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Evaluation of Denitrification Systems for Improving Groundwater Quality from On-Site Waste Disposal Systems

EVALUATION OF DENITRIFICATION SYSTEMS FOR IMPROVING GROUNDWATER QUALITY FROM ON-SITE WASTE DISPOSAL SYSTEMS

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PROJECT MID REPORT TO DNR

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INTRODUCTION AND JUSTIFICATION

1.1 Introduction

The Central Wisconsin Sand Plains region contains some of the largest and most productive aquifers in the state of Wisconsin. The sandy glacial outwash soils of the area are highly permeable and the terrain is relatively flat. These factors combined with a relatively shallow unconfined aquifer make this region particularly susceptible to contamination from various land use practices.

One of the land use practices which is increasingly becoming a concern involves the residential development of unsewered areas. Trends in the 1970's and 1980's saw population increases in suburban areas. As a result, suburban expansion quickly exceeded beyond the reaches of municipal water and sewage and thus private sewage systems became common.

The primary purposes of current private sewage systems are the disposal of wastewater and the removal of bacteria. Only recently has consideration been given to the level of chemical treatment which can be expected from private sewage systems and their potential for groundwater pollution.

Soil absorption systems are designed to receive wastewater from a septic tank and dispose of it below ground where it is hopefully treated before it reaches the groundwater. It is generally recognized that three feet of unsaturated soil is required to properly treat sewage effluent to allow adequate removal of disease causing bacteria, viruses, suspended solids, and some organic materials.

Treatment efficiency in private sewage systems for other chemical constituents may be less than ideal or simply unknown in the present. Because nitrate, a breakdown of organic nitrogen compounds, is very soluble and does not adsorb to soil, it often reaches groundwater from what are considered well functioning septic systems. When used on sandy soils, many properly functioning septic systems have been shown to result in significant nitrate-N concentrations in groundwater.

1.2 Project Justification and Goals

This project was initiated due to increasing concern regarding the impact private on-site waste disposal systems have on groundwater quality. The major quantifiable contaminant that has been shown to impact groundwater from private sewage systems is nitrate-N. This concern has led to a number of ordinances restricting lot sizes to two or more acres to allow for adequate dilution of septic system waste. Increased lot size cause a number of problems related to urban sprawl. Interest in alternative or improved waste disposal systems has increased with a number of innovative systems being used in many areas.

This project was designed to evaluate a denitrification system's ability to reduce nitrogen loading to groundwater from on-site sewage disposal systems. This will be done by installing two systems in the sand plain areas of central Wisconsin. The systems used have been installed on sites where we already had groundwater monitoring wells in place and contaminant plumes well identified.

The goals of the project are to install and evaluate low-cost denitrification systems to determine their suitability for reducing nitrogen loading to groundwater from on-site waste disposal systems, to monitor groundwater to determine the extent of improvement that occurs from the use of these systems and to compare treatment system effluent concentration to worst case groundwater concentrations to evaluate additional treatment that may be occurring in the soil absorption system.

LITERATURE REVIEW

2.1 On-Site Waste Disposal Systems

Most on-site waste disposal systems consist of a septic tank followed by a subsurface soil absorption system. Results vary relative to the treatment efficiency of wastewater by septic tanks. Lawrence (1973) reported Suspended Solid removals of 35 to 45%, and BOD removals of 15% or less. However, Viraraghaven (1976) reported Total Suspended Solids removal of 25% with BOD and COD removals on the order of 50%. Typical effluent concentrations from septic tanks for Suspended Solids, BOD_5, COD, Total Nitrogen and Total Phosphorous are 75 mg/l, 140 mg/l, 300 mg/l, 40 mg/l, and 15 mg/l respectively (Canter and Knox, 1986).

The quantities of indicator bacteria such as fecal coliform, whose presence suggests that other enteric organisms are also possibly present, are usually high in septic tank effluent with pathogenic bacteria such as Pseudomonas aeruginosa commonly being isolated. When infections have occurred, viruses are also found in septic tank effluent in high concentrations (Canter and Knox, 1986). Because of the limited wastewater treatment provided by septic tanks, their effluent must be purified further prior to release to either surface of groundwater. The primary mechanism for providing this treatment is through on-site soil absorption systems.

Soil Absorption Systems are essential components of septic systems. Soil Absorption Systems, which may be trenches, beds, pits or mounds, hydraulically receive septic tank effluent and discharge it below ground where it is absorbed and treated by the soil as is percolates towards groundwater.

Soil Absorption Systems are capable of treating organic materials, some inorganic substances and pathogens present in the wastewater through physical, chemical and biological processes. By acting as a filter, exchanger, adsorber, and providing a surface on which many chemical and biological processes may occur, Soil Adsorption Systems are capable of enhancing treatment of wastewater from septic tanks (U.S. EPA, 1980).

Wastewater microbes can be effectively treated through 1.2 m of soil if the soil is unsaturated. Unsaturated conditions enhance the removals of pathogenic organisms and other pollutants from the wastewater by increasing their chances to react with soil particles. Furthermore, under unsaturated conditions the larger pore volumes often contain air which allows for the efficient aerobic decomposition of many suspended and dissolved organic substances present in the wastewater. These processes tend to work much better under unsaturated conditions because the wastewater movement is primarily through only the smaller pore volumes of the soil which increases both the retention and liquid-solid contact time. When saturated conditions exist, the water flows through the larger pores and receives minimal treatment.

For instance, Romero (1970) cited a number of studies in which the effluent intersected or was close to the water table. Elevated bacteria levels were temporarily detected up to 24.4 m horizontally away from the source. USEPA (1980), on the other hand, reports that under unsaturated flow conditions, bacteria can be removed within .9 to 1.2 m of effluent flow through the soil.

Present site criteria that must be met for a septic tank system approval include a specified percolation test, and a minimum of 1.2 m separation between the bottom of the seepage system and the maximum seasonal elevation of groundwater (Canter and Knox, 1984). This is required so the unsaturated soil has a high ability to remove Total Suspended Solids, BOD, COD, and soluble organic carbon with a 75-95% reduction occurring in these concentrations typically within the first five feet of soil.

Unfortunately, the unsaturated flow of septic tank effluent increases the chance of nitrate contamination of groundwater. The principal sources of nitrogen in wastewater are feces and urine which contain urea, uric acid, ammonia, undigested proteinaceous materials and bacterial cells. Typically, 75% of the nitrogen in septic tank effluent exists in the ammonium form and 25% exists in the organic form (Canter and Knox, 1986). Most of the ammonium is biologically converted to nitrate as the wastewater moves through the unsaturated soil beneath the crust of the soil absorption system. Walker et. al. (1973) studied five subsurface seepage beds in which the subcrust contained 19.6% oxygen. They concluded that nitrification of ammonium to nitrate was essentially complete and commenced in the unsaturated subcrust soil within about 2 cm of the crust. The ammonium levels were relatively high beneath the seepage beds but decreased to low levels within a few centimeters. The general increase in NO_3-N with depth concurrent with the decrease in NH_4-N suggests that nitrification was the major mechanism of NH_4-N removal.

The high solubility of the nitrate anion allows it to move freely with groundwater. If the nitrates enter an anaerobic environment in which organic material is available, denitrification, the reduction of nitrate to nitrogen gas, may occur. However, significant denitrification is unlikely to occur in a well-aerated sandy subsoil or in a carbon-deficient groundwater (Walker et al., 1973).

Nitrate-nitrogen leaching from on-site sewage disposal systems has been shown to threaten both surface and groundwater quality in unsewered areas of the United States (Lamb et. al., 1989). Nitrates may contribute to the eutrophication of surface waters and they have also been linked to cases of methemoglobinemia in infants (U.S. EPA, 1975). Consequently, the U.S. Environmental Protection Agency and World Health Organization drinking water standard for nitrate is 10 mg/l as nitrate-nitrogen (45 mg/l as nitrate) (Kaplan, 1987).

Nitrate contamination of groundwater from septic tanks has been documented. Walker et. al. (1973) found that soil disposal systems of septic tank effluents in sands added significant quantities of nitrate to the underlying ground water. Concentrations as high as 40 mg/l of nitrate-nitrogen were found in the upper 30 cm of aquifer adjacent to the systems. Relatively large areas of .2 ha (0.5 acre) down gradient were needed before concentrations were lower than the standard 10 mg/l.

In conditions of high groundwater or very slowly permeable soils, anaerobic soil conditions may exist. Under these conditions, nitrification will not occur and the nitrogen will remain in the form of ammonium. Ammonium is readily adsorbed by soil materials of high clay content and hence migrates much more slowly (U.S. EPA, 1978). As adsorption sites for ammonium are exhausted on the soil particles, the ammonium will migrate farther and farther from the septic system. Most of the ammonium is later subjected to nitrification and leaching if aerobic conditions become reestablished (Lance, 1972).

Because denitrification is unlikely to occur beneath soil absorption systems and adsorption of ammonium to soil particles is limited, dilution has been the primary mechanism for nitrate reduction. Because groundwater flow patterns are difficult to predict and because many residential areas have high densities of homes, dilution is an unacceptable part of the wastewater treatment system. Wastewater treatment should incorporate a denitrification system into it because this process provides the most feasible means to reduce the nitrogen content of the effluent (Walker et. al., 1973).

2.2 Nitrification and Denitrification Processes

Nitrogen entering a conventional septic system is in the organic-N and ammonium-N forms. A properly functioning septic tank will remove approximately 10% of the influent organic nitrogen which is stored in the sludge (Laak et. al., 1981). In the septic tank, settlement and ammonification occur, resulting in effluent containing primarily ammonium-N (USEPA, 1980; Canter and Knox, 1985). One of the most effective means of ammonium removal is through biological nitrification and denitrification. Ammonium is converted to nitrate (nitrification) and the nitrate is then converted to nitrogen gas (denitrification) which is released to the atmosphere.

The nitrification and denitrification processes require a variety of bacteria and environmental conditions. In order for these processes to be successful, an understanding of the conditions necessary for each process is essential.

Nitrification is commonly defined as the biological oxidation of ammonium to nitrate with nitrite as an intermediate. Autotrophic microorganisms are largely, if not entirely, responsible for nitrification in natural systems. These nitrifying autotrophs require oxygen and derive the carbon for cell synthesis largely from CO_2, carbonates, or bicarbonates (Delwiche,1981).

Oxidation of ammonium to nitrite by Nitrosomonas and the subsequent oxidation of nitrite to nitrate by Nitrobacter is usually represented by the following equations:

$$NH_4^+ + 1.5\ O_2 + 2\ HCO_3^- \text{ ---> } NO_2^- + 2\ H_2CO_3 + H_2O$$

$$NO_2^- + .5\ O_2 \text{ ---> } NO_3^-$$

Nitrosomonas obtain energy from the oxidation of ammonium to nitrite while Nitrobacter obtain energy from the further oxidation of nitrite to nitrate.

The overall reduction of ammonium to nitrate can be shown as (EPA , 1975):

$$NH_4^+ + 2\ O_2 + 2\ HCO_3^- \longrightarrow NO_3^- + 2\ H_2CO_3 + H_2O$$

The above equation shows that alkalinity is destroyed by the oxidation of ammonia and that carbon dioxide (H_2CO_3 in the aqueous phase) is produced. Past studies have shown that 6.3 to 7.4 mg of alkalinity are destroyed for every mg of NH_4^+-N oxidized in attached growth systems (EPA, 1975). Thus the process of nitrification tends to lower the pH. The significance of this pH depression is that nitrification rates can be rapidly depressed. Almost all nitrifying bacteria have an optimum pH in the alkaline range, usually near 8.0, and grow only slowly at pH values much below neutral (Gaudy & Gaudy, 1980). Lamb et. al. (1990) reported that alkalinity in the septic tank effluent appeared to limit the nitrification process in a sand filter during warm weather. If sufficient alkalinity is not available, the pH of the system can drop below 5.5 at which point nitrification could be inhibited (Loudon et. al., 1989). Thus, it is recommended that the level of alkalinity as $CaCO_3$ be maintained above 40 mg/l (Sandy, 1987).

The above equation also shows that dissolved oxygen is required for the nitrification process. An oxygen requirement of 4.6 mg of O_2 for every mg NH_4^+ oxidized has been theorized to be sufficient for aeration requirements (EPA, 1975). Several investigations have provided indirect evidence of the importance of the effect of DO on nitrification rates (EPA, 1975). Low DO levels can inhibit nitrification and thus it is recommended that DO levels should be maintained above 2 mg/l for nitrification systems (Grady and Lim, 1980).

Temperature also plays an important role in the nitrification process. The optimum temperature range for nitrification has been reported as 18 to 35^{0}C with nitrification ceasing at 5^{0}C and below (Shammas, 1986). Lamb et. al. (1989) reported nitrification rates as low as 25% at temperatures lower than 10^{0}C and a number of other studies also suggests that below 15^{0}C, temperature has a significant impact on nitrification rates.

The biological process of denitrification involves the conversion of nitrate nitrogen to a gaseous nitrogen species. The gaseous product is primarily nitrogen gas but also may be nitrous oxide or nitric oxide. Denitrification can be accomplished by a relatively broad range of facultative heterotrophic bacteria including Psuedomonas, Micrococcus, Archromobacter and Bacillus (EPA, 1975).

Because denitrifying bacteria are facultative anaerobes, a sufficiently high concentration of dissolved oxygen can prevent the use of NO_3^- as the terminal electron acceptor. In general, cells exposed to more than 0.1 to 0.2 mg/l of O_2 do not denitrify (Rittman and Langeland, 1985).

Denitrification is also a two-step process in which the first step is a conversion of nitrate to nitrite. The second step converts the nitrite to nitrogen gas:

$$NO_3^- + 0.33\ CH_3OH \text{ ---> } NO_2^- + 0.33\ H_2O + 0.33\ H_2CO_3$$

$$NO_2^- + 0.5\ CH_3OH + 0.5\ H_2CO_3 \text{ ---> } 0.5\ N_2 + HCO_3^- + H_2O$$

The overall denitrification reaction can be written as (EPA, 1975):

$NO_3^- + 0.833\ CH_3OH + 0.167\ H_2CO_3 \longrightarrow 0.5\ N_2 + 1.33\ H_2O + HCO_3^-$

The above equation shows that bicarbonate is produced and carbonic acid concentration is reduced whenever nitrate or nitrite is denitrified to nitrogen gas. Experiments have shown that approximately 3.0 mg alkalinity as $CaCO_3$ are produced for every mg of nitrogen reduced. Thus, the tendency of denitrification is to at least partially reverse the effects of nitrification and raise the pH of the wastewater.

CH_3OH (methanol) is shown in the above equation to indicate the an adequate carbon source is needed for the denitrifying bacteria as a source of energy and carbon. In general, 3 mg of methanol for every mg of NO_3^--N will enable "complete" denitrification (95% removal of nitrate) (EPA, 1975).

Denitrification is also influenced by temperature. Bremner and Shaw (1958) reported denitrification rates increased with temperature over a 2-25^{0}C temperature range. Crites et. al. (1981) reported the minimum temperature for denitrification in land treatment systems is 2-5^{0}C.

pH also affects denitrification rates. Denitrification rates are depressed below pH 6.0 and above pH 8.0. The highest rates of denitrification occur within the range of pH 7.0 to 7.5 (EPA, 1975).

2.3 Nitrogen Removal Systems for On-Site Waste Disposal Systems

Intermittent sand filters have been shown to produce effluents of very high quality and are presently used throughout the United States. They are well suited to onsite wastewater treatment and disposal because the process is highly efficient, yet requires a minimum of operation and maintenance.

The quality of effluent from intermittent sand filters was documented in Oregon by the Department of Environmental Quality (Ronayne et al. 1982). Biological oxygen demand (BOD_5) and suspended solid (TSS) were consistently less than 5 mg/l, ammonia less than 1 mg/l, nitrates between 20 and 40 mg/l and fecal coliform bacterial averaged a little more than 400 organisms/100 ml.

Sand filtration of septic tank effluent was also studied by Sauer and Boyle (1977). They found that while the unit was efficient for nitrification of the septic tank effluent, no change in nitrogen concentration was found to occur. Only after the filters remained continuously ponded for over three weeks did ammonia appear in the effluent. The BOD concentrations for all the sand filter effluent were less than 10 mg/l. The same conclusion was reached by Kristiansen (1981a, 1981b), who reported on the operation of sand filter trenches. Due to aerobic conditions and lack of an available energy source, denitrification was not found.

Because sand filters accomplish excellent BOD_5 and suspended solids removal, denitrification will not occur without the addition of a suitable energy source. Sikoro and Keeney (1974) stated that in a septic tank adsorption field, the energy source is the most difficult problem in promoting denitrification.

A nitrogen reducing on-site wastewater disposal system for individual homes may be practical if the organic matter in wastewater could be used as the carbon source for denitrification. Laak et al. (1981) and Laak (1981) reported on a different modification of a conventional septic tank system. Laak developed the RUCK system in which the organic matter in greywater (kitchen and laundry wastewater) is used as the carbon source for denitrification of nitrified blackwater (bathroom wastewater). They concluded that organic carbon in the greywater was as efficient as methanol in supporting denitrification and that an overall nitrogen removal level of 70% could be achieved using the passive RUCK system.

Warnock and Biswas (1981) used effluent from a kitchen garbage grinder as an energy source for denitrification in columns. A C:N ratio of 4:1 was found to be optimal to produce satisfactory denitrification.

One of the most recent on-site wastewater disposal system with nitrogen reducing potential is a recirculation sand filter, which utilizes the organic matter in septic tank effluent as the carbon source for denitrification.

The recirculating sand filter is a simple, compact method of providing improved treatment of wastewater with a low level of maintenance. Recirculating sand filters provide secondary treatment beyond a septic tank prior to surface or subsurface disposal (Loudon et. al., 19).

A typical recirculating sand filter consists of a septic tank, a free access sand filter, and a recirculation tank as shown in figure 2.1. The recirculation tank is typically 1/4 to 1/2 the size of the septic tank (or a volume equivalent to at least one day's volume of raw wastewater flow) and receives both the effluent from the septic tank and a portion of the sand filter effluent. When the recirculation tank is full, the sand filter effluent by-passes the tank and is discharged (USEPA, 1980).

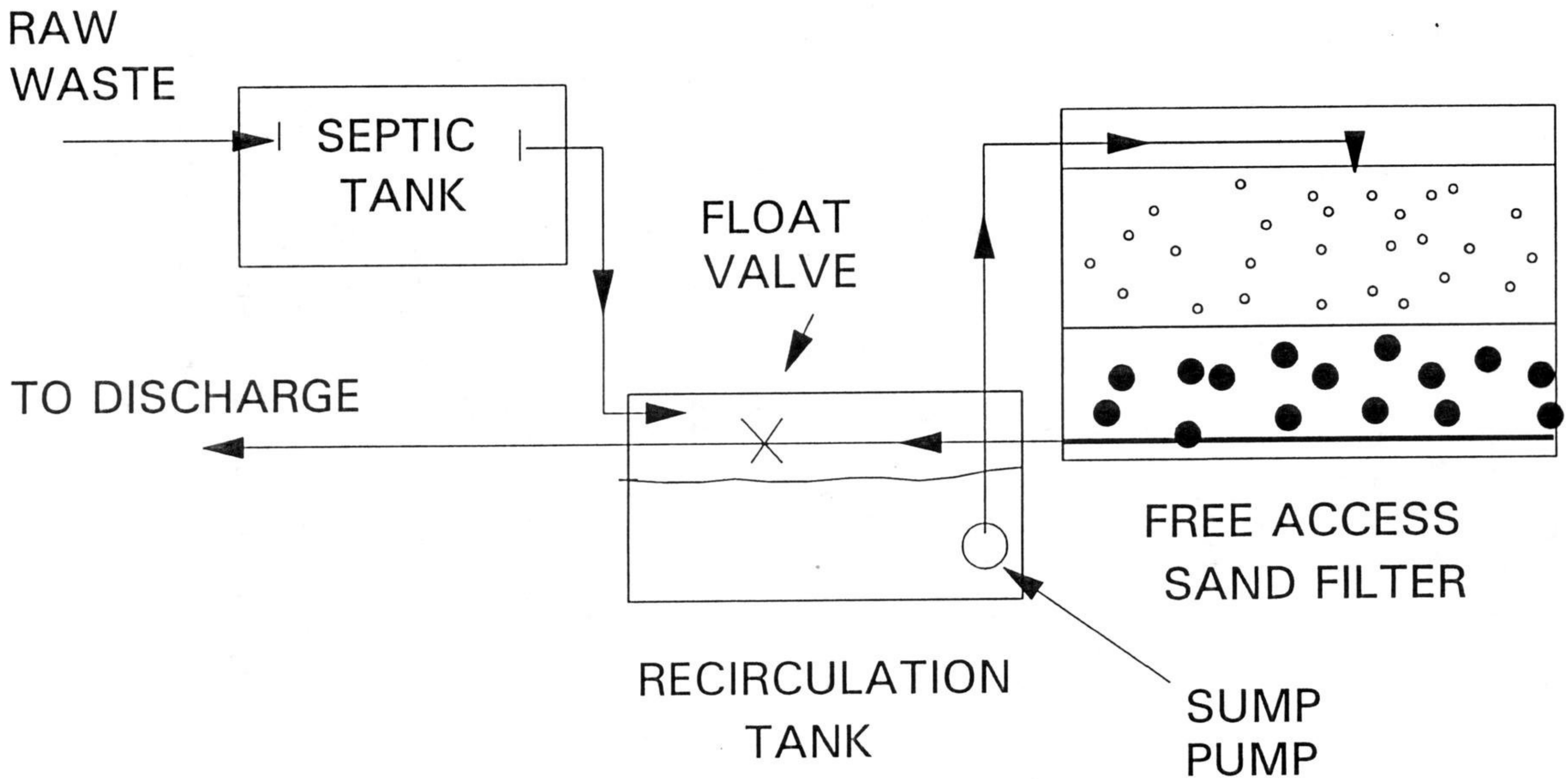
Since nitrified sand filter effluent mixes with septic tank effluent in the recirculation tank, it is possible that denitrification of the nitrified sand filter effluent can take place through utilization of the carbon source provided by the septic tank effluent.

Recirculating sand filters were not originally designed for nitrogen removal and thus little data on the effectiveness of the nitrogen removal capabilities of recirculating sand filters is a available from literature. Two recirculating sand filters which were installed in Michigan generally showed nitrogen removal rates of 40 - 60% (Louden et. al., 19).

Another study of a recirculating sand filter was conducted in which the recirculation tank was replaced with a tank filled with rock. The carbon source was added directly to the rock tank. When septic tank effluent was used as a carbon source, an average of only 25% denitrification was observed in the rock tank with the whole system achieving a total nitrogen removal of 36%. The low amount of denitrification was assumed to be the result of the low C:N ratio found in the rock tank. A C:N ration of 0.7:1 was maintained while past studies generally suggest a C:N ratio of 1:1 to 3:1 is needed. Thus the amount and availability of

Figure 2.1 Typical Recirculating Intermittent Filter System

(EPA, 1980)



carbon in the septic tank effluent was probably the limiting factor to greater denitrification (Lamb et. al., 1990).

Swanson and Dix modified the traditional recirculating sand filter. Instead of using a recirculation tank, they put gravel in the bottom of the sand filter which served as the recirculation tank. They also used bottom ash, a waste product of coal-fired power plants, instead of sand as the filter media. The filter plus the gravel storage is referred to as a batch recirculating bottom ash filter (BRBAF).

The system includes a septic tank, a BRBAF, and an ultraviolet disinfection unit. The 2.4 m x 4.5 m x 1.4 m BRBAF is filled with 80 cm of screened bottom ash overlying 15 cm of peagravel atop 40 cm of washed gravel. These layers are enclosed within treated plywood walls and posts and sealed with three layers of 6-mil plastic.

They concluded that the bottom ash recirculating sand filter system produced a good quality effluent consistent with effluent from other RSF's in terms of pH, BOD_5, SS, and TKN. However, nitrates and nitrites were not monitored and thus they were unable to determine the nitrogen removal of the system.

Sandy (1987) modified the BRBAF system and monitored its potential for nitrogen reduction. The main modification was that a provision was made to recycle the highly nitrified filter effluent back to the septic tank. Since the amount of organic carbon is often a limiting factor in achieving nitrogen removal, it was felt that the "sink of carbon" in the septic tank could be tapped for this purpose.

The study was divided into eight runs starting in August, 1986 and ending in February, 1987. During the first three runs, no effluent from the filter was recycled to the septic tank. Nitrification was sought in the bottom ash filter and denitrification in the rock filter. Nitrification worked reasonably well in the bottom ash filter as could be seen by the reduced ammonia-N levels of 3.4 to 14.9 mg/l (Average 9.6). Ammonia-N levels in the septic tank on the other hand were 33.3 to 51.5 mg/l (Average 43.6) However, denitrification in the rock filter was incomplete allowing effluent nitrate-N concentrations from 9.4 to 14.6 mg/l (Average 11.9).

In runs 4 to 8, a portion of the BRBAF effluent was recirculated to the septic tank. Total nitrogen removal of the system was much better during these runs. For runs 4 - 8 the average TN values for the system effluent was 7.2 to 9.6 mg/l (Average 8.4) as compared to runs 1 - 3 in which the values ranged from 15.8 to 25.7 mg/l (Average 22.1). Apparently the anoxic conditions and organic carbon in the septic tank provided suitable conditions for denitrification to occur. A modification of this design has been utilized for this research.

METHODS

3.1 Study Sites

This project was designed to evaluate a denitrification systems ability to reduce nitrogen loading to groundwater from on-site sewage disposal systems. Two single-family homes north of the Stevens Point area were selected for the installation of an experimental denitrification system in the summer of 1992. The two homes were chosen because they already had groundwater monitoring wells in place, contaminant plumes well identified, high nitrate levels in the groundwater contaminant plumes, and homeowner cooperation.

One of the sites chosen, site 1, was William and Barbara Reed's residence located at 5371 Echo Court, Lot 15, Blk 1, Jordan Acres Estates Subdivision, NW 1/4, NW 1/4, Sec. 14, T24N, R8E, Township Hull, Portage County Wisconsin. The denitrification system at this location has been retrofitted onto an existing conventional septic system which has a one chambered, 1000 gallon septic tank which was installed in the summer of 1982. The septic system serves a three bedroom home which currently has two people living in it.

The other site chosen, site 2, was Frank Sniadajewski's residence located at 3328 Jordan Road. SE 1/4, NE 1/4, Sec. 9, T24N, R8E, Hull Township, Portage County, Wisconsin. The denitrification system at this site has been retrofitted onto an existing pressurized mound system which has a 1000 gallon septic tank and a 1000 gallon dosing chamber which were installed in the people presently living in it.

3.2 Monitoring Well Installation and Design

Although the author was not directly involved with the installation of the monitoring wells, the following is a description of the methods, techniques, and procedures employed in the construction, installation, and sampling of groundwater monitoring wells. The information for these descriptions is based on documentation provided in William Van Ryswyek's MS Thesis and "A Comparative Study of Nitrate-N Loading to Groundwater from Mound, In Ground Pressure and At Grade Septic Systems", Shaw and Turyk, 1992.

At Site 1, originally one up-gradient and one down-gradient well were installed in the summer of 1988. These monitoring wells were constructed of 3.18 cm (1 $^{1}/_{4}$ in) PVC (polyvinyl chloride) and were fitted with 91.44 cm (36 in) slotted, 0.0254 cm (.01 in) slot size, PVC screens.

The original down-gradient well showed no significant difference in water quality from the up-gradient well. Thus, in the summer of 1989, two nested wells (REC and REW) were also installed down-gradient of the drainfield. These two wells were installed in an east-west transect with the existing down-gradient well, 4.9 m (16 ft) away from and parallel to the down-gradient edge of the drainfield as shown in figure 3.1. It was believed that these wells would show whether or not preferential percolation was occurring out of this system or if strong vertical flow components were transporting contamination deeper into the aquifer and below the existing monitoring well.

These two well nests consisted of three 1.91 cm (3/4 in) PVC pipes taped together with nylon reinforced tape. The threaded joint pipes were screened with 30.48 cm (1 ft), 0.0254 cm (0.10 in) slotted, PVC points. The screens were positioned at 15.24 cm (6 in) intervals with the lower portion of the uppermost screen being placed at the watertable, as shown in figure 3.2.

During the summer of 1990 five more multilevel monitoring wells were installed at this location. These wells were installed in a transect perpendicular to groundwater flow with well "B" being positioned 33.5 meters (110 ft) downgradient of well REC, with 3.05 M (10 ft) of separation between each of the five wells as shown in figure 3.1.

These wells were constructed based on a design by Bradbury and Bahr (1987). The wells consisted of a 1.91 cm (3/4 in) PVC spine which was screened over its last foot interval with a 30.48 cm (1 ft) slotted point with 0.0254 cm openings. Surrounding the spine are up to 6, 0.635 cm inside diameter polypropylene tubes which were attached to the PVC center spine with nylon reinforced tape. The polypropylene tubes were perforated with 0.32 cm (1/8 in) holes and screened with TYPAR over the last 25.4 cm (10 in) section at the bottom of each tube. Each tube extends to a different depth in the aquifer to allow discrete samples to be taken from various depths as shown in figure 3.3.

Four of the wells (A,C,D,E) have 5 sampling ports, including the spine, at 30.48 cm (1 ft) intervals with the upper most screened interval at or just below the watertable. Thus, the five wells were capable of sampling the upper 1.5 m (5 ft) of the aquifer at 30.48 cm (1 ft) intervals over a 12.2 meter wide transect as shown in figures 3.1 and 3.4. Well "B" had two additional poly sampling ports as shown in figure 3.4.

At Site 2, monitoring wells were installed downgradient of the mound system in the fall of 1990 as shown in figure 3.5. The downgradient monitoring wells were multilevel well nests consisting of four 1.9 cm (3/4 in.) PVC wells with 45 cm (1 $^1/^2$ in) slotted screens with 46 cm screen intervals. The shallowest well in the well nest was placed with half of the screen above the water table to allow for the annual fluctuations of the water table.

All monitoring wells were sampled using a 0.5 l/min peristaltic pump powered by a twelve volt battery. Samples were extracted through polypropylene sampling tubes and field filtered through an in line 0.45 micron membrane filter. The samples were then collected into 250 ml polypropylene bottles with polyethylene caps both of which where double rinsed with sample water after several well volumes had been purged from the well. Samples were then placed in coolers containing ice packs and transported to the Environmental Task Force Laboratory (Lab State ID No. 750040280) at the University of Wisconsin-Stevens Point for analysis and storage at 4^0C.

Groundwater samples were collected at the two locations prior to the initiation of the denitrification project. The two sites were each used previously for different projects and thus the

Figure 3.1 Monitoring Well Locations at Site 1

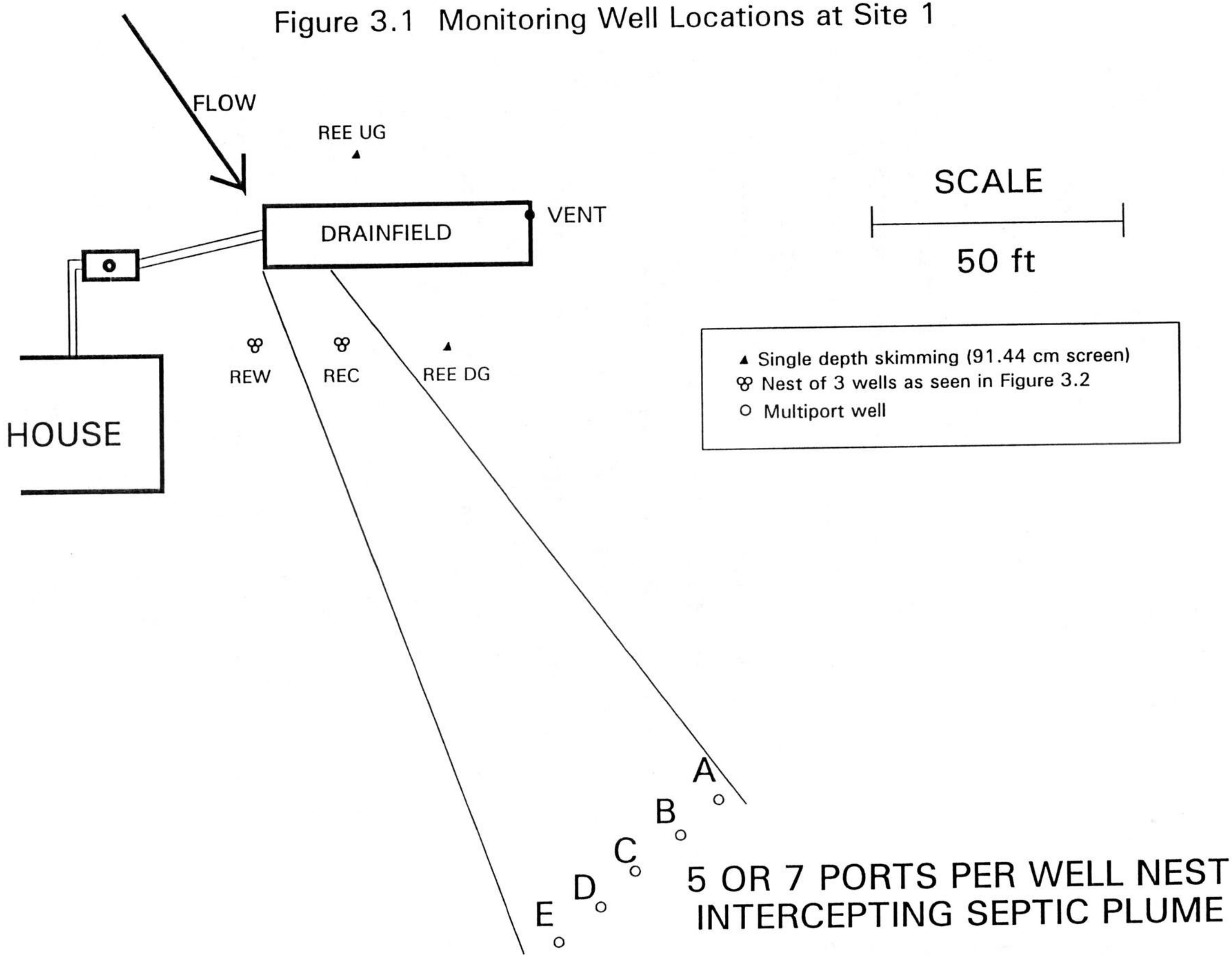


Figure 3.2 REC and REW well design, includes shallow, medium and deep ports located 4.6 m down-gradient of drainfield

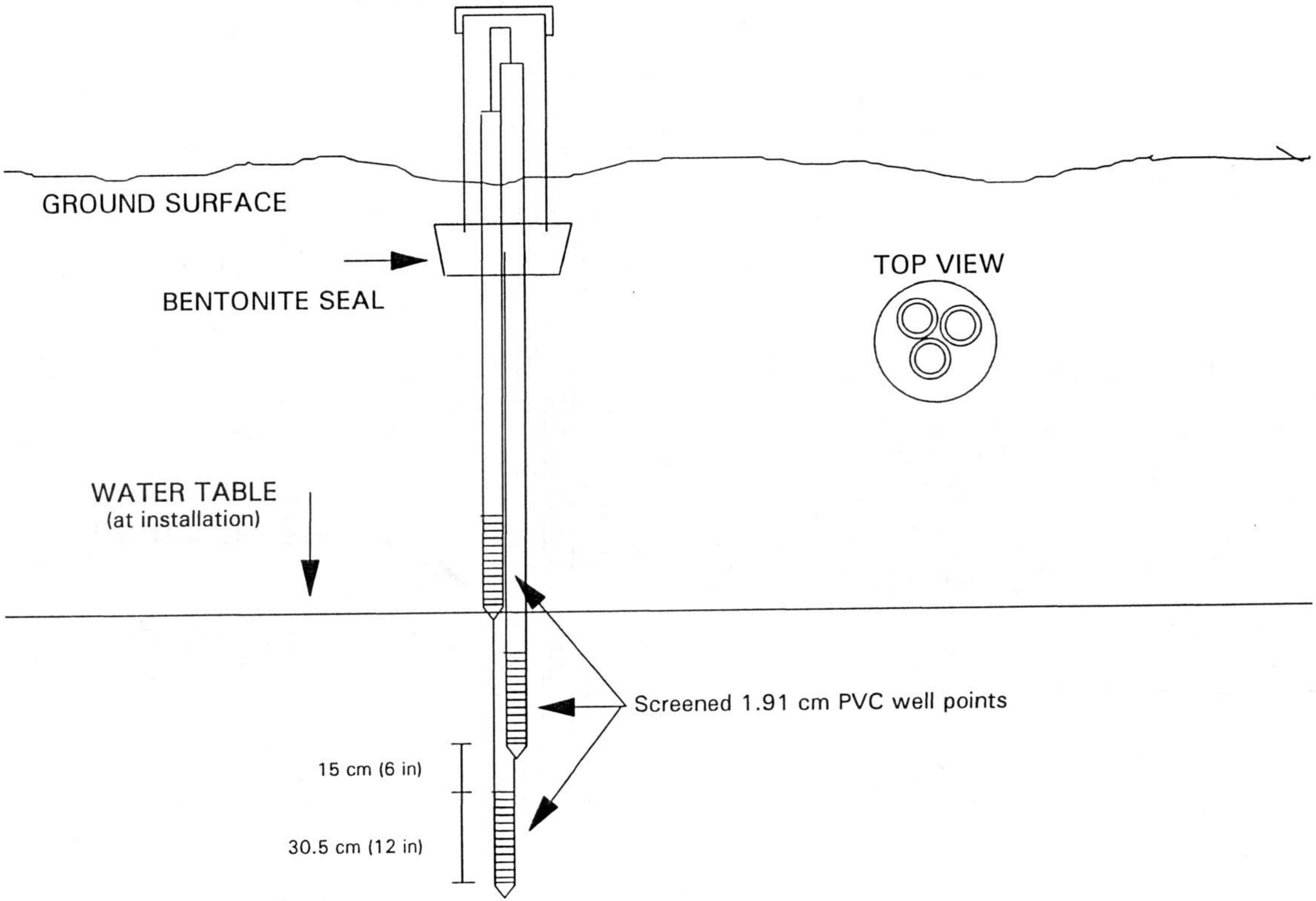


Figure 3.3 Multiport Well Design at Site 1.

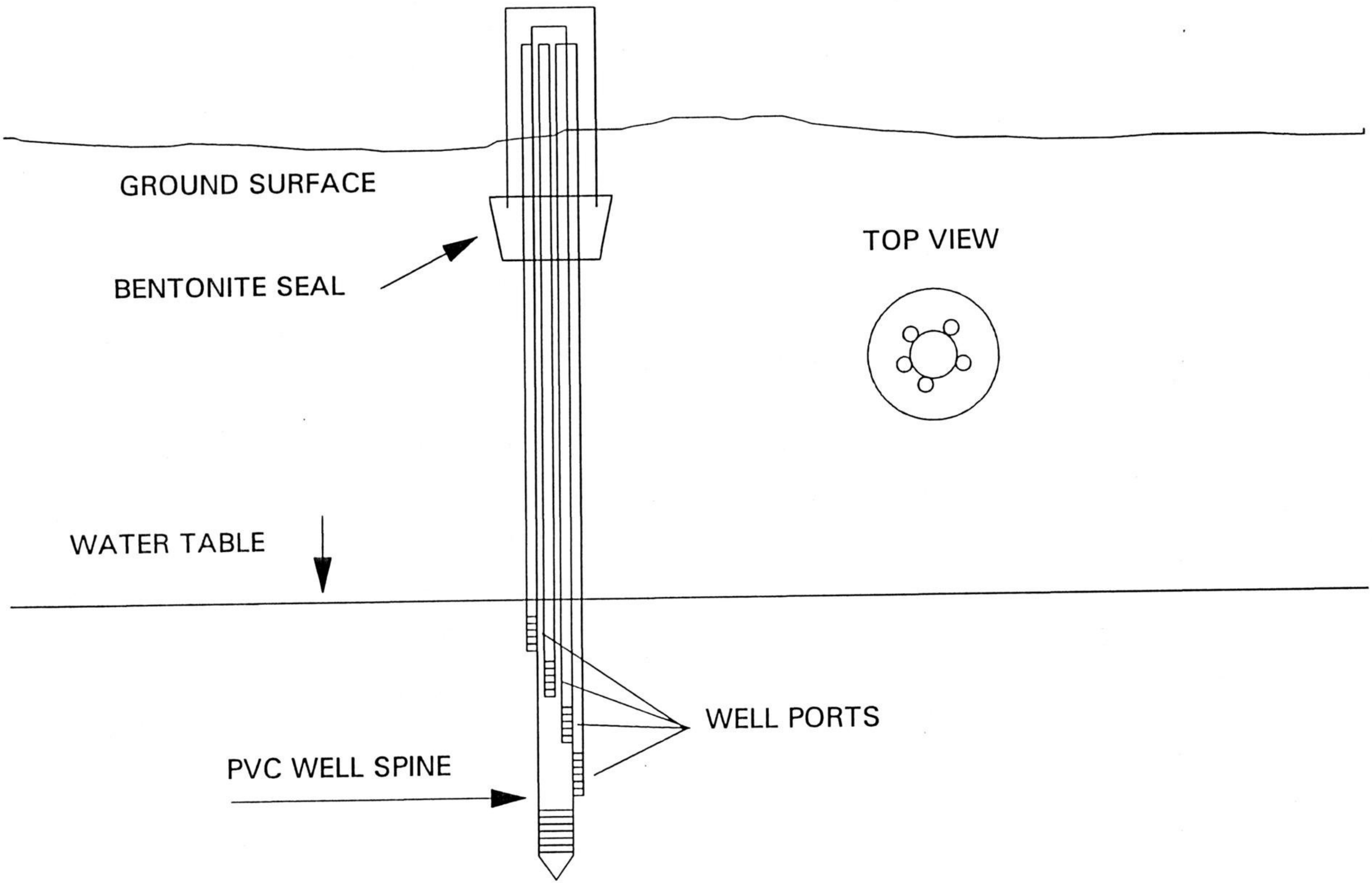


Figure 3.4 Cross sectional view of multiport wells at Site 1 looking from up to down-gradient. Wells are located 38 meter down-gradient of drainfield. Hash marks represent the center of the 30.5 cm sampling interval.

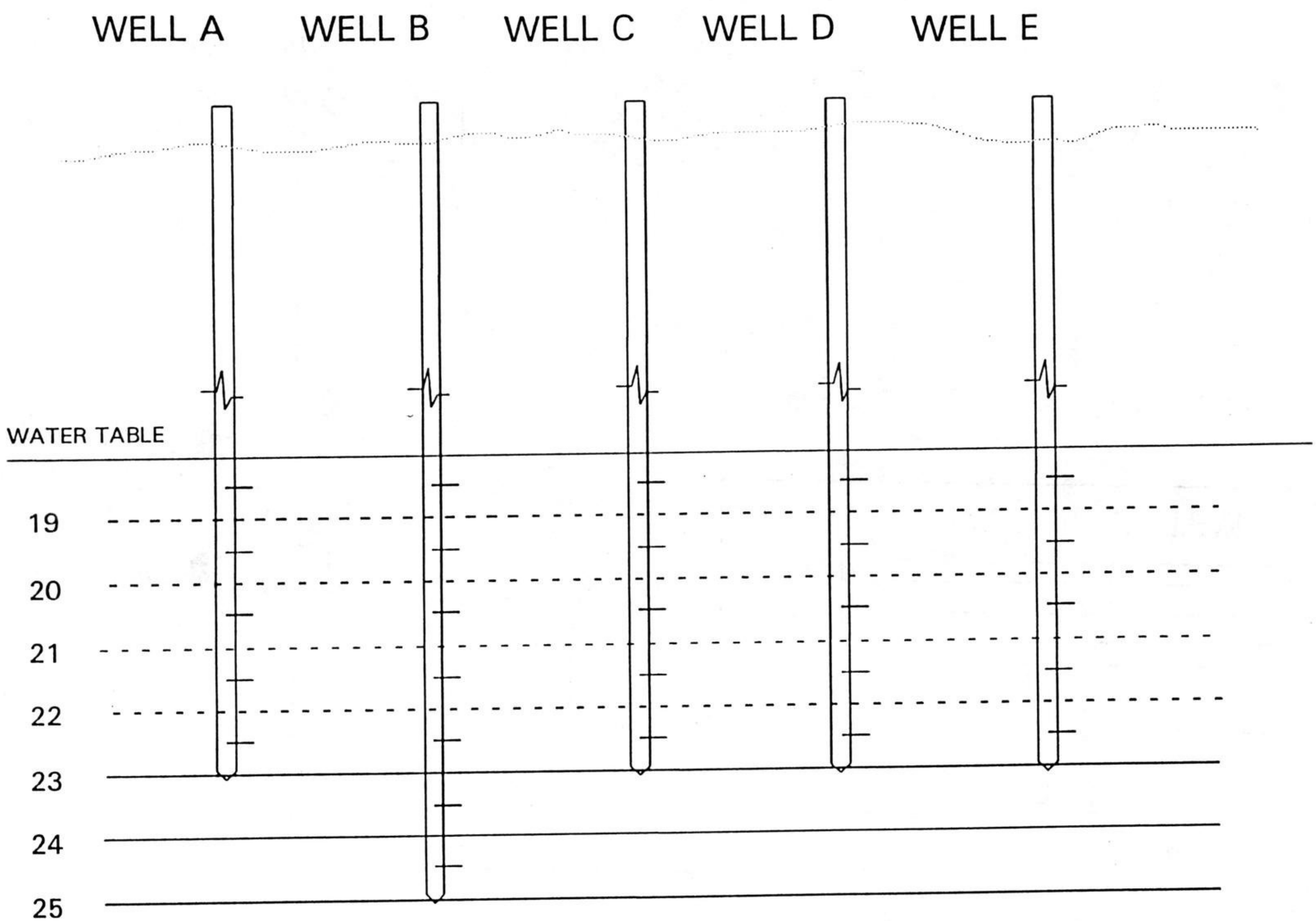
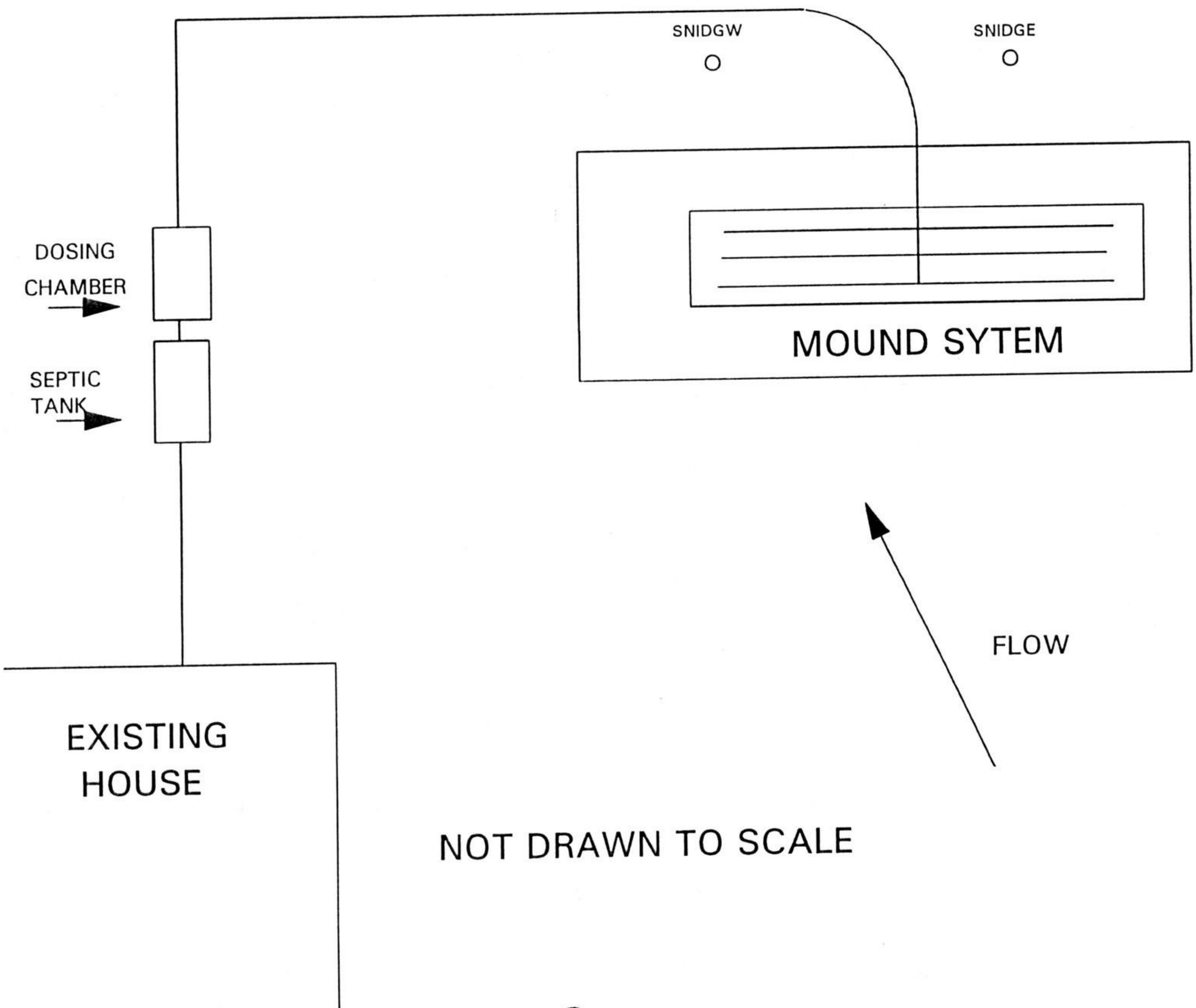


Figure 3.5 Location of down-gradient monitoring wells at Site 2.



previous sampling schedule and chemical analyses of the samples varied from one site to the other. Since the beginning of the denitrification project in the summer of 1991, groundwater samples have been taken from both sites on at least a bimonthly basis with samples typically analyzed for nine different water quality indicators. These include pH, electrical conductance, alkalinity, total hardness, ammonium-N, Nitrate + Nitrite-N, sodium, chloride, and fluorescence.

3.3 Denitrification System Design and Installation

The Denitrification systems retrofitted onto the two existing septic systems are quite similar. The systems involve using a recirculating sand filter with a built in rock storage area similar to that described by Swanson and Dix (1986). A 2000 gallon septic tank has been used to house the various components of the sand filter system. The major components include a collection system at the bottom, 15.5 inches of 1.5 inch diameter limestone, 3 inches of pea gravel, 23 inches of a 1.8 mm effective size sand with a uniformity coefficient of 1.4, a pump chamber, and a distribution system on the top of the sand filter. A more complete description of the various parts can be seen with the attached designs.

The systems were designed to remove nitrogen via denitrification in the septic tank following nitrification in the sand filter. Effluent from the RSF will be recirculated to the septic tank where an adequate carbon source and anaerobic conditions should enable bacteria to denitrify most of the nitrogen to nitrogen gas.

Originally, it was hoped that through the use of solenoid valves and a timing system it would be possible to pump effluent from the sand filter to either the top of the sand filter, back to the septic tank, or out to the drainfield or dosing chamber. Unfortunately, we could find no reliable solenoid valves and thus we could not pump the effluent to one place at a time.

Gate valves located along the three destination lines allow us to change the flow rate for the three destinations. By pumping to all three locations at once and varying the flow rate to each location, we have been able to accomplish our original goal of pumping various amounts to each destination. This concept proved to be much simpler and cheaper than the original plan and still allows us the opportunity to change the amounts pumped to each location at one time.

The Denitrification System at Site 1 was retrofitted onto a conventional septic system in July 16, 1992. Septic tank effluent flows from the septic tank by gravity to the bottom of the sand filter. Once there, with the help of floats and timers, it is pumped to the top of the sand filter, the septic tank, and the drainfield at different rates.

The Denitrification System at Site 2 was retrofitted onto the existing pressurized mound system in August 13, 1992. A few differences between this system and the other system can be noted. Due to the depth of the existing system, effluent from the septic tank flows by gravity to a sewage ejector pit which was placed in the dosing chamber. Through the use of floats, the effluent from this pit is pumped up to the top, rather than the bottom, of the sand filter. The effluent is pumped to the top of the sand filter in this system because we felt that since we have to pump it up to the sand filter we may as well allow it to run through the filter rather than pumping it directly to the bottom. The effluent from the sand filter is then pumped to the top of the sand filter, the septic tank, and the dosing chamber which in turn pumps it to the mound system.

3.4 Denitrification System Monitoring

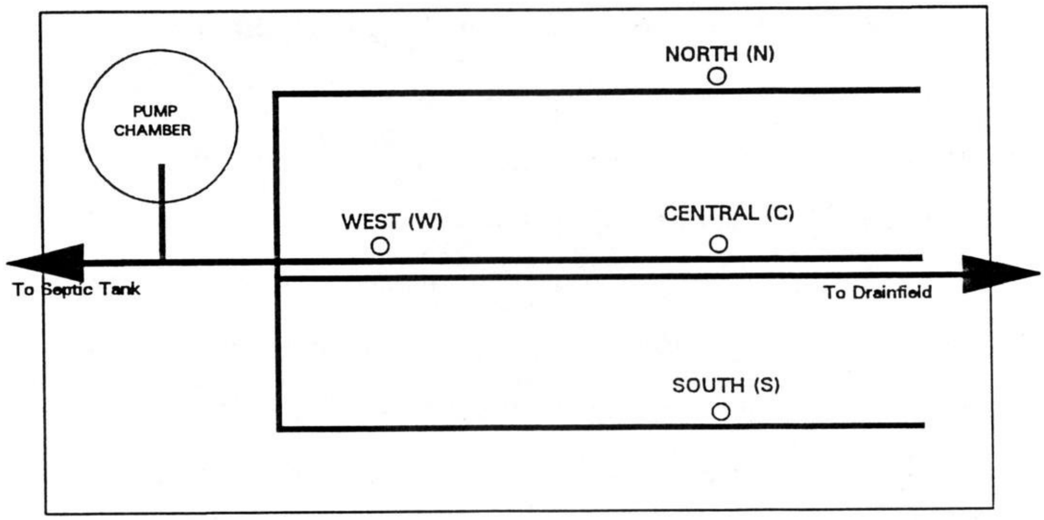
In addition to the original design of the denitrification systems, temperature probes have been placed in the two systems. The temperature probes are made out of type T thermocouple wire which have been soldered together at the bottom end and sealed with a Silicone Rubber Adhesive Sealant. An omega HH21 hand held microprocessor digital thermometer is used to record the temperatures from these thermocouple wires.

At Site 1, four groups of these thermocouples were placed in the sand filter as shown in figure 3.6. Each group consists of four thermocouple wires with the wires extending about 2.2 ft, 1.2 ft, 0.2 ft, and 0.0 ft below the surface of the sand in the sand filter.

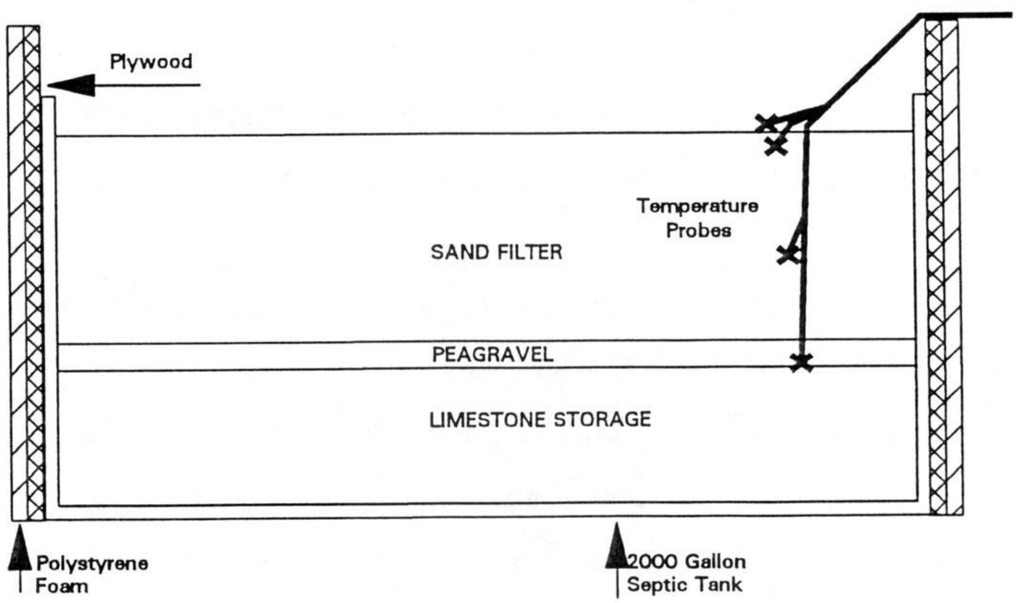
At Site 2, only one group of four thermocouples was placed in the sand filter at the same depths. We only placed one group in this system because the sand filter is deeper in the ground than the sand filter at Site 1 and thus we felt that temperature may not play as important a role on the nitrification and denitrification

Figure 3.6 Temperature probe locations in the recirculating sand filter at Site 1.

Top view of location of temperature probes in the recirculating sand filter.



Cross sectional view of location of temperature probes in the recirculating sand filter.



processes at this site as it may at the other. Temperature readings are taken on a weekly basis from all of the thermocouples within the sand filters. At Site 1, temperature readings are also taken weekly from the septic tank and from the pump chamber in the sand filter by lowering a thermocouple into the wastewater within them. At Site 2, additional temperature readings are taken from the sewage ejector pit, from the pump chamber within the sand filter, and from the dosing chamber by the same method.

Wastewater samples are taken from the denitrification systems on a weekly basis. At Site 1, samples are collected from the septic tank, from the pump chamber in the recirculating sand filter, and occasionally from the monitoring well in the sand filter. At Site 2, samples are collected from the sewage ejector pit in the dosing chamber, from the pump chamber in the recirculating sand filter, from the dosing chamber, and occasionally from the monitoring well in the sand filter.

The samples are collected by lowering a polypropylene bottle into the wastewater with a string. The sample bottle is rinsed four times with the wastewater before a sample is collected into a 125 ml polypropylene bottle with a polyethylene cap. 1 ml of concentrated H_2SO_4 is placed within the bottles before the sample is collected to preserve the various nitrogen forms. The samples are then placed within a cooler with ice packs and transported to the Environmental Task Force Laboratory at the University of Wisconsin-Stevens Point for analysis and storage at 4^0C. These weekly samples are analyzed for nitrate+nitrite-N, Ammonia-N, TKN (Total Keldjhal

Nitrogen), and chlorides.

On a monthly basis, samples are taken from the same places by the same method and collected in 500 ml polypropylene bottles with polyethylene caps. These samples have no preservatives in them and are analyzed for pH, electrical conductance, alkalinity, total hardness, sodium, total phosphorous, Biological Oxygen Demand$_5$, Chemical Oxygen Demand, and fluorescence.

Flow rates to the various places are measured through the use of a quick disconnect value located on each of the three destination lines. The lines are disconnected beyond the gate valves and a regular garden hose is then connected to it. A bucket is then filled up for a minute from each of the three destination lines and the total volume is measured in gallons giving us a flow rate in gallons/minute.

PRELIMINARY RESULTS

4.1 Site 1

At Site 1, the Recirculating Sand Filter was installed in July of 1992. Unfortunately, the electrician who designed and constructed our timing system encountered many problems debugging the controls. Thus, we could not begin pumping the effluent from the sand filter to the top of the sand filter, to the septic tank, and to the drainfield until early October.

Once, the pump was started, it took approximately one month before the nitrifying bacteria became adequately established to begin nitrifying the effluent. As can be seen in Figure 4.2, nitrate levels in the pump chamber of the sand filter did not reach detectable levels until mid November. As the nitrate levels increased, ammonia levels showed a corresponding decrease which indicates that the nitrifying bacteria were indeed converting the ammonia to nitrate.

As of December, no detectable amounts of nitrate have been found in the septic tank. This indicates that denitrifying bacteria are present in the septic tank and are able to convert any nitrate-N entering the septic tank to nitrogen gas.

Furthermore, as can be seen in Figure 4.1, as of early November, TKN concentrations, which is a measure of both ammonia-N and organic-N, have begun to drop significantly in the septic tank. Since no appreciable amounts of nitrates have been found in the septic tank, the TKN concentration is a very accurate measure of the Total Nitrogen concentration of the septic tank. As of late

December, TKN concentrations in the septic tank are lower than any concentrations from the past which indicates that the recirculating sand filter is indeed lowering the concentration of nitrogen in the septic tank.

As is shown in figure 4.2, Total Nitrogen concentrations, a measure of nitrate-N, ammonia-N, and organic-N, within the pump chamber of the recirculating sand filter have also been decreasingly steadily since mid-November. By comparing figures 4.1 and 4.2, it becomes apparent that the Total amount of Nitrogen present in both the septic tank and recirculating sand filter at Site 1 has decreased significantly since the pump has been started. Total Nitrogen concentrations of approximately 20 - 25 mg/l N are being pumped to the drainfield for disposal as compared to concentrations of approximately 70 mg/l N before the system was installed.

However, as can be seen in Figure 4.3, the temperatures of the effluent in both the septic tank and the pump chamber of the sand filter have steadily declined since the pump was originally started. As of mid-January 1993, temperatures of the effluent in both the sand filter and the septic tank are approximately 5_0C, which is near the reported minimum temperature for both nitrification and denitrification processes.

As can be seen in Figure 4.2, the level of nitrates present in the pump chamber of the recirculating sand filter have begun to decline since mid-November. However, this may not be a result of the temperature limiting the nitrification process as much as it

Figure 4.1 Ammonia and TKN Concentrations for the septic tank at Site 1.

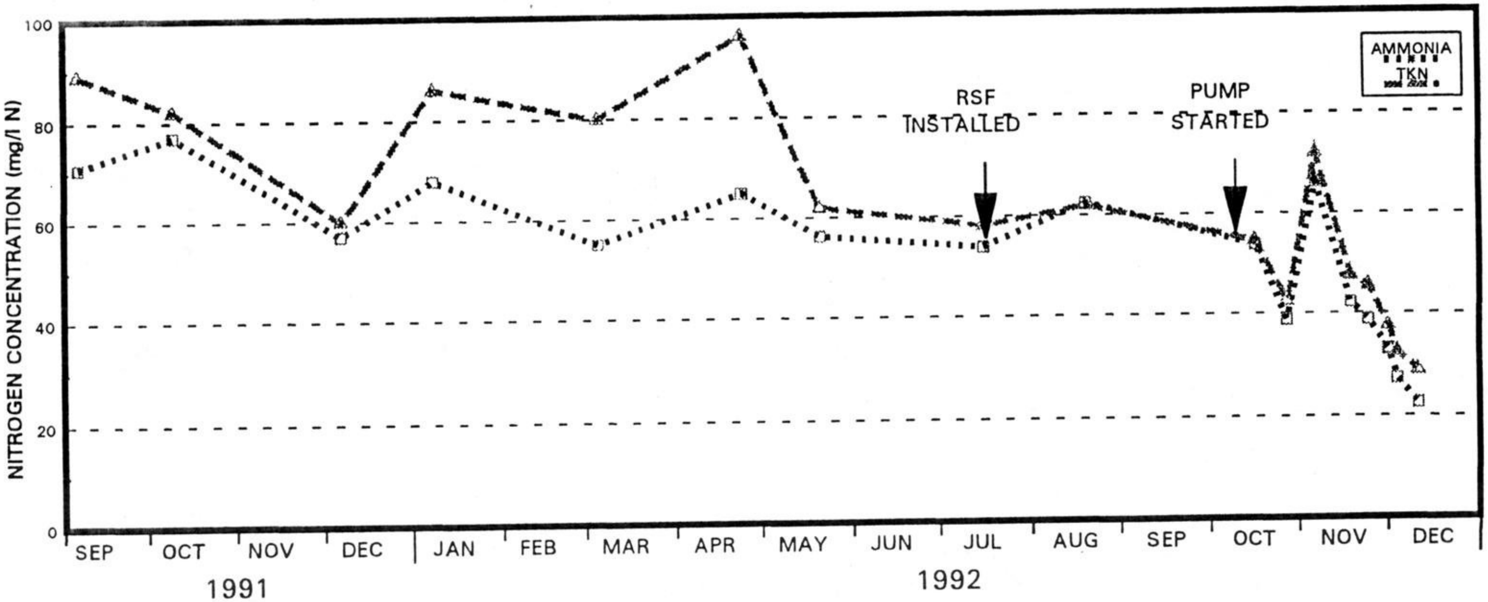


Figure 4.2 Nitrate/Nitrite, Ammonia, TKN, and Total Nitrogen concentrions for the pump chamber in the recirculating sand filter at Site 1.

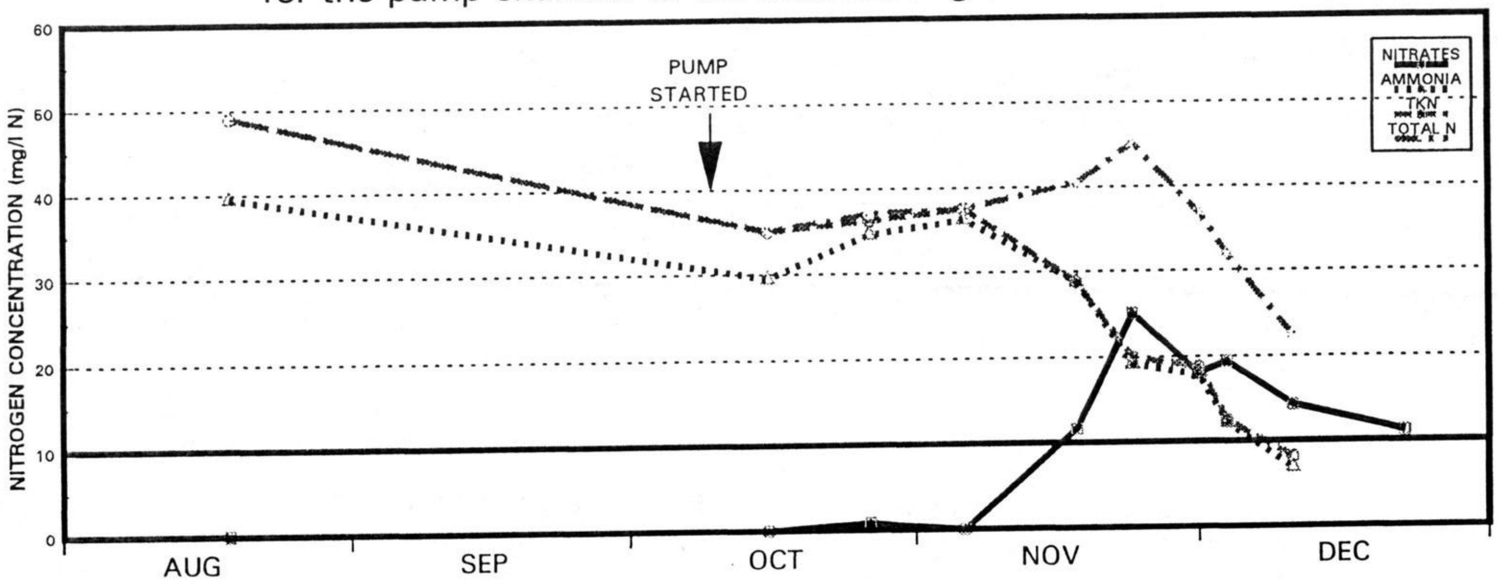
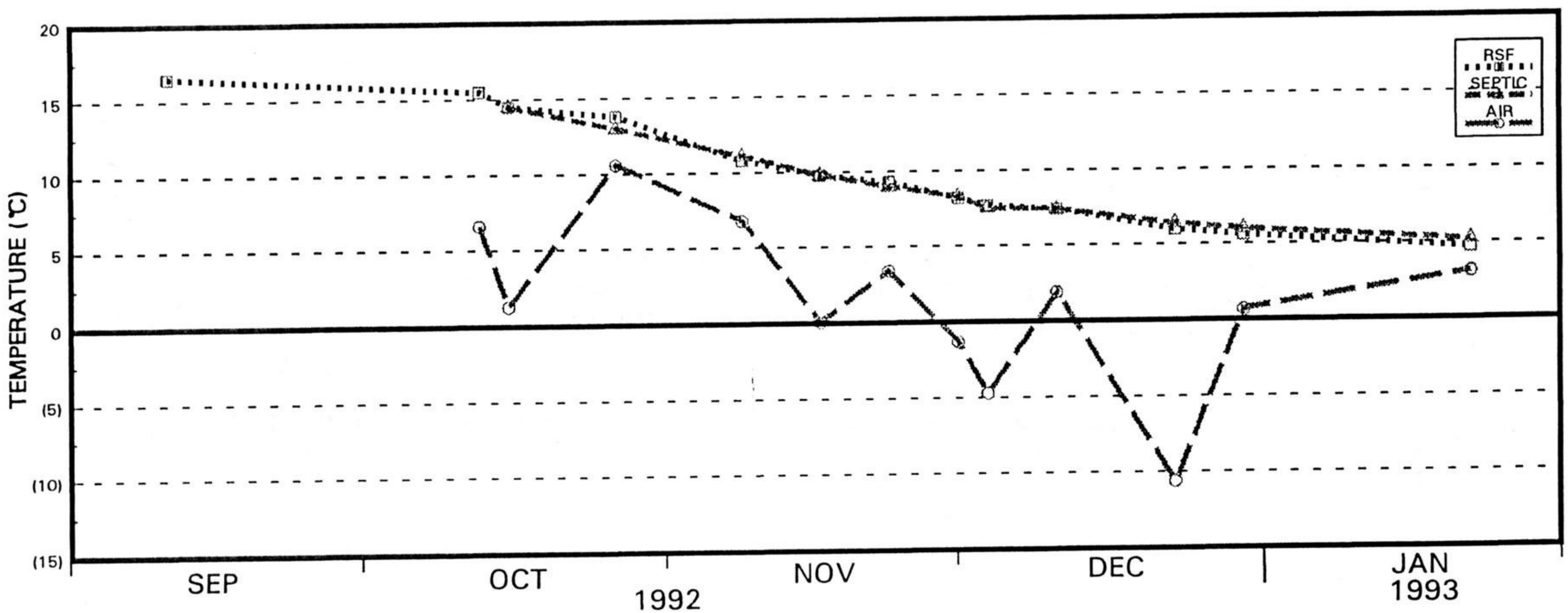


Figure 4.3 Temperature readings for the pump chamber in the recirculating sand filter and the septic tank at Site 1.



may be a result of a lower concentration of Total Nitrogen within the whole system. As the lab analyses become available for the mid-winter period we will see if the lower temperature is indeed limiting the nitrification and denitrification processes.

4.2 Site 2

At Site 2, the recirculating sand filter was installed in August of 1992 and the pump was started in early November. As can be seen in Figure 4.5, the nitrate levels in the pump chamber of the recirculating sand filter began to rise appreciably within a couple of weeks. This coupled with a corresponding decrease in ammonia levels again indicates that the nitrifying bacteria had become adequately established to nitrify the ammonia-N to nitrate-N.

We feel that the nitrate levels rose faster in this system than the other system because although the pump in the sand filter was not started until early November, effluent from the septic tank was being applied to the top of the sand filter since the system was first installed. This would allow the nitrifying bacteria to have become somewhat established within the sand filter before the pump within the sand filter was originally started.

By comparison, no effluent was applied to the top of the sand filter at Site 1 until early October when the pump within the sand filter was originally started. This meant that the nitrifying bacteria had no chance at becoming established in the sand filter until the pump began pumping effluent to the top of the sand filter.

Once the pump in the recirculating sand filer was started, TKN concentrations within the septic tank, again a reliable indication of Total Nitrogen concentration, declined almost immediately as can be seen in Figure 4.4. As in Site 1, no detectable amounts of nitrates were found leaving the septic tank which indicates that denitrifying bacteria are able to convert any nitrate entering the septic tank to nitrogen gas.

Figure 4.6 shows that the as of mid-December, approximately 12 mg/l of Total Nitrogen is exiting the denitrification system to the mound system. Conversely, Figure 4.4 shows that before the recirculating sand filter was installed an average of 43 mg/l of Total Nitrogen was being pumped to the mound system. This amounts to a 72% decrease in Total Nitrogen leaving the system.

As can be seen in Figure 4.7, as of mid-January the temperature of the septic tank and pump chamber of the sand filter is around 14^0C. This is much higher than the temperatures at Site 1 which we feel is due primarily to the facts that the recirculating sand filter at this site is located deeper in the ground and that this site presently has a much higher water usage than the other site. While these temperatures are higher than the temperatures at Site 1, they are still on the low range of temperatures reported for nitrification rates and thus may have an impact on the nitrification process before the winter is over.

Groundwater samples have been taken at both sites a few times since the systems have been installed and started. Presently, we are beginning to increase the monitoring schedule of groundwater samples to document any changes which may be occurring due to these systems.

Figure 4.4 Nitrate/Nitrite, Ammonia, and TKN concentrations for the effluent from the septic tank at Site 2.

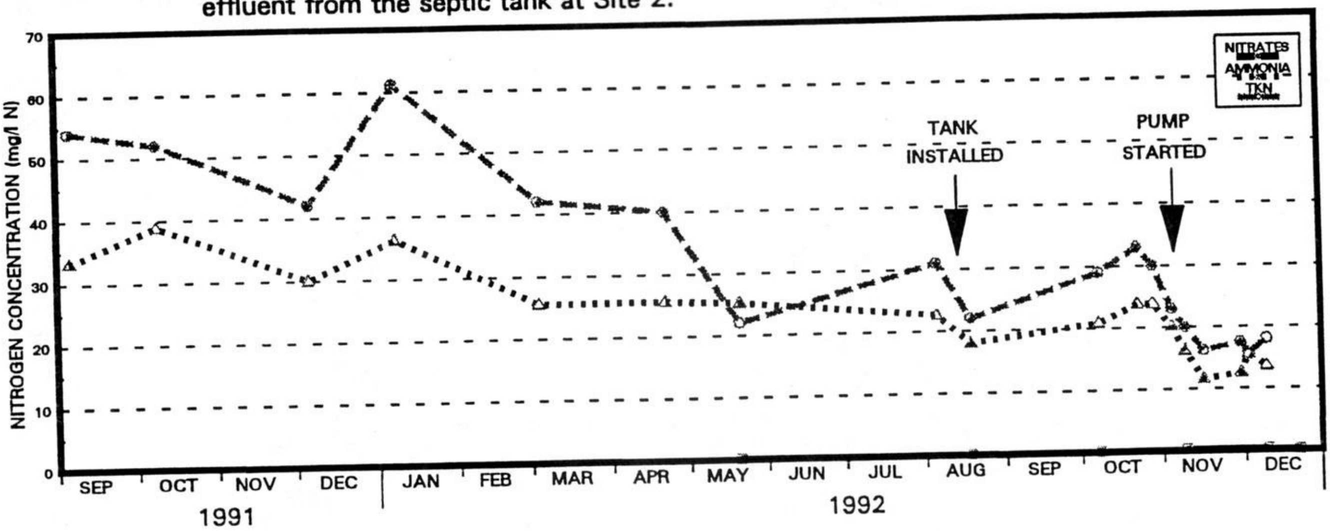


Figure 4.5 Nitrate/Nitrite, Ammonia, and TKN concentrations for the pump chamber in the recirculating sand filter at Site 2.

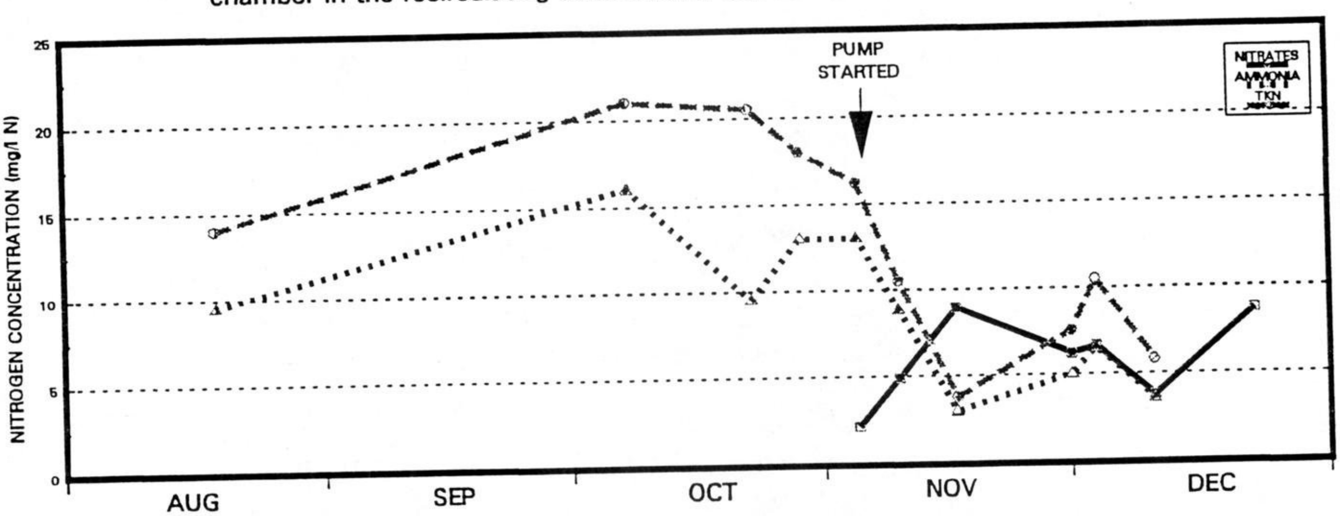


Figure 4.6 Nitrate/Nitrite, Ammonia, TKN, and Total Nitrogen concentrations for the dosing chamber immediately before the mound system at Site 2.

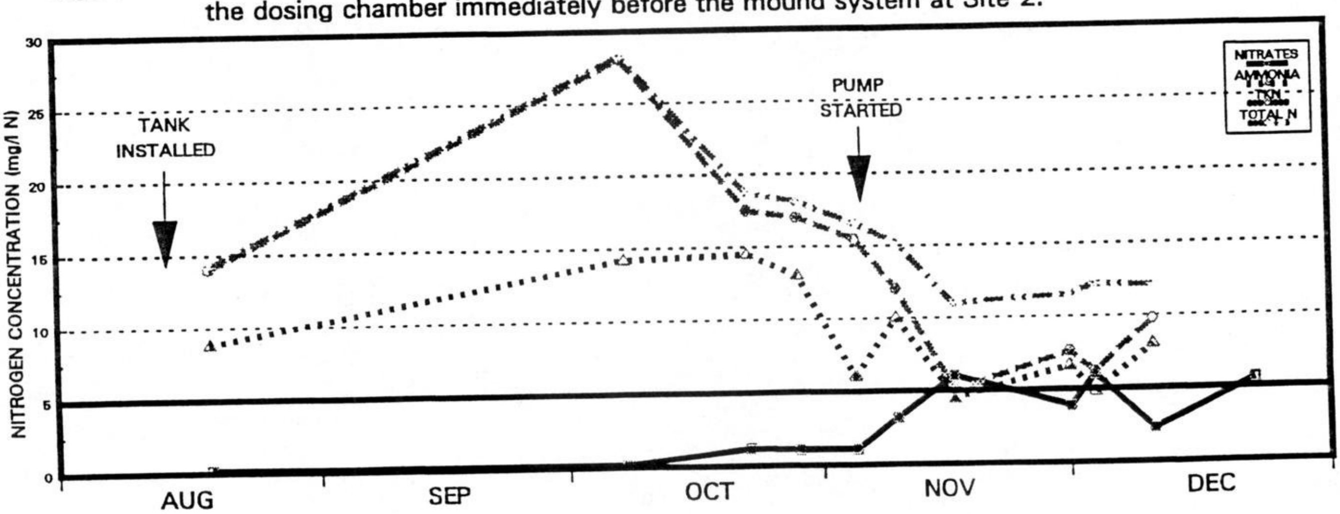
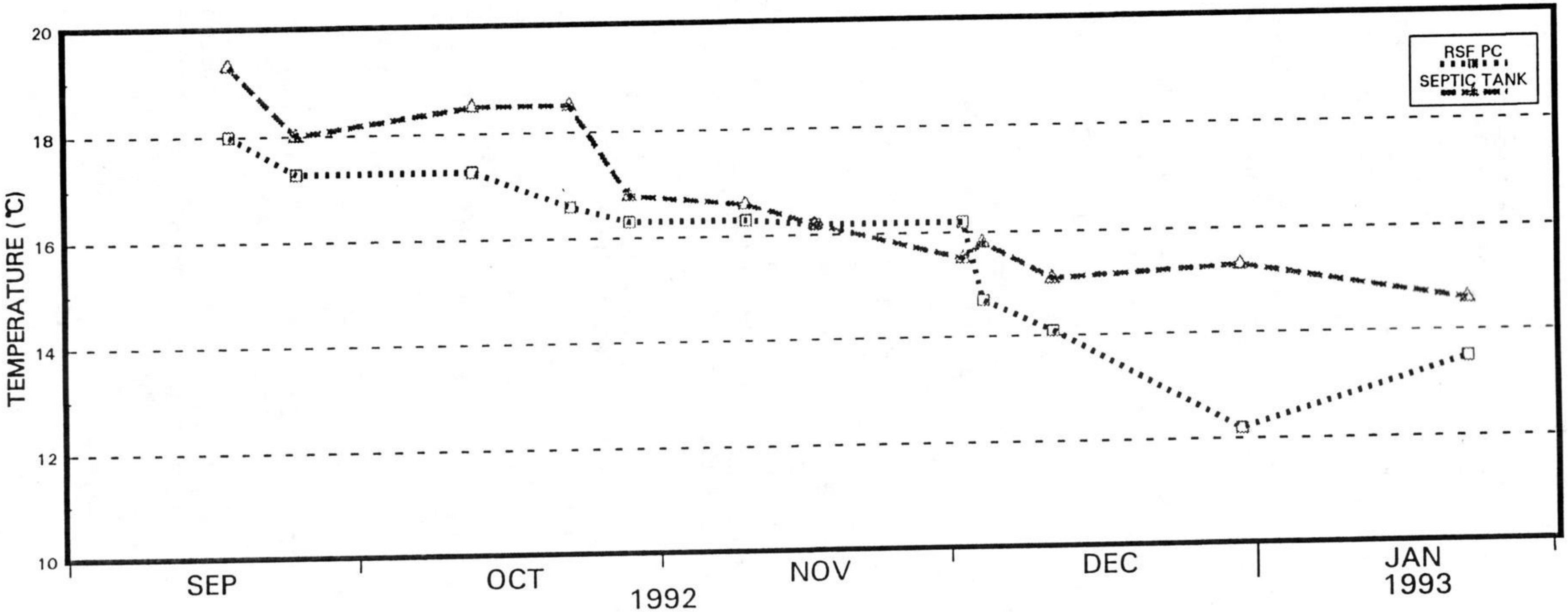


Figure 4.7 Temperature readings for the pump chamber in the recirculating sand filter and the sewage ejector pit at Site 2.



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APPENDIX 1
GROUNDWATER CHEMISTRY FOR SITE 1

Well	ID	Date	GW Dep	pH	Cond. mhos	Alk. mg/l	T. Hard mg/l	PO4 mg/l	NH4-N mg/l	NO2+NO3-N mg/l	Cl mg/l	Na mg/l	K mg/l	Fluor. mg/l
REE	LU	30-Jun-88		8.14	232	100	128		0.03	0.5	7	2.0		5.0
REE	LU	03-Aug-88	78.32	8.17	239	84	124	<0.002	0.02	0.5	6	0.8		
REE	SD	04-Oct-88		8.02	206	84	104	<0.002	<0.01	0.5	5	1.5		
REE	SU	04-Oct-88		7.96	178	72	100	<0.002	<0.01	<0.2	3	1.5		
REE	LU	20-Oct-88	78.10	8.07	226	96	124	<0.002	0.02	0.8	7	1.5		8.0
REE	SD	20-Oct-88	78.63	8.17	195	88	100	<0.002	0.02	0.8	5	1.3		8.3
REE	SU	20-Oct-88	78.77	8.14	195	88	104	<0.002	<0.01	0.5	4	1.0		6.3
REE	LU	18-Jan-89	77.90	8.15	275	124	132	0.002	<0.02	0.8	5	2.5		5.0
REE	SD	18-Jan-89	78.43	8.31	251	104	116	0.005	<0.02	1.8	7	2.0		6.0
REE	SU	18-Jan-89	78.58	8.31	255	112	128	0.005	<0.02	1.2	6	2.0		5.0
REE	LU	31-Mar-89	78.33	8.09	169	60	80	0.005		1.0	7	1.0		7.0
REE	SD	31-Mar-89	78.86	8.15	248	112	124	0.005		1.5	5	1.5		7.0
REE	SU	31-Mar-89	79.99	8.06	262	116	132	0.005		1.0	5	1.6		7.0
REE	LU	26-May-89	78.27	8.03	242	120	140	<0.002	0.05	1.2	6	1.6		6.0
REE	SD	13-Jun-89	80.21	8.21	269	112	144	<0.002		3.0	6	2.2		6.0
REE	SU	13-Jun-89	80.35	8.20	251	116	140	<0.002		1.0	5	1.6		5.5
REE	LU	08-Aug-89	19.22	8.34	208	92	108	<0.002	<0.02	1.5	3	1.0		7.0
REE	SD	08-Aug-89	19.28	8.36	280	116	140	<0.002	<0.02	3.0	5	2.0		10.0
REE	SU	08-Aug-89	19.40	8.37	250	116	140	<0.002	<0.02	1.8	3	1.0		9.0
REC	SDD	08-Sep-89	19.07	7.71	364	114	176	<0.002		9.8	10	6.5		14.0
REC	SDM	08-Sep-89	19.07	7.50	685	120	268	<0.002		38.0	45	27.5		47.0
REE	LU	08-Sep-89	19.39	8.09	232	110	132	<0.002		0.8	5	1.5		4.0
REE	SD	08-Sep-89	19.42	8.02	238	102	132	<0.002		2.5	5	1.5		6.0
REE	SU	08-Sep-89	19.54	8.10	237	112	136	<0.002		0.8	5	1.5		5.0
REW	SDD	08-Sep-89		8.00	274	126	168	0.002		1.6	5	2.0		5.0
REW	SDM	08-Sep-89	19.42	7.78	336	132	180	<0.002		6.2	7	2.5		6.0
REC	SDD	26-Oct-89	19.46	7.71	361	124	168	<0.002		7.0	2	2.0		12.0
REC	SDM	26-Oct-89	19.46	7.44	685	136	260	<0.002		25.5	36	19.5		36.0
REE	LU	26-Oct-89	19.75	8.06	230	96	116	<0.002		1.2	<1	1.5		5.0
REE	SD	26-Oct-89	19.79	8.16	232	100	116	<0.002		1.0	4	1.5		4.0
REE	SU	26-Oct-89	19.92	8.05	215	104	112	<0.002		0.2	<1	1.0		4.0
REW	SDD	26-Oct-89	19.80	8.08	233	104	116	<0.002		0.5	2	1.0		4.0
REW	SDM	26-Oct-89	19.80	7.78	343	144	168	<0.002		2.2	2	2.0		4.0
REC	SDD	05-Jan-90		7.65	515	112	232	0.005		23.2	18	10.0		10.0
REC	SDM	05-Jan-90		7.50	767	88	288	0.005		47.0	40	32.5		20.0
REC	SD	05-Jan-90		8.11	234	96	124	0.005		1.5	7	1.0		3.0
REE	SU	05-Jan-90		8.01	203	96	116	<0.002		0.5	3	1.0		2.0
REW	SDD	05-Jan-90		8.01	245	108	132	0.005		0.5	5	1.0		2.0
REW	SDM	05-Jan-90		7.80	342	144	180	0.002		4.8	4	1.5		2.0
REE	LU	08-Jan-90		8.17	224	100	128	0.005		1.0	3	1.5		3.0
REC	SDD	14-Feb-90		7.73	318	116	140	<0.002		8.5	8	8.4		
REC	SDM	14-Feb-90		7.63	698	88	244	<0.002		44.5	46	36.0		
REE	LU	14-Feb-90	20.40	8.12	250	120	132	0.002		0.5	3	1.4		
REE	SD	14-Feb-90		8.01	217	108	116	0.005		1.2	6	1.5		
REW	SDD	14-Feb-90		8.04	246	124	132	<0.002		0.5	5	1.3		
REW	SDM	14-Feb-90		7.86	287	140	156	<0.002		1.2	3	1.4		
REC	SDD	17-May-90		7.51	598			<0.002	0.65	32.5	24	15.0		13.0
REC	SDM	17-May-90		7.56	787			<0.002	0.20	49.5	39	21.1		14.0
REE	LU	17-May-90		8.08	211			<0.002	<0.02	<0.2	4	1.6		2.0
REE	SD	17-May-90		7.97	258			<0.002	<0.02	3.2	7	2.0		2.0
REE	SU	17-May-90		7.74	230			<0.002	<0.02	<0.2	5	1.2		2.0
REW	SDD	17-May-90		7.92	271			<0.002	<0.02	5.2	8	1.4		2.0
REW	SDM	17-May-90		7.73	448			<0.002	0.02	15.5	15	5.8		3.0
RSB	19	20-Jun-90		7.99	341	136	176	0.002		7.5	7	7.5		5.0
RSB	20	20-Jun-90		7.98	451	156	212	<0.002		15.5	26	15.5		6.0
RSB	21	20-Jun-90		8.00	537	128	248	<0.002		21.5	18	21.5		7.0
RSB	22	20-Jun-90		8.15	493			<0.002		18.5	16	18.5		7.0
RSB	23	20-Jun-90		8.26	382	116	184	<0.002		10.8	12	10.8		6[illegible]
RSB	24	20-Jun-90		8.30	299	152	152	<0.002		3.5	10	3.5		[illegible]
RSB	25	20-Jun-90		8.33	292	204	148	<0.002		2.5	11	2.5		5.[illegible]
RSA	19	25-Jun-90		7.85	326			<0.002		6.8	6	2.5		4.0

Well	ID	Date	GW Dep	pH	Cond. mhos	Alk. mg/l	T. Hard mg/l	PO4 mg/l	NH4-N mg/l	NO2+NO3-N mg/l	Cl mg/l	Na mg/l	K mg/l	Fluor. mg/l
RSA	20	25-Jun-90		7.99	340			<0.002		10.2	7	2.0		4.0
RSA	21	25-Jun-90		8.19	256			<0.002		3.0	7	1.5		4.0
RSA	22	25-Jun-90		8.27	253			0.002		2.2	7	1.5		4.0
RSA	23	25-Jun-90		8.31	247			<0.002		1.8	7	2.0		5.0
RSC	19	25-Jun-90		7.94	359			<0.002		12.5	11	6.5		5.0
RSC	20	25-Jun-90		7.76	618			<0.002		33.8	29	17.5		9.0
RSC	21	25-Jun-90		7.74	639			<0.002		35.2	32	19.0		12.0
RSC	22	25-Jun-90		7.93	375			<0.002		11.5	15	10.0		7.0
RSC	23	25-Jun-90		7.89	473			<0.002		21.0	22	13.0		9.0
REC	SDD	09-Jul-90		7.48	749			<0.002		47.2	43	22.0		34.0
REC	SDM	09-Jul-90		7.47	822			<0.002		59.0	43	26.0		30.0
REC	SDS	09-Jul-90		7.56	876			<0.002		70.0	32	12.0		21.0
REE	SD	09-Jul-90		7.91	290			<0.002		5.5	8	2.5		5.0
REW	SDD	09-Jul-90		7.89	280			<0.002		1.5	8	1.5		5.0
REW	SDM	09-Jul-90		7.69	485			<0.002		24.5	21	5.0		6.0
REW	SDS	09-Jul-90		7.55	744			<0.002		47.0	40	22.0		10.0
RSA	19	09-Jul-90		7.86	324			<0.002		10.0	8	2.0		5.0
RSA	20	09-Jul-90		7.97	301			<0.002		9.2	7	1.5		4.0
RSA	21	09-Jul-90		8.06	304			<0.002		9.5	8	2.0		5.0
RSA	22	09-Jul-90		8.09	290			<0.002		7.8	8	2.0		5.0
RSA	23	09-Jul-90		8.12	255			<0.002		4.0	8	1.5		5.0
RSB	19	09-Jul-90		7.90	358			<0.002		11.5	10	3.0		5.0
RSB	20	09-Jul-90		7.94	457			<0.002		19.8	14	7.5		7.0
RSB	21	09-Jul-90		8.01	406			<0.002		14.0	11	8.0		6.0
RSB	22	09-Jul-90		8.13	364			<0.002		11.8	11	5.5		6.0
RSB	23	09-Jul-90		8.23	257			<0.002		2.0	8	1.5		5.0
RSB	24	09-Jul-90		8.19	265			<0.002		2.0	9	1.5		5.0
RSB	25	09-Jul-90		8.12	270			<0.002		2.5	11	2.0		6.0
RSC	19	09-Jul-90		7.85	338			<0.002		12.8	11	5.5		6.0
RSC	20	09-Jul-90		7.80	436			0.002		18.5	17	13.0		10.0
RSC	21	09-Jul-90		7.81	422			0.002		15.5	16	14.0		11.0
RSC	22	09-Jul-90		7.81	550			<0.002		26.0	25	17.5		15.0
RSC	23	09-Jul-90		7.89	438			<0.002		17.2	18	13.0		12.0
RSD	19	09-Jul-90		7.96	244			<0.002		4.5	11	1.5		4.0
RSD	20	09-Jul-90		7.42	315			<0.002		7.2	11	5.0		5.0
RSD	21	09-Jul-90		7.80	573			<0.002		30.8	26	15.5		11.0
RSD	22	09-Jul-90		7.80	567			<0.002		31.2	26	12.5		9.0
RSD	23	09-Jul-90		7.83	434			<0.002		19.2	17	5.5		7.0
RSE	19	09-Jul-90		7.98	295			<0.002		9.2	17	1.5		3.0
RSE	20	09-Jul-90		7.98	322			<0.002		9.2	17	1.5		3.0
RSE	21	09-Jul-90		7.96	290			<0.002		4.2	8	2.5		5.0
RSE	22	09-Jul-90		8.06	263			<0.002		2.5	12	2.0		5.0
RSE	23	09-Jul-90		8.03	266			<0.002		2.8	14	2.0		7.0
REC	SDD	13-Aug-90	18.46	7.83	319	124	164	<0.002	0.05	4.6	5	1.7		10.0
REC	SDM	13-Aug-90	18.46	7.49	778	148	336	<0.002	0.40	41.9	28	17.0		51.0
REC	SDS	13-Aug-90	18.46	7.58	895	112	364	<0.002	0.10	63.1	40	24.2		29.0
REE	SD	13-Aug-90	18.81	8.16	262	112	148	<0.002	<0.02	1.8	6	2.0		4.0
REE	SU	13-Aug-90	18.93	8.14	250	112	140	<0.002	<0.02	1.2	4	1.3		5.0
REW	SDD	13-Aug-90	18.81	8.03	303	120	164	<0.002		1.5	7	1.9		6.0
REW	SDM	13-Aug-90	18.81	7.88	329	140	172	<0.002		1.9	4	2.0		4.0
REW	SDS	13-Aug-90	18.81	7.73	677	116	308	<0.002		43.6	30	8.4		9.0
RSA	19	13-Aug-90	18.77	7.91	345			<0.002		7.3	7	2.0		4.0
RSA	20	13-Aug-90	18.77	7.99	380			<0.002		13.1	10	2.4		6.0
RSA	21	13-Aug-90	18.77	8.20	260	108	144	<0.002		1.8	5	2.4		6.0
RSA	22	13-Aug-90	18.77	8.21	294	112	148	<0.002		4.4	6	2.4		6.0
RSA	23	13-Aug-90	18.77	8.26	284	108	144	<0.002		3.4	8	2.2		6.0
RSB	19	13-Aug-90	18.60	8.01	374	116	180	<0.002		11.6	11	2.9		5.0
RSB	20	13-Aug-90	18.60	8.03	538	120	248	<0.002		27.1	19	7.8		9.0
RSB	21	13-Aug-90	18.60	8.00	530	136	248	<0.002		24.4	17	9.0		9.0
RSB	22	13-Aug-90	18.60	8.06	603	144	288	<0.002		30.6	21	7.5		10.0
RSB	23	13-Aug-90	18.60	8.30	313	120	164	<0.002		4.9	9	2.0		6.0

Well	ID	Date	GW Dep	pH	Cond. mhos	Alk. mg/l	T. Hard mg/l	PO4 mg/l	NH4-N mg/l	NO2+NO3-N mg/l	Cl mg/l	Na mg/l	K mg/l	Fluor. mg/l
RSB	24	13-Aug-90	18.60	8.30	290	116	156	<0.002		2.4	10	1.7		6.0
RSB	25	13-Aug-90	18.60	8.30	292	116	160	<0.002		2.8	11	2.0		6.0
RSC	19	13-Aug-90	18.64	7.91	497	128	228	<0.002		22.9	21	5.8		9.0
RSC	20	13-Aug-90	18.64	7.82	787	120	344	<0.002		50.8	40	16.0		21.0
RSC	21	13-Aug-90	18.64	7.83	827	124	344	<0.002		53.3	43	21.8		26.0
RSC	22	13-Aug-90	18.64	7.90	701	128	304	<0.002		40.3	35	19.7		24.0
RSC	23	13-Aug-90	18.64	7.98	431	116	204	<0.002		14.9	17	5.9		13.0
RSD	19	13-Aug-90	18.41	8.07	253	112	132	<0.002		3.6	11	1.7		3.0
RSD	20	13-Aug-90	18.41	7.98	374	120	176	<0.002		11.0	15	7.2		5.0
RSD	21	13-Aug-90	18.41	7.78	652	136	292	<0.002		36.4	30	14.0		13.0
RSD	22	13-Aug-90	18.41	7.90	415	124	200	<0.002		14.3	15	6.9		8.0
RSD	23	13-Aug-90	18.41	7.98	458	128	220	<0.002		18.1	18	9.4		9.0
RSE	19	13-Aug-90	18.35	8.07	335	112	176	<0.002		10.3	13	2.0		4.0
RSE	20	13-Aug-90	18.35	8.00	375	132	200	<0.002		9.7	13	3.0		4.0
RSE	21	13-Aug-90	18.35	7.98	379	124	200	<0.002		10.6	14	4.0		5.0
RSE	22	13-Aug-90	18.35	8.10	286	116	152	<0.002		2.0	10	1.9		5.0
RSE	23	13-Aug-90	18.35	8.17	287	116	152	<0.002		2.3	12	2.0		6.0
REC	SDD	27-Aug-90		6.93	281			<0.002		11.1	12	4.5		14.0
REC	SDM	27-Aug-90		6.80	599			0.005		54.9	42	27.0		68.0
REC	SDS	27-Aug-90		6.73	623			<0.002		59.0	39	23.0		37.0
REE	LU	27-Aug-90		6.81	177			<0.002		0.5	4	1.0		5.0
REE	SD	27-Aug-90		6.89	190			0.025		1.9	9	1.5		5.0
REW	SDD	27-Aug-90		6.95	210			<0.002		11.1	12	4.5		6.0
REW	SDM	27-Aug-90		6.89	236			<0.002		0.9	5	1.5		7.0
REW	SDS	27-Aug-90		6.91	434			<0.002		34.8	25	6.5		8.0
RSA	19	27-Aug-90		6.82	235			<0.002		6.0	8	1.5		4.0
RSA	20	27-Aug-90		7.02	246			<0.002		10.0	9	1.5		5.0
RSA	21	27-Aug-90		7.02	259			<0.002		12.1	11	1.5		6.0
RSA	22	27-Aug-90		7.06	262			<0.002		13.0	12	2.0		6.0
RSA	23	27-Aug-90		7.03	204			<0.002		2.6	10	2.0		6.0
RSB	19	27-Aug-90		7.10	241			<0.002		7.9	12	2.5		4.0
RSB	20	27-Aug-90		7.22	334			<0.002		16.8	15	6.5		8.0
RSB	21	27-Aug-90		7.20	300			<0.002		11.0	12	6.0		7.0
RSB	22	27-Aug-90		7.00	325			<0.002		14.6	14	8.5		7.0
RSB	23	27-Aug-90		6.61	303			<0.002		11.9	14	2.0		6.0
RSB	24	27-Aug-90		6.81	216			<0.002		2.6	12	1.5		6.0
RSB	25	27-Aug-90		7.08	221			<0.002		2.9	13	1.5		8.0
RSC	19	27-Aug-90		7.30	337			<0.002		14.8	19	5.0		7.0
RSC	20	27-Aug-90		7.20	565			<0.002		46.4	37	5.5		20.0
RSC	21	27-Aug-90		7.01	465			<0.002		29.2	27	17.0		17.0
RSC	21D	27-Aug-90		7.06	455			<0.002		28.2	27	17.0		16.0
RSC	22	27-Aug-90		7.11	293			<0.002		9.6	13	13.0		11.0
RSC	23	27-Aug-90		6.94	336			<0.002		12.5	16	8.0		11.0
RSD	19	27-Aug-90		7.13	216			<0.002		2.0	13	1.5		4.0
RSD	19D	27-Aug-90		6.88	201			<0.002		2.4	13	1.5		4.0
RSD	20	27-Aug-90		6.88	329			<0.002		16.9	22	2.5		6.0
RSD	21	27-Aug-90		7.10	435			<0.002		34.2	30	9.0		11.0
RSD	22	27-Aug-90		7.00	314			<0.002		10.1	14	3.0		6.0
RSD	23	27-Aug-90		7.22	336			<0.002		13.7	17	5.5		8.0
RSE	19	27-Aug-90		7.17	245			<0.002		2.7	20	1.5		3.0
RSE	20	27-Aug-90		7.36	320			<0.002		11.0	19	3.0		4.0
RSE	21	27-Aug-90		7.26	301			<0.002		8.7	15	3.5		5.0
RSE	22	27-Aug-90		7.01	241			<0.002		1.7	12	1.5		5.0
RSE	23	27-Aug-90		7.08	237			<0.002		2.0	13	0.5		6.0
REC	SDD	25-Sep-90	18.31	7.83	274			<0.002		1.6	5	1.5		5.0
REC	SDM	25-Sep-90	18.31	7.10	655			<0.002		34.1	28	18.0		38.0
REC	SDS	25-Sep-90	18.31	7.38	841			<0.002		61.6	42	23.0		24.0
REE	SD	25-Sep-90	18.67	7.94	246			<0.002		1.3	5	1.5		4[illegible]
REW	SDD	25-Sep-90	18.67	7.99	269			<0.002		0.9	7	2.0		4[illegible]
REW	SDM	25-Sep-90	18.67	7.75	297			<0.002		0.4	5	1.5		5.0
REW	SDS	25-Sep-90	18.67	7.69	532			<0.002		30.3	24	9.0		6.0

Well	ID	Date	GW Dep	pH	Cond. mhos	Alk. mg/l	T. Hard mg/l	PO4 mg/l	NH4-N mg/l	NO2+NO3-N mg/l	Cl mg/l	Na mg/l	K mg/l	Fluor. mg/l
RSA	19	25-Sep-90	18.63	7.73	453			<0.002		23.4	18	2.5		5.0
RSA	20	25-Sep-90	18.63	7.92	413			<0.002		20.2	16	2.8		5.0
RSA	21	25-Sep-90	18.63	8.05	263			<0.002		1.2	10	1.7		4.0
RSA	22	25-Sep-90	18.63	8.16	271			0.005		2.1	11	1.7		4.0
RSA	23	25-Sep-90	18.63	8.20	336			<0.002		9.5	14	2.2		5.0
RSB	19	25-Sep-90	18.45	7.89	457			<0.002		19.3	17	5.0		5.0
RSB	20	25-Sep-90	18.45	7.97	318			0.002		4.7	8	4.6		4.0
RSB	21	25-Sep-90	18.45	8.00	279			0.002		2.4	8	3.0		4.0
RSB	22	25-Sep-90	18.45	8.07	282			0.002		3.0	10	3.0		4.0
RSB	23	25-Sep-90	18.45	7.85	261			<0.002		2.6	12	1.7		4.0
RSB	24	25-Sep-90	18.45	8.00	265			<0.002		2.8	13	2.0		4.0
RSB	25	25-Sep-90	18.45	8.06	266			0.002		3.2	14	2.2		5.0
RSC	19	25-Sep-90	18.50	7.73	527			<0.002		24.2	29	5.0		6.0
RSC	20	25-Sep-90	18.50	7.70	608			0.002		31.7	25	11.0		11.0
RSC	21	25-Sep-90	18.50	7.62	673			<0.002		40.3	26	13.5		13.0
RSC	22	25-Sep-90	18.50	7.62	768			<0.002		51.2	33	16.5		14.0
RSC	23	25-Sep-90	18.50	7.80	520			<0.002		24.6	23	8.4		10.0
RSD	19	25-Sep-90	18.26	7.82	319			<0.002		4.1	18	2.2		3.0
RSD	20	25-Sep-90	18.26	7.77	464			<0.002		19.7	24	8.0		5.0
RSD	21	25-Sep-90	18.26	7.77	413			<0.002		14.6	20	8.4		6.0
RSD	22	25-Sep-90	18.26	7.73	688			<0.002		41.3	34	12.6		9.0
RSD	23	25-Sep-90	18.26	7.78	578			<0.002		29.7	28	8.1		7.0
RSE	19	25-Sep-90	18.21	7.80	323			<0.002		4.6	15	1.5		3.0
RSE	20	25-Sep-90	18.21	7.82	424			<0.002		17.9	22	4.5		4.0
RSE	21	25-Sep-90	18.21	7.84	369			<0.002		9.4	17	5.0		4.0
RSE	22	25-Sep-90	18.21	7.98	283			<0.002		2.2	15	2.5		4.0
RSE	23	25-Sep-90	18.21	8.14	278			<0.002		2.7	16	1.5		5.0
REE	LU	13-Oct-90		7.97	236			<0.002		0.7	4	1.5		4.0
REC	SDD	06-Nov-90	18.53	8.55	249			<0.002		0.6	4	1.5		5.0
REC	SDM	06-Nov-90	18.53	7.94	342			<0.002		2.1	2	2.0		23.0
REC	SDS	06-Nov-90	18.53	7.73	602			<0.002		14.1	11	10.2		45.0
REE	SD	06-Nov-90	18.88	8.43	264			<0.002		1.7	7	3.6		5.0
REW	SDD	06-Nov-90	18.87	8.28	295			<0.002		1.2	8	3.8		6.0
REW	SDM	06-Nov-90	18.87	8.18	296			<0.002		0.6	2	1.8		5.0
REW	SDS	06-Nov-90	18.87	8.06	480			<0.002		9.6	8	2.2		6.0
RSA	19	06-Nov-90	18.83	7.58	516			<0.002		24.2	16	4.5		7.0
RSA	20	06-Nov-90	18.83	7.80	524			0.002		25.6	16	5.0		9.0
RSA	21	06-Nov-90	18.83	8.09	330			0.005		12.0	10	2.6		7.0
RSA	22	06-Nov-90	18.83	8.16	275			0.002		2.4	8	2.5		6.0
RSA	23	06-Nov-90	18.83	8.33	282			<0.002		2.1	10	2.6		6.0
RSB	19	06-Nov-90	18.66	8.02	448			<0.002		15.4	10	6.2		8.0
RSB	20	06-Nov-90	18.66	8.04	424			<0.002		13.5	9	5.8		9.0
RSB	21	06-Nov-90	18.66	8.09	297			<0.002		2.3	4	2.5		5.0
RSB	22	06-Nov-90	18.66	8.12	290			<0.002		1.6	6	2.2		5.0
RSB	23	06-Nov-90	18.66	8.24	276			<0.002		2.0	9	2.5		6.0
RSB	24	06-Nov-90	18.66	8.24	271			0.002		2.5	11	2.6		6.0
RSB	25	06-Nov-90	18.66	8.22	272			<0.002		3.1	12	2.8		8.0
RSC	19	06-Nov-90	18.70	7.83	690			<0.002		37.9	21	6.0		13.0
RSC	20	06-Nov-90	18.70	7.80	722			<0.002		39.0	22	10.4		18.0
RSC	21	06-Nov-90	18.70	7.79	760			<0.002		41.6	25	13.2		25.0
RSC	22	06-Nov-90	18.70	7.87	514			<0.002		20.2	17	8.4		16.0
RSC	23	06-Nov-90	18.70	8.00	609			<0.002		26.4	22	9.0		23.0
RSD	19	06-Nov-90	18.46	7.95	584			<0.002		24.1	22	4.5		7.0
RSD	20	06-Nov-90	18.46	7.98	481			<0.002		17.0	15	7.8		9.0
RSD	21	06-Nov-90	18.46	8.03	425			<0.002		13.9	13	9.2		10.0
RSD	22	06-Nov-90	18.46	8.22	337			<0.002		7.1	10	4.4		7.0
RSD	23	06-Nov-90	18.46	8.31	327			<0.002		2.4	10	2.5		7.0
RSE	19	06-Nov-90	18.40	8.08	503			<0.002		15.9	20	3.0		4.0
RSE	20	06-Nov-90	18.40	8.13	519			<0.002		19.9	22	6.5		6.0
RSE	21	06-Nov-90	18.40	8.29	322			<0.002		1.6	10	2.5		5.0
RSE	22	06-Nov-90	18.40	8.52	315			<0.002		1.9	11	2.5		7.0

Well	ID	Date	GW Dep	pH	Cond. mhos	Alk. mg/l	T. Hard mg/l	PO4 mg/l	NH4-N mg/l	NO2+NO3-N mg/l	Cl mg/l	Na mg/l	K mg/l	Fluor. mg/l
RSE	23	06-Nov-90	18.40	8.33	304			<0.002		2.3	13	3.0		6.0
REC	SDD	12-Jan-91	19.03	7.81	252			<0.002		1.4	3	2.6		3.0
REC	SDM	12-Jan-91	19.03	7.66	531			<0.002		20.5	38	21.0		17.0
REC	SDS	12-Jan-91	19.03	7.79	564			<0.002		22.5	47	26.5		25.0
REE	SD	12-Jan-91	19.36	8.12	232			<0.002		1.6	7	2.0		3.0
REE	SU	12-Jan-91	19.48	8.05	189			0.002		0.3	<1	1.2		2.0
REW	SDD	12-Jan-91	19.36	8.01	265			0.002		1.0	7	2.0		3.0
REW	SDM	12-Jan-91	19.36	7.76	278			<0.002		0.5	3	1.6		2.0
RSA	19	12-Jan-91	19.32	7.77	400			0.005		14.5	10	4.0		4.0
RSA	20	12-Jan-91	19.32	7.96	341			0.002		8.9	7	2.8		3.0
RSA	21	12-Jan-91	19.32	8.17	228			0.008		0.7	4	1.6		2.0
RSA	22	12-Jan-91	19.32	8.27	238			0.002		1.3	6	2.2		2.0
RSA	23	12-Jan-91	19.32	8.33	263			0.002		1.8	8	2.6		3.0
RSB	19	12-Jan-91	19.15	7.82	550			<0.002		25.6	16	6.4		5.0
RSB	20	12-Jan-91	19.15	7.91	370			<0.002		9.1	7	3.2		4.0
RSB	21	12-Jan-91	19.15	8.08	244			<0.002		0.8	4	1.8		2.0
RSB	22	12-Jan-91	19.15	8.13	246			<0.002		1.2	6	2.4		3.0
RSB	23	12-Jan-91	19.15	8.26	260			<0.002		1.8	8	2.8		3.0
RSB	24	12-Jan-91	19.15	8.28	268			0.008		2.6	12	3.2		3.0
RSB	25	12-Jan-91	19.15	8.30	269			0.002		3.1	13	3.8		3.0
RSC	19	12-Jan-91	19.19	7.65	347			0.005		6.1	5	11.8		4.0
RSC	20	12-Jan-91	19.19	7.80	428			<0.002		12.5	8	7.8		6.0
RSC	21	12-Jan-91	19.19	7.85	534			0.002		21.0	12	9.2		9.0
RSC	22	12-Jan-91	19.19	7.94	283			0.002		3.4	6	3.5		3.0
RSC	23	12-Jan-91	19.19	8.06	250			<0.002		1.2	7	2.5		3.0
RSD	19	12-Jan-91	18.95	7.76	542			0.028		27.3	24	6.6		4.0
RSD	20	12-Jan-91	18.95	7.75	668			0.002		34.4	27	14.5		8.0
RSD	21	12-Jan-91	18.95	7.78	522			<0.002		19.6	17	12.0		8.0
RSD	22	12-Jan-91	18.95	8.00	313			<0.002		4.6	9	4.4		4.0
RSD	23	12-Jan-91	18.95	8.17	256			<0.002		1.4	9	2.5		3.0
RSE	19	12-Jan-91	18.90	7.86	474			<0.002		20.8	19	5.8		3.0
RSE	20	12-Jan-91	18.90	7.82	472			<0.002		17.2	16	7.2		3.0
RSE	21	12-Jan-91	18.90	7.96	272			<0.002		1.4	8	2.4		3.0
RSE	22	12-Jan-91	18.90	8.08	278			<0.002		1.8	11	2.6		3.0
RSE	23	12-Jan-91	18.90	8.09	273			0.002		2.2	13	3.4		3.0
REC	SDD	07-Feb-91		7.68	220			<0.002		<0.2	2	1.5		4.0
REC	SDM	07-Feb-91		7.59	498			<0.002		21.3	24	18.6		26.0
REE	SD	07-Feb-91		8.19	207			0.005		0.7	2	1.3		4.0
REW	SDD	07-Feb-91		7.90	271			0.005		1.2	8	1.5		4.0
REW	SDM	07-Feb-91		7.63	275			<0.002		0.6	3	1.3		3.0
RSA	19	07-Feb-91		7.72	303			<0.002		5.9	4	2.8		6.0
RSA	20	07-Feb-91		7.94	215			0.008		0.3	3	1.3		3.0
RSA	21	07-Feb-91		8.12	195			0.005		0.5	3	1.3		4.0
RSA	22	07-Feb-91		8.13	202			0.002		0.9	5	1.7		4.0
RSA	23	07-Feb-91		8.29	237			<0.002		1.7	8	2.1		5.0
RSB	19	07-Feb-91		7.85	478			0.002		21.8	13	7.2		8.0
RSB	20	07-Feb-91		7.93	271			<0.002		3.4	4	2.4		4.0
RSB	21	07-Feb-91		8.07	227			0.002		0.8	5	1.5		3.0
RSB	22	07-Feb-91		8.14	236			0.002		1.2	7	1.9		4.0
RSB	23	07-Feb-91		8.31	242			0.005		1.8	9	2.6		5.0
RSB	24	07-Feb-91		8.33	252			0.005		2.7	12	3.0		5.0
RSB	25	07-Feb-91		8.32	258			0.002		3.4	14	3.1		6.0
RSC	19	07-Feb-91		7.89	281			<0.002		3.2	3	2.8		6.0
RSC	20	07-Feb-91		7.88	302			<0.002		5.1	4	2.1		7.0
RSC	21	07-Feb-91		7.87	319			<0.002		7.3	6	2.1		8.0
RSC	22	07-Feb-91		8.02	217			<0.002		0.8	6	1.7		4.0
RSC	23	07-Feb-91		8.08	215			0.002		1.2	7	2.1		4.0
RSD	19	07-Feb-91		7.80	544			<0.002		31.3	28	8.6		11[illegible]
RSD	20	07-Feb-91		7.77	621			<0.002		35.2	28	15.1		16[illegible]
RSD	21	07-Feb-91		7.78	482			<0.002		18.8	16	9.5		14.0
RSD	22	07-Feb-91		8.03	277			<0.002		2.4	6	2.6		5.0

Well	ID	Date	GW Dep	pH	Cond. mhos	Alk. mg/l	T. Hard mg/l	PO4 mg/l	NH4-N mg/l	NO2+NO3-N mg/l	Cl mg/l	Na mg/l	K mg/l	Fluor. mg/l
RSD	23	07-Feb-91		8.11	256			<0.002		1.0	6	1.9		5.0
RSE	19	07-Feb-91		7.85	440			0.002		19.3	16	5.7		5.0
RSE	20	07-Feb-91		7.94	356			<0.002		7.5	8	5.2		4.0
RSE	21	07-Feb-91		8.06	261			<0.002		0.9	7	1.9		4.0
RSE	22	07-Feb-91		8.21	262			0.002		1.6	10	2.1		5.0
RSE	23	07-Feb-91		8.28	260			0.005		2.0	13	2.6		5.0
REC	SDD	27-Mar-91		8.02	186			<0.002		0.2	2	1.0		2.0
REC	SDM	27-Mar-91		7.44	467			<0.002		21.7	13	13.2		9.0
REE	LU	27-Mar-91		8.15	244			<0.002		0.4	3	1.6		2.0
REE	SD	27-Mar-91		8.20	225			<0.002		1.0	6	1.6		2.0
REE	SU	27-Mar-91		8.16	191			<0.002		0.5	3	1.0		2.0
REW	SDD	27-Mar-91		8.11	248			0.002		1.4	8	1.8		3.0
REW	SDM	27-Mar-91		7.81	271			<0.002		0.8	3	1.2		2.0
RSA	19	27-Mar-91		7.82	262			<0.002		3.6	4	1.5		2.0
RSA	20	27-Mar-91		8.18	193			0.002		0.3	2	1.0		2.0
RSA	21	27-Mar-91		8.03	211			<0.002		1.4	2	1.0		2.0
RSA	22	27-Mar-91		8.26	205			<0.002		0.7	4	1.4		2.0
RSA	23	27-Mar-91		8.34	229			<0.002		1.5	6	2.0		3.0
RSB	19	27-Mar-91		7.92	368			<0.002		11.4	8	4.4		4.0
RSB	20	27-Mar-91		7.97	243			<0.002		1.4	3	1.5		2.0
RSB	21	27-Mar-91		8.17	230			<0.002		1.3	5	1.5		3.0
RSB	22	27-Mar-91		8.15	236			<0.002		1.6	7	1.8		2.0
RSB	23	27-Mar-91		8.21	246			<0.002		2.2	9	2.4		3.0
RSB	24	27-Mar-91		8.29	264			<0.002		3.0	12	2.8		3.0
RSB	25	27-Mar-91		8.28	271			<0.002		3.5	15	3.4		4.0
RSC	19	27-Mar-91		7.83	435			<0.002		15.8	11	4.5		6.0
RSC	20	27-Mar-91		7.87	321			<0.002		7.9	8	2.8		5.0
RSC	21	27-Mar-91		7.93	322			<0.002		8.5	10	4.2		6.0
RSC	22	27-Mar-91		8.07	194			<0.002		0.9	5	1.4		3.0
RSC	23	27-Mar-91		8.12	205			<0.002		1.3	7	1.8		3.0
RSD	19	27-Mar-91		7.77	553			<0.002		29.3	32	13.4		8.0
RSD	20	27-Mar-91		7.81	587			<0.002		26.7	29	15.0		11.0
RSD	21	27-Mar-91		7.79	354			<0.002		7.8	8	5.5		5.0
RSD	22	27-Mar-91		8.04	259			<0.002		1.7	5	1.8		3.0
RSD	23	27-Mar-91		8.02	247			<0.002		1.6	5	2.0		2.0
RSE	20	27-Mar-91		7.87	326			0.005		4.6	5	1.2		3.0
RSE	21	27-Mar-91		8.00	277			<0.002		2.4	8	1.8		3.0
RSE	22	27-Mar-91		8.15	276			<0.002		2.9	12	2.0		3.0
RSE	23	27-Mar-91		8.20	265			<0.002		2.4	14	2.6		4.0
REC	SDD	26-Apr-91		7.88	203			<0.002		0.7	2	1.0		7.0
REC	SDM	26-Apr-91		7.29	795			<0.002		63.0	36	27.0		47.0
REC	SDS	26-Apr-91		7.25	889			<0.002		81.6	53	28.0		50.0
REE	SD	26-Apr-91		8.02	231			0.005		1.7	8	1.5		8.0
REW	SDD	26-Apr-91		7.96	257			0.005		1.2	8	1.5		7.0
REW	SDM	26-Apr-91		7.71	469			<0.002		21.1	17	7.5		10.0
REW	SDS	26-Apr-91		7.36	785			<0.002		55.0	42	21.0		14.0
RSA	19	26-Apr-91		7.77	249			0.002		2.5	3	1.0		5.0
RSA	20	26-Apr-91		7.93	209			0.015		0.4	2	1.0		6.0
RSA	21	26-Apr-91		8.08	207			<0.002		0.7	4	1.0		6.0
RSA	22	26-Apr-91		8.23	231			<0.002		0.9	5	1.0		5.0
RSA	23	26-Apr-91		8.29	257			0.002		1.3	7	1.5		6.0
RSB	19	26-Apr-91		8.00	289			<0.002		2.8	4	2.0		7.0
RSB	20	26-Apr-91		8.06	252			<0.002		1.7	2	1.0		4.0
RSB	21	26-Apr-91		8.06	245			<0.002		1.4	4	1.0		5.0
RSB	22	26-Apr-91		8.23	244			0.002		1.9	8	1.5		7.0
RSB	23	26-Apr-91		8.21	264			<0.002		2.8	11	2.0		7.0
RSB	24	26-Apr-91		8.24	280			<0.002		3.6	14	2.5		10.0
RSB	25	26-Apr-91		8.35	287			0.005		3.9	16	3.0		9.0
RSC	19	26-Apr-91		8.10	323			<0.002		8.3	9	4.0		11.0
RSC	20	26-Apr-91		7.92	274			<0.002		5.7	6	2.5		10.0
RSC	21	26-Apr-91		7.95	252			<0.002		4.8	8	2.0		10.0

Well	ID	Date	GW Dep	pH	Cond. mhos	Alk. mg/l	T. Hard mg/l	PO4 mg/l	NH4-N mg/l	NO2+NO3-N mg/l	Cl mg/l	Na mg/l	K mg/l	Fluor. mg/l
RSC	22	26-Apr-91		8.12	206			<0.002		1.9	7	1.5		8.0
RSC	23	26-Apr-91		8.15	224			<0.002		1.9	10	1.5		8.0
RSD	19	26-Apr-91		7.89	504			<0.002		27.0	28	12.0		17.0
RSD	20	26-Apr-91		7.85	519			<0.002		24.5	22	10.0		18.0
RSD	21	26-Apr-91		7.89	262			0.005		1.8	4	2.0		9.0
RSD	22	26-Apr-91		7.93	240			0.008		1.2	5	1.5		7.0
RSD	23	26-Apr-91		8.13	241			0.002		1.2	7	1.5		11.0
RSE	19	26-Apr-91		7.85	441			0.002		28.6	16	4.0		7.0
RSE	20	26-Apr-91		7.98	378			0.002		10.6	11	3.5		9.0
RSE	21	26-Apr-91		8.09	315			<0.002		4.5	8	1.5		8.0
RSE	22	26-Apr-91		8.13	268			<0.002		1.9	12	2.0		9.0
RSE	23	26-Apr-91		8.32	269			0.002		2.8	16	2.5		10.0
REC	SDD	02-May-91		7.89	290			<0.002		6.6	6	1.5		9.0
REC	SDM	02-May-91		7.45	842			<0.002		59.2	42	30.0		30.0
REC	SDS	02-May-91		7.52	921			<0.002		74.9	50	27.0		50.0
REC	SDD	03-Jun-91		7.94	193			<0.002		0.8	5	1.0		9.0
REC	SDM	03-Jun-91		7.24	526			<0.002		21.5	16	10.0		50.0
REC	SDS	03-Jun-91		7.17	933			<0.002		66.8	40	28.0		63.0
REE	SD	03-Jun-91		8.11	241			0.002		1.7	9	2.0		9.0
REW	SDD	03-Jun-91		7.96	277			0.045		2.9	16	3.0		12.0
REW	SDM	03-Jun-91		7.81	260			0.002		0.7	6	1.5		8.0
REW	SDS	03-Jun-91		7.64	634			0.005		44.4	34	10.0		15.0
RSA	19	03-Jun-91		7.82	309			0.002		6.1	6	2.0		10.0
RSA	20	03-Jun-91		8.02	264			0.002		2.5	3	1.0		9.0
RSA	21	03-Jun-91		8.22	232			0.002		0.8	5	1.0		9.0
RSA	22	03-Jun-91		8.28	244			0.005		1.5	9	2.0		9.0
RSA	23	03-Jun-91		8.34	253			0.002		1.5	9	2.0		9.0
RSB	19	03-Jun-91		7.95	255			0.002		4.6	5	2.5		11.0
RSB	20	03-Jun-91		7.95	353			<0.002		10.2	9	3.0		13.0
RSB	21	03-Jun-91		8.01	262			<0.002		3.2	5	2.0		10.0
RSB	22	03-Jun-91		8.07	235			0.002		1.5	5	2.0		10.0
RSB	23	03-Jun-91		8.12	247			0.005		2.2	9	2.5		11.0
RSB	24	03-Jun-91		8.04	272			0.005		3.3	13	3.0		10.0
RSB	25	03-Jun-91		8.13	281			0.005		4.2	16	4.0		11.0
RSC	19	03-Jun-91		7.78	453			<0.002		19.2	17	8.5		19.0
RSC	20	03-Jun-91		7.83	397			<0.002		15.8	12	13.0		17.0
RSC	21	03-Jun-91		7.90	418			<0.002		19.6	13	7.0		17.0
RSC	22	03-Jun-91		8.00	251			<0.002		4.9	8	2.5		10.0
RSC	23	03-Jun-91		8.03	230			0.002		1.9	10	2.5		9.0
RSD	19	03-Jun-91		7.91	237			0.002		4.5	9	5.0		7.0
RSD	20	03-Jun-91		7.77	476			<0.002		19.4	20	13.0		19.0
RSD	21	03-Jun-91		7.82	505			<0.002		19.7	20	9.0		19.0
RSD	22	03-Jun-91		7.96	297			<0.002		5.1	9	3.0		10.0
RSD	23	03-Jun-91		8.04	221			<0.002		1.2	8	2.0		9.0
RSE	19	03-Jun-91		7.96	207			0.002		3.8	5	3.0		6.0
RSE	20	03-Jun-91		7.89	331			<0.002		8.1	8	4.5		8.0
RSE	21	03-Jun-91		7.94	272			<0.002		2.3	8	2.5		8.0
RSE	22	03-Jun-91		8.07	263			<0.002		2.4	13	3.0		11.0
RSE	23	03-Jun-91		8.13	267			0.002		3.0	17	3.5		13.0
REC	SDD	01-Jul-91		7.81	256			0.005		0.8	3	1.3		7.0
REC	SDM	01-Jul-91		7.42	565			<0.002		21.5	21	9.4		32.0
REC	SDS	01-Jul-91	17.78	7.34	729			0.002		35.1	42	25.7		54.0
REE	LU	01-Jul-91	18.08	8.11	256			0.005		0.4	3	1.8		6.0
REE	SD	01-Jul-91	18.07	8.10	258			0.005		1.5	8	1.9		6.0
REE	SU	01-Jul-91	18.19	8.20	245			0.005		0.9	6	1.6		6.0
REW	SDD	01-Jul-91		7.83	300			0.002		2.1	11	2.4		8.0
REW	SDM	01-Jul-91		7.70	304			0.002		0.3	2	1.6		8.0
REW	SDS	01-Jul-91	18.09	7.53	760			<0.002		50.0	37	7.5		11[illegible]
RSA	19	01-Jul-91		7.67	313			0.002		8.7	8	2.1		5[illegible]
RSA	20	01-Jul-91		7.72	329			0.002		11.0	10	1.7		6.0
RSA	21	01-Jul-91		7.82	319			0.005		9.6	11	1.7		6.0

Well	ID	Date	GW Dep	pH	Cond. mhos	Alk. mg/l	T. Hard mg/l	PO4 mg/l	NH4-N mg/l	NO2+NO3-N mg/l	Cl mg/l	Na mg/l	K mg/l	Fluor. mg/l
RSA	22	01-Jul-91		7.97	246			0.008		1.8	9	1.9		5.0
RSA	23	01-Jul-91	18.06	8.04	264			0.005		2.1	12	2.2		7.0
RSB	19	01-Jul-91		7.81	421			0.002		17.9	17	2.9		8.0
RSB	20	01-Jul-91		7.77	431			<0.002		14.5	15	3.9		9.0
RSB	21	01-Jul-91		7.88	301			0.002		3.6	10	1.9		8.0
RSB	22	01-Jul-91		7.95	290			0.005		3.0	12	1.9		8.0
RSB	23	01-Jul-91		8.03	288			0.005		3.0	13	2.2		8.0
RSB	24	01-Jul-91		8.07	298			0.005		3.6	15	2.7		8.0
RSB	25	01-Jul-91	17.89	8.10	309			0.005		4.3	17	3.4		10.0
RSC	19	01-Jul-91		7.83	422			0.002		13.7	12	7.8		11.0
RSC	20	01-Jul-91		7.87	332			0.002		10.8	10	5.2		9.0
RSC	21	01-Jul-91		7.85	392			0.002		15.0	13	4.6		11.0
RSC	22	01-Jul-91		7.86	519			0.032		24.2	18	3.9		13.0
RSC	23	01-Jul-91	17.93	7.91	465			<0.002		19.2	16	2.7		12.0
RSD	19	01-Jul-91		7.97	247			<0.002		3.4	8	2.2		6.0
RSD	20	01-Jul-91		7.76	456			<0.002		15.6	17	9.5		12.0
RSD	21	01-Jul-91		7.68	616			0.002		31.2	25	6.6		14.0
RSD	22	01-Jul-91		7.82	362			0.002		10.8	13	2.4		8.0
RSD	23	01-Jul-91	17.70	7.90	313			0.002		5.3	11	2.5		8.0
RSE	19	01-Jul-91		7.89	294			<0.002		8.2	8	2.2		6.0
RSE	20	01-Jul-91		7.85	366			0.008		9.4	10	3.2		6.0
RSE	21	01-Jul-91		7.82	412			0.002		12.1	12	2.4		7.0
RSE	22	01-Jul-91		7.90	400			0.002		12.6	14	2.7		8.0
RSE	23	01-Jul-91	17.65	8.02	380			0.005		11.7	18	3.4		9.0
REC	SDD	05-Aug-91	18.08	7.86	240				<0.02	0.7	3			3.0
REC	SDM	05-Aug-91	18.08	7.49	651				<0.02	33.4	29			17.0
REC	SDS	05-Aug-91	18.08	7.36	849				<0.02	55.2	41			17.0
REE	SD	05-Aug-91	18.37	8.09	261				<0.02	1.8	6			2.0
REE	SU	05-Aug-91	18.49	8.10	234				<0.02	0.6	3			2.0
REW	SDD	05-Aug-91	18.39	7.95	292				<0.02	1.7	8			2.0
REW	SDM	05-Aug-91	18.39	7.84	300				<0.02	0.3	3			3.0
REW	SDS	05-Aug-91	18.39	7.71	367				<0.02	8.3	8			3.0
RSA	19	05-Aug-91	18.34	7.77	349				<0.02	12.2	11			2.0
RSA	20	05-Aug-91	18.34	7.79	325				<0.02	10.4	12			3.0
RSA	21	05-Aug-91	18.34	7.94	241				<0.02	1.4	7			2.0
RSA	22	05-Aug-91	18.34	8.02	252				<0.02	1.9	9			2.0
RSA	23	05-Aug-91	18.34	8.12	267				<0.02	2.5	12			2.0
RSB	19	05-Aug-91	18.18	7.89	434				0.02	19.3	16			3.0
RSB	20	05-Aug-91	18.18	7.95	388				<0.02	13.3	14			3.0
RSB	21	05-Aug-91	18.18	8.12	259				<0.02	2.3	8			2.0
RSB	22	05-Aug-91	18.18	8.19	255				<0.02	2.1	8			2.0
RSB	23	05-Aug-91	18.18	7.40	291				<0.02	3.9	15			3.0
RSB	24	05-Aug-91	18.18	7.60	304				<0.02	4.6	17			3.0
RSB	25	05-Aug-91	18.18	7.94	305				<0.02	4.7	18			3.0
RSC	19	05-Aug-91	18.22	7.70	586				<0.02	32.0	25			5.0
RSC	20	05-Aug-91	18.22	7.75	680				<0.02	36.1	29			9.0
RSC	21	05-Aug-91	18.22	7.81	656				<0.02	31.8	26			10.0
RSC	22	05-Aug-91	18.22	7.95	429				<0.02	13.1	17			6.0
RSC	23	05-Aug-91	18.22	8.10	323				<0.02	5.1	15			4.0
RSD	19	05-Aug-91	17.99	7.78	269				<0.02	5.1	10			3.0
RSD	20	05-Aug-91	17.99	7.71	481				<0.02	25.1	19			5.0
RSD	21	05-Aug-91	17.99	7.78	386				<0.02	12.6	14			4.0
RSD	22	05-Aug-91	17.99	7.84	407				<0.02	14.1	18			5.0
RSD	23	05-Aug-91	17.99	7.84	569				<0.02	30.2	28			5.0
RSE	19	05-Aug-91	17.94	7.52	291				<0.02	6.4	10			3.0
RSE	20	05-Aug-91	17.94	7.54	464				<0.02	24.2	22			3.0
RSE	21	05-Aug-91	17.94	7.52	453				<0.02	20.6	21			3.0
RSE	22	05-Aug-91	17.94	7.56	475				<0.02	23.0	23			4.0
RSE	23	05-Aug-91	17.00	7.74	386				<0.02	13.3	20			5.0
RSA	19	05-Sep-91	18.70	7.91	436				<0.02	23.1	19			8.0
RSA	20	05-Sep-91	18.70	8.00	306				<0.02	9.8	10			6.0

Well	ID	Date	GW Dep	pH	Cond. mhos	Alk. mg/l	T. Hard mg/l	PO4 mg/l	NH4-N mg/l	NO2+NO3-N mg/l	Cl mg/l	Na mg/l	K mg/l	Fluor. mg/l
RSA	21	05-Sep-91	18.70	8.06	230				<0.02	0.8	5			5.0
RSA	22	05-Sep-91	18.70	8.08	243				<0.02	1.3	7			5.0
RSA	23	05-Sep-91	18.70	8.13	253				<0.02	1.6	9			5.0
RSB	19	05-Sep-91	18.52	8.00	407				<0.02	17.2	12			9.0
RSB	20	05-Sep-91	18.52	7.89	419				<0.02	18.4	15			10.0
RSB	21	05-Sep-91	18.52	7.98	275				<0.02	3.5	10			7.0
RSB	22	05-Sep-91	18.52	8.04	285				<0.02	3.4	12			8.0
RSB	23	05-Sep-91	18.52	8.09	291				<0.02	4.4	14			7.0
RSB	24	05-Sep-91	18.52	8.13	289				<0.02	4.7	16			7.0
RSB	25	05-Sep-91	18.52	8.15	295				<0.02	5.0	17			7.0
RSC	19	05-Sep-91	18.56	7.82	549				<0.02	31.2	23			13.0
RSC	20	05-Sep-91	18.56	7.81	364				<0.02	10.7	13			12.0
RSC	21	05-Sep-91	18.56	7.78	388				<0.02	13.6	14			12.0
RSC	22	05-Sep-91	18.56	7.85	330				<0.02	8.8	14			9.0
RSC	23	05-Sep-91	18.56	7.92	288				<0.02	4.1	14			8.0
RSD	19	05-Sep-91	18.33	7.80	404				<0.02	18.5	17			7.0
RSD	20	05-Sep-91	18.33	7.69	652				<0.02	40.1	29			13.0
RSD	21	05-Sep-91	18.33	7.75	508				<0.02	22.7	17			13.0
RSD	22	05-Sep-91	18.33	8.04	326				<0.02	6.9	11			8.0
RSD	23	05-Sep-91	18.33	7.91	288				<0.02	3.1	12			7.0
RSE	19	05-Sep-91	18.28	7.78	462				<0.02	19.4	18			6.0
RSE	20	05-Sep-91	18.28	7.77	532				<0.02	27.2	22			6.0
RSE	21	05-Sep-91	18.28	7.77	473				<0.02	19.8	18			6.0
RSE	22	05-Sep-91	18.28	7.88	435				<0.02	15.9	18			6.0
RSE	23	05-Sep-91	18.28	8.02	352				<0.02	8.3	16			7.0
REC	SDD	09-Sep-91	18.48	7.94	204				<0.02	0.5	4			6.0
REC	SDM	09-Sep-91	18.47	7.66	341				<0.02	6.9	6			23.0
REE	SD	09-Sep-91	18.77	8.29	236				<0.02	1.2	5			5.0
REE	SU	09-Sep-91	18.88	7.96	187				<0.02	<0.2	2			4.0
REW	SDD	09-Sep-91	18.77	8.01	270				<0.02	1.2	6			5.0
REW	SDM	09-Sep-91	18.77	7.81	256				<0.02	0.3	3			4.0
REW	SDS	09-Sep-91	18.78	7.73	329				<0.02	5.3	4			8.0
RSB	19	04-Oct-91	18.74	7.81	594				0.05	38.1	26			4.0
RSB	20	04-Oct-91	18.74	7.90	359				0.05	12.2	13			27.0
RSB	21	04-Oct-91	18.74	8.07	257				<.02	2.3	9			31.0
RSB	22	04-Oct-91	18.74	8.14	264				<.02	3.1	12			4.0
RSB	23	04-Oct-91	18.74	8.23	276				0.05	4.2	14			4.0
RSB	24	04-Oct-91	18.74	8.12	299				0.05	4.9	15			4.0
RSB	25	04-Oct-91	18.74	8.17	303				0.12	5.1	16			4.0
RSC	19	04-Oct-91	18.78	7.71	526				0.05	26.0	19			7.0
RSC	20	04-Oct-91	18.78	7.79	370				0.05	12.0	12			7.0
RSC	21	04-Oct-91	18.78	7.92	334				0.10	9.6	12			6.0
RSC	22	04-Oct-91	18.78	7.98	261				0.05	2.1	10			4.0
RSC	23	04-Oct-91	18.78	8.09	271				0.12	2.6	11			4.0
RSD	19	04-Oct-91	18.55	7.73	707				0.10	45.1	36			6.0
RSD	20	04-Oct-91	18.55	7.73	606				0.12	31.8	27			5.0
RSD	21	04-Oct-91	18.55	7.84	349				0.05	8.8	10			4.0
RSD	22	04-Oct-91	18.55	7.99	254				0.08	1.5	8			5.0
RSD	23	04-Oct-91	18.55	8.02	263				0.05	1.9	10			5.0
RSE	19	04-Oct-91	18.51	7.82	536				0.20	28.8	25			5.0
RSE	20	04-Oct-91	18.51	7.80	476				0.10	22.0	19			[illegible]
RSE	21	04-Oct-91	18.51	7.88	336				0.15	8.1	11			11.[illegible]
RSE	22	04-Oct-91	18.51	7.94	413				0.10	16.9	16			10.0

Well	ID	Date	GW Dep	pH	Cond. mhos	Alk. mg/l	T. Hard mg/l	PO4 mg/l	NH4-N mg/l	NO2+NO3-N mg/l	Cl mg/l	Na mg/l	K mg/l	Fluor. mg/l
RSE	23	04-Oct-91	18.51	8.05	474				0.02	21.2	18			11.0
REC	SDD	07-Oct-91	18.70	7.98	201				<0.02	<0.2	3			5.0
REC	SDM	07-Oct-91	18.69	8.26	525				0.02	29.3	18			5.0
REC	SDS	07-Oct-91	18.70	7.38	801				0.12	61.9	41			11.0
REE	SD	07-Oct-91	18.99	8.20	199				<0.02	0.4	2			7.0
REE	SU	07-Oct-91	19.11	8.18	180				<0.02	0.2	1			7.0
REW	SDD	07-Oct-91	19.00	8.07	254				<0.02	1.0	5			6.0
REW	SDM	07-Oct-91	19.00	7.89	227				<0.02	0.2	2			5.0
RSA	19	07-Oct-91	18.95	7.83	238				0.02	3.1	4			5.0
RSA	20	07-Oct-91	18.95	8.08	214				<0.02	1.1	3			6.0
RSA	21	07-Oct-91	18.95	8.13	256				<0.02	4.4	6			5.0
RSA	22	07-Oct-91	18.95	8.24	242				<0.02	2.0	6			5.0
RSA	23	07-Oct-91	18.95	8.17	251				0.02	1.6	8			6.0
REC	SDD	20-Nov-91	19.02	8.08	197	100	104		<0.02	0.3	2	1.1		8.0
REC	SDM	20-Nov-91	19.02	7.77	614	104	268		<0.02	40.4	37	18.6		49.0
REE	SD	20-Nov-91	19.31	8.14	194	100	112		<0.02	0.8	3	1.4		51.0
REE	SU	20-Nov-91	19.44	8.09	172	84	116		0.02	0.9	4	1.2		8.0
REW	SDD	20-Nov-91	19.32	8.06	241	124	136		<0.02	0.5	3	1.7		6.0
REW	SDM	20-Nov-91	19.32	8.01	234	120	144		<0.02	0.6	2	1.2		8.0
RHOUSE		20-Nov-91		8.21	250	88	120		<0.02	4.0	17	6.0		9.0
RSA	19	20-Nov-91	19.27	7.94	376	116	192		<0.02	15.7	12	2.9		15.0
RSA	20	20-Nov-91	19.27	7.90	314	120	164		<0.02	11.0	8	2.2		9.0
RSA	21	20-Nov-91	19.27	8.09	214	100	124		<0.02	3.0	2	1.3		10.0
RSA	22	20-Nov-91	19.27	8.03	188	100	104		<0.02	0.5	2	1.5		7.0
RSA	23	20-Nov-91	19.27	8.11	210	108	120		<0.02	0.9	4	1.7		6.0
RSB	19	20-Nov-91	19.09	8.09	257	116	128		<0.02	3.3	4	2.7		7.0
RSB	20	20-Nov-91	19.09	8.12	220	112	120		<0.02	0.9	3	1.5		8.0
RSB	21	20-Nov-91	19.09	8.14	230	112	128		<0.02	1.1	5	2.0		8.0
RSB	22	20-Nov-91	19.09	8.14	255	116	144		<0.02	2.3	8	2.7		7.0
RSB	23	20-Nov-91	19.09	8.23	272	116	156		<0.02	3.8	12	3.4		8.0
RSB	24	20-Nov-91	19.09	7.91	279	120	148		<0.02	4.6	14	3.9		8.0
RSB	25	20-Nov-91	19.09	7.53	283	112	144		<0.02	5.2	16	4.2		9.0
RSC	19	20-Nov-91	19.14	7.90	387	136	180		<0.02	12.9	12	8.4		11.0
RSC	20	20-Nov-91	19.14	7.97	275	120	132		<0.02	4.7	6	5.1		25.0
RSC	21	20-Nov-91	19.14	8.12	236	116	124		<0.02	1.4	5	2.2		8.0
RSC	22	20-Nov-91	19.14	8.07	254	120	136		<0.02	1.8	8	2.2		12.0
RSC	23	20-Nov-91	19.14	8.16	261	120	148		<0.02	2.7	10	2.6		7.0
RSD	19	20-Nov-91	18.90	8.00	700	152	320		<0.02	38.0	27	15.8		7.0
RSD	20	20-Nov-91	18.90	7.91	681	144	308		<0.02	39.0	27	18.8		20.0
RSD	21	20-Nov-91	18.90	7.88	652	140	288		<0.02	35.7	27	18.6		9.0
RSD	22	20-Nov-91	18.90	8.05	295	120	128		<0.02	4.7	8	3.4		9.0
RSD	23	20-Nov-91	18.90	7.99	268	120	144		<0.02	1.6	8	1.8		9.0
RSE	19	20-Nov-91	18.86	7.95	482	140	240		<0.02	23.2	20	8.0		9.0
RSE	20	20-Nov-91	18.86	7.98	451	140	224		<0.02	19.7	18	6.2		7.0
RSE	21	20-Nov-91	18.86	8.07	274	124	144		<0.02	2.5	7	2.3		10.0
RSE	22	20-Nov-91	18.86	8.10	278	152	152		<0.02	2.9	10	3.1		10.0
RSE	23	20-Nov-91	18.86	8.19	292	140	156		<0.02	3.9	13	3.8		8.0
REC	SDD	07-Dec-91	18.94	8.02	194	92	100		<0.02	<0.2	<1	1.4		10.0
REC	SDM	07-Dec-91	18.93	7.60	586	100	228		<0.02	33.6	34	20.3		10.0
REC	SDS	07-Dec-91	18.93	7.74	738	96	248		0.05	49.7	50	31.2		41.0
REE	SD	07-Dec-91	19.22	8.15	222	100	104		<0.02	1.1	1	1.4		67.0
REE	SU	07-Dec-91	19.35	8.11	172	76	84		<0.02	0.6	1	1.0		7.0
REW	SDD	07-Dec-91	19.23	8.02	254	120	132		<0.02	0.3	<1	1.7		8.0
REW	SDM	07-Dec-91	19.23	7.96	296	132	128		<0.02	3.3	3	1.4		7.0
RSA	19	07-Dec-91	19.17	7.78	480	116	224		<0.02	26.8	17	3.2		8.0
RSA	20	07-Dec-91	19.17	7.92	436	104	208		<0.02	24.9	14	2.4		8.0
RSA	21	07-Dec-91	19.17	7.94	398	100	184		<0.02	18.6	19	1.8		7.0
RSA	22	07-Dec-91	19.17	8.12	204	96	100		<0.02	0.5	<1	1.5		8.0
RSA	23	07-Dec-91	19.17	8.19	218	100	112		<0.02	0.9	1	1.8		8.0
RSB	19	07-Dec-91	19.00	7.82	410	128	200		<0.02	17.3	12	5.3		7.0
RSB	20	07-Dec-91	19.00	7.93	310	112	160		<0.02	9.9	8	2.2		6.0

Well	ID	Date	GW Dep	pH	Cond. mhos	Alk. mg/l	T. Hard mg/l	PO4 mg/l	NH4-N mg/l	NO2+NO3-N mg/l	Cl mg/l	Na mg/l	K mg/l	Fluor. mg/l
RSB	21	07-Dec-91	19.00	8.12	219	108	280		<0.02	1.1	4	1.7		14.0
RSB	22	07-Dec-91	19.00	8.18	226	116	124		<0.02	1.6	6	2.5		38.0
RSB	23	07-Dec-91	19.00	8.23	255	112	132		<0.02	2.7	9	3.2		5.0
RSB	24	07-Dec-91	19.00	8.25	269	116	132		<0.02	3.7	11	3.9		6.0
RSB	25	07-Dec-91	19.00	8.22	284	108	136		<0.02	5.3	15	4.2		7.0
RSC	19	07-Dec-91	19.05	7.75	387	128	180		<0.02	13.3	11	7.7		6.0
RSC	20	07-Dec-91	19.05	7.78	361	120	176		<0.02	14.3	10	3.8		12.0
RSC	21	07-Dec-91	19.05	7.85	387	120	196		<0.02	16.8	12	2.8		6.0
RSC	22	07-Dec-91	19.05	8.04	246	120	136		<0.02	1.8	6	2.0		7.0
RSC	23	07-Dec-91	19.05	8.11	247	124	132		<0.02	1.6	7	2.6		5.0
RSD	19	07-Dec-91	18.81	7.81	563	144	264		<0.02	28.5	21	14.3		6.0
RSD	20	07-Dec-91	18.81	7.82	298	116	144		<0.02	5.5	6	7.0		6.0
RSD	21	07-Dec-91	18.81	7.84	298	116	144		<0.02	6.9	8	5.3		5.0
RSD	22	07-Dec-91	18.81	7.94	272	120	140		<0.02	4.4	7	2.9		5.0
RSD	23	07-Dec-91	18.81	8.07	247	112	136		<0.02	1.8	8	1.8		5.0
RSE	19	07-Dec-91	18.77	7.78	467	144	232		0.02	21.7	19	7.3		7.0
RSE	20	07-Dec-91	18.77	7.79	497	140	248		<0.02	24.5	21	7.2		7.0
RSE	21	07-Dec-91	18.77	7.93	311	124	160		<0.02	7.0	10	2.6		8.0
RSE	22	07-Dec-91	18.77	8.06	276	122	144		0.22	2.8	11	3.4		8.0
RSE	23	07-Dec-91	18.77	8.14	285	120	148		<0.02	3.7	12	4.3		9.0
REC	SDD	07-Jan-92	18.79	8.07	207	92	108		<0.02	2.2	3	2.4		7.0
REC	SDM	07-Jan-92	18.79	7.78	589	80	220		<0.02	34.7	40	27.7		14.0
REC	SDS	07-Jan-92	18.79	7.61	777	108	292		<0.02	51.7	47	28.4		11.0
REE	SD	07-Jan-92	19.05	8.23	212	96	112		<0.02	1.8	6	1.5		5.0
REE	SU	07-Jan-92	19.18	8.19	183	84	100		0.02	1.2	5	1.2		5.0
REW	SDD	07-Jan-92	19.08	8.07	230	116	128		0.02	0.7	4	2.0		8.0
REW	SDM	07-Jan-92	19.08	7.88	369	136	192		0.02	11.2	8	3.4		8.0
REW	SDS	07-Jan-92	19.08	7.83	692	112	308		<0.02	47.8	34	14.3		6.0
RSA	19	07-Jan-92	19.01	7.95	326	112	164		<0.02	11.8	7	2.5		6.0
RSA	20	07-Jan-92	19.01	8.11	278	100	144		<0.02	8.0	6	1.7		5.0
RSA	21	07-Jan-92	19.01	8.17	197	100	108		<0.02	0.8	2	1.4		6.0
RSA	22	07-Jan-92	19.01	8.11	212	104	112		<0.02	0.8	4	1.7		5.0
RSA	23	07-Jan-92	19.01	8.29	215	100	112		<0.02	1.0	4	1.9		6.0
RSB	19	07-Jan-92	18.86	7.99	231	108	120		<0.02	2.8	3	2.7		8.0
RSB	20	07-Jan-92	18.86	8.02	256	104	140		<0.02	6.0	5	1.6		4.0
RSB	21	07-Jan-92	18.86	8.17	260	108	140		<0.02	5.2	5	2.0		30.0
RSB	22	07-Jan-92	18.86	8.26	247	124	140		<0.02	1.3	5	2.5		4.0
RSB	23	07-Jan-92	18.86	8.28	258	124	140		<0.02	2.0	6	3.0		4.0
RSB	24	07-Jan-92	18.86	8.25	268	116	144		<0.02	3.3	9	3.8		4.0
RSB	25	07-Jan-92	18.86	8.31	278	116	148		<0.02	4.5	12	4.3		4.0
RSC	19	07-Jan-92	18.88	7.86	540	136	244		<0.02	28.3	18	11.7		6.0
RSC	20	07-Jan-92	18.88	7.95	354	112	164		<0.02	13.7	10	6.2		7.0
RSC	21	07-Jan-92	18.88	7.97	273	104	136		<0.02	6.3	6	4.7		6.0
RSC	22	07-Jan-92	18.88	8.10	225	104	124		<0.02	1.8	4	2.3		6.0
RSC	23	07-Jan-92	18.88	8.17	226	108	124		<0.02	1.7	5	2.4		5.0
RSD	19	07-Jan-92	18.65	7.93	432	140	204		<0.02	15.8	12	11.0		5.0
RSD	20	07-Jan-92	18.65	7.93	279	120	140		<0.02	3.4	4	2.4		7.0
RSD	21	07-Jan-92	18.65	7.99	248	112	128		<0.02	1.8	4	2.4		7.0
RSD	22	07-Jan-92	18.65	8.05	237	112	128		<0.02	1.7	5	2.0		6.0
RSD	23	07-Jan-92	18.65	8.12	243	116	136		<0.02	1.5	6	2.1		9.0
RSE	19	07-Jan-92	18.62	7.92	436	116	216		<0.02	24.0	17	4.9		9.0
RSE	20	07-Jan-92	18.62	7.89	460	144	228		<0.02	19.2	18	5.9		10.0
RSE	21	07-Jan-92	18.62	7.95	346	128	184		<0.02	10.1	10	2.7		10.0
RSE	22	07-Jan-92	18.62	8.16	272	120	152		<0.02	2.1	8	3.0		19.0
RSE	23	07-Jan-92	18.62	8.22	282	124	156		<0.02	3.0	10	4.0		13.0
REC	SDD	24-Mar-92	18.77	8.07	184	84	100		0.10	1.7	<1	1.3		10.0
REC	SDM	24-Mar-92	18.76	7.74	500	108	222		0.05	28.7	17	8.2		8.0
REC	SDS	24-Mar-92	18.77	7.32	837	84	300		0.08	65.0	46	34.1		9.0
REE	SD	24-Mar-92	19.02	8.15	192	84	96		0.05	1.4	<1	1.0		1[illegible]
REE	SU	24-Mar-92	19.15	7.36	120	56	72		0.05	1.7	<1	1.0		2[illegible]
REW	SDD	24-Mar-92	19.05	7.97	252	108	120		0.05	3.1	1	1.9		31.0

Well	ID	Date	GW Dep	pH	Cond. mhos	Alk. mg/l	T. Hard mg/l	PO4 mg/l	NH4-N mg/l	NO2+NO3-N mg/l	Cl mg/l	Na mg/l	K mg/l	Fluor. mg/l
REW	SDM	24-Mar-92	19.05	7.88	261	128	140		0.02	1.1	<1	1.4		10.0
REW	SDS	24-Mar-92	19.05	7.77	544	132	240		0.02	27.6	14	8.7		8.0
RSA	19	24-Mar-92	18.99	7.92	280	92	136		0.05	10.1	3	2.1		10.0
RSA	20	24-Mar-92	18.99	7.98	270	84	124		0.02	9.0	2	1.4		9.0
RSA	21	24-Mar-92	18.99	8.18	202	88	100		0.02	1.9	1	1.1		9.0
RSA	22	24-Mar-92	18.99	8.23	227	94	116		0.05	2.8	4	1.4		9.0
RSA	23	24-Mar-92	18.99	8.26	229	96	124		0.05	2.8	3	1.5		9.0
RSB	19	24-Mar-92	18.82	7.97	240	96	112		0.02	4.2	<1	2.8		7.0
RSB	20	24-Mar-92	18.82	8.02	204	94	100		0.12	1.4	<1	1.8		23.0
RSB	21	24-Mar-92	18.82	8.16	217	98	112		0.18	2.1	<1	1.6		36.0
RSB	22	24-Mar-92	18.82	8.18	235	102	128		0.02	3.7	2	1.8		6.0
RSB	23	24-Mar-92	18.82	8.24	242	104	128		0.08	4.3	4	2.0		11.0
RSB	24	24-Mar-92	18.82	8.24	265	104	136		0.02	5.2	5	2.6		7.0
RSB	25	24-Mar-92	18.82	8.23	282	108	140		0.10	6.3	7	3.0		8.0
RSC	19	24-Mar-92	18.85	7.73	436	104	176		0.02	21.5	13	9.5		14.0
RSC	20	24-Mar-92	18.85	7.88	379	100	160		0.85	15.3	10	7.9		5.0
RSC	21	24-Mar-92	18.85	7.97	259	94	124		0.05	6.3	3	2.4		8.0
RSC	22	24-Mar-92	18.85	7.98	469	106	216		0.05	26.7	16	6.5		6.0
RSC	23	24-Mar-92	18.85	8.01	517	108	240		0.05	31.0	18	8.1		6.0
RSD	19	24-Mar-92	18.62	7.81	344	104	156		0.02	12.5	17	5.7		6.0
RSD	20	24-Mar-92	18.62	7.88	280	104	124		0.02	7.2	2	4.2		6.0
RSD	21	24-Mar-92	18.62	7.95	267	100	128		<0.02	7.0	2	2.7		5.0
RSD	22	24-Mar-92	18.62	7.97	393	104	184		0.05	18.4	10	3.5		6.0
RSD	23	24-Mar-92	18.62	8.04	266	98	128		0.18	6.4	2	2.7		7.0
RSE	19	24-Mar-92	18.59	7.86	297	100	128		0.08	9.5	11	3.3		8.0
RSE	20	24-Mar-92	18.59	7.69	419	116	204		0.05	20.2	13	4.4		7.0
RSE	21	24-Mar-92	18.59	7.89	377	116	184		0.42	14.9	9	3.6		8.0
RSE	22	24-Mar-92	18.59	7.94	257	92	128		0.02	4.1	4	3.0		20.0
RSE	23	24-Mar-92	18.59	8.02	266	88	136		0.05	4.9	5	3.4		18.0
REC	SDD	23-Apr-92	18.34	8.10	204	88	100		0.12	1.8	4	1.4		17.0
REC	SDM	23-Apr-92	18.34	7.55	527	112	220		<0.02	27.3	27	17.5		9.0
REC	SDS	23-Apr-92	18.34	7.40	886	92	344		<0.02	73.0	47	31.2		13.0
REE	SD	23-Apr-92	18.59	8.25	219	96	116		<0.02	3.0	7	2.1		7.0
REE	SU	23-Apr-92	18.72	8.30	218	84	104		<0.02	2.0	8	1.7		8.0
REW	SDD	23-Apr-92	18.62	8.02	260	108	132		0.08	3.5	7	2.1		7.0
REW	SDM	23-Apr-92	18.63	7.89	339	128	168		<0.02	7.6	8	3.1		6.0
REW	SDS	23-Apr-92	18.63	7.68	531	84	216		0.02	34.4	24	12.6		7.0
RSA	19	23-Apr-92	18.57	7.96	243	96	124		0.18	5.3	5	2.0		6.0
RSA	20	23-Apr-92	18.57	8.00	317	104	164		<0.02	12.3	10	2.0		7.0
RSA	21	23-Apr-92	18.57	8.15	247	96	128		0.02	6.4	8	1.4		7.0
RSA	22	23-Apr-92	18.57	8.28	220	92	116		<0.02	3.0	8	1.7		6.0
RSA	23	23-Apr-92	18.57	8.31	236	100	120		0.02	3.3	10	2.0		8.0
RSB	19	23-Apr-92	18.41	8.11	229	104	116		<0.02	3.3	3	2.9		3.0
RSB	20	23-Apr-92	18.41	8.10	205	104	88		<0.02	2.0	3	1.7		9.0
RSB	21	23-Apr-92	18.41	8.17	217	100	220		<0.02	2.2	4	1.7		30.5
RSB	22	23-Apr-92	18.41	8.23	228	104	120		<0.02	3.1	6	1.9		3.0
RSB	23	23-Apr-92	18.41	8.27	253	108	132		<0.02	4.6	9	2.1		5.0
RSB	24	23-Apr-92	18.41	8.27	276	108	140		<0.02	6.0	11	2.5		5.0
RSB	25	23-Apr-92	18.41	8.27	293	112	148		<0.02	6.8	13	3.3		2.5
RSC	19	23-Apr-92	18.44	7.76	626	112	260		<0.02	37.5	34	15.9		8.0
RSC	20	23-Apr-92	18.44	7.83	617	116	268		<0.02	40.2	30	16.3		4.0
RSC	21	23-Apr-92	18.44	7.90	556	112	240		<0.02	33.7	23	14.5		2.0
RSC	22	23-Apr-92	18.44	8.03	361	104	168		0.05	15.0	14	5.2		3.0
RSC	23	23-Apr-92	18.44	8.03	448	112	212		<0.02	23.3	20	7.3		3.0
RSD	19	23-Apr-92	18.21	7.95	373	112	172		0.05	15.4	17	7.0		3.5
RSD	20	23-Apr-92	18.21	7.97	345	104	160		<0.02	13.0	12	3.4		2.0
RSD	21	23-Apr-92	18.21	8.06	238	100	116		<0.02	4.2	5	2.6		4.0
RSD	22	23-Apr-92	18.21	8.08	237	100	124		0.02	3.6	6	2.6		2.0
RSD	23	23-Apr-92	18.21	8.08	252	104	124		<0.02	4.2	8	3.4		4.0
RSE	19	23-Apr-92	18.17	7.89	320	96	160		<0.02	15.1	14	2.9		3.0
RSE	20	23-Apr-92	18.17	7.83	458	116	224		<0.02	24.8	20	5.0		5.0

Well	ID	Date	GW Dep	pH	Cond. mhos	Alk. mg/l	T. Hard mg/l	PO4 mg/l	NH4-N mg/l	NO2+NO3-N mg/l	Cl mg/l	Na mg/l	K mg/l	Fluor. mg/l
RSE	21	23-Apr-92	18.17	7.96	283	116	156		<0.02	7.4	8	3.4		5.0
RSE	22	23-Apr-92	18.17	8.15	247	112	128		<0.02	4.4	8	3.1		9.5
RSE	23	23-Apr-92	18.17	8.21	267	108	144		<0.02	5.5	10	3.8		11.0
REC	SDD	20-May-92	17.56	7.98	380	96	116		<0.02	3.0	6	1.2		5.0
REC	SDM	20-May-92	17.56	7.53	322	120	144		<0.02	6.2	9	7.6		9.0
REC	SDS	20-May-92	17.56	7.27	698	128	276		<0.02	34.8	42	30.5		11.0
REE	SD	20-May-92	17.82	8.11	221	96	124		<0.02	2.4	6	2.3		4.0
REE	SU	20-May-92	17.94	8.10	207	92	112		<0.02	2.2	7	2.5		4.5
REW	SDD	20-May-92	17.84	7.91	259	104	140		<0.02	4.6	8	2.3		4.0
REW	SDM	20-May-92	17.84	7.85	254	120	140		<0.02	2.0	4	1.5		8.0
REW	SDS	20-May-92	17.84	7.69	390	96	168		0.15	18.1	14	7.3		4.0
RSA	19	20-May-92	17.80	7.66	270	104	140		<0.02	6.2	6	1.9		3.0
RSA	20	20-May-92	17.80	7.94	267	96	132		<0.02	7.0	12	1.7		4.5
RSA	21	20-May-92	17.80	8.14	218	88	116		<0.02	3.8	6	1.7		3.5
RSA	22	20-May-92	17.80	8.24	221	92	116		<0.02	3.3	8	1.5		3.5
RSA	23	20-May-92	17.80	8.23	234	92	120		<0.02	4.1	10	1.7		5.0
RSB	19	20-May-92	17.64	7.87	247	108	132		<0.02	4.7	7	3.4		13
RSB	20	20-May-92	17.64	8.02	252	104	140		<0.02	4.0	5	1.9		8
RSB	21	20-May-92	17.64	8.12	229	100	124		<0.02	2.9	4	1.5		6
RSB	22	20-May-92	17.64	8.07	235	100	116		<0.02	2.7	5	1.7		7
RSB	23	20-May-92	17.64	8.13	252	104	136		<0.02	4.8	9	2.1		6
RSB	24	20-May-92	17.64	8.09	295	108	152		<0.02	6.0	11	2.8		7
RSB	25	20-May-92	17.64	8.15	304	112	160		<0.02	7.3	13	3.2		7
RSC	19	20-May-92	17.68	7.87	364	112	144		<0.02	9.1	-1	8.2		12
RSC	20	20-May-92	17.68	7.76	275	96	136		<0.02	8.8	15	8.2		11
RSC	21	20-May-92	17.68	7.89	260	92	120		<0.02	6.9	8	6.7		10
RSC	22	20-May-92	17.68	8.01	263	112	256		<0.02	31.9	25	10.0		6
RSC	23	20-May-92	17.68	7.95	483	108	228		<0.02	24.1	19	6.7		5
RSD	19	20-May-92	17.45	8.06	300	72	88		<0.02	2.7	8	2.5		13
RSD	20	20-May-92	17.45	7.98	201	104	140		<0.02	8.0	10	5.5		14
RSD	21	20-May-92	17.45	7.87	325	96	140		<0.02	7.2	8	2.5		9
RSD	22	20-May-92	17.45	7.98	257	96	124		<0.02	4.5	7	2.1		6
RSD	23	20-May-92	17.45	8.00	272	100	132		<0.02	4.3	8	2.1		6
RSE	19	20-May-92	17.41	7.68	266	80	124		<0.02	6.1	16	2.3		6
RSE	20	20-May-92	17.41	7.64	404	112	168		<0.02	14.2	16	5.8		6
RSE	21	20-May-92	17.41	7.82	284	104	128		<0.02	3.8	6	2.5		6
RSE	22	20-May-92	17.41	8.08	287	104	132		<0.02	4.1	8	2.8		8
RSE	23	20-May-92	17.41	8.03	303	108	136		<0.02	5.3	10	3.4		8
REC	SDD	15-Jul-92	17.56	8.10	228	108	116		<.02	1.8	4	1.0		7
REC	SDM	15-Jul-92	17.55	8.11	271	112	132		0.22	2.4	2	1.9		44
REC	SDS	15-Jul-92	17.55	7.01	563	108	200		0.45	24.7	18	15.0		17
REE	SD	15-Jul-92	17.81	8.10	250	104	116		<.02	2.8	5	3.2		6
REE	SU	15-Jul-92	17.93	8.13	214	92	104		0.05	2.3	6	1.0		11
REW	SDD	15-Jul-92	17.84	8.21	266	116	132		<.02	3.0	6	1.8		7
REW	SDM	15-Jul-92	17.84	8.07	268	132	136		<.02	1.1	2	1.0		7
REW	SDS	15-Jul-92	17.84	7.91	274	96	120		<.02	5.3	6	1.0		6
RSA	19	28-Aug-92	18.24	8.24	409	104	192		<.02	17.9	11	2.1		12
RSA	20	28-Aug-92	18.24	7.98	316	108	156		<.02	8.1	6	1.8		10
RSA	21	28-Aug-92	18.24	8.17	215	100	120		<.02	1.4	3	1.0		9
RSA	22	28-Aug-92	18.24	8.17	216	96	112		<.02	2.0	5	1.1		8
RSA	23	28-Aug-92	18.24	8.21	226	96	128		<.02	2.6	7	1.5		7
RSB	19	28-Aug-92	18.08	8.02	352	108	160		<.02	11.8	8	3.5		12
RSB	20	28-Aug-92	18.08	8.07	245	104	132		<.02	2.5	2	1.5		19
RSB	21	28-Aug-92	18.08	8.13	226	108	120		<.02	1.8	2	1.5		15
RSB	22	28-Aug-92	18.08	8.09	227	104	128		<.02	1.7	3	1.8		7
RSB	23	28-Aug-92	18.08	7.95	239	104	124		<.02	3.0	6	1.9		7
RSB	24	28-Aug-92	18.08	8.22	271	104	140		<.02	5.4	9	2.2		15
RSB	25	28-Aug-92	18.08	8.14	289	108	196		<.02	6.5	11	2.6		[illegible]
RSC	19	28-Aug-92	18.11	7.92	470	120	200		<.02	20.9	13	11.5		[illegible]
RSC	20	28-Aug-92	18.11	7.97	358	108	144		<.02	11.7	7	7.5		[illegible]
RSC	21	28-Aug-92	18.11	7.96	389	116	180		<.02	14.4	10	11.0		8

Well	ID	Date	GW Dep	pH	Cond. mhos	Alk. mg/l	T. Hard mg/l	PO4 mg/l	NH4-N mg/l	NO2+NO3-N mg/l	Cl mg/l	Na mg/l	K mg/l	Fluor. mg/l
RSC	22	28-Aug-92	18.11	7.96	316	104	136		<.02	10.9	7	7.5		10
RSC	23	28-Aug-92	18.11	8.13	238	104	116		<.02	3.4	5	4.2		10
RSD	19	28-Aug-92	17.88	8.06	536	92	264		<.02	31.1	24	4.0		8
RSD	20	28-Aug-92	17.88	7.92	694	108	308		<.02	40.3	34	15.0		6
RSD	21	28-Aug-92	17.88	7.98	456	120	200		<.02	18.0	16	11.0		6
RSD	22	28-Aug-92	17.88	8.09	234	108	128		<.02	2.6	4	1.9		9
RSD	23	28-Aug-92	17.88	8.11	481	108	120		<.02	2.6	4	1.5		9
RSE	19	28-Aug-92	17.85	7.92	398	104	200		<.02	18.3	14	5.0		16
RSE	20	28-Aug-92	17.85	8.08	323	124	164		<.02	8.4	8	4.5		12
RSE	21	28-Aug-92	17.85	8.19	246	120	132		<.02	1.9	4	1.9		7
RSE	22	28-Aug-92	17.85	8.22	251	112	136		<.02	3.2	6	2.0		6
RSE	23	28-Aug-92	17.85	8.26	265	112	136		<.02	4.4	8	2.5		6
REC	SDD	16-Oct-92	17.73	8.03	191	88	100		<.02	1.8	3	1.3		8
REC	SDM	16-Oct-92	17.73	7.90	178	88	96		<.02	0.3	<1	1.3		10
REC	SDS	16-Oct-92	17.73	7.46	471	118	212		<.02	21.2	14	13.6		10
REE	SD	16-Oct-92	17.99	8.22	200	89	100		0.02	2.7	5	1.8		7
REE	SU	16-Oct-92	18.11	8.12	159	79	88		0.02	0.8	3	1.0		8
REW	SDD	16-Oct-92	18.02	8.00	216	98	120		<.02	2.2	3	1.6		14
REW	SDM	16-Oct-92	18.02	8.02	161	74	88		0.02	0.5	2	1.1		18
REW	SDS	16-Oct-92	18.02	7.87	360	102	160		0.02	15.9	13	4.3		8
RSA	19	16-Oct-92	17.96	7.93	342	74	152		<.02	17.5	11	4.7		9
RSA	20	16-Oct-92	17.96	7.99	269	86	124		<.02	9.4	6	3.5		8
RSA	21	16-Oct-92	17.96	8.11	186	88	100		<.02	1.5	3	1.3		24
RSA	22	16-Oct-92	17.96	8.19	206	89	108		0.02	2.9	6	1.6		17
RSA	23	16-Oct-92	17.96	8.23	222	91	116		<.02	3.8	7	1.7		10
RSB	19	16-Oct-92	17.80	7.80	278	98	136		<.02	6.6	5	4.8		9
RSB	20	16-Oct-92	17.80	7.85	202	99	104		<.02	0.8	2	1.6		7
RSB	21	16-Oct-92	17.80	7.95	207	102	104		<.02	1.2	2	1.3		10
RSB	22	16-Oct-92	17.80	7.96	222	101	120		<.02	2.4	4	1.5		6
RSB	23	16-Oct-92	17.80	8.02	235	104	120		<.02	3.7	6	1.9		8
RSB	24	16-Oct-92	17.80	8.05	244	98	120		<.02	5.1	8	2.4		6
RSB	25	16-Oct-92	17.80	8.16	257	102	124		<.02	6.2	9	2.8		7
RSC	19	16-Oct-92	17.82	7.63	543	108	224		0.02	30.6	19	11.2		8
RSC	20	16-Oct-92	17.82	7.70	295	118	132		<.02	4.2	2	4.6		9
RSC	21	16-Oct-92	17.82	7.81	251	104	120		0.05	3.2	4	2.7		15
RSC	22	16-Oct-92	17.82	7.82	229	97	124		<.02	3.3	5	1.7		12
RSC	23	16-Oct-92	17.82	7.90	240	99	120		<.02	4.5	7	1.9		6
RSD	19	16-Oct-92	17.60	7.55	450	105	208		<.02	23.3	18	9.6		6
RSD	20	16-Oct-92	17.60	7.62	476	118	212		<.02	23.0	19	13.9		7
RSD	21	16-Oct-92	17.60	7.67	239	108	120		<.02	2.1	3	2.7		7
RSD	22	16-Oct-92	17.60	7.74	244	106	124		<.02	4.1	7	2.3		45
RSD	23	16-Oct-92	17.60	7.85	258	105	132		<.02	4.7	5	1.8		11
RSE	19	16-Oct-92	17.56	7.62	292	101	156		<.02	10.8	10	3.3		6
RSE	20	16-Oct-92	17.56	7.60	340	91	156		<.02	14.9	12	7.7		14
RSE	21	16-Oct-92	17.56	7.66	262	109	136		<.02	3.1	4	2.7		7
RSE	22	16-Oct-92	17.56	7.82	243	109	132		<.02	2.6	4	2.0		10
RSE	23	16-Oct-92	17.56	7.83	245	106	140		<.02	3.8	5	2.4		5
REC	SDD	04-Jan-93	17.49	8.05	178	88	88		0.05	1.5	2	1.0		7
REC	SDM	04-Jan-93	17.49	7.82	197	96	100		<.02	0.9	1	2.0		10
REC	SDS	04-Jan-93	17.49	7.46	554	100	204		0.45	27.9	25	22.0		7
REE	SD	04-Jan-93	17.75	8.14	171	92	92		<.02	0.6	<1	1.0		9
REE	SU	04-Jan-93	17.87	8.16	178	80	88		<.02	1.8	4	1.3		8
REW	SDD	04-Jan-93	17.77	7.99	217	96	108		0.05	3.1	4	1.6		11
REW	SDM	04-Jan-93	17.77	8.00	196	92	100		0.12	1.3	2	1.2		8
REW	SDS	04-Jan-93	17.77	7.83	255	108	120		<.02	3.7	4	3.5		5
RSA	19	04-Jan-93	17.72	7.90	365	84	156		<.02	18.4	11	2.3		6
RSA	20	04-Jan-93	17.72	7.96	261	100	120		<.02	6.3	4	2.3		7
RSA	21	04-Jan-93	17.72	8.13	199	100	108		<.02	0.8	1	1.0		19
RSA	22	04-Jan-93	17.72	8.16	198	96	104		<.02	1.6	3	1.5		18
RSA	23	04-Jan-93	17.72	8.15	204	92	104		<.02	2.2	4	1.5		11
RSB	19	04-Jan-93	17.56	7.97	192	92	92		<.02	1.3	1	1.5		7

Well	ID	Date	GW Dep	pH	Cond. mhos	Alk. mg/l	T. Hard mg/l	PO4 mg/l	NH4-N mg/l	NO2+NO3-N mg/l	Cl mg/l	Na mg/l	K mg/l	Fluor. mg/l
RSB	20	04-Jan-93	17.56	7.99	176	92	92		<.02	0.7	1	1.0		6
RSB	21	04-Jan-93	17.56	8.05	182	92	92		0.02	1.0	1	1.2		6
RSB	22	04-Jan-93	17.56	8.09	193	96	100		<.02	1.6	2	1.5		4
RSB	23	04-Jan-93	17.56	8.17	209	96	104		0.08	2.5	4	2.0		5
RSB	24	04-Jan-93	17.56	8.19	222	96	108		<.02	3.9	6	2.2		5
RSB	25	04-Jan-93	17.56	8.22	244	100	120		<.02	5.1	8	2.5		5
RSC	19	04-Jan-93	17.59	7.62	457	112	192		<.02	20.5	14	6.5		6
RSC	20	04-Jan-93	17.59	7.77	344	116	148		<.02	10.0	6	6.8		7
RSC	21	04-Jan-93	17.59	7.88	295	104	132		<.02	8.3	6	4.0		12
RSC	22	04-Jan-93	17.59	8.01	218	96	104		<.02	2.8	4	1.8		8
RSC	23	04-Jan-93	17.59	8.04	225	96	108		<.02	3.8	5	1.5		5
RSD	19	04-Jan-93	17.36	7.82	342	108	152		<.02	10.4	8	7.8		5
RSD	20	04-Jan-93	17.36	7.85	253	104	116		<.02	3.6	3	3.0		6
RSD	21	04-Jan-93	17.36	7.90	224	104	116		<.02	1.8	2	1.5		4
RSD	22	04-Jan-93	17.36	7.93	237	108	120		<.02	3.1	4	1.8		41
RSD	23	04-Jan-93	17.36	8.05	255	104	132		<.02	4.6	7	2.3		11
RSE	19	04-Jan-93	17.34	7.77	328	112	156		0.02	12.5	10	4.8		5
RSE	20	04-Jan-93	17.34	7.86	326	112	152		0.02	9.3	8	5.0		7
RSE	21	04-Jan-93	17.34	7.87	248	104	120		0.05	3.0	5	1.8		5
RSE	22	04-Jan-93	17.34	7.71	272	100	128		0.10	4.7	16	2.3		6
RSE	23	04-Jan-93	17.34	7.97	270	104	132		<.02	5.5	10	2.3		6

APPENDIX 2
GROUNDWATER CHEMISTRY FOR SITE 2

Well ID	Date	GW Dep	pH	Cond. mhos	Alk. mg/l	T. Hard mg/l	NO2+NO3-N mg/l	NH4-N mg/l	Na mg/l	Cl mg/l	Fluor. mg/l
SNIDGE1	04-Jan-93	8.97	6.70	396.0	96.0	136	15.2	<.02	24.5	24	43.0
SNIDGE1	20-Oct-92	9.89	6.85	530.0	92.0	184	26.2	<.02	23.3	27	62.0
SNIDGE1	06-Aug-92	11.07	6.91	572.0	112.0	196	27.2	<.02	25.0	29	51.0
SNIDGE1	21-May-92	8.88	6.88	420.0	64.0	140	12.5	<.02	21.0	13	39.0
SNIDGE1	22-Apr-92	9.16	6.69	463.0	58.0	152	17.8	<.02	21.5	19	39.0
SNIDGE1	27-Mar-92	10.22	6.88	489.0	76.0	180	32.0	0.12	23.8	24	43.0
SNIDGE1	08-Jan-92	10.67	7.41	510.0	56.0	176	36.4	0.05	24.4	23	61.0
SNIDGE1	13-May-91	8.99	6.61	530.0	57.0	164	36.2			29	
SNIDGE1	15-Nov-90	10.50	6.78	720.0	88.0	264	44.8			30	
SNIDGE2	04-Jan-93	8.98	6.69	406.0	100.0	136	14.4	<.02	24.8	24	43.0
SNIDGE2	20-Oct-92	9.89	6.65	536.0	100.0	192	25.7	<.02	22.6	28	58.0
SNIDGE2	06-Aug-92	11.07	6.78	570.0	124.0	208	26.9	<.02	26.5	29	51.0
SNIDGE2	21-May-92	8.88	7.08	545.0	88.0	180	22.8	<.02	27.7	28	43.0
SNIDGE2	22-Apr-92	9.16	6.74	560.0	77.6	180	31.4	<.02	27.3	32	43.0
SNIDGE2	27-Mar-92	10.22	6.73	534.0	76.0	192	34.4	0.08	26.6	27	40.0
SNIDGE2	08-Jan-92	10.66	6.93	550.0	64.0	192	36.9	0.02	26.6	30	52.0
SNIDGE2	20-Dec-91	10.88	7.16	600.0	48.0	188	39.8	<.02	25.9	28	33.0
SNIDGE2	13-Nov-91	11.69	7.24	649.0	80.0	224	49.3	<.02	33.0	42	36.0
SNIDGE2	07-Oct-91	11.67	7.18	539.0			28.4	<.02		22	63.0
SNIDGE2	09-Sep-91	11.34	7.00	495.0			24.9	<.02		21	55.0
SNIDGE2	13-Aug-91	10.83	6.91	599.0			37.1			30	54.0
SNIDGE2	13-May-91	8.99	6.69	610.0	83.0	204	41.5			34	
SNIDGE2	05-Mar-91	11.48	7.14	553.0	80.0	204	36.8	<.02	25.0	31	
SNIDGE2	15-Nov-90	10.49	6.81	718.0	106.0	272	44.8			26	
SNIDGE3	04-Jan-93	9.02	6.67	414.0	104.0	140	15.0	<.02	25.0	23	42.0
SNIDGE3	20-Oct-92	9.92	6.65	548.0	99.0	192	26.3	<.02	23.3	27	55.0
SNIDGE3	06-Aug-92	11.11	6.86	566.0	120.0	212	26.9	<.02	24.5	29	50.0
SNIDGE3	21-May-92	8.91	6.94	529.0	88.0	184	21.6	<.02	27.7	24	46.0
SNIDGE3	22-Apr-92	9.16	6.75	557.0	104.8	184	30.6	<.02	26.8	32	41.0
SNIDGE3	27-Mar-92	10.24	6.79	533.0	80.0	172	34.2	0.05	27.0	28	39.0
SNIDGE3	08-Jan-92	10.68	7.00	561.0	64.0	200	37.5	0.02	27.0	30	53.0
SNIDGE3	20-Dec-91	10.89	7.03	587.0	52.0	200	39.6	<.02	26.8	28	33.0
SNIDGE3	13-Nov-91	11.71	7.03	653.0	80.0	224	45.9	<.02	32.8	38	34.0
SNIDGE3	07-Oct-91	11.69	6.93	561.0			30.8	<.02		23	63.0
SNIDGE3	09-Sep-91	11.38	6.78	544.0			29.5	<.02		25	57.0
SNIDGE3	13-Aug-91	10.83	6.88	606.0			36.4			30	56.0
SNIDGE3	13-May-91	9.02	6.69	623.0	84.0	208	40.5			34	
SNIDGE3	05-Mar-91	11.48	6.84	552.0	76.0	204	35.8	<.02	25.5	31	
SNIDGE3	15-Nov-90	10.54	6.84	731.0	108.0	276	45.3			28	
SNIDGE4	04-Jan-93	9.03	6.85	407.0	100.0	136	14.4	<.02	27.2	23	43.0
SNIDGE4	20-Oct-92	9.93	6.69	545.0	99.0	180	25.8	<.02	23.0	28	56.0
SNIDGE4	06-Aug-92	11.12	6.95	568.0	124.0	200	26.8	<.02	24.5	29	53.0
SNIDGE4	21-May-92	8.92	7.15	537.0	88.0	184	25.2	<.02	27.7	35	47.0
SNIDGE4	22-Apr-92	9.16	6.89	560.0	34.4	184	31.3	<.02	26.8	32	42.0
SNIDGE4	27-Mar-92	10.25	6.84	542.0	80.0	176	34.3	0.02	27.7	28	39.0
SNIDGE4	08-Jan-92	10.69	7.04	553.0	64.0	192	37.5	0.02	26.7	31	55.0
SNIDGE4	20-Dec-91	10.89	7.30	596.0	48.0	196	39.2	<.02	26.1	27	33.0
SNIDGE4	13-Nov-91	11.71	6.97	631.0	76.0	216	45.5	<.02	31.9	39	36.0
SNIDGE4	07-Oct-91	11.70	7.27	531.0			27.5	<.02		22	68.0
SNIDGE4	09-Sep-91	11.43	6.85	542.0			29.1	<.02		25	55.0
SNIDGE4	13-Aug-91	10.83	6.90	593.0			36.3			30	58.0
SNIDGE4	13-May-91	9.03	6.75	616.0	80.0	204	40.0			33	
SNIDGE4	05-Mar-91	11.48	6.86	558.0	80.0	200	36.3	<.02	25.0	30	
SNIDGE4	15-Nov-90	10.54	6.96	714.0	104.0	272	44.9			27	

Well ID	Date	GW Dep	pH	Cond. mhos	Alk. mg/l	T. Hard mg/l	NO2+NO3-N mg/l	NH4-N mg/l	Na mg/l	Cl mg/l	Fluor. mg/l
SNIDGW1	04-Jan-93	9.01	6.58	225.0	60.0	76	7.3	<.02	13.0	12	39.0
SNIDGW1	20-Oct-92	9.92	6.42	405.0	67.0	136	20.1	0.10	17.9	20	45.0
SNIDGW1	06-Aug-92	11.12	6.65	455.0	96.0	164	21.4	<.02	17.0	24	39.0
SNIDGW1	21-May-92	8.89	6.69	124.0	28.0	40	3.0	<.02	6.1	4	31.0
SNIDGW1	22-Apr-92	9.13	6.41	145.0	31.6	48	2.1	<.02	7.0	3	30.0
SNIDGW1	27-Mar-92	10.23	6.60	245.0	52.0	84	11.7	0.08	12.5	7	30.0
SNIDGW1	08-Jan-92	10.71	7.32	251.0	40.0	84	12.2	<.02	13.2	10	52.0
SNIDGW1	13-May-91	8.99	6.46	239.0	32.0	80	14.0			11	
SNIDGW1	15-Nov-90	10.51	6.84	625.0	74.0	220	40.3			28	
SNIDGW2	04-Jan-93	9.01	6.61	410.0	100.0	136	15.7	<.02	27.2	24	41.0
SNIDGW2	20-Oct-92	9.92	6.53	519.0	91.0	168	25.7	<.02	21.8	27	51.0
SNIDGW2	06-Aug-92	11.12	6.68	602.0	128.0	216	28.2	<.02	26.5	28	48.0
SNIDGW2	21-May-92	8.90	6.99	289.0	48.0	104	13.6	<.02	7.0	13	42.0
SNIDGW2	22-Apr-92	9.13	6.74	320.0	62.4	112	7.6	<.02	12.7	7	45.0
SNIDGW2	27-Mar-92	10.23	6.63	485.0	60.0	172	32.3	0.02	24.9	26	37.0
SNIDGW2	08-Jan-92	10.69	6.80	373.0	40.0	144	21.4	<.02	15.4	15	64.0
SNIDGW2	20-Dec-91	10.85	7.00	417.0	44.0	148	27.9	<.02	13.5	20	33.0
SNIDGW2	13-Nov-91	11.72	6.93	610.0	60.0	208	44.9	<.02	31.4	38	36.0
SNIDGW2	09-Sep-91	11.41	6.48	638.0			41.1	<.02		31	54.0
SNIDGW2	13-Aug-91	10.95	6.75	478.0			27.5			22	52.0
SNIDGW2	13-May-91	9.00	6.63	539.0	87.0	188	32.3			27	
SNIDGW2	05-Mar-91	11.51	6.94	448.0	68.0	160	28.0	<.02	19.2	22	
SNIDGW2	15-Nov-90	10.51	6.67	722.0	104.0	276	45.9			33	
SNIDGW3	04-Jan-93	9.01	6.59	430.0	96.0	148	17.2	<.02	26.2	24	40.0
SNIDGW3	20-Oct-92	9.92	6.53	522.0	90.0	172	25.8	<.02	22.3	26	49.0
SNIDGW3	06-Aug-92	11.12	6.69	589.0	112.0	200	26.7	<.02	25.0	27	46.0
SNIDGW3	21-May-92	8.90	6.96	333.0	52.0	120	16.0	<.02	11.4	15	41.0
SNIDGW3	22-Apr-92	9.13	6.69	354.0	64.0	120	17.0	<.02	15.0	16	43.0
SNIDGW3	27-Mar-92	10.23	6.59	464.0	64.0	164	30.9	0.02	23.8	23	36.0
SNIDGW3	08-Jan-92	10.69	6.69	425.0	64.0	180	26.1	<.02	18.8	19	62.0
SNIDGW3	20-Dec-91	10.85	6.80	565.0	44.0	192	37.6	<.02	23.4	27	31.0
SNIDGW3	13-Nov-91	11.72	6.74	643.0	80.0	232	45.2	<.02	32.4	36	36.0
SNIDGW3	07-Oct-91	11.74	6.49	679.0			44.0	<.02		30	61.0
SNIDGW3	09-Sep-91	11.41	6.53	654.0			40.6	<.02		31	55.0
SNIDGW3	13-Aug-91	10.95	6.61	500.0			30.0			24	52.0
SNIDGW3	13-May-91	9.00	6.64	554.0	84.0	188	33.6			28	
SNIDGW3	05-Mar-91	11.51	6.71	512.0	76.0	184	33.8	<.02	22.0	26	
SNIDGW3	15-Nov-90	10.51	6.84	732.0	102.0	276	46.1			32	
SNIDGW4	04-Jan-93	9.01	6.61	425.0	100.0	148	16.6	<.02	27.2	23	40.0
SNIDGW4	20-Oct-92	9.93	6.51	518.0	89.0	164	25.3	<.02	21.7	26	49.0
SNIDGW4	06-Aug-92	11.13	6.65	564.0	120.0	204	26.7	<.02	26.0	28	45.0
SNIDGW4	21-May-92	8.90	6.95	320.0	52.0	116	15.8	<.02	10.7	14	41.0
SNIDGW4	22-Apr-92	9.13	6.73	368.0	63.2	128	10.6	<.02	15.9	11	43.0
SNIDGW4	27-Mar-92	10.23	6.61	452.0	60.0	156	30.1	0.08	22.6	22	37.0
SNIDGW4	08-Jan-92	10.70	6.76	432.0	68.0	160	26.4	0.02	18.5	19	63.0
SNIDGW4	20-Dec-91	10.86	6.82	488.0	60.0	160	31.8	<.02	19.4	23	32.0
SNIDGW4	13-Nov-91	11.72	6.68	641.0	80.0	224	46.2	<.02	33.0	36	35.0
SNIDGW4	05-Mar-91	11.51	6.83	533.0	80.0	204	34.7	<.02	23.2	28	
SNIDGW4	15-Nov-90	10.51	6.71	731.0	109.0	272	45.5			32	
SNIUG3	04-Jan-93	7.53	6.65	245.0	72.0	8	<0.2	<.02	58.8	31	51.0
SNIUG3	20-Oct-92	8.40	6.50	278.0	62.0	16	<0.2	<.02	50.0	39	78.0
SNIUG3	06-Aug-92	9.52	6.42	711.0	20.0	36	0.2	<.02	124.0	198	26.0
SNIUG3	21-May-92	7.20	6.85	251.0	24.0	8	0.2	<.02	44.3	51	43.0
SNIUG3	22-Apr-92	7.25	6.60	295.0	29.6	12	0.2	0.02	56.0	70	43.0
SNIUG3	27-Mar-92	8.57	6.48	254.0	28.0	24	<0.2	0.30	48.2	59	36.0
SNIUG3	08-Jan-92	9.18	6.65	375.0	16.0	20	<0.2	0.05	65.0	90	47.0
SNIUG3	20-Dec-91	9.27	6.80	233.0	48.0	12	<0.2	0.05	42.6	36	30.0
SNIUG3	13-Nov-91	10.09	6.39	436.0	36.0	28	<0.2	0.02	75.0	128	15.0
SNIUG3	07-Oct-91	10.19	5.85	1535.0			0.7	0.02		512	15.0

Well ID	Date	GW Dep	pH	Cond. mhos	Alk. mg/l	T. Hard mg/l	NO2+NO3-N mg/l	NH4-N mg/l	Na mg/l	Cl mg/l	Fluor. mg/l
SNIUG	17-Sep-90		5.81	89.0	4.0	28	4.7		1.7	3	
SNIUG1	20-Oct-92	9.02	5.23	218.0	5.0	48	18.7	<.02	2.2	7	18.0
SNIUG1	06-Aug-92	10.19	6.05	80.0	8.0	32	3.8	<.02	1.5	2	16.0
SNIUG1	21-May-92	7.91	5.85	87.0	<4	28	4.0	<.02	1.5	2	16.0
SNIUG1	22-Apr-92	8.09	5.53	88.5	4.8	44	4.5	<.02	2.0	3	17.0
SNIUG1	27-Mar-92	9.23	5.62	93.0	8.0	36	4.1	0.05	2.5	<1	17.0
SNIUG1	08-Jan-92	9.70	6.78	430.0	4.0	40	4.6	0.02	1.9	8	24.0
SNIUG1	20-Dec-91	9.78	5.91	111.0	4.0	40	4.9	<.02	1.5	5	16.0
SNIUG1	13-May-91	8.01	5.46	96.0	4.0	32	5.6			3	
SNIUG1	15-Nov-90	9.55	6.18	95.0	6.0	24	1.9			2	
SNIUG2	20-Oct-92	9.15	5.64	124.0	9.0	36	8.0	<.02	2.1	2	25.0
SNIUG2	06-Aug-92	10.36	5.90	93.0	16.0	28	3.4	<.02	1.8	3	25.0
SNIUG2	21-May-92	8.05	6.10	111.0	8.0	36	5.4	<.02	2.5	3	22.0
SNIUG2	22-Apr-92	8.10	5.82	105.0	7.6	40	4.9	<.02	2.5	4	22.0
SNIUG2	27-Mar-92	9.33	5.80	104.0	8.0	40	5.4	0.02	2.2	<1	22.0
SNIUG2	08-Jan-92	9.83	5.97	114.0	12.0	44	6.7	<.02	1.9	2	31.0
SNIUG2	20-Dec-91	9.89	6.00	122.0	1.2	40	7.1	<.02	1.7	2	19.0
SNIUG2	13-Nov-91	10.76	6.11	115.4	12.0	36	5.5	0.05	1.9	3	18.0
SNIUG2	07-Oct-91	10.91	5.81	121.0			5.8	<.02		5	31.0
SNIUG2	09-Sep-91	10.65	5.97	118.0			6.9	<.02		2	29.0
SNIUG2	13-Aug-91	10.10	6.91	106.0			5.1			2	31.0
SNIUG2	13-May-91	8.16	5.86	109.0	10.0	32	5.0			3	
SNIUG2	05-Mar-91	10.69	5.91	104.0	16.0	24	3.4	<.02		2	
SNIUG2	15-Nov-90	9.70	6.06	100.0	9.0	28	2.7			3	

APPENDIX 3
RECIRCULATING SAND FILTER
CHEMISTRY FOR SITE 1

Location	Date	pH	Cond. mhos	Alk. mg/l	T. Hard mg/l	BOD mg/l	Na mg/l	Cl mg/l	Fluor mg/l	COD mg/l	NO2+NO3-N mg/l	NH4-N mg/l	TKN mg/l	TOTAL P mg/l
REEDPU	19-Aug-92	7.53	761	300	108	70	35.0	35	132	252.5	<0.2	39.5	49.0	2.4
REEDPU	16-Oct-92	7.68	738	300	100	16	40.0	21	126	135.0	<0.2	29.5	35.0	1.7
REEDPU	27-Oct-92	7.50	729	293	172	11	45.0	34	129	260.0	0.9	34.5	36.2	1.5
REEDPU	06-Nov-92	7.62	820	329	196	17	33.0	38	75	44.0	<0.2	36.2	37.5	2.5
REEDPU	18-Nov-92							37			11.7	28.8	28.8	
REEDPU	24-Nov-92							34			25.1	19.2	20.0	
REEDPU	01-Dec-92							37			18.1	17.8	18.8	
REEDPU	04-Dec-92							35			19.4	12.2	12.5	
REEDPU	11-Dec-92							30			14.3	6.9	8.2	
REEDSEP	06-Sep-91	7.21		432	180	330	35.5	53	350	344.0	<0.2	70.8	89.0	13.0
REEDSEP	09-Oct-91	7.38	1005	404	176	272	32.2	<1	380	357.0	<0.2	77.0	82.0	13.8
REEDSEP	06-Dec-91	7.23		348	124	218	31.1	48	250	486.0	<0.2	57.0	60.0	7.5
REEDSEP	07-Jan-92	8.21		388	160	203	34.2	57	340	420.0	<0.2	68.0	86.0	6.8
REEDSEP	04-Mar-92	7.80		376	140	337	33.5	56	420	519.5	<0.2	55.0	80.0	7.0
REEDSEP	23-Apr-92	7.59		395.2	172	325	35.3	59	280	402.5	<0.2	65.0	96.0	11.2
REEDSEP	20-May-92	7.77		340	144	232	40.1	47	350	585.0	<0.2	56.2	62.0	6.8
REEDSEP	15-Jul-92	7.13		368	140	248	32.0	60	222	465.9	<0.2	53.8	58.0	6.2
REEDSEP	19-Aug-92	7.25	936	388	144		45.0	53	177	265.0	0.2	62.5	62.0	5.6
REEDSEP	16-Oct-92	7.56	946	368	40	125	40.0	22	213	235.0	<0.2	53.8	54.5	6.1
REEDSEP	27-Oct-92	7.67	731	306	164	80	38.0	36	195	160.0	<0.2	38.8	42.5	3.8
REEDSEP	06-Nov-92	7.59	1047	409	176	130	41.0	60	111	125.2	0.2	66.2	72.0	6.1
REEDSEP	18-Nov-92							38			<0.2	42.2	47.5	
REEDSEP	24-Nov-92							36			<0.2	38.8	45.5	
REEDSEP	01-Dec-92							38			0.3	33.0	37.5	
REEDSEP	04-Dec-92							35			<0.2	27.2	32.5	
REEDSEP	11-Dec-92							31			0.3	22.5	28.8	
RRSFL	16-Oct-92									96.0	2.4	14.0	16.2	0.5
RRSFL	24-Nov-92							34			29.5	14.2	15.0	
RRSFL	01-Dec-92							35			27.0	9.5	10.5	
RRSFM	16-Oct-92	7.65	692	292	128	7	34.2	33	132	120.0	<0.2	29.0	35.5	1.6
RRSFM	27-Oct-92	7.41	741	298	180	8	37.4	34	126	100.0	1.7	33.0	36.2	1.2

APPENDIX 4
RECIRCULATING SAND FILTER
CHEMSITRY FOR SITE 2

Location	Date	pH	Cond. mhos	Alk. mg/l	T. Hard mg/l	BOD mg/l	Na mg/l	Cl mg/l	Fluor mg/l	COD mg/l	NO2+NO3-N mg/l	NH4-N mg/l	TKN mg/l	TOTAL P mg/l
SNIDC1	19-Aug-92	6.62	373	108	60	148	26.0	29	195	252.5	0.2	18.0	22.0	5.0
SNIDC1	08-Oct-92	6.87	413	128	52	110	34.0	22	410	480.0	0.2	20.8	29.0	4.1
SNIDC1	23-Oct-92	6.84	402	144	40	179	28.0	24	680	240.0	<0.2	23.8	33.0	5.6
SNIDC1	29-Oct-92	6.67	361	136	44	149	30.0	20	660	266.0	<0.2	23.8	30.0	3.6
SNIDC1	05-Nov-92	6.89	389	147	72	68	28.0	24	273	410.0	<0.2	20.0	23.0	2.8
SNIDC1	17-Nov-92							18			<0.2	11.5	16.2	
SNIDC1	01-Dec-92							18			<0.2	12.5	17.5	
SNIDC1	04-Dec-92							18			<0.2	15.5	15.5	
SNIDC1	11-Dec-92							18			0.3	13.5	18.0	
SNIDC2	19-Aug-92	7.25	794	316	96	92	40.0	33	150	202.5	0.2	8.8	14.0	1.4
SNIDC2	08-Oct-92	7.20	491	172	80	30	38.0	24	105	147.5	0.2	14.2	28.0	4.7
SNIDC2	23-Oct-92	7.06	421	176	108	12	33.0	19	123	110.0	1.2	14.5	17.5	3.3
SNIDC2	29-Oct-92	6.99	410	160	100	11	30.0	19	156	54.4	1.1	13.0	17.0	3.1
SNIDC2	05-Nov-92	7.09	427	150	96	10	26.0	23	219	70.0	1.1	6.0	15.5	2.1
SNIDC2	17-Nov-92							18			6.0	4.5	5.0	
SNIDC2	01-Dec-92							18			3.9	6.6	7.6	
SNIDC2	04-Dec-92							16			6.0	4.8	6.2	
SNIDC2	11-Dec-92							19			2.3	8.0	9.8	
SNIRSF	19-Aug-92	6.88	432	136	112	71	21.0	30	138	165.0	<0.2	9.5	14.0	1.1
SNIRSF	08-Oct-92	7.02	489	176	88	50	33.0	25	98	185.0	<0.2	16.0	21.0	4.8
SNIRSF	23-Oct-92	6.88	440	164	88	32	30.0	21	98	130.0	<0.2	9.5	20.5	4.1
SNIRSF	29-Oct-92	6.77	402	164	112	24	25.0	19	105	74.4	<0.2	13.0	18.0	4.0
SNIRSF	05-Nov-92	6.87	403	149	96	13	23.0	21	174	72.0	2.2	13.0	16.2	1.5
SNIRSF	17-Nov-92							19			8.9	3.0	3.8	
SNIRSF	01-Dec-92							18			6.2	5.0	7.5	
SNIRSF	04-Dec-92							18			6.6	6.5	10.5	
SNIRSF	11-Dec-92							18			3.8	3.6	5.8	
SNIRSFL	08-Oct-92							10			20.5	3.5	6.8	2.6
SNIRSFL	23-Oct-92									24.5	13.1	15.5	24.5	3.6
SNIRSFL	01-Dec-92							17			2.9	9.8	11.1	
SNIRSFM	09-Oct-92	7.39	413	180	100	55	35.0	24	87	172.5	<0.2	15.5	28.0	4.5
SNIRSFM	29-Oct-92	6.78	430	176	112	17	27.0	20	99	56.4	0.9	13.8	17.0	3.1
SNISEP	06-Sep-91	6.94		192	70	150	30.4	41	195	187.0	<0.2	33.2	54.0	5.9
SNISEP	09-Oct-91	7.08	589	208	60	145	39.9	29	160	144.0	<0.2	38.8	52.0	6.0
SNISEP	06-Dec-91	6.75		212	56	225	25.6	32	190	745.2	<0.2	30.0	42.0	5.8
SNISEP	08-Jan-92	6.92		280	80	278	28.4	36	130	543.0	<0.2	36.2	61.2	8.7
SNISEP	04-Mar-92	6.79		172	52	160	27.4	37	156	98.0	<0.2	25.5	42.0	6.8
SNISEP	22-Apr-92	6.59		158.8	84	292	25.9	37	153	383.5	<0.2	25.6	40.0	6.5
SNISEP	21-May-92	6.89		136	56	237	30.6	78	189	482.5	0.2	25.2	22.0	7.5
SNISEP	06-Aug-92	6.70		160	52	130	29.0	35	141	300.7	<0.2	22.5	31.0	4.6
SNIST	17-Nov-92							20			<0.2	13.2	17.5	
SNIST	01-Dec-92							21			<0.2	13.5	16.2	
SNIST	04-Dec-92							20			<0.2	13.5	15.2	