			0.014 (40)	0.011		0.010	
1,1-Dichloroethene				0.006			0.012
Vinyl chloride							0.091
Acetone			0.170 (50) 0.190 (60) 0.300 (70) 0.028 (80)		0.021		

[a]Only results above detectable limits are shown.

[b]UI - unfiltered influent; FI - filtered influent; E - effluent (Stage 1). FI concentrations for batches 2, 3, and 4 are all below detectable limits, and E concentrations for batches 3 and 4 are all below detectable limits.

[c]Numbers in parentheses indicate minutes after treatment was initiated.

Table 9. Groundwater treatment plant volatile organic compound sampling list, batch operation

Chloromethane	Bromodichloromethane
Bromomethane	1,2-Dichloropropane
Vinyl chloride	*cis*-1,3-Dichloropropane
Chloroethane	Trichloroethene
Methylene chloride	Dibromochloromethane
Acetone	1,1,2-Trichloroethane
Carbon disulfide	Benzene
1,1-Dichloroethene	*trans*-1,3-Dichloropropane
1,1-Dichloroethane	Bromoform
1,2-Dichloroethene (total)	4-Methyl-2-pentanone
Chloroform	2-Hexanone
1,2-Dichloroethane	Tetrachloroethene
2-Butanone	Chlorobenzene
1,1-Trichloroethane	Ethylbenzene
Carbon tectrachloride	Styrene
Vinyl acetate	Xylene (total)

Table 10. Groundwater treatment plant, batch results[a] (mg/L)

Parameter	Unfiltered influent	Effluent		
		Stage 1	Stage 6	Standard
BOD[b]	6	3	2.5	-
Chloride	45		8.0	-
pH	6.9	8.3	8.1	6-10
TSS[b]	230	382	71	-
Sulfide	0.3	<0.1	<0.1	10.0
Arsenic	0.006	0.048	0.015	0.25
Barium	-	0.23	-	-
Boron	2.11	0.30	0.19	1.0
Cadmium	0.007	0.004	0.009	0.69
Chromium	0.016	0.065	0.047	2.77
Copper	0.67	0.067	0.12	3.38
Iron	47.6	32.5	15.3	100
Lead	0.63	0.05	0.042	0.69
Manganese	5.07	13.6	6.8	20.00
Nickel	0.022	0.043	0.023	3.98
Zinc	3.81	0.49	0.34	2.61
Cyanide	<0.001	<0.001	<0.001	2.0
Oil and grease	6.5	0.7	0.6	10

[a]These are average values for the four batch tests.

[b]BOD = biochemical oxygen demand; TSS = total suspended solids.

Table 11. Groundwater treatment plant flow data

Month	Flow (gal)	Flow (gal/min)	Percentage of design flow
May	145,760	5.9	24
June	133,041	5.4	22
July	92,929	5.4	22
August	157,080	7.3	29
September	57,652	10.0	40
Average	117,292	6.8	27

[a]The design flow is 25 gal/min.

Table 12. **Groundwater treatment plant total suspended solids data[a] (mg/L)**

Month	IBF[B] (Grab)	IAF[B] (Grab)	EFF[b]	
			Grab	Composite
May	148	9.9	62	32
June	272	7.0	49	30
July	149	16.9	33.7	29
August	139	12.9	33.4	22.9
September	78	11.0	16.0	8.4
Average	157	11.5	38.8	24.5
Standard	NA[b]	NA	None	None

[a]The grab samples are collected weekly and averaged for each month. The composite is a single monthly 24-h sample.

[b]IBF = influent before filter; IAF = influent after filter; EFF = effluent; NA = not applicable.

Table 13. Groundwater treatment plant pH data[a] (mg/L)

Month	IBF[b] (Grab)	IAF[b] (Grab)	EFF[b] Grab	EFF[b] Composite
May	6.8	6.9	8.0	8.1
June	7.1	7.2	7.9	8.0
July	6.9	6.9	7.9	8.0
August	6.9	7.1	8.0	8.1
September	6.9	7.0	8.3	8.3
Average	6.9	7.0	8.0	8.1
Standard	NA[b]	NA	6-10	6-10

[a]The grab samples are collected weekly and averaged for each month. The composite is a single monthly 24-h sample.

[b]IBF = influent before filter; IAF = influent after filter; EFF = effluent; NA = not applicable.

Table 14. Groundwater treatment plant sulfur data (mg/L)[a]

Month	IBF[b]			IAF[b]			EFF[b]			
	Sulfite	Sulfide	Sulfate	Sulfite	Sulfide	Sulfate	Sulfite	Sulfide	Sulfide(C)	Sulfate
May	<0.5	<0.5	70	<0.5	2.0	72	<0.5	<0.5	<0.5	62
June	<0.5	<0.5	68	<0.5	<0.5	64	<0.5	<0.5	<0.5	63
July	<0.5	0.53	54	<0.5	<0.5	52	<0.5	<0.5	<0.5	49
August	<0.5	<0.5	65	<0.5	<0.5	63	<0.5	<0.5	<0.5	69
September	<0.5	0.7	70	<0.5	<0.5	51	<0.5	<0.5	-	42
Average	<0.5	0.5	65	<0.5	0.8	60	<0.5	<0.5	<0.5	57
Standard	NA[b]	NA	NA	NA	NA	NA	None	10.0	10.0	None

[a]All values represent grab samples (collected weekly and averaged for each month) unless otherwise noted as composite (C).
[b]IBF = influent before filter; IAF = influent after filter; EFF = effluent; NA = not applicable.

Table 15. Groundwater treatment plant nitrogen data (mg/L)[a]

Month	IBF[b]			IAF[b]			EFF[b]		
	Nitrite	Nitrate	Ammonia	Nitrite	Nitrate	Ammonia	Nitrite	Nitrate	Ammonia
May	<0.10	0.13	0.83	<0.10	0.16	0.80	0.11	3.53	0.70
June	<0.10	0.12	0.84	<0.10	0.13	0.92	<0.10	3.6	0.80
July	0.27	<0.10	0.79	<0.10	<0.10	0.69	0.60	2.2	0.33
August	<0.10	0.15	0.78	<0.10	0.10[c]	0.77	<0.10	2.7	0.73
September	<0.10	<0.10	0.83	<0.10	<0.10	0.86	<0.10	2.4	0.86
Average	0.13	0.12	0.81	<0.10	0.81	0.81	0.20	2.9	0.68
Standard	NA[b]	NA	NA	NA	NA	NA	None	None	None

[a]All samples are weekly grab samples averaged for each month.

[b]IBF = influent before filter; IAF = influent after filter; EFF = effluent; NA = not applicable.

[c]One nitrate analysis of 6.9 mg/L on August 12, 1988, was not considered in this average because it is out of line with all other analyses. If this analysis is included, the monthly average is 1.80 mg/L.

Table 16. Groundwater treatment plant iron data (mg/L)[a]

Month	IBF[b]		IAF[b]		EFF[b]		
	Ferrous ion	Total iron	Ferrous ion	Total iron	Ferrous ion	Total iron	Total iron (C)
May	1.00	46.6	0.917	2.83	0.158	3.47	3.30
June	2.67	58.7	0.953	2.27	0.375	3.49	2.63
July	3.51	43.7	1.953	6.00	2.213	6.67	2.72
August	1.57	6.5	0.67	2.93	0.45	5.44	5.21
September	1.39	7.6	<0.05	4.6	<0.05	5.61	--
Average	2.03	32.6	0.909	3.73	0.649	4.94	3.47
Standard	NA[b]	NA	NA	NA	None	100.	100.

[a]All values represent grab samples (collected weekly and averaged for each month) except for one 24-h monthly composite (C) effluent sample.

[b]IBF = influent before filter; IAF = influent after filter; EFF = effluent; NA = not applicable.

Table 17. Groundwater treatment plant manganese data (mg/L)[a]

Month	IBF[b]		IAF[b]		EFF[b]		
	Manganous ion	Manganese	Manganous ion	Manganese	Manganous ion	Manganese	Manganese (C)
May	6.03	6.81	5.01	6.12	1.04	6.23	6.07
June	6.48	6.11	6.91	5.65	1.16	7.0	1.65
July	6.46	6.68	5.22	6.31	3.03	6.78	2.67
August	6.43	5.61	8.29	5.45	5.65	6.52	4.97
September	7.88	5.91	8.28	5.87	6.13	5.65	-
Average	6.66	6.22	6.74	5.88	3.40	6.44	3.84
Standard	NA[b]	NA	NA	NA	None	20.	20.

[a]All values represent grab samples (collected weekly and averaged for each month) except for one 24-h monthly composite (C) effluent sample.

[b]IBF = influent before filter; IAF = influent after filter; EFF = effluent; NA = not applicable.

Table 18. Groundwater treatment plant trace metals results[a] (mg/L)

Parameter	IBF[b]	IAF[b]	EFF[b]	EFF (C)[b]	Standard
Cadmium	0.006	0.003	0.003	0.003	0.69
Chromium	0.017	0.012	0.015	0.015	2.77
Copper	0.444	0.044	0.034	<0.010	3.38
Lead	0.067	0.039	0.058	0.046	0.69
Nickel	0.024	0.014	0.014	0.015	3.98
Zinc	0.497	0.064	0.061	0.020	2.61
Boron	0.121	0.112	0.092	0.099	1.0
Arsenic	0.037	0.022	0.024	0.018	0.25
Total cyanide	<0.001	<0.001	0.001	<0.001	2.0

[a]Values are monthly averages for grab samples (collected from May through September 1988) except for one composite (C) effluent sample, which is the average of all 24-h monthly composites.

[b]IBF = influent before filter; IAF = influent after filter; EFF = effluent.

Table 19. Groundwater treatment plant oil and grease results[a] (mg/L)

Month	IBF[b]	IAF[b]	EFF[b]	EFF (C)[b]
May	21	1.0	1.8	2.0
June	1.8	1.2	0.6	0.5
July	<0.5	<0.5	<0.5	<0.5
August	3.4	0.5	<0.5	<0.5
September	-	-	-	-
Average	6.7	0.8	0.9	0.9
Standard	NA[b]	NA	100	100

[a]All samples are weekly grab samples except for one 24-h monthly composite (C) effluent sample.

[b]IBF = influent before filter; IAF = influent water filter; EFF = effluent; NA = not applicable.

Table 20. Groundwater treatment plant biochemical oxygen demand data (mg/L unless otherwise indicated)[a]

Month	IBF[b] (Grab)	IAF[b] (Grab)	EFF[b] Grab	EFF[b] Composite
May	4.5	3.6	2.9	3.3
June	21.6	3.6	1.8	20.0
July	7.2	4.1	4.1	3.0
August	9.2	3.9	4.6	5.6
September	5.8	2.0	<1.0	<1.0
Average	9.7	3.4	2.9	6.6
Standard	NA[b]	NA	None	None

[a]All samples are daily grab samples except for 24-h daily composite effluent samples. Values are monthly averages.

[b]IBF = influent before filter; IAF = influent after filter; EFF = effluent; NA = not applicable.

Table 21. Groundwater treatment plant total organic carbon data (mg/L)[a]

Month	IBF[b]	IAF[b]	Reaction chamber stages						EFF[b]	Percent Reduction[c]
			1	2	3	4	5	6		
May	8.7	5.3	4.9	4.9	5.3	3.2	3.4	3.5	7.2 (4.5)[d]	15
June	3.9	5.6	4.2	3.2	4.3	4.5	2.9	3.2	3.4	39
July	3.6	4.8	3.4	3.1	3.1	3.1	3.1	2.4	3.9	19
August	6.5	4.5	4.4	3.9	3.3	4.4	3.7	4.2	3.2	29
September	3.3	4.4	3.3	6.8	5.4	3.6	6.2	4.4	2.8	36
Average	5.2	4.9	4.0	4.4	4.3	3.8	3.9	3.5	3.6	27
Standard	NA[b]	NA	NA	NA	NA	NA	NA	NA	None	

[a]All samples are weekly grab samples; all values are monthly averages.
[b]IBF = influent before filter; IAF = influent after filter; EFF = effluent; NA = not applicable.
[c]Percent reduction values use IAF values for initial concentrations.
[d]The average of all values for the month is 7.2 mg/L, but if an abnormally high value of 15.3 mg/L is eliminated, the monthly average is 4.5 mg/L. The 4.5 mg/L value is used for the average.

samples. All TOC samples were weekly grab samples. In both cases the values shown are monthly averages. BOD and TOC samples were collected at the IBF, IAF, and EFF, and TOC samples were collected also at all six sample taps along the reactor.

Tables 22 and 23 contain the TOX and VOC results, respectively. Samples were collected at the IBF, IAF, and EFF and at all six sample taps. The values are monthly averages of weekly grab samples except for the single 24-h composite effluent sample collected once a month for TOX.

The results of the total plate count analyses are in Table 24. The results are based on monthly grab samples collected at the IBF, IAF, and EFF.

5.2.2 Costs

The monthly operating and maintenance costs are shown in Table 25, and the capital cost is $304,000 for the bench scale study, pilot plant study, and construction of the treatment plant.

5.2.3 Operations

Construction of the $UV/O_3/H_2O_2$ groundwater treatment plant was completed in October 1987, and a discharge permit was issued by the Kansas City, Missouri, Water Pollution Control on February 8, 1988. Batch operation (four batches) of the plant continued from February 23 through March 29, 1988, and continuous operation was initiated on May 3, 1988.

When continuous operation of the treatment plant was started, the operating parameters were as follows:

- A total of 411 ft^3/h of air from the O_3 generator (with 27 wt% O_3 content) was used to bubble 21 lbs/d of O_3 into the reaction chamber, which resulted in an O_3 concentration in the 7-gal/min influent of 314 mg/L.

- All 72 of the 65-W UV lamps were operating (1.7 W/L).

- H_2O_2 was fed into the reaction chamber at 5.4 ml/min, which resulted in an H_2O_2 concentration in the 7-gal/min influent of 99.5 mg/L.

On June 20, 1988, the O_3 production was reduced by 25% to 15.8 lbs/d (236 mg/L); on August 11, 1988, it was reduced again to 10.5 lbs/d (157 mg/L). The air flow rate was not changed. All UV lamps were used for the entire time, and approximately 27 gal of H_2O_2 (99.5 mg/L) were used each month.

The plant was shut down several times during the 5 months of continuous operation. Table 26 shows the length of time the plant was shut down and the reasons for the downtime.

Table 22. Groundwater treatment plant total organic halogens (mg/L)[a]

Month	IBF[B]	IAF[B]	Reaction chamber stages						EFF[b]		Percent removal[c]	
			1	2	3	4	5	6	Grab	Composite	Grab	Composite
May	0.351	0.304	0.159	0.087	0.134	0.094	0.063	0.067	0.073	0.090	76	70
June	0.383	0.218	0.107	0.064	0.061	0.052	0.042	0.028	0.064	0.085	71	61
July	0.185	0.173	0.110	0.100	0.087	0.110	0.061	0.051	0.040	0.048	77	72
August	0.296	0.340	0.188	0.141	0.069	0.062	0.059	0.053	0.081	0.147	76	60
September	0.318	0.268	0.177	0.145	0.110	0.114	0.103	0.095	0.120	--	55	--
Average	0.307	0.261	0.148	0.107	0.092	0.086	0.066	0.059	0.076	0.09	71	66
Standard	NA[b]	NA	NA	NA	NA	NA	NA	NA	0.16	0.16		

[a]All samples are weekly grab samples (averaged monthly) except for the composite effluent sample, which is a single 24-h composite sample.

[b]IBF = influent before filter; IAF = influent after filter; EFF = effluent; NA = not applicable.

[c]Percent removal values use the IAF values for initial concentrations.

Table 23. Groundwater treatment plant volatile organic compounds results (mg/L)[a]

Parameter	IBF[b]	IAF[b]	Reaction chamber stages 1	2	3	4	5	6	EFF[b]
Chloromethane	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Bromomethane	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Vinyl chloride	0.015	0.014	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Chloroethane	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Methylene chloride	0.021	0.007	0.016	0.014	<0.005	<0.005	<0.005	<0.005	<0.005
Acetone	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Carbon disulfide	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,1-Dichloroethene	0.014	0.017	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,1-Dichloroethane	0.019	0.020	0.010	0.007	0.006	<0.005	<0.005	<0.005	<0.005
1,2-Dichloroethene (total)	0.714	0.856	0.113	0.034	0.011	0.008	<0.005	<0.005	<0.005
Chloroform	0.007	0.006	0.005	0.006	0.005	<0.005	<0.005	<0.005	<0.005
1,2-Dichloroethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2-Butanone	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,1,1-Trichloroethane	0.014	0.013	0.008	0.006	<0.005	<0.005	<0.005	<0.005	<0.005
Carbon tetrachloride	<0.005[c]	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Vinyl acetate	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Bromodichloromethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,2-Dichloropropane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
cis-1,3-Dichloropropene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Trichloroethene	0.520	0.573	0.088	0.025	0.008	0.006	<0.005	<0.005	<0.005
Dibromochloromethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,1,2-Trichloroethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
trans-1,3-Dichloropropene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Bromoform	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
4-Methyl-2-pentanone	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

Table 23. (Continued)

Parameter	IBF[b]	IAF[b]	Reaction chamber stages 1	2	3	4	5	6	EFF[b]
2-Hexanone	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Tetrachloroethene	0.042	0.050	0.011	0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,1,2,2-Tetrachloroethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Toluene	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Chlorobenzene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Ethylbenzene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Styrene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Xylene (total)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

[a]Values are averages for all analyses performed from May through August 1988. No analyses were performed in September. All samples were weekly grab samples.

[b]IBF = influent before filter; IAF = influent after filter; EFF = effluent.

[c]Carbon tetrachloride was below detectable limits in all analyses except one, in which it was at the detectable limit (0.005 mg/L).

Table 24. Groundwater treatment plant total plate count results (in colonies per mL)[a]

Month	IBF[b]	IAF[b]	EFF[b]	Percent removal		
				Filter	Reactor	Overall
May	13,000	1,100	12	92	99	99.9
June	2,900	60	2	98	97	99.9
July	4,200	580	7	86	99	99.8
August	4,700	3,700	181	21	95	96
September	-	-	-	-	-	-
Average	6,200	1,360	51	78	96	99.2

[a]Samples are monthly grab samples.
[b]IBF = influent before filter; IAF = influent after filter; EFF = effluent.

Table 25. Groundwater treatment plant operation and maintenance costs for FY 1988 (in dollars, with kWh indicated parenthetically for electricity)

Month	Sampling and analysis		Electricity		Filters	H_2O_2	Total[a]
	Routine	Evaluation	Cost	kWh			
February	ND[b]	3,295	ND	(ND)	ND	ND	0
March	ND	3,784	ND	(ND)	ND	ND	0
April	ND	280	ND	(ND)	ND	295	0
May	1,525	14,184	359	(8,620)	176	0	2,060
June	1,696	13,908	262	(NR)[c]	125	0	2,083
July	1,347	12,341	353	(NR)	100	295	2,095
August	1,428	13,950	280	(NR)	50	147	1,905
September	415	3,732	35	(NR)	13	0	463
Total	6,411	65,474	1,289	(8,620)	464	737	8,606

[a]The total cost excludes the evaluation costs for sampling and analysis because they do not contribute to ongoing long-term operation and maintenance costs. The H_2O_2 costs in April are not considered in the total cost because they were incurred prior to startup.

[b]ND = costs not monitored prior to startup in May 1988.

[c]NR = not reported.

Table 26. Groundwater treatment plant downtime

Month	Shutdown period (d)	Reason for downtime
May	1	Spargers had to be cleaned
June	5	Excessive ozone in building caused shutdown; operator out of town
July	8	Operator on vacation
August	13	Excessive ozone in building caused shutdown; spargers had to be cleaned and replaced
September	22	Escape of excessive O_3 in the exhaust (cause unknown)

The filters remove a considerable quantity of suspended matter and have been replaced at a frequency of every other day to once every 2 weeks. Analyses of the material being removed in the filter are being performed, but no results have been received. Precipitation occurs in the reaction chamber, and, in June, the O_3 diffusers had to be cleaned because of the deposition. The UV lamps have not been cleaned, but a coating is evident on them.

Three of the O_3 spargers broke in August, and all six were replaced with spargers with substantially larger pore sizes. The larger pore size was selected in order to reduce clogging problems from precipitation.

When viewed through observation ports, the color of the water in the reaction chamber is green, and the color darkens progressively down the reaction chamber. When a sample is withdrawn, the color is not apparent except in stages 5 and 6 and in the effluent, where the water retains a dark greenish-brown color. When samples from these three locations are allowed to sit, a very small amount of suspended material settles.

On the average, an operator at the plant spends one hour per day on monitoring and maintenance.

6. DISCUSSION

6.1 INTRODUCTION

Since the purpose of this treatment plant is the removal of organics from groundwater, the discussion initially deals with the performance of the plant in organics removal. The ability of the plant to meet its permit is then discussed. Following that, the plant's effect on other parameters--TSS, pH, sulfur compounds, nitrogen compounds, iron and manganese, heavy metals, O&G, off-gas, and bacteria--is described. Finally, operations, maintenance, and capital costs are considered.

6.2 ORGANICS REMOVAL

To evaluate the ability of the treatment plant to remove specific VOCs, it is necessary to examine the results of analyses at all sampling locations for all 35 VOCs, as shown in Table 23. These data indicate that only 11 of the 35 VOCs are detectable in the influent, that the VOC concentrations decrease through the reactor, and that all VOCs are below detectable limits by Stage 5. The data in Table 23 may be somewhat misleading because all analyses for all months are averaged without regard to the change in O_3 dosage, which is discussed in the following paragraph. However, it is still useful for a qualitative evaluation, particularly since the low flow rate should cause a treatment overdose in the reaction chamber and the operating parameters are unbalanced, masking the impact of the O_3 dose. The problem with the operating parameters is discussed later.

Table 27 lists the VOCs that are detectable in the influent to the treatment plant and then indicates at which stage of the treatment process each VOC was found each month at various O_3 dosages. The resistance of different VOCs to destruction by the treatment process can be determined from this table. In general, the following observations were made: (1) the VOCs detected in the influent during the flow-through operations are the same as those detected in the influent during the batch test; (2) the primary influent VOCs are consistent with those that were considered for removal during the batch and pilot plant tests and confirm that the correct VOC compounds were considered; and (3) the primary contaminants are TCE and DCE, as assumed. There is not a consistent relationship between the persistence of the individual VOCs and the reduction in O_3 dose, but several, including TCE and DCE, persist longer in the reaction chamber at the lower O_3 doses. The VOCs that persist longer are generally the most complex.

The effluent standard for the treatment plant that is indicative of the removal of organics is TOX. As Table 22 shows, the average effluent TOX concentrations are 0.076 mg/L and 0.09 mg/L, respectively, for grab and composite samples, and the average removals are 71% and 66% for grab and composite samples, respectively. While this average concentration is below the standard of 0.16 mg/L (as are all of the monthly averages) and the individual VOCs are all removed, there are three trends that indicate

Table 27. **Groundwater treatment plant volatile organic compounds removal at different ozone dosages**[a]

Parameter	Location (by month)[b]				
	May (21 lbs/d)	June	July (15.8 lbs/d)	August (10.5 lbs/d)	September
Vinyl chloride	BDL	BDL	IAF	IAF	BDL
Methylene chloride	ST2	IAF	IAF	BDL	BDL
1,1-Dichloroethene	IAF	IAF	IAF	ST1	ST5
1,1-Dichloroethene	ST2	ST1	ST3	ST4	ST5
1,2-Dichloroethane (total)	ST2	ST4	ST3	ST4	ST5
1,2-Dichloroethane	BDL	BDL	BDL	BDL	ST4
Chloroform	ST2	ST3	ST2	IAF	BDL
1,1,1-Trichloroethane	ST1	ST1	ST2	ST2	ST2
Vinyl acetate	BDL	BDL	BDL	BDL	BDL
Trichloroethene	ST2	ST4	ST2	ST4	ST4
Tetrachloroethene	ST4	ST1	ST2	ST2	ST2
Toluene	BDL	IAF	BDL	BDL	BDL

[a]Data represent locations in the treatment plant where parameter was last detected, BDL = below detectable limits; IAF = influent after filter; ST1 = Stage 1 in reaction chamber; ST2 = Stage 2 in reaction chamber; ST3 = Stage 3 in reaction chamber; ST4 = Stage 4 in reaction chamber; ST5 = Stage 5 in reaction chamber.

[b]Dosages are indicated parenthetically for May, July, and August.

potential problems. First of all, the effluent TOX concentrations are higher than the Stage 6 concentrations for all months except July, and in August and September effluent concentrations of 0.147 mg/L and 0.120 mg/L, respectively, were found. These values approach the standard. Second, the composite sample, from which compliance with the standard is determined, is consistently higher than the grab sample; third, the removal percentages do not appear to be as high as expected. There is no apparent change in any of these findings when the O_3 dose is reduced.

The reasons for these three trends are not clear. One possibility is that the plant cannot remove organics sufficiently, probably because of poor gas transfer efficiency. A factor supporting this is the poor (27% average) TOC removal shown by the data in Table 21. A much greater amount of the TOC should be removed, indicating a possible problem in gas transfer. The oxidation of the ferrous ion (Table 16) also is not as great as expected, a finding again supporting the possibility of an inadequate gas transfer. The increase in diffuser pore size should have reduced the transfer of O_3 from the gaseous to the liquid phase, reducing treatment efficiency, but the results do not show this. A continuous O_3 monitor should be installed for the off-gas to determine the efficiency of O_3 use in the reactor. Another treatment-related possibility is that the VOCs are being removed by air stripping and not by reaction with the hydroxyl radical. This could account for the removal of VOCs but not the indicator parameters of TOC and TOX. This theory will be tested next year.

A related possibility is that the operating parameters are not adjusted properly. As Fig. 2 indicates, because H_2O_2 adsorbs UV radiation much less than O_3 and because the conversion of H_2O_2 and O_3 to the hydroxyl radical is much slower than the conversion of O_3 to H_2O_2, an excess of O_3 in the system just causes a buildup of H_2O_2, with no resultant improvement in treatment. Also, the oxidants may be used up in reacting with one another rather than in reacting with the organics. Therefore, overdosing with O_3 may not be overtreatment. There also may be scavengers (carbonate and bicarbonate) of the hydroxyl radicals that prevent them from reacting with the organics. In the coming year, the operating parameters should be modified to test this hypothesis.

It is also conceivable that the higher TOX values in the effluent are related to the discolored effluent. On September 22, 1988, samples were re-analyzed. Those samples with "obvious" particulate matter had higher TOX concentrations, while clearer samples had lower TOX concentrations.[28] Analyses will be performed in the future on filtered and unfiltered samples to see if there is a relationship. Since the Stage 6 samples are taken at middepth and the effluent samples are taken from the bottom, it is possible that sediment in the reaction chamber is either contributing to the TOX or interferring with the analysis.

Another possibility is a problem with the TOX analyses. The average TOX concentrations are 0.307 mg/L and 0.261 mg/L, respectively, before and after the filter (Table 22). However, when the concentrations of VOCs from Table 23 are added together, the total IBF and IAF concentrations are

1.39 mg/L and 1.57 mg/L, respectively. This discrepancy between the TOX concentrations and the sum of the VOC concentrations indicates a potential problem with the analytical results. TOX normally is used as a screening analysis, and its reliability is questionable for plant evaluation and compliance.

A final consideration is that the VOCs might be converted to other organic compounds. Again, this would account for the removal of VOCs without a concomitant reduction in TOC and TOX.

The removal of VOCs with no apparent difficulty contradicts the poor removals exhibited by the indicator parameters TOC and TOX. This may support the previous contention that the problem is the use of an improper operating parameter and the inherent inaccuracy of the TOC and TOX analyses, rather than a limitation with the process. Consideration should be given to switching the control parameter and regulatory parameter from TOX to one or more of the individual VOCs.

Considering that (1) the flow rate through the treatment plant is only 27% (Table 11) of the design flow rate, (2) the treatment requirement for the groundwater is not severe, and (3) O_3, H_2O_2, and UV radiation are overdosed, the fact that the plant is barely meeting its effluent TOX standard is disturbing and perplexing. The evaluation work in FY 1989 should focus on this.

6.3 EFFLUENT STANDARDS AND SPECIFICATIONS

Table 28 compares the effluent standards to the average effluent concentrations and plant specifications. As this table shows, the plant meets all of the effluent standards and specifications except for vinyl chloride. The plant specification for vinyl chloride is 0.001 mg/L, while the analysis shows <0.01 mg/L. In the bench and pilot plant studies and in the batch tests, vinyl chloride was reported to be removed adequately. If the sensitivity of the analysis were improved, the specifications would probably be met. However, the average effluent concentrations mask several observations which are discussed in other sections, such as the increased effluent TOX concentrations and increased effluent iron and manganese concentrations with time.

The results of the batch operation indicated that the plant could meet the effluent standards, and flow-through operation of the plant verified this.

6.4 MISCELLANEOUS PARAMETERS

The average flow rate was 7 gal/min (Table 11), which is 27% of the design flow rate of 25-gal/min. This low flow rate makes it difficult to operate the plant efficiently and to optimize the operation. In addition to the low flow rate, the use of normal doses of O_3, H_2O_2, and UV radiation makes it difficult to evaluate process performance. In the

Table 28. Groundwater treatment plant effluent standards, specifications, and average concentrations (in mg/L unless otherwise noted)

Parameters[a]	Effluent standards	Average effluent[b]		Plant specifications
		Grab	Composite	
Cadmium	0.69	0.003	0.003	NA[c]
Chromium	2.77	0.015	0.0015	NA
Copper	3.38	0.034	<0.010	NA
Lead	0.69	0.058	0.046	NA
Nickel	3.98	0.014	0.015	NA
Zinc	2.61	0.061	0.020	NA
Iron	100	4.94	3.47	NA
Manganese	20	6.12	3.84	NA
Boron	1.0	0.092	0.099	NA
pH (units)	6-10	8.0	8.1	NA
Arsenic	0.25	0.024	0.018	NA
Total organic halogens	0.16	0.076	0.09	NA
Sulfides	10	<0.5	<0.5	NA
Oil and grease	100	0.9	0.9	NA
Cyanide	2.0	0.001	<0.001	NA
trans-1,2-Dichloroethene	NA	<0.005	-	0.005
Trichloroethene	NA	<0.005	-	0.005
1,1,1-Trichloroethane	NA	<0.005	-	0.002
Methylene chloride	NA	<0.005	-	0.005
1,1-Dichloroethane	NA	<0.005	-	0.005
Vinyl chloride	NA	<0.010	-	0.001

[a]Parameters refer to total where applicable.

[b]The single monthly 24-h composite samples are used to determine compliance with the standards, while the weekly grab samples are used for evaluation purposes.

[c]NA = Not applicable.

coming year, an effort needs to be made to adjust the operational parameters to the actual flow rate so that a more meaningful evaluation of the plant's performance can be made.

As Table 12 indicates, the filter removed approximately 90% of the TSS, but the TSS in the effluent from the reactor was always considerably higher than in the influent to the reactor. This increase in TSS in the reactor is probably the result of oxidation of iron and manganese and heavy metals, but only the data for iron in Table 16 confirm this. The increase in TSS in the reactor effluent had decreased with time, a phenomenon which could be related to the operational changes (e.g., reduced O_3 dose, reduced air flow, and changed O_3 diffusers).

As shown in Table 13, the pH increases in the reactor from an average of approximately 7.0 in the influent to approximately 8.0 in the effluent. Not only was this increase unexpected, but a decrease was actually anticipated. Generally, the pH decreases because of the formation of organic acids. In this system, the concentration of organic acids may be too low and the system too well-buffered to see this effect. The reason for this pH increase is not known.

Table 14 contains the results of the monitoring for sulfite, sulfide, and sulfate. While the O_3 and H_2O_2 should oxidize sulfite and sulfide, the concentrations are too low to verify this. An increase in sulfates was expected from the oxidation of sulfites and sulfides, but this phenomenon was not seen. Again, this finding results from low concentrations of sulfides and sulfites.

The nitrate (Table 15) concentration increases from approximately 0.8 mg/L to 3 mg/L in the reactor. This increase should be the result of oxidation of nitrite and ammonia, although their concentrations are too low to verify this. The increase is expected as a result of operating the plant. In May and July, nitrite concentrations of 0.11 mg/L and 0.60 mg/L, respectively, were reported in the effluent. Since nitrite is unstable and was not found on other occasions, the values are believed to be erroneous.

Iron (Table 16) and manganese (Table 17) are removed in the filter and in the reaction chamber. The ferrous ion is removed primarily in the reaction chamber, while total iron is removed only in the filter (approximately 90%). This phenomenon is consistent with the findings of the bench scale study in which iron was precipitated in the reactor, indicating that the iron was in a suspended form. In fact, total iron generally increases in the reaction chamber. Approximately 80% of the manganous ion is removed in the reaction chamber, and total manganese is removed about equally in the filter and the reaction chamber. However, the scatter in the effluent manganese data makes a trend hard to find. The removal of the ferrous and manganous ions in the reaction chamber was expected by oxidation with O_3 and H_2O_2. The fact that the overall iron and manganese removal was not as great as expected indicates a treatment problem (discussed earlier).

The trace metals, particularly copper (90%) and zinc (87%), (Table 18) are removed by the filter and remain basically unaffected in the reaction chamber. This finding is expected.

O&G is removed by the filter (Table 19) but is unaffected in the reaction chamber. Some removal was expected in the reaction chamber because of oxidation of the organics, but the O&G values are probably too low to show this. Also, the O&G analysis is not very accurate at these levels.

The BOD concentration (Table 20) decreased by 55% in the filter and is virtually unaffected in the reaction chamber. The fact that the other organic indicators (TOC and TOX) were not reduced in the filter shows that the BOD has a much larger particulate component than seen in the other organics.

With the exception of August, in each month approximately 92% of the bacteria were removed in the filter (Table 24), and another 98% were removed in the reactor. This results in an overall removal of 99.9%. The removal rate decreased in August as the O_3 dose was decreased. This bacteria removal was expected because O_3, H_2O_2, and UV radiation are all effective disinfectants.

The purpose of the groundwater treatment plant is to remove VOCs. However, since O_3 and H_2O_2 are excellent oxidants and, along with UV radiation, are excellent disinfectants, other demands are exerted on them, as indicated in these results. Primarily, the results show that nitrite, ammonia, ferrous ion, manganous ion, and bacteria exert a demand. Sulfites and sulfides should exert a demand, but the results do not show this because of the low concentrations.

The plant was shut down 30% of the time (Table 26) for maintenance, which is excessive, even considering that a higher than normal shutdown is expected for a startup period. The frequent replacement of filters and the buildup of sediment in the reaction chamber are expected operational consequences based on the analytical data for TSS removal and oxidation of iron and manganese.

6.5 COSTS

The O&M costs in Table 25, when combined with the flow data in Table 11, show an average O&M cost for groundwater treatment of approximately $4/m^3 ($15/1000 gal) (Table 29). This compares with predicted costs by Ultrox International of $0.225-0.38/m^3 ($0.90-1.52/1000 gal). The actual costs are 1 order of magnitude greater than those predicted by Ultrox International.[25, 26]

The difficulty in making these comparisons at this time is caused by the low flow rates through the treatment plant coupled with full treatment doses for most of the evaluation period. Since the average flow rate has been 27% of the design flow rate, similar O&M costs should support the

Table 29. Groundwater treatment plant operation and maintenance (O&M) costs

Month	O&M costs ($)	Flow (m^3)	Flow (gal)	Cost per volume ($/$m^3$)	Cost per volume ($/1000 gal)
May	2,060	583	145,760	3.5	14.1
June	2,083	532	133,041	3.9	15.7
July	2,095	372	92,929	5.6	22.5
August	1,905	628	157,080	3.0	12.1
September	463	231	57,652	2.0	8.0
Total	8,606	2,346	586,462	3.7	14.7

design flow rate of 0.1 m^3/min (25 gal/min). This assumption predicts O&M costs of \$0.88/m^3 (\$3.52/1000 gal). This amount is still considerably above the values reported in the literature and those predicted by Ultrox International.

Perhaps a fairer evaluation of costs excludes the sampling and analysis costs, which are primarily for determining compliance with the discharge standard. In this situation, the costs are \$0.94/m^3 (\$3.75/1000 gal) under current operating conditions and \$0.225/m^3 (\$0.90/1000 gal) if operating at design flows. While this depicts a more equitable cost, a true operating cost must include the sampling and analysis costs.

So far, personnel costs have not been recorded as O&M costs. In the future these costs should be included to determine the true costs.

The actual capital costs of \$304,000 are significantly greater than the \$92,000 equipment cost predicted by Ultrox International. However, the \$92,000 probably does not include engineering and construction.

In the next year, a comparison of these costs with competing processes should be made, and a better comparison of these costs with those for similar processes should be made in order to document the operating costs of this technology.

7. CONCLUSION/RECOMMENDATIONS

The effluent standards are met consistently, and the VOCs are eliminated in the reaction chamber. However, the TOX concentrations in the plant effluent are higher than those in Stage 6 of the reaction chamber, and the TOX removal is not as high as expected. In August the effluent TOX concentration was 0.147 mg/L versus a standard of 0.16 mg/L. Since the flow rate is approximately 27% of the design flow rate and the O_3 dosage has been reduced by only 50%, this finding is disturbing. Potential causes are the inapplicability of using TOX as a control parameter, improper operating parameters, volatilization of VOCs, and conversion of VOCs to other organic compounds. These must be evaluated during the coming year so that a remedy can be determined.

The pilot plant study and the literature indicate that a H_2O_2/UV radiation system, an O_3/UV radiation system, or a H_2O_2/O_3/UV radiation system can reduce the organics in the groundwater. A selection of the proper one should be based on economics, process flexibility, process effectiveness, and ease of operation. In evaluating the expansion of the existing plant, these factors should be considered.

A demand on the treatment plant is exerted by ammonia, ferrous ion, manganous ion, and bacteria as well as by the VOCs. This demand must be considered and met when optimizing the plant's operating parameters.

A pretreatment system should be evaluated once the analyses of the sediment in the reaction chamber and the suspended material in the filter is complete. This pretreatment system may reduce the O_3 demand by removing O_3 scavengers and may minimize the downtime from clogged O_3 diffusers.

A continuous O_3 monitor should be installed for the off-gas for process control purposes. The monitor will assist in evaluating the use of O_3 in the reactor and the effectiveness of its transfer from the gaseous to the liquid phase.

An optimization of the plant should be attempted to match flow rate with operating parameters so that a more accurate assessment of the plant's performance can be made. This is difficult while the TOX effluent concentrations are approaching the standard because the changes may jeopardize the plant's ability to comply with the standard. The use of short-term tests and a mechanistic model should assist in this optimization.

Uncorrected O&M costs are much higher than those predicted. Once they are corrected for the low flow rate and sampling costs, they are consistent with those predicted by Ultrox International. In the coming year, emphasis should be placed on a comparative cost evaluation with competing treatment technologies. Before expanding the plant, an economic analysis should be performed again for competing processes. Personnel costs should be reported in FY 1989.

Precipitation in the reaction chambers, coating of the UV lamps, and frequent replacement of the prefilter increased the operations and maintenance time over what was expected. The plant was out of operation 30% of the time.

A few modifications to the evaluation monitoring program should be made as described in Section 4.

8. REFERENCES

1. National Primary Drinking Water Regulations; Synthetic Organic Chemicals, Monitoring for Unregulated Contaminants, Fed. Regist. 52:130:25690 (1987).

2. W. H. Glaze and Joon-Wun Kang, "Advanced Oxidation Processes for Treating Groundwater Contaminated with TCE and PCE: Laboratory Studies," J. Am. Water Works Assoc., 80, pp. 57-63 (May 1988).

3. H. P. Klein, "Ozone for Potable Water Treatment," Middle East Water and Sewage," July/August 1982.

4. E. M. Aieta, K. M. Reagan, J. S. Lang, L. McReynolds, J. Kung, and W. H. Glaze, "Advanced Oxidation Processes for Treating Groundwater Contaminated with TCE and PCE: Pilot-Scale Evaluation," J. Am. Water Works Assoc., 80, pp. 64-72 (May 1988).

5. D. W. Sundstrom, H. E. Klei, T. A. Nalette, D. J. Reidy, and B. A. Weir, "Destruction of Halogenated Aliphatics by UV Catalyzed Oxidation with H_2O_2," Hazard. Wastes Hazard. Mater., 3, (N. 1), 101-110 (1986).

6. Carol Anne Fronk, "Destruction of Volatile Organic Contaminants in Drinking Water by Ozone Treatment," Ozone Sci. Eng., 9, pp. 265-288 (1987).

7. J. P. Duguet, E. Brodard, B. Dussert, and J. Mallevialle. "Improvement in the Effectiveness of Ozonation of Drinking Water Through the Use of H_2O_2," Ozone Sci. Eng. 7, 241 (1985).

8. R. L. Garrison, C. E. Mauk, and H. W. Prengle, Jr. "Advanced Ozone System for Complexed Cyanides," IN: Proceedings, First International Symposium on Ozone for Waste and Wastewater Treatment, ed. R. G. Rice and M. E. Brown, International Ozone Association, Norwalk, Conn., 1975, p. 551.

9. H. W. Prengle, Jr., C. G. Hewes III, and C. E. Mauk, "Oxidation of Refractory Materials by Ozone w/UV Radiation," IN: Proceedings, First International Symposium on Ozone for Waste and Wastewater Treatment, ed. R. G. Rice and M. E. Brown, International Ozone Association, Norwalk, Conn., 1975, p. 551.

10. Eriks Leitis, Jack D. Zeff, and Matthew M. Smith, Chemistry and Application of Ozone and Ozone/UV Light for Water Reuse II, OWR/RU-83/5, U.S. Dept. of Interior, (1983).

11. Mirat D. Gurol and Robert Vatistas, "Oxidation of Phenolic Compounds by Ozone and Ozone + u.v. Radiation: A Comparative Study," Water Res. 21, (8), 895-900 (1987).

12. H. W. Prengle, Jr., Environ. Sci. Technol., 17, 743-747 (1983).

13. J. L. Benoit-Guyod, D. G. Crosby, and J. B. Bowers, "Degradation of MCPA by Ozone and Hight,"Water Res., 20:1, 67-72 (1986).

14. H. Taube, Trans. Faraday Soc., 53, 656 (1957).

15. G. R. Peyton, and William H. Glaze, "Destruction of Pollutants in Water with Ozone in Combination with UV Radiation, 3. Photolysis of Aqueous Ozone," Environ. Sci. Technol., 22, 761-767 (1988).

16. William H. Glaze, Joon-Wum Kang, and Douglas H. Chapin. "The Chemistry of Water Treatment Processes Involving Ozone, H_2O_2 and UV Radiation," Ozone Sci. & Eng., 9, 335-352 (1987).

17. Gary R. Peyton, "Oxy-Radical Treatment Process for the Destruction of Hazardous Organic Compounds in Water," Abstract for presentation to the Division of Environmental Chemistry, American Chemical Society, Toronto, Ontario, Canada, June 5-11, 1988.

18. Gary R. Peyton, M. A. Smith, and B. M. Peyton, "Photolytic Ozonation for Protection and Rehabilitation of Ground-Water Resources; a Mechanistic Study," University of Illinois at Urbana-Champaign, Water Resources Center, Research Report 206 (January 1987).

19. D. B. Fletcher, "UV/Ozone Process Treats Toxics," Water World News, 3, (3) (May/June 1987).

20. K. Brooks, Chemical Week reprint.

21. D. A. Cheuvront, C. L. Giggy, C. G. Loven, and G. H. Sevett, "Groundwater Treatment with Zero Air Emissions," presented at the Petroleum Hydrocarbons and Organic Chemicals in Groundwater Conference, Houston, Texas, November 8-11, 1988.

22. D. G. Hager, C. G. Loven, and C. L. Giggy, "On-Site Chemical Oxidation of Organic Contaminants in Groundwater Using UV Catalyzed Hydrogen Peroxide," presented at AWWA Annual Conference, Orlando, Florida, June 19-23, 1988.

23. D. A. Cheuvront and G. H. Seoett, "Innovative Groundwater Treatment Technologies with Zero Air Emissions," presented at Haymacon 88, Anaheim, California, April 5-7, 1988.

24. David W. Hand, John C. Crittenden, Joseph L. Gehin, and Benjamin W. Lykins, Jr., "Design and Evaluation of an Air-Stripping Tower for Removing VOCs from Groundwater," J. Am. Water Works Assoc., 78, 87-97 (September 1986).

25. O. B. Fletcher, Ultrox International, letter Concerning Analyses Results and Recommendations, P. O. 26199 November 17, 1986.

26. O. B. Fletcher, Ultrox International, letter to J. Fredericks, Allied Bendix Aerospace, December 9, 1986.

27. Ultrox Internationa, "Operation and Maintenance Manual for Model F-725 Ultrox Water Treatment System with G-21 Ozone Generator and 0-50 Hydrogen Peroxide Feed System," prepared for Allied Bendix Aerospace, Kansas City, Mixxour, December 1987.

28. D. D. Miller, Allied-Signal Aerospace Company, letter to S. B. Garland II, author, October 18, 1988..

APPENDIX A

STUDY PLAN

UV/OZONE GROUNDWATER TREATMENT FACILITY EVALUATION

BENDIX KANSAS CITY PLANT

STUDY PLAN

SIDNEY B. GARLAND II, PE
ENVIRONMENTAL SCIENCES DIVISION
OAK RIDGE NATIONAL LABORATORY
OAK RIDGE, TENNESSEE, 1989

MAY, 1989

REVISION 1

TABLE OF CONTENTS

I. PURPOSE

The purposes of this evaluation are to:

- o determine if the technology can meet the discharge standards,
- o determine if the technology can meet its specifications,
- o determine the operation and maintenance costs of the technology,
- o compare the capital, operation, and maintenance costs with other technologies, and
- o evaluate contaminant removal mechanisms.

II. OPERATING PHASES

Operation of the UV/ozone groundwater treatment plant will take place in several phases. Phase 1 is the start-up and commissioning performed by and for the vendor to insure that the treatment system works. The second operational phase is the batch operation necessary to demonstrate that the plant can meet its discharge standards. Treated water from the plant cannot be discharged to the community sanitary sewer until this is demonstrated. When the ability of the treatment plant to meet the discharge standards has been demonstrated, then Phase 3 of the operation will start. During this phase the plant will be operated continuously at a flow rate of approximately 6 gallons per minute (gpm). It will be necessary during this phase to perform optimization studies to determine how far the treatment system can be turned-down from its design flow rate of 25 gpm to the actual flow of 6 gpm. This should be done incrementally by decreasing the ozone flow and then decreasing the number of UV lights that are turned-on. When these levels are selected, then the H_2O_2 dose can be decreased. It will be helpful during this phase to sample along the length of the ozone reaction chamber to see where the discharge standards are being met. If they are met prior to the end of the reaction chamber, then the UV lights and possibly the ozone flow to the remainder of the tank can be stopped. In order to perform this sampling, the sample taps should be installed in all six sections of the reaction chamber. Phase 4 will then begin following the optimization study when steady state conditions at approximately 6 gpm will prevail.

Phase 5 will occur when the flow rate is increased to the design flow rate of 25 gpm. At this time the optimization study will be redone to determine the amount of ozone, number of UV lights, and amount of H_2O_2 necessary. This should be done as discussed above. When the optimization is complete, and a steady state is reached, then phase 6 will begin which will be the long-term operation at 25 gpm.

If the flow rate increases incrementally to 25 gpm, then at each level the optimization study will have to take place.

III. EVALUATION PLAN

A. Introduction

In order to evaluate the performance of the UV/ozone groundwater treatment plant and achieve the objectives stated above, a plan for sampling and analysis, data collection, and data interpretation is necessary. Therefore, the following evaluation plan will be discussed in terms of sampling, operations and maintenance, and design and construction.

B. Sampling

During Phase 1, a certain amount of sampling and analysis was performed to check the equipment and instrumentation and determine if the contaminants were being removed. This information should be provided to the evaluator.

The batch testing of the treatment facility was conducted as Phase 2 to demonstrate its ability to meet the discharge standards. During this Phase samples were collected from the reaction chamber at various time intervals for analysis of those parameters regulated by the discharge permit. This information should be provided to the evaluator also.

During Phases 3 through 6, operations will be continuous, and three types of monitoring will be performed--routine, evaluation, and geochemical. Routine monitoring will be conducted continuously, daily, or monthly and primarily involves those parameters regulated by the discharge permit. Sampling will take place at the influence, after the in-line filter, and after the ozone reaction tank. The parameters to be monitored as part of routine monitoring are shown in Table I.

Evaluation monitoring involves those parameters that are of more interest to evaluating the actual performance of the ground water treatment facility. This monitoring will take place weekly for most parameters at the influent, after the in-line filter, and after the ozone reaction tank. The off gases wil be sampled at the vent prior to the ozone destruct unit and analyzed for total organic halogens to determine how much of the volatile organics are removed by air stripping. Total organic halogens and priority volatile pollutants also will be sampled at each of the six sampling taps along the ozone reaction tank. The parameters to be monitored as part of evaluation monitoring are shown in Table II.

A geochemical analysis of the water will be determined of the influent, after the filter, and after the ozone reaction tank once during Phase 3 or 4 and once during Phase 6, as shown in Table III.

A comprehensive monitoring plan showing the parameters to be monitored, the frequency of monitoring, and the location of sampling is contained in Table IV.

As the monitoring is taking place, and the results are analyzed, then the above sampling schedule may change to reflect what is found. Also, some additional analyses may be needed to determine the degradation products of the treatment process.

Quality control of the sample collection, handling, transportation, and analysis is critical to the reliability of the results and their interpretation. Therefore, the quality control plan of the laboratory should be provided to the evaluator.

C. Operations and Maintenance

Any observations concerning operations and maintenance made during Phase 1 when the manufacturer's representatives were starting-up the treatment plant should be reported so that the ease of start-up and any problems encountered can be documented. This should also be done for Phase 2 during the batch operation.

For Phases 3 through 6 emphasis should be placed on maintaining a record of operations and maintenance expenses and time and an operations log. The operations log should be a checklist of what is to be done each day during the operator's visit, should document the amount of time spent and any special maintenance performed, and should record any observations made, e.g., the color of the water, the amount of foaming, and the amount of scaling on the UV lights.

Since ozone generation and UV radiation are energy intensive operations, the amount of electricity used at the treatment plant should also be documented. Some means of measuring the power usage should be installed. Chemical costs and spare parts costs should be available from purchase orders, but their quantity and costs should be gathered and summarized on a regular basis, perhaps as part of a monthly operations report. Also, the cost of monitoring should be maintained since this will represent an on-going cost. Depending upon the length of time a water treatment plant is operational, the operations cost can amount to 40-80% of the total cost, so it is important to document these costs.

D. Design and Construction

The cost associated with the design and construction of the UV/ozone ground water treatment plant need to be reported so that they can be factored into the cost of this type of treatment. This should include any bench and pilot testing that was performed. This information should be collected and provided to the evaluator.

IV. REQUIRED ACTIONS

In order to complete the evaluation plan described above, it is necessary that the operations check list and log be developed, the sample taps be installed along the ozone reaction chamber, a method of measuring and recording power usage be installed, arrangements for the monitoring be made, design and construction cost data be gathered, and the laboratory's quality control plan be obtained. These actions must be done by personnel at the plant.

V. PROJECT DURATION

It is anticipated that after approximately six months of continuous operation at the design flow rate of 25 gpm, an evaluation of the plant can be prepared. This is not really enough time to get sufficient operations and maintenance data because certain equipment like the UV lights should not need replacement by this time. However, it is sufficient to evaluate treatment performance and predict operations and maintenance costs. A year following the initial report, a follow-up report should be prepared to verify findings and predictions in the initial report.

VI. PROJECT MANAGEMENT

Sidney B. Garland II is the Principal Investigator for this project, and Nic Korte will be the Project Manager. The primary point of contact with the Bendix Kansas City Plant is Dave Brown.

TABLE 1

ROUTINE MONITORING PLAN PARAMETERS

Cadmium	BOD
TSS	Chromium
Copper	Flow
Lead	pH
Nickel	Arsenic
Zinc	Sulfides
Iron	Oil and Grease
Manganese	Total Cyanide
Boron	Total Organic Halogens

TABLE II

EVALUATION MONITORING PLAN PARAMETERS

Sulfite
Nitrite
Nitrate
Ammonia
Sulfate
Priority Volatile Pollutants
Ferrous Ion
Manganous Ion
TOC
Total Plate Count
Off Gases

*The off gases will be analyzed for total organic halogens.

TABLE III

GEOCHEMICAL MONITORING PLAN PARAMETERS*

Calcium
Magnesium
Sodium
Potassium
Sulfate
Chloride
Fluoride
Phosphate
Carbonate
Bicarbonate
Iron

*In addition to concentration, the results for these analyses will also be shown in a Stiff Diagram, or similar graphical presentation.

TABLE IV

COMPREHENSIVE MONITORING PLAN

Frequency	Parameter	Location (1)
Continuous	pH	E
	Flow	I
Daily	BOD	I, AF, E
	TSS	I, AF, E
Weekly	Sulfite	I, AF, E
	Sulfate	I, AF, E
	Sulfides	I, AF, E
	Nitrite	I, AF, E
	Nitrate	I, AF, E
	Ammonia	I, AF, E
	Iron	I, AF, E
	Ferrous Ion	I, AF, E
	Manganous Ion	I, AF, E
	Manganese	I, AF, E
	TOX	I, AF, E, ST
	Priority Volatile Pollutants	I, AF, E, ST
	TOC	I, AF, E, ST
Monthly	Cadmium	I, AF, E
	Chromium	I, AF, E
	Copper	I, AF, E
	Lead	I, AF, E
	Nickel	I, AF, E
	Zinc	I, AF, E
	Iron	I, AF, E
	Manganese	I, AF, E
	Boron	I, AF, E
	Arsenic	I, AF, E
	Sulfides	I, AF, E
	Oil & Grease	I, AF, E
	Total Cyanide	I, AF, E

	Total Plate Count	I, AF, E
	Off Gases (TOX)	T
Twice (2) (3)	Calcium	I, AF, E
	Magnesium	I, AF, E
	Sodium	I, AF, E
	Potassium	I, AF, E
	Chloride	I, AF, E
	Fluoride	I, AF, E
	Phosphate	I, AF, E
	Carbonate	I, AF, E
	Bicarbonate	I, AF, E

(1) I=influent; AF=after the inline filter; E=effluent from ozone reaction tank; ST=6 sample taps on ozone reaction tank; and T=sample tap on air vent.

(2) In addition to concentration, these results will be shown in a Stiff Diagram or in a similar graphical presentation.

(3) These analyses should be performed once during Phases 3 or 4 and once during Phase 6.

APPENDIX B

DATA

TRICHLOROETHENE

				GROUNDWATER TREATMENT PLANT							
					TRICHLOROETHENE						
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	0.440	0.650	-48%	0.055	0.007	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	0.310	0.400	-29%	0.040	0.006	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	0.380	0.390	-3%	0.038	0.007	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	0.416	0.500	-20%	0.044	0.013	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	0.850	0.840	1%	0.035	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	0.266	0.270	-2%	0.039	0.008	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	0.591	0.248	58%	0.072	0.015	<.005	0.005	<.005	<.005	<.005	06/24/88
06/30/88	0.574	0.451	21%	0.048	0.010	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	0.420	0.600	-43%	0.094	0.024	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	0.510	0.490	4%	0.080	0.016	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	0.632	0.647	-2%	0.063	0.018	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	0.578	0.696	-20%	0.099	0.033	0.007	0.006	<.005	<.005	<.005	08/05/88
08/12/88	0.540	0.830	-54%	0.114	0.047	0.010	0.009	<.005	<.005	<.005	08/12/88
08/19/88	0.956	1.240	-30%	0.101	0.045	0.009	0.008	<.005	<.005	<.005	08/19/88
08/30/88	0.320	0.480	-50%	0.188	0.083	0.028	0.012	<.005	<.005	<.005	08/30/88
09/02/88	0.540	0.440	19%	0.238	0.068	0.026	0.011	<.005	<.005	<.005	09/02/88

GROUNDWATER TREATMENT PLANT
STYRENE

DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

1,1-DICHLOROETHENE

GROUNDWATER TREATMENT PLANT
1,1-DICHLOROETHENE

DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	0.007	0.013	-86%	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	0.009	0.013	-44%	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	0.013	0.013	0%	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	0.019	0.024	-26%	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	0.010	0.010	0%	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	0.012	0.013	-8%	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	0.033	0.012	64%	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	0.008	0.008	0%	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	0.013	0.020	-54%	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	0.020	0.016	20%	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	0.017	0.019	-12%	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	0.015	0.018	-20%	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	0.011	0.023	-109%	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	0.010	0.014	-40%	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	0.010	0.018	-80%	0.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	0.020	0.018	10%	0.007	<.005	<.005	<.005	0.005	<.005	<.005	09/02/88

1,2-DICHLOROETHANE

			GROUNDWATER TREATMENT PLANT							
				1,2-DICHLOROETHANE						
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	0.026	0.034	<.005	<.005	<.005	09/02/88

BROMOMETHANE

			GROUNDWATER TREATMENT PLANT							
				BROMOMETHANE						
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	05/06/88
05/13/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	05/13/88
05/20/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	05/20/88
05/27/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	05/27/88
06/03/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	06/03/88
06/10/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	06/10/88
06/24/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	06/24/88
06/30/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	06/30/88
07/15/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	07/15/88
07/22/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	07/22/88
07/29/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	07/29/88
08/05/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	08/05/88
08/12/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	08/12/88
08/19/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	08/19/88
08/30/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	08/30/88
09/02/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	09/02/88

CHLOROMETHANE

			GROUNDWATER TREATMENT PLANT							
			CHLOROMETHANE							
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	05/06/88
05/13/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	05/13/88
05/20/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	05/20/88
05/27/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	05/27/88
06/03/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	06/03/88
06/10/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	06/10/88
06/24/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	06/24/88
06/30/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	06/30/88
07/15/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	07/15/88
07/22/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	07/22/88
07/29/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	07/29/88
08/05/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	08/05/88
08/12/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	08/12/88
08/19/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	08/19/88
08/30/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	08/30/88
09/02/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	09/02/88

CHLOROETHANE

			GROUNDWATER TREATMENT PLANT							
				CHLOROETHANE						
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	05/06/88
05/13/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	05/13/88
05/20/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	05/20/88
05/27/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	05/27/88
06/03/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	06/03/88
06/10/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	06/10/88
06/24/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	06/24/88
06/30/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	06/30/88
07/15/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	07/15/88
07/22/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	07/22/88
07/29/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	07/29/88
08/05/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	08/05/88
08/12/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	08/12/88
08/19/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	08/19/88
08/30/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	08/30/88
09/02/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	09/02/88

ACETONE

GROUNDWATER TREATMENT PLANT

ACETONE

DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

CARBON DISULFIDE

			GROUNDWATER TREATMENT PLANT							
			CARBON DISULFIDE							
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

			GROUNDWATER TREATMENT PLANT							
			2-BUTANONE							
	INFLUENT	INFLUENT	REACTION	REACTION	REACTION	REACTION	REACTION	REACTION	EFFLUENT	
DATE	BEFORE	AFTER	CHAMBER	CHAMBER	CHAMBER	CHAMBER	CHAMBER	CHAMBER	GRAB	DATE
	FILTERING	FILTERING	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6		
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

TRANS-1,3-DICHLOROPROPENE

GROUNDWATER TREATMENT PLANT TRANS-1,3-DICHLOROPROPENE										
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

VINYL ACETATE

			GROUNDWATER TREATMENT PLANT							
				VINYL ACETATE						
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

BROMODICHLOROMETHANE

			GROUNDWATER TREATMENT PLANT							
			BROMODICHLOROMETHANE							
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

1,2-DICHLOROPROPANE

			GROUNDWATER TREATMENT PLANT 1,2-DICHLOROPROPANE							
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

cis-1,3-DICHLOROPROPENE

GROUNDWATER TREATMENT PLANT

cis-1,3-DICHLOROPROPENE

DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

DIBROMOCHLOROMETHANE

GROUNDWATER TREATMENT PLANT
DIBROMOCHLOROMETHANE

DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

1,1,2-TRICHLOROETHANE

			GROUNDWATER TREATMENT PLANT							
				1,1,2-TRICHLOROETHANE						
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

BENZENE

			GROUNDWATER TREATMENT PLANT							
				BENZENE						
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

BROMOFORM

GROUNDWATER TREATMENT PLANT
BROMOFORM

DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
			GROUNDWATER TREATMENT PLANT 4-METHYL-2-PENTANONE							
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

2-HEXANONE

			GROUNDWATER TREATMENT PLANT							
				2-HEXANONE						
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

1,1,2,2-TETRACHLOROETHANE

			GROUNDWATER TREATMENT PLANT							
			1,1,2,2-TETRACHLOROETHANE							
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

CHLOROBENZENE

			GROUNDWATER TREATMENT PLANT							
			CHLOROBENZENE							
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

			GROUNDWATER TREATMENT PLANT							
				ETHYLBENZENE						
	INFLUENT	INFLUENT	REACTION	REACTION	REACTION	REACTION	REACTION	REACTION	EFFLUENT	
DATE	BEFORE	AFTER	CHAMBER	CHAMBER	CHAMBER	CHAMBER	CHAMBER	CHAMBER	GRAB	DATE
	FILTERING	FILTERING	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6		
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

XYLENE

			GROUNDWATER TREATMENT PLANT XYLENE							
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

METHYLENE CHLORIDE

			GROUNDWATER TREATMENT PLANT							
				METHYLENE CHLORIDE						
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	0.160	<.005	0.170	0.140	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	0.100	0.035	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

1,1-DICHLOROETHANE

GROUNDWATER TREATMENT PLANT

1,1-DICHLOROETHANE

DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	0.014	0.017	-21%	0.010	0.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	0.006	0.007	-17%	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	0.016	0.018	-13%	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	0.020	0.025	-25%	0.009	0.006	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	0.020	0.014	30%	0.006	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	0.017	0.016	6%	0.009	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	0.049	0.016	67%	0.007	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	0.015	0.013	13%	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	0.018	0.030	-67%	0.011	0.006	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	0.020	0.020	0%	0.011	0.007	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	0.022	0.021	5%	0.012	0.009	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	0.024	0.031	-29%	0.016	0.012	0.006	0.006	<.005	<.005	<.005	08/05/88
08/12/88	0.017	0.032	-88%	0.014	0.011	<.005	0.005	<.005	<.005	<.005	08/12/88
08/19/88	0.017	0.021	-24%	0.014	0.011	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	0.015	0.026	-73%	0.019	0.013	0.008	0.006	<.005	<.005	<.005	08/30/88
09/02/88	0.025	0.024	4%	0.019	0.012	0.008	0.006	0.006	<.005	<.005	09/02/88

VINYL CHLORIDE

GROUNDWATER TREATMENT PLANT

VINYL CHLORIDE

DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	05/06/88
05/13/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	05/13/88
05/20/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	05/20/88
05/27/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	05/27/88
06/03/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	06/03/88
06/10/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	06/10/88
06/24/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	06/24/88
06/30/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	06/30/88
07/15/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	07/15/88
07/22/88	0.030	0.020	<.010	<.010	<.010	<.010	<.010	<.010	<.010	07/22/88
07/29/88	0.038	0.039	<.010	<.010	<.010	<.010	<.010	<.010	<.010	07/29/88
08/05/88	0.046	0.031	<.010	<.010	<.010	<.010	<.010	<.010	<.010	08/05/88
08/12/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	08/12/88
08/19/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	08/19/88
08/30/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	08/30/88
09/02/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	09/02/88

CHLOROFORM

			GROUNDWATER TREATMENT PLANT							
			CHLOROFORM							
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	0.013	<.005	0.007	0.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	0.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	0.007	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	0.020	0.014	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	0.017	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	0.005	0.005	<.005	0.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	0.010	0.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	0.005	0.006	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	0.007	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

1,2-DICHLOROETHENE

				GROUNDWATER TREATMENT PLANT							
					1,2-DICHLOROETHENE						
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	0.400	0.780	-95%	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	0.490	0.630	-29%	0.047	0.006	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	0.570	0.570	0%	0.044	0.007	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	0.800	0.980	-23%	0.061	0.016	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	0.010	0.010	0%	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	0.615	0.660	-7%	0.073	0.013	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	1.303	0.517	60%	0.080	0.017	0.006	0.007	<.005	<.005	<.005	06/24/88
06/30/88	0.879	0.704	20%	0.068	0.013	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	0.610	0.940	-54%	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	0.790	0.770	3%	0.106	0.017	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	0.920	0.940	-2%	0.091	0.027	0.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	0.110	1.102	-902%	0.146	0.043	0.008	0.009	<.005	<.005	<.005	08/05/88
08/12/88	0.690	1.160	-68%	0.132	0.054	<.005	0.008	<.005	<.005	<.005	08/12/88
08/19/88	1.420	1.715	-21%	0.103	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	0.660	1.130	-71%	0.330	0.150	0.040	0.020	<.005	<.005	<.005	08/30/88
09/02/88	1.110	1.060	5%	0.486	0.150	0.054	0.018	0.006	<.005	<.005	09/02/88

1,1,1-TRICHLOROETHANE

			GROUNDWATER TREATMENT PLANT 1,1,1-TRICHLOROETHANE							
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.005	<.005	0.007	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	0.013	0.017	0.007	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	0.018	0.021	0.007	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	0.017	0.023	0.006	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	0.013	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	0.007	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	0.017	<.005	0.009	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	0.022	0.020	0.010	0.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	0.022	0.027	0.009	0.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	0.020	0.030	0.008	0.006	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	0.020	<.005	0.012	0.012	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	0.014	0.022	0.013	0.008	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	0.021	0.018	0.013	0.006	<.005	<.005	<.005	<.005	<.005	09/02/88

CARBON TETRACHLORIDE

			GROUNDWATER TREATMENT PLANT							
				CARBON TETRACHLORIDE						
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

TOLUENE

			GROUNDWATER TREATMENT PLANT							
					TOLUENE					
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	0.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	09/02/88

TETRACHLOROETHENE

			GROUNDWATER TREATMENT PLANT							
				TETRACHLOROETHENE						
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	DATE
05/06/88	0.022	0.050	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/06/88
05/13/88	0.029	0.045	0.008	<.005	<.005	<.005	<.005	<.005	<.005	05/13/88
05/20/88	0.038	0.048	0.007	<.005	<.005	<.005	<.005	<.005	<.005	05/20/88
05/27/88	0.050	0.066	<.005	<.005	<.005	<.005	<.005	<.005	<.005	05/27/88
06/03/88	0.068	0.066	0.008	<.005	<.005	<.005	<.005	<.005	<.005	06/03/88
06/10/88	<.005	<.005	0.011	<.005	<.005	<.005	<.005	<.005	<.005	06/10/88
06/24/88	0.084	0.029	0.010	<.005	<.005	<.005	<.005	<.005	<.005	06/24/88
06/30/88	0.033	0.030	0.005	<.005	<.005	<.005	<.005	<.005	<.005	06/30/88
07/15/88	0.040	0.077	0.018	<.005	<.005	<.005	<.005	<.005	<.005	07/15/88
07/22/88	0.066	0.060	0.013	0.005	<.005	<.005	<.005	<.005	<.005	07/22/88
07/29/88	0.058	0.068	0.011	<.005	<.005	<.005	<.005	<.005	<.005	07/29/88
08/05/88	0.041	0.064	0.013	<.005	<.005	<.005	<.005	<.005	<.005	08/05/88
08/12/88	0.024	0.054	0.011	0.005	<.005	<.005	<.005	<.005	<.005	08/12/88
08/19/88	0.043	0.065	0.006	<.005	<.005	<.005	<.005	<.005	<.005	08/19/88
08/30/88	0.023	0.038	0.023	0.011	<.005	<.005	<.005	<.005	<.005	08/30/88
09/02/88	0.040	0.034	0.019	0.007	<.005	<.005	<.005	<.005	<.005	09/02/88

SULFATE

GROIUNDWATER TREATMENT PLANT					
		SULFATE			
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	EFFLUENT GRAB MG/L	PERCENT REMOVAL TOTAL %
05/06/88	72.00	84.00	-17%	62.00	14%
05/13/88	66.00	70.00	-6%	66.00	0%
05/20/88	74.00	60.00	19%	53.00	28%
05/27/88	68.00	75.00	-10%	66.00	3%
06/03/88	75.00	65.00	13%	63.00	16%
06/10/88	56.00	57.00	-2%	56.00	0%
06/24/88	72.00	79.00	-10%	63.00	13%
06/30/88	70.00	56.00	20%	70.00	0%
07/15/88	50.00	39.00	22%	61.00	-22%
07/22/88	53.00	49.00	8%	42.00	21%
07/29/88	60.00	67.00	-12%	45.00	25%
08/05/88	63.00	47.00	25%	60.00	5%
08/12/88	60.00	61.00	-2%	94.00	-57%
08/19/88	77.00	87.00	-13%	74.00	4%
08/30/88	58.00	55.00	5%	48.00	17%
09/02/88	70.00	51.00	27%	42.00	40%

GROUNDWATER TREATMENT PLANT
TOTAL ORGANIC CARBON

DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	PERCENT REMOVAL BY CHAMBERS %	PERCENT REMOVAL TOTAL %
05/06/88	7.30	6.80	7%	7.40	8.00	6.90	6.70	6.40	5.60	5.10	25%	30%
05/13/88	17.60	7.20	59%	4.40	6.40	5.80	2.30	3.50	2.70	15.30	-113%	13%
05/20/88	5.90	4.60	22%	4.80	2.40	5.60	6.00	4.00	3.20	4.70	-2%	20%
05/27/88	4.10	2.50	39%	3.00	2.70	3.00	3.10	3.20	2.50	3.60	-44%	12%
06/03/88	3.70	4.20	-14%	4.60	3.70	2.50	3.90	1.90	3.00	3.60	14%	3%
06/10/88	3.50	9.10	-160%	2.80	2.10	1.80	6.60	1.70	2.00	4.30	53%	-23%
06/24/88	4.20	3.50	17%	4.10	2.80	2.60	4.30	3.80	4.30	2.30	34%	45%
06/30/88	4.20	5.60	-33%	5.10	4.10	10.40	3.30	4.30	3.50	3.30	41%	21%
07/15/88	4.40	7.10	-61%	4.40	3.50	3.70	3.90	3.20	2.60	5.20	27%	-18%
07/22/88	4.20	2.80	33%	3.70	3.10	3.10	2.60	4.00	2.40	3.00	-7%	29%
07/29/88	2.30	4.50	-96%	2.20	2.60	2.50	2.90	2.20	2.20	3.50	22%	-52%
08/05/88	3.80	4.60	-21%	3.70	2.80	2.60	4.20	3.10	2.80	2.60	43%	32%
08/12/88	5.50	4.90	11%	4.80	5.10	3.00	3.80	2.70	6.00	1.70	65%	69%
08/19/88	12.80	4.20	67%	3.40	3.50	3.80	4.60	3.90	4.10	3.60	14%	72%
08/30/88	3.70	4.30	-16%	5.60	4.10	3.80	4.90	4.90	3.80	4.70	-9%	-27%
09/02/88	3.30	4.40	-33%	3.30	6.80	5.40	3.60	6.20	4.40	2.80	36%	15%

SULFITE

GROUNDWATER TREATMENT PLANT			
	SULFITE		
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	EFFLUENT GRAB MG/L
05/06/88	<.5	<.5	<.5
05/13/88	<.5	<.5	<.5
05/20/88	<.5	<.5	<.5
05/27/88	<.5	<.5	<.5
06/03/88	<.5	<.5	<.5
06/10/88	<.5	<.5	<.5
06/24/88	<.5	<.5	<.5
06/30/88	<.5	<.5	<.5
07/15/88	<.5	<.5	<.5
07/22/88	<.5	<.5	<.5
07/29/88	<.5	<.5	<.5
08/05/88	<.5	<.5	<.5
08/12/88	<.5	<.5	<.5
08/19/88	<.5	<.5	<.5
08/30/88	<.5	<.5	<.5
09/02/88	<.5	<.5	<.5

FERROUS ION

GROIUNDWATER TREATMENT PLANT			
	FERROUS ION		
	INFLUENT	INFLUENT	EFFLUENT
DATE	BEFORE	AFTER	GRAB
	FILTERING	FILTERING	
	MG/L	MG/L	MG/L
05/06/88	0.17	0.18	0.04
05/13/88	0.48	0.14	0.03
05/20/88	1.61	0.69	0.25
05/27/88	1.75	2.66	0.32
06/03/88	1.62	0.42	0.25
06/10/88	5.36	1.86	0.51
06/24/88	1.63	1.33	0.51
06/30/88	2.05	0.20	0.23
07/15/88	1.30	<.05	<.05
07/22/88	3.53	0.50	1.17
07/29/88	5.71	5.31	5.42
08/05/88	6.13	2.53	1.65
08/12/88	<.05	<.05	<.05
08/19/88	<.05	<.05	<.05
08/30/88	<.05	<.05	<.05
09/02/88	1.39	<.05	<.05

AMMONIA

	GROIUNDWATER TREATMENT PLANT			
		AMMONIA		
	INFLUENT	INFLUENT	PERCENT	EFFLUENT
DATE	BEFORE	AFTER	REMOVAL BY	GRAB
	FILTERING	FILTERING	FILTERING	
	MG/L	MG/L	%	MG/L
05/06/88	0.76	0.74	3%	0.70
05/13/88	0.83	0.73	12%	0.63
05/20/88	0.77	0.89	-16%	0.76
05/27/88	0.95	0.83	13%	0.69
06/03/88	0.74	1.24	-68%	0.69
06/10/88	0.92	0.80	13%	0.83
06/24/88	0.81	0.85	-5%	0.90
06/30/88	0.90	0.77	14%	0.77
07/15/88	1.00	0.68	32%	<.01
07/22/88	0.65	0.65	0%	0.28
07/29/88	0.72	0.73	-1%	0.71
08/05/88	0.82	0.77	6%	0.70
08/12/88	0.72	0.83	-15%	0.74
08/19/88	0.74	0.79	-7%	0.66
08/30/88	0.83	0.68	18%	0.83
09/02/88	0.83	0.86	-4%	0.86

MANGANOUS ION

GROIUNDWATER TREATMENT PLANT			
	MANGANOUS ION		
	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	EFFLUENT GRAB MG/L
DATE			
05/06/88	5.91	<.2	<.2
05/13/88	3.90	6.85	<.2
05/20/88	6.90	6.50	1.09
05/27/88	7.39	6.50	0.26
06/03/88	6.82	7.58	<.2
06/10/88	6.63	6.88	<.2
06/24/88	6.82	7.50	<.2
06/30/88	5.65	5.68	4.05
07/15/88	3.51	4.87	<.2
07/22/88	7.47	7.88	1.22
07/29/88	8.39	2.91	7.66
08/05/88	2.28	8.92	6.51
08/12/88	7.63	8.06	5.13
08/19/88	7.68	8.03	4.50
08/30/88	8.13	7.88	6.47
09/02/88	7.88	8.28	6.13

GROUNDWATER TREATMENT PLANT			
	NITRATE		
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	EFFLUENT GRAB MG/L
05/06/88	<.10	<.10	3.21
05/13/88	0.20	0.29	3.66
05/20/88	<.10	0.14	3.70
05/27/88	<.10	<.10	3.55
06/03/88	0.20	0.20	3.90
06/10/88	<.10	<.10	3.50
06/24/88	<.10	<.10	2.90
06/30/88	<.10	<.10	<.10
07/15/88	<.10	<.10	2.00
07/22/88	<.10	<.10	1.70
07/29/88	0.60	<.10	2.80
08/05/88	0.20	0.10	3.40
08/12/88	<.10	6.90	2.40
08/19/88	0.20	<.10	2.40
08/30/88	<.10	<.10	2.50
09/02/88	<.10	<.10	2.40

GROUNDWATER TREATMENT PLANT			
	NITRITE		
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	EFFLUENT GRAB MG/L
05/06/88	<.10	<.10	<.10
05/13/88	<.10	<.10	<.10
05/20/88	<.10	<.10	<.10
05/27/88	<.10	<.10	<.10
06/03/88	<.10	<.10	<.10
06/10/88	<.10	<.10	<.10
06/24/88	<.10	<.10	<.10
06/30/88	<.10	<.10	<.10
07/15/88	<.10	<.10	0.90
07/22/88	<.10	<.10	0.80
07/29/88	0.60	<.10	<.10
08/05/88	<.10	<.10	<.10
08/12/88	<.10	<.10	<.10
08/19/88	<.10	<.10	<.10
08/30/88	<.10	<.10	<.10
09/02/88	<.10	<.10	<.10

SULFIDES

	GROUNDWATER TREATMENT PLANT			
		SULFIDES		
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	EFFLUENT GRAB MG/L	MONTHLY COMPOSITE EFFLUENT MG/L
05/06/88	<.5	<.5	<.5	
05/13/88	<.5	<.5	<.5	
05/20/88	<.5	4.00	<.5	
05/27/88	<.5	2.90	<.5	<.5
06/03/88	<.5	<.5	<.5	
06/10/88	<.5	<.5	<.5	
06/24/88	<.5	<.5	<.5	<.5
06/30/88	<.5	<.5	<.5	
07/15/88	<.5	<.5	<.5	
07/22/88	<.5	<.5	<.5	
07/29/88	0.60	<.5	<.5	<.5
08/05/88	<.5	<.5	<.5	
08/12/88	<.5	<.5	<.5	
08/19/88	<.5	<.5	<.5	
08/30/88	<.5	<.5	<.5	<.5
09/02/88	0.70	<.5	<.5	

TOX

GROUNDWATER TREATMENT PLANT

TOTAL ORGANIC HALOGENS

DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L	PERCENT REMOVAL BY CHAMBERS %	PERCENT REMOVAL MG/L	EFFLUENT COMPOSITE MG/L
05/06/88	0.312	0.488	-56%	0.049	0.055	0.058	0.025	0.047	0.058	0.061	88%	80%	
05/13/88	0.269	0.275	-2%	0.180	0.177	0.266	0.175	0.080	0.072	0.093	66%	65%	
05/20/88	0.240	0.273	-14%	0.176	0.130	0.132	0.107	0.059	0.065	0.042	85%	83%	
05/27/88	0.583	0.178	69%	0.231	0.087	0.081	0.069	0.068	0.074	0.097	46%	83%	0.090
06/03/88	0.374	0.194	48%	0.157	0.118	0.082	0.094	0.033	0.022	0.071	63%	81%	
06/10/88	0.520	0.377	28%	0.102	0.059	0.057	0.046	0.059	0.020	0.044	88%	92%	
06/24/88	0.331	0.133	60%	0.083	0.032	0.041	0.024	0.022	0.027	0.073	45%	78%	0.085
06/30/88	0.307	0.166	46%	0.086	0.046	0.063	0.045	0.053	0.044	0.066	60%	79%	
07/15/88	0.119	0.131	-10%	0.116	0.110	0.087	0.111	0.038	0.010	0.025	81%	79%	
07/22/88	0.228	0.220	4%	0.093	0.094	0.097	0.143	0.072	0.087	0.073	67%	68%	
07/29/88	0.210	0.167	20%	0.120	0.096	0.078	0.075	0.074	0.056	0.023	86%	89%	0.048
08/05/88	0.274	0.304	-11%	0.159	0.142	0.078	0.095	0.050	0.067	0.070	77%	74%	
08/12/88	0.275	0.298	-8%	0.215	0.139	0.064	0.051	0.043	0.010	0.010	97%	96%	
08/19/88	0.247	0.390	-58%	0.218	0.129	0.061	0.061	0.088	0.083	0.095	76%	62%	
08/30/88	0.387	0.369	5%	0.161	0.155	0.072	0.062	0.055	0.051	0.147	60%	62%	0.137
09/02/88	0.318	0.268	16%	0.177	0.145	0.110	0.114	0.103	0.095	0.120	55%	62%	

OIL AND GREASE

	GROUNDWATER TREATMENT PLANT			
	OIL AND GREASE			
	INFLUENT	INFLUENT	EFFLUENT	MONTHLY
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING		EFFLUENT
	MG/L	MG/L	MG/L	MG/L
05/27/88	21.00	1.00	1.80	2.00
06/24/88	1.80	1.20	0.60	0.50
07/29/88	<.5	<.5	<.5	<.5
08/30/88	3.40	0.50	<.5	<.5

IRON

		GROIUNDWATER TREATMENT PLANT				
			IRON			
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	EFFLUENT GRAB MG/L	PERCENT REMOVAL TOTAL MG/L	MONTHLY COMPOSITE EFFLUENT MG/L
05/06/88	23.40	2.68	89%	3.98	83%	
05/13/88	130.00	2.06	98%	2.57	98%	
05/20/88	16.50	2.84	83%	3.97	76%	
05/27/88	16.50	3.73	77%	3.37	80%	3.30
06/03/88	86.00	2.25	97%	4.65	95%	
06/10/88	77.90	2.42	97%	3.80	95%	
06/24/88	22.70	2.45	89%	2.80	88%	2.63
06/30/88	48.10	1.96	96%	2.69	94%	
07/15/88	115.00	4.93	96%	6.25	95%	
07/22/88	7.72	6.48	16%	7.32	5%	
07/29/88	8.25	6.60	20%	6.42	22%	2.72
08/05/88	5.92	2.87	52%	6.51	-10%	
08/12/88	1.54	0.45	71%	0.78	49%	
08/19/88	11.10	3.74	66%	8.53	23%	
08/30/88	7.48	4.66	38%	4.89	35%	5.21
09/02/88	7.58	4.63	39%	5.61	26%	

MANGANESE

		GROIUNDWATER TREATMENT PLANT				
			MANGANESE			
	INFLUENT	INFLUENT	PERCENT	EFFLUENT	PERCENT	MONTHLY
DATE	BEFORE	AFTER	REMOVAL BY	GRAB	REMOVAL	COMPOSITE
	FILTERING	FILTERING	FILTERING		TOTAL	EFFLUENT
	MG/L	MG/L	%	MG/L	MG/L	MG/L
05/06/88	5.54	5.18	6%	6.27	-13%	
05/13/88	7.46	6.54	12%	8.73	-17%	
05/20/88	7.46	6.22	17%	7.27	3%	
05/27/88	7.39	6.55	11%	2.65	64%	6.07
06/03/88	7.50	5.15	31%	8.50	-13%	
06/10/88	5.16	5.31	-3%	7.68	-49%	
06/24/88	6.13	6.80	-11%	6.32	-3%	1.65
06/30/88	5.65	5.35	5%	5.48	3%	
07/15/88	6.36	4.97	22%	5.94	7%	
07/22/88	7.05	7.01	1%	7.77	-10%	
07/29/88	6.62	6.94	-5%	6.64	0%	2.67
08/05/88	5.57	5.30	5%	6.24	-12%	
08/12/88	5.73	6.21	-8%	7.00	-22%	
08/19/88	5.59	4.89	13%	7.18	-28%	
08/30/88	5.55	5.40	3%	5.67	-2%	4.97
09/02/88	5.91	5.87	1%	5.65	4%	

ARSENIC

	GROUNDWATER TREATMENT PLANT			
		ARSENIC		
	INFLUENT	INFLUENT	MONTHLY	MONTHLY
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING	EFFLUENT	EFFLUENT
	MG/L	MG/L	MG/L	MG/L
05/27/88	0.064	0.013	0.018	0.020
06/24/88	0.014	0.010	0.016	0.001
07/29/88	0.051	0.047	0.039	0.031
08/30/88	0.018	0.017	0.021	0.020

	GROUNDWATER TREATMENT PLANT BORON			
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	MONTHLY GRAB EFFLUENT MG/L	MONTHLY COMPOSITE EFFLUENT MG/L
05/27/88	0.209	0.133	0.068	0.115
06/24/88	0.164	0.125	0.079	0.094
07/29/88	0.014	0.085	0.121	0.087
08/30/88	0.098	0.106	0.101	0.100

CADMIUM

	GROUNDWATER TREATMENT PLANT			
		CADMIUM		
	INFLUENT	INFLUENT	MONTHLY	MONTHLY
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING	EFFLUENT	EFFLUENT
	MG/L	MG/L	MG/L	MG/L
05/27/88	0.010	0.002	0.001	0.002
06/24/88	0.004	0.002	0.002	0.004
07/29/88	0.004	0.003	0.003	0.002
08/30/88	0.005	0.006	0.004	0.004

CHROMIUM

	GROUNDWATER TREATMENT PLANT			
		CHROMIUM		
	INFLUENT	INFLUENT	MONTHLY	MONTHLY
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING	EFFLUENT	EFFLUENT
	MG/L	MG/L	MG/L	MG/L
05/27/88	0.016	<.010	0.025	0.026
06/24/88	0.023	<.010	0.011	0.012
07/29/88	0.013	0.011	0.012	0.011
08/30/88	0.016	0.015	0.013	0.012

LEAD

	GROUNDWATER TREATMENT PLANT			
		LEAD		
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	MONTHLY GRAB EFFLUENT MG/L	MONTHLY COMPOSITE EFFLUENT MG/L
05/27/88	0.100	0.060	0.110	0.040
06/24/88	0.068	0.030	0.051	0.090
07/29/88	0.089	0.051	0.054	0.034
08/30/88	0.012	0.013	0.016	0.018

NICKEL

	GROUNDWATER TREATMENT PLANT			
		NICKEL		
	INFLUENT	INFLUENT	MONTHLY	MONTHLY
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING	EFFLUENT	EFFLUENT
	MG/L	MG/L	MG/L	MG/L
05/27/88	0.016	<.010	0.012	0.015
06/24/88	0.019	<.010	<.010	0.016
07/29/88	0.026	0.015	0.013	<.010
08/30/88	0.033	0.022	0.020	0.020

	GROUNDWATER TREATMENT PLANT			
	TOTAL CYANIDE			
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	MONTHLY GRAB EFFLUENT MG/L	MONTHLY COMPOSITE EFFLUENT MG/L
05/27/88	<.001	<.001	0.002	<.001
06/24/88	<.001	<.001	<.001	<.001
07/29/88	<.001	<.001	<.001	<.001
08/30/88	0.001	<.001	0.001	<.001

TOTAL PLATE COUNT

	GROUNDWATER TREATMENT PLANT TOTAL PLATE COUNT		
DATE	INFLUENT BEFORE FILTERING PER ML	INFLUENT AFTER FILTERING PER ML	MONTHLY GRAB EFFLUENT PER ML
05/27/88	13,000	1,100	12
06/24/88	2,900	60	2
07/29/88	4,200	580	7
08/30/88	4,700	3,700	181

ZINC

	GROUNDWATER TREATMENT PLANT			
		ZINC		
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	MONTHLY GRAB EFFLUENT MG/L	MONTHLY COMPOSITE EFFLUENT MG/L
05/27/88	0.540	0.140	0.025	0.021
06/24/88	0.263	0.021	0.033	0.027
07/29/88	0.464	0.058	0.045	0.021
08/30/88	0.722	0.040	0.141	0.011

MONTHLY FLOWS

	GROUNDWATER TREATMENT PLANT		
	FLOW MONITORING		
MONTH	FLOW	FLOW	PERCENT OF
	GALLONS	GAL/MIN	DESIGN FLOW
AVERAGE	95,354	3.21	13%
MAXIMUM	134,970	4.57	18%
MINIMUM	4,052	0.40	2%
MAY '88	134,970	3.47	14%
JUNE	115,730	3.49	14%
JULY	92,070	4.57	18%
AUGUST	129,950	4.10	16%
SEPTEMBER	4,052	0.40	2%

FLOW MAY88

		CUMMULATIVE FLOW				
			GALLONS			
DATE	P-1	P-2	P-3	TOTAL		
05/04/88	3,430	2,130	4,960	10,520		
05/05/88	6,000	3,600	7,920	17,520		
05/06/88						
05/07/88						
05/08/88						
05/09/88	15,700	9,070	18,760	43,530		
05/10/88	18,160	10,350	20,690	49,200		
05/11/88	23,180	11,750	**20,480**	34,930		
05/12/88	**22,420**	12,850	25,140	37,990		
05/13/88	28,040	14,400	25,210	67,650		
05/14/88						
05/15/88						
05/16/88	**35,300**	18,050	32,060	50,110		
05/17/88	33,900	19,480	37,810	91,190		
05/18/88	36,360	20,900	40,580	97,840		
05/19/88	38,360	22,160	42,980	103,500		
05/20/88	40,780	23,530	45,370	109,680		
05/21/88						
05/22/88						
05/23/88	41,610	24,110	46,310	112,030		
05/24/88	43,330	25,230	48,030	116,590		
05/26/88	44,610	26,140	49,400	120,150		
05/27/88	45,660	26,850	50,560	123,070		
05/28/88						
05/29/88						
05/30/88						PERCENT
05/31/88	53,580	32,150	59,760	145,490	FLOW	OF DESIGN
					GPM	FLOW
		TOTAL GALLONS FOR MONTH		134,970	3.47	14%

FLOW JUN88

		CUMMULATIVE FLOW				
			GALLONS			
DATE	P - 1	P - 2	P - 3	TOTAL		
06/03/88	60,370	35,700	66,980	163,050		
06/04/88						
06/05/88						
06/06/88	62,640	37,080	69,340	169,060		
06/07/88	64,870	37,860	71,840	174,570		
06/09/88	68,790	40,720	76,390	185,900		
06/10/88	70,850	42,250	79,030	192,130		
06/11/88						
06/12/88						
06/13/88	74,790	45,930	82,880	203,600		
06/15/88	79,320	48,780	86,990	215,090		
06/16/88	81,700	50,260	89,260	221,220		
06/20/88	82,430	50,810	89,940	223,180		
06/21/88	84,400	52,340	92,210	228,950		
06/22/88	86,510	54,010	94,560	235,080		
06/23/88	88,430	55,490	96,660	240,580		
06/24/88	90,640	56,970	98,760	246,370		
06/25/88						
06/26/88						
06/27/88	96,400	60,690	103,020	260,110		
06/28/88	98,870	62,230	105,550	266,650		
06/29/88	100,800	63,770	107,850	272,420		PERCENT
06/30/88	103,270	65,300	110,210	278,780	FLOW	OF DESIGN
					GPM	FLOW
		TOTAL GALLONS FOR MONTH		115,730	3.49	14%

FLOW JUL88

		CUMMULATIVE FLOW				
			GALLONS			
DATE	P - 1	P - 2	P - 3	TOTAL		
07/11/88	103,550	65,570	110,540	279,660		
07/12/88	105,980	67,400	112,600	285,980		
07/13/88	108,340	68,980	114,660	291,980		
07/14/88	110,760	70,560	116,540	297,860		
07/18/88	116,080	72,790	119,300	308,170		
07/20/88	121,400	74,710	124,410	320,520		
07/21/88	123,820	75,580	126,610	326,010		
07/22/88	126,750	77,090	129,510	333,350		
07/23/88						
07/24/88						
07/25/88	134,150	80,890	136,850	351,890		
07/26/88	136,860	82,200	139,500	358,560		
07/27/88	139,480	83,520	142,190	365,190		
07/28/88	142,130	84,770	144,830	371,730		
						PERCENT
					FLOW	OF DESIGN
					GPM	FLOW
		TOTAL GALLONS FOR MONTH		92,070	4.57	18%

FLOW AUG88

		CUMMULATIVE FLOW				
			GALLONS			
DATE	P - 1	P - 2	P - 3	TOTAL		
08/01/88	153,350	89,780	155,730	398,860		
08/02/88	156,070	91,000	158,230	405,300		
08/03/88	158,340	92,010	160,330	410,680		
08/04/88	160,770	93,140	162,800	416,710		
08/05/88	163,500	94,420	165,590	423,510		
08/06/88						
08/12/88	170,270	96,850	168,690	435,810		
08/13/88						
08/14/88						
08/15/88	176,620	100,940	177,420	454,980		
08/16/88	179,310	102,370	179,820	461,500		
08/17/88	181,940	103,370	182,200	467,510		
08/18/88	184,700	105,180	184,770	474,650		
08/19/88	187,260	106,520	187,090	480,870		
08/20/88						
08/21/88						
08/22/88	193,940	110,190	193,060	497,190		
08/27/88						
08/28/88						
08/29/88	201,960	114,610	198,940	515,510		
08/30/88	204,990	116,220	201,340	522,550		PERCENT
08/31/88	207,700	117,630	203,480	528,810	FLOW	OF DESIGN
					GPM	FLOW
		TOTAL GALLONS FOR MONTH		129,950	4.10	16%

FLOW SEP88

		CUMMULATIVE FLOW				
			GALLONS			
DATE	P - 1	P - 2	P - 3	TOTAL		
09/01/88	21,073	11,925	20,602	53,600		
09/02/88	21,373	12,088	20,869	54,330		
09/03/88						
09/04/88						
09/05/88						
09/06/88	22,514	12,680	21,822	57,016		
09/07/88	22,795	12,815	22,042	57,652		
						PERCENT
					FLOW	OF DESIGN
					GPM	FLOW
		TOTAL GALLONS FOR MONTH		4,052	0.40	2%

	TOTAL SUSPENDED SOLIDS			
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	EFFLUENT GRAB	EFFLUENT COMPOSITE
	MG/L	MG/L	MG/L	MG/L
AVERAGE	169.44	9.94	61.89	31.74
MAXIMUM	444.0	36.0	150.0	60.0
MINIMUM	28.0	1.0	16.0	12.0
05/04/88	320.0	36.0	150.0	32.0
05/05/88	131.0	10.0	84.0	52.0
05/06/88	176.0	8.0	76.0	52.0
05/07/88				
05/08/88				
05/09/88	240.0	24.0	28.0	40.0
05/10/88	35.0	5.0	52.0	32.0
05/11/88	44.0	6.0	36.0	14.0
05/12/88	56.0	10.0	40.0	20.0
05/13/88	444.0	4.0	28.0	16.0
05/14/88				
05/15/88				
05/16/88	136.0	1.0	68.0	16.0
05/17/88	50.0	8.0	60.0	14.0
05/18/88	142.0	2.0	44.0	41.0
05/19/88	228.0	26.0	76.0	38.0
05/20/88	356.0	3.0	32.0	28.0
05/21/88				
05/22/88				
05/23/88	92.0	11.0	72.0	30.0
05/24/88	68.0	4.0	52.0	22.0
05/25/88	MISSING	MISSING	MISSING	12.0
05/26/88	28.0	12.0	68.0	52.0
05/27/88	108.0	3.0	16.0	32.0
05/28/88				
05/29/88				
05/30/88				
05/31/88	396.0	6.0	132.0	60.0

TSS JUNE

	TOTAL SUSPENDED SOLIDS			
	INFLUENT	INFLUENT	EFFLUENT	EFFLUENT
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING		
	MG/L	MG/L	MG/L	MG/L
AVERAGE	271.76	7.00	49.10	29.65
MAXIMUM	864.0	21.0	116.0	64.0
MINIMUM	25.0	1.0	4.0	1.0
06/01/88	76.0	14.0	32.0	30.0
06/02/88	152.0	7.0	14.0	36.0
06/03/88	25.0	11.0	49.0	1.0
06/04/88				
06/05/88				
06/06/88	420.0	1.0	64.0	MISSING
06/07/88	284.0	5.0	84.0	12.0
06/08/88	148.0	21.0	40.0	24.0
06/09/88	100.0	8.0	84.0	8.0
06/10/88	270.0	5.0	44.0	64.0
06/11/88				
06/12/88				
06/13/88	288.0	4.0	100.0	36.0
06/14/88	360.0	8.0	116.0	64.0
06/15/88	188.0	2.0	16.0	8.0
06/16/88	390.0	2.0	52.0	36.0
06/17/88	MISSING	MISSING	MISSING	MISSING
06/18/88				
06/19/88				
06/20/88	280.0	10.0	28.0	32.0
06/21/88	260.0	8.0	60.0	44.0
06/22/88	460.0	14.0	56.0	12.0
06/23/88	364.0	4.0	52.0	52.0
06/24/88	92.0	5.0	4.0	10.0
06/25/88				
06/26/88				
06/27/88	226.0	5.0	40.0	40.0
06/28/88	260.0	5.0	20.0	24.0
06/29/88	864.0	6.0	48.0	44.0
06/30/88	200.0	2.0	28.0	16.0

TSS JULY

	TOTAL SUSPENDED SOLIDS			
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	EFFLUENT GRAB MG/L	EFFLUENT COMPOSITE MG/L
AVERAGE	149.33	16.93	36.67	29.00
MAXIMUM	740.0	40.0	60.0	50.0
MINIMUM	40.0	2.0	20.0	11.0
07/11/88	272.0	40.0	52.0	MISSING
07/12/88	120.0	12.0	34.0	28.0
07/13/88	184.0	6.0	22.0	36.0
07/14/88	188.0	2.0	30.0	25.0
07/15/88	740.0	7.0	36.0	44.0
07/16/88				
07/17/88				
07/18/88	166.0	17.0	32.0	MISSING
07/19/88	70.0	17.0	30.0	24.0
07/20/88	40.0	17.0	39.0	40.0
07/21/88	126.0	13.0	40.0	25.0
07/22/88	50.0	29.0	60.0	50.0
07/23/88				
07/24/88				
07/25/88	70.0	20.0	48.0	28.0
07/26/88	54.0	18.0	49.0	25.0
07/27/88	44.0	21.0	36.0	26.0
07/28/88	64.0	13.0	20.0	15.0
07/29/88	52.0	22.0	22.0	11.0

TSS AUGUST

	TOTAL SUSPENDED SOLIDS			
	INFLUENT	INFLUENT	EFFLUENT	EFFLUENT
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING		
	MG/L	MG/L	MG/L	MG/L
AVERAGE	139.00	12.93	33.43	22.93
MAXIMUM	524.0	28.0	96.0	50.0
MINIMUM	31.0	5.0	13.0	8.0
08/01/88	216.0	9.0	23.0	25.0
08/02/88	75.0	12.0	23.0	23.0
08/03/88	55.0	10.0	13.0	8.0
08/04/88	36.0	10.0	16.0	17.0
08/05/88	41.0	5.0	22.0	10.0
08/15/88	488.0	11.0	29.0	23.0
08/16/88	74.0	13.0	48.0	24.0
08/17/88	38.0	9.0	24.0	19.0
08/18/88	56.0	14.0	42.0	29.0
08/19/88	63.0	16.0	19.0	24.0
08/22/88	MISSING	28.0	96.0	24.0
08/29/88	524.0	17.0	54.0	50.0
08/30/88	31.0	10.0	13.0	9.0
08/31/88	110.0	17.0	46.0	36.0

TSS SEPTEMBER

	TOTAL SUSPENDED SOLIDS			
	INFLUENT	INFLUENT	EFFLUENT	EFFLUENT
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING		
	MG/L	MG/L	MG/L	MG/L
AVERAGE	78.50	10.50	16.00	8.40
MAXIMUM	152.0	12.0	42.0	15.0
MINIMUM	26.0	7.0	2.0	4.0
09/01/88	32.0	12.0	14.0	6.0
09/02/88	26.0	12.0	6.0	13.0
09/03/88				
09/04/88				
09/05/88				
09/06/88	152.0	7.0	42.0	4.0
09/07/88	104.0	11.0	2.0	4.0
09/08/88	MISSING	MISSING	MISSING	15.0
09/09/88				

TSS OCTOBER

	TOTAL SUSPENDED SOLIDS			
	INFLUENT	INFLUENT	EFFLUENT	EFFLUENT
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING		
	MG/L	MG/L	MG/L	MG/L
AVERAGE	140.33	17.17	67.83	23.17
MAXIMUM	517.0	39.0	135.0	43.0
MINIMUM	28.0	5.0	16.0	4.0
10/21/88				
10/22/88				
10/23/88				
10/24/88	517.0	15.0	105.0	43.0
10/25/88	28.0	39.0	16.0	24.0
10/26/88	95.0	5.0	75.0	20.0
10/27/88	54.0	13.0	50.0	4.0
10/28/88	66.0	16.0	26.0	20.0
10/29/88				
10/30/88				
10/31/88	82.0	15.0	135.0	28.0

TSS NOVEMBER

	TOTAL SUSPENDED SOLIDS			
	INFLUENT	INFLUENT	EFFLUENT	EFFLUENT
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING		
	MG/L	MG/L	MG/L	MG/L
AVERAGE	40.31	15.38	17.54	14.67
MAXIMUM	97.0	22.0	42.0	34.0
MINIMUM	7.0	11.0	2.0	1.0
11/01/88	75.0	14.0	10.0	33.0
11/02/88	49.0	13.0	32.0	19.0
11/03/88	86.0	22.0	20.0	6.0
11/04/88	97.0	19.0	42.0	8.0
11/18/88	22.0	22.0	36.0	MISSING
11/19/88	MISSING	MISSING	MISSING	32.0
11/20/88				
11/21/88	46.0	15.0	10.0	MISSING
11/22/88	27.0	14.0	5.0	7.0
11/23/88	7.0	14.0	4.0	1.0
11/24/88	18.0	12.0	2.0	34.0
11/25/88	30.0	16.0	34.0	15.0
11/26/88				
11/27/88				
11/28/88	27.0	11.0	6.0	8.0
11/29/88	29.0	13.0	14.0	4.0
11/30/88	11.0	15.0	13.0	9.0

TSS DECEMBER

	TOTAL SUSPENDED SOLIDS			
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	EFFLUENT GRAB MG/L	EFFLUENT COMPOSITE MG/L
AVERAGE	80.00	10.80	17.60	16.00
MAXIMUM	175.0	15.0	37.0	22.0
MINIMUM	28.0	4.0	6.0	8.0
12/01/88	33.0	15.0	14.0	22.0
12/02/88	47.0	10.0	25.0	19.0
12/03/88				
12/04/88				
12/05/88	MISSING	11.0	16.0	8.0
12/06/88	MISSING	MISSING	MISSING	MISSING
12/07/88	MISSING	MISSING	MISSING	MISSING
12/08/88	MISSING	MISSING	MISSING	MISSING
12/09/88				
12/10/88	93.0	13.0	37.0	
12/11/88				
12/12/88	28.0	15.0	15.0	11.0
12/13/88	105.0	4.0	6.0	14.0
12/14/88	44.0	10.0	23.0	19.0
12/15/88	160.0	5.0	14.0	20.0
12/16/88	35.0	12.0	13.0	21.0
12/17/88				
12/18/88				
12/19/88	175.0	13.0	13.0	10.0

BOD MAY

		BOD		
	INFLUENT	INFLUENT	EFFLUENT	EFFLUENT
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING		
	MG/L	MG/L	MG/L	MG/L
AVERAGE	5.27	4.29	4.40	3.87
MAXIMUM	12.0	19.0	11.0	10.0
MINIMUM	1.0	1.0	2.0	1.0
05/04/88	12.0	19.0	9.0	1.0
05/05/88	6.0	2.0	<1	4.0
05/06/88	<1	2.0	<1	3.0
05/07/88				
05/08/88				
05/09/88	5.0	6.0	<1	8.0
05/10/88	<1	<1	<1	<1
05/11/88	4.0	2.0	2.0	<1
05/12/88	9.0	5.0	4.0	2.0
05/13/88	2.0	<1	2.0	3.0
05/14/88				
05/15/88				
05/16/88	3.0	4.0	2.0	3.0
05/17/88	1.0	1.0	<1	<1
05/18/88	2.0	<1	<1	2.0
05/19/88	5.0	5.0	4.0	10.0
05/20/88	<1	<1	<1	<1
05/21/88				
05/22/88				
05/23/88	12.0	4.0	11.0	9.0
05/24/88	8.0	4.0	4.0	4.0
05/25/88	MISSING	MISSING	MISSING	3.0
05/26/88	4.0	2.0	3.0	2.0
05/27/88	4.0	3.0	3.0	2.0
05/28/88				
05/29/88				
05/30/88				
05/31/88	2.0	1.0	<1	2.0

BOD JUNE

DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	EFFLUENT GRAB MG/L	EFFLUENT COMPOSITE MG/L
		BOD		
AVERAGE	22.60	5.91	3.29	3.00
MAXIMUM	100.0	25.0	7.0	13.0
MINIMUM	1.0	1.0	2.0	1.0
06/01/88	<1	<1	7.0	4.0
06/02/88	5.0	<1	<1	1.0
06/03/88	17.0	5.0	3.0	4.0
06/04/88				
06/05/88				
06/06/88	24.0	4.0	2.0	MISSING
06/07/88	22.0	<1	<1	1.0
06/08/88	2.0	3.0	<1	2.0
06/09/88	18.0	<1	<1	1.0
06/10/88	2.0	<1	<1	<1
06/11/88				
06/12/88				
06/13/88	17.0	5.0	<1	<1
06/14/88	24.0	4.0	<1	3.0
06/15/88	8.0	<1	<1	<1
06/16/88	39.0	8.0	3.0	2.0
06/17/88	MISSING	MISSING	MISSING	MISSING
06/18/88				
06/19/88				
06/20/88	26.0	6.0	4.0	<1
06/21/88	42.0	2.0	<1	3.0
06/22/88	1.0	<1	2.0	13.0
06/23/88	6.0	<1	<1	<1
06/24/88	10.0	1.0	<1	<1
06/25/88				
06/26/88				
06/27/88	50.0	25.0	2.0	2.0
06/28/88	31.0	<1	<1	2.0
06/29/88	100.0	<1	<1	3.0
06/30/88	8.0	2.0	<1	1.0

BOD JULY

		BOD		
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	EFFLUENT GRAB MG/L	EFFLUENT COMPOSITE MG/L
AVERAGE	8.15	5.40	6.88	4.25
MAXIMUM	30.0	25.0	14.0	13.0
MINIMUM	2.0	1.0	3.0	1.0
07/11/88	11.0	9.0	14.0	MISSING
07/12/88	9.0	1.0	5.0	1.0
07/13/88	10.0	3.0	<1	1.0
07/14/88	5.0	1.0	10.0	8.0
07/15/88	4.0	<1	<1	<1
07/16/88				
07/17/88				
07/18/88	30.0	25.0	<1	MISSING
07/19/88	5.0	4.0	<1	<1
07/20/88	<1	<1	6.0	13.0
07/21/88	8.0	2.0	5.0	<1
07/22/88	3.0	<1	4.0	<1
07/23/88				
07/24/88				
07/25/88	10.0	4.0	8.0	3.0
07/26/88	5.0	3.0	<1	2.0
07/27/88	<1	<1	<1	2.0
07/28/88	2.0	<1	<1	<1
07/29/88	4.0	2.0	3.0	4.0

BOD AUGUST

		BOD		
	INFLUENT	INFLUENT	EFFLUENT	EFFLUENT
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING		
	MG/L	MG/L	MG/L	MG/L
AVERAGE	9.15	5.10	5.55	6.33
MAXIMUM	42.0	15.0	13.0	14.0
MINIMUM	1.0	1.0	1.0	1.0
08/01/88	6.0	<1	13.0	14.0
08/02/88	9.0	2.0	12.0	9.0
08/03/88	8.0	5.0	5.0	5.0
08/04/88	4.0	5.0	4.0	4.0
08/05/88	4.0	1.0	3.0	9.0
08/15/88	21.0	15.0	4.0	10.0
08/16/88	7.0	<1	5.0	2.0
08/17/88	2.0	4.0	<1	<1
08/18/88	1.0	<1	<1	<1
08/19/88	6.0	4.0	3.0	4.0
08/22/88	MISSING	<1	7.0	6.0
08/29/88	42.0	3.0	<1	9.0
08/30/88	6.0	11.0	4.0	3.0
08/31/88	3.0	1.0	1.0	1.0

BOD SEPTEMBER

		BOD		
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	EFFLUENT GRAB MG/L	EFFLUENT COMPOSITE MG/L
AVERAGE	7.33	2.33	#DIV/0!	#DIV/0!
MAXIMUM	10.0	3.0	0.0	0.0
MINIMUM	4.0	2.0	0.0	0.0
09/01/88	<1	<1	<1	<1
09/02/88	4.0	2.0	<1	<1
09/03/88				
09/04/88				
09/05/88				
09/06/88	10.0	3.0	<1	<1
09/07/88	8.0	2.0	<1	<1
09/08/88				<1

BOD OCTOBER

		BOD		
	INFLUENT	INFLUENT	EFFLUENT	EFFLUENT
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING		
	MG/L	MG/L	MG/L	MG/L
AVERAGE	11.00	3.50	6.60	4.00
MAXIMUM	25.0	6.0	18.0	8.0
MINIMUM	5.0	1.0	1.0	1.0
10/21/88				
10/22/88				
10/23/88				
10/24/88	25.0	4.0	8.0	8.0
10/25/88	6.0	3.0	2.0	<1
10/26/88	13.0	2.0	4.0	3.0
10/27/88	5.0	1.0	<1	<1
10/28/88	6.0	5.0	1.0	1.0
10/29/88				
10/30/88				
10/31/88	11.0	6.0	18.0	4.0

BOD NOVEMBER

		BOD		
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	EFFLUENT GRAB MG/L	EFFLUENT COMPOSITE MG/L
AVERAGE	4.69	1.33	2.00	2.50
MAXIMUM	15.0	2.0	2.0	4.0
MINIMUM	1.0	1.0	2.0	1.0
11/01/88	6.0	2.0	<1	2.0
11/02/88	5.0	1.0	<1	1.0
11/03/88	15.0	<1	2.0	<1
11/04/88	7.0	1.0	<1	<1
11/18/88	9.0	<1	<1	4.0
11/19/88				
11/20/88				
11/21/88	3.0	2.0	<1	MISSING
11/22/88	1.0	<1	<1	3.0
11/23/88	3.0	<1	<1	<1
11/24/88	1.0	<1	<1	<1
11/25/88	4.0	<1	<1	<1
11/26/88				
11/27/88				
11/28/88	2.0	<1	<1	<1
11/29/88	3.0	1.0	<1	<1
11/30/88	2.0	1.0	<1	<1

BOD DECEMBER

		BOD		
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	EFFLUENT GRAB	EFFLUENT COMPOSITE
	MG/L	MG/L	MG/L	MG/L
AVERAGE	2.43	1.25	1.00	2.00
MAXIMUM	4.0	2.0	1.0	2.0
MINIMUM	1.0	1.0	1.0	2.0
12/01/88	4.0	1.0	1.0	<1
12/02/88	3.0	2.0	1.0	<1
12/03/88				
12/04/88				
12/05/88	MISSING	<1	<1	<1
12/06/88	MISSING	MISSING	MISSING	MISSING
12/07/88	MISSING	MISSING	MISSING	MISSING
12/08/88	MISSING	MISSING	MISSING	MISSING
12/09/88				
12/10/88	2.0	<1	<1	<1
12/11/88				
12/12/88	3.0	1.0	<1	<1
12/13/88	1.0	<1	1.0	<1
12/14/88	1.0	<1	<1	<1
12/15/88	<1	<1	<1	<1
12/16/88	3.0	1.0	1.0	<1
12/17/88				
12/18/88				
12/19/88	<1	<1	<1	2.0

pH MAY

		pH RESULTS		
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	EFFLUENT GRAB MG/L	EFFLUENT COMPOSITE MG/L
AVERAGE	6.78	6.93	7.97	8.10
MAXIMUM	7.2	7.3	8.4	8.3
MINIMUM	6.2	6.5	7.3	7.8
05/04/88	7.2	7.3	8.4	8.2
05/05/88	MISSING	MISSING	8.0	8.2
05/06/88	MISSING	MISSING	MISSING	7.8
05/07/88				
05/08/88				
05/09/88	MISSING	MISSING	8.3	8.2
05/10/88	6.9	7.0	8.4	8.2
05/11/88	6.8	6.9	7.8	8.3
05/12/88	6.8	7.1	8.3	8.3
05/13/88	MISSING	MISSING	MISSING	8.2
05/14/88				
05/15/88				
05/16/88	6.5	6.8	7.3	8.0
05/17/88	6.7	6.7	8.1	8.3
05/18/88	6.2	6.5	7.7	8.1
05/19/88	6.7	6.8	7.6	7.9
05/20/88	MISSING	MISSING	MISSING	8.2
05/21/88				
05/22/88				
05/23/88	6.9	7.1	8.0	8.2
05/24/88	6.9	7.0	7.8	7.8
05/25/88	MISSING	MISSING	MISSING	7.9
05/26/88	6.8	6.9	7.9	7.9
05/27/88	MISSING	MISSING	MISSING	8.1
05/28/88				
05/29/88				
05/30/88				
05/31/88	7.0	7.1	8.0	8.1

pH JUNE

		pH RESULTS		
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	EFFLUENT GRAB MG/L	EFFLUENT COMPOSITE MG/L
AVERAGE	7.10	7.21	7.92	7.96
MAXIMUM	7.5	8.2	8.4	8.7
MINIMUM	6.8	6.9	7.0	7.1
06/01/88	6.9	7.0	7.5	7.8
06/02/88	7.1	7.0	7.9	8.1
06/03/88	6.9	6.9	7.9	8.0
06/04/88				
06/05/88				
06/06/88	6.8	7.0	8.2	MISSING
06/07/88	6.8	6.9	7.8	7.9
06/08/88	7.0	7.0	7.6	7.9
06/09/88	6.9	6.9	7.7	7.7
06/10/88	7.1	7.9	7.0	7.1
06/11/88				
06/12/88				
06/13/88	7.2	7.1	8.0	8.3
06/14/88	7.3	7.3	7.8	8.0
06/15/88	7.3	7.1	8.1	8.1
06/16/88	7.2	7.5	8.1	8.1
06/17/88	MISSING	MISSING	MISSING	MISSING
06/18/88				
06/19/88				
06/20/88	6.9	7.1	8.2	8.2
06/21/88	7.2	7.3	7.9	8.1
06/22/88	7.2	7.2	8.0	7.9
06/23/88	6.9	7.1	7.7	8.0
06/24/88	7.3	7.1	8.2	8.1
06/25/88				
06/26/88				
06/27/88	7.5	8.2	8.1	7.2
06/28/88	7.1	7.1	8.2	8.1
06/29/88	7.1	7.2	8.0	7.9
06/30/88	7.4	7.6	8.4	8.7

pH JULY

		pH RESULTS		
	INFLUENT	INFLUENT	EFFLUENT	EFFLUENT
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING		
	MG/L	MG/L	MG/L	MG/L
AVERAGE	6.85	6.94	7.85	8.04
MAXIMUM	7.1	8.0	8.2	8.2
MINIMUM	6.5	6.6	6.9	7.5
07/11/88	6.9	6.9	8.0	MISSING
07/12/88	6.9	6.9	8.0	8.1
07/13/88	6.9	6.9	8.0	8.1
07/14/88	6.5	6.6	7.6	7.7
07/15/88	6.6	6.6	7.6	7.5
07/16/88				
07/17/88				
07/18/88	6.8	6.8	7.8	MISSING
07/19/88	6.8	6.9	7.8	7.9
07/20/88	7.1	7.0	8.2	8.1
07/21/88	7.0	7.0	8.1	8.2
07/22/88	6.9	8.0	6.9	8.1
07/23/88				
07/24/88				
07/25/88	6.9	6.9	8.1	8.2
07/26/88	6.9	7.0	7.9	8.1
07/27/88	6.7	6.8	7.8	8.1
07/28/88	6.9	6.9	7.8	8.2
07/29/88	7.0	6.9	8.2	8.2

pH AUGUST

		pH RESULTS		
	INFLUENT	INFLUENT	EFFLUENT	EFFLUENT
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING		
	MG/L	MG/L	MG/L	MG/L
AVERAGE	6.94	7.10	7.99	8.07
MAXIMUM	7.2	8.0	8.4	8.4
MINIMUM	6.8	6.8	7.6	7.7
08/01/88	7.0	7.1	7.6	7.9
08/02/88	6.8	7.0	7.6	7.9
08/03/88	6.8	6.9	7.6	7.8
08/04/88	7.0	7.1	8.3	8.3
08/05/88	7.0	7.1	8.3	8.4
08/15/88	7.1	7.2	8.3	8.2
08/16/88	7.1	7.2	8.3	8.4
08/17/88	7.2	7.2	8.4	8.4
08/18/88	6.9	6.9	7.8	8.1
08/19/88	6.8	6.9	8.0	7.8
08/22/88	MISSING	8.0	8.1	8.1
08/29/88	6.9	7.0	8.1	8.3
08/30/88	6.8	7.0	7.8	7.7
08/31/88	6.8	6.8	7.7	7.7

pH SEPTEMBER

		pH RESULTS		
	INFLUENT	INFLUENT	EFFLUENT	EFFLUENT
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING		
	MG/L	MG/L	MG/L	MG/L
AVERAGE	6.93	6.98	8.28	8.28
MAXIMUM	7.1	7.2	8.9	8.4
MINIMUM	6.8	6.8	8.0	8.2
09/01/88	6.8	6.8	8.0	8.2
09/02/88	6.9	6.9	8.0	8.2
09/03/88				
09/04/88				
09/05/88				
09/06/88	6.9	7.0	8.9	8.3
09/07/88	7.1	7.2	8.2	8.3
09/08/88	MISSING	MISSING	MISSING	8.4
09/09/88				
09/10/88				
09/11/88				
09/12/88				
09/13/88				
09/14/88				
09/15/88				
09/16/88				
09/17/88				
09/18/88				
09/19/88				
09/20/88				
09/21/88				
09/22/88				
09/23/88				
09/24/88				
09/25/88				
09/26/88				
09/27/88				
09/28/88				
09/29/88				
09/30/88				

pH OCTOBER

		pH RESULTS		
	INFLUENT	INFLUENT	EFFLUENT	EFFLUENT
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING		
	MG/L	MG/L	MG/L	MG/L
AVERAGE	6.85	6.92	7.93	8.05
MAXIMUM	6.9	7.0	8.0	8.1
MINIMUM	6.8	6.9	7.8	7.9
10/21/88				
10/22/88				
10/23/88				
10/24/88	6.9	6.9	8.0	8.1
10/25/88	6.8	6.9	8.0	8.1
10/26/88	6.8	6.9	7.8	7.9
10/27/88	6.8	6.9	7.9	8.1
10/28/88	6.9	7.0	8.0	8.0
10/29/88				
10/30/88				
10/31/88	6.9	6.9	7.9	8.1

pH NOVEMBER

		pH RESULTS		
	INFLUENT	INFLUENT	EFFLUENT	EFFLUENT
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING		
	MG/L	MG/L	MG/L	MG/L
AVERAGE	7.02	7.22	8.23	8.33
MAXIMUM	7.2	8.4	8.5	9.0
MINIMUM	6.8	6.9	7.9	8.0
11/01/88	6.9	7.0	8.2	8.1
11/02/88	7.0	7.1	8.3	8.2
11/03/88	6.8	8.4	8.5	8.3
11/04/88	6.8	7.0	8.0	8.2
11/18/88	7.2	7.3	8.5	MISSING
11/19/88	MISSING	MISSING	MISSING	8.4
11/20/88				
11/21/88	7.2	7.3	8.2	MISSING
11/22/88	7.2	7.2	8.1	8.4
11/23/88	6.9	7.2	8.5	9.0
11/24/88	6.9	6.9	7.9	8.0
11/25/88	7.1	7.1	8.2	8.5
11/26/88				
11/27/88				
11/28/88	7.1	7.2	8.3	8.4
11/29/88	7.2	7.1	8.2	8.3
11/30/88	6.9	7.1	8.1	8.1

pH DECEMBER

		pH RESULTS		
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	EFFLUENT GRAB MG/L	EFFLUENT COMPOSITE MG/L
AVERAGE	7.08	7.43	8.12	8.17
MAXIMUM	7.7	8.4	8.4	8.5
MINIMUM	6.7	6.8	7.8	7.3
12/01/88	6.7	6.8	7.9	8.1
12/02/88	7.0	7.0	8.1	8.3
12/03/88				
12/04/88				
12/05/88	MISSING	8.0	8.3	8.5
12/06/88	MISSING	8.4	8.4	8.2
12/07/88	MISSING	7.8	8.2	8.3
12/08/88	MISSING	7.9	7.8	7.3
12/09/88				
12/10/88	7.1	7.0	8.0	MISSING
12/11/88				
12/12/88	6.8	6.9	8.3	8.5
12/13/88	7.2	7.5	8.4	8.1
12/14/88	7.2	7.5	7.9	7.9
12/15/88	7.7	7.5	8.3	8.5
12/16/88	6.9	6.9	8.0	8.2
12/17/88				
12/18/88				
12/19/88	7.1	7.4	8.0	8.1

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