WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Loon Lake Sewer District 4
Treatment Plant
Class II Inspection

August 1995

Publication No. 95-341

printed on recycled paper

For additional copies of this publication, please contact:

Department of Ecology
Publications Distributions Office
P.O. Box 47600
Olympia, Washington 98504-7600
(360) 407-7472

Refer to Publication Number 95-341

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Loon Lake Sewer District #4 Treatment Plant Class II Inspection

by
Guy Hoyle-Dodson

Environmental Investigations and Laboratory Services Program
Olympia, Washington 98504-7710

August 1995

Water Body No. WA-59-1010

Publication No. 95-341

printed on recycled paper

Table of Contents

List of Figures and Tables

Abstract

A Class II Inspection was conducted August 23-25, 1994 at the City of Loon Lake Wastewater Treatment facility in Spokane County, Washington. The Loon Lake facility operates an aerated lagoon connected in series with two large unaerated detention/polishing lagoons. Effluent is discharged to a sprayfield which is under cultivation. Flow through the plant is presently measured at the influent and it is recommended that an effluent flow metering device be installed. Increases in BOD_5 and total solids occurred across the aeration lagoon and these were attributed to algae growth. In contrast, nitrification across the aeration lagoon was pronounced.

Large reductions in BOD_5, additional nitrification, and denitrification occurred across the polishing lagoons. It is suggested that further degradation of BOD_5 is enhanced by aerobic-anaerobic processes dependent on the growth and impoundment of algae within the lagoons. It is advised that biological treatment is temperature dependent and that the treatment process should be evaluated at different times of the year.

All influent, effluent, and flow results were within State Discharge Permit limits. Agronomic analysis of the effluent discharged to the sprayfield identified sodium ion concentrations and pH as having the potential to adversely impact crop cultivation. Split sample analyzes found good correspondence between laboratories for all parameters except ammonia nitrogen, nitrite&nitrate nitrogen, and total nitrogen. It is recommended that Loon lake review their analytic protocols for these parameters. Comparisons of samples were not performed due to Loon Lake's dual influent sample stations, and it is recommended that either concurrent composite samples of both Loon Lake and Deer Lake influent be taken or the headworks be modified to permit sampling of mixed influents. A number of metals were detected in the effluent, but a site specific analysis of their impact on ground water was not possible due to a lack of information on specific ground water characteristics.

Summary

Flow Measurements

Loon Lake's plant flow is measured at the influent, and was inaccessible to independent verification of accuracy. The Loon Lake facility independently measures flow for both Loon Lake and Deer Lake influents. These flows are added and used for comparisons to State Discharge Permit influent design and effluent flow limits. The combined influent flow was approximately 0.108 MGD.

Effluent discharges to the sprayfield are estimated from effluent pump records. Since the accuracy of such a method is dependent on uncertain factors, influent flows were used as an approximation of sprayfield discharge for the purposes of the report.

Wastewater General Chemistry

Influent concentrations for oxygen demand and solids parameters were generally below typical values. An increase in BOD_5 and total solids occurred across the aeration lagoon. Ammonia nitrogen and TKN decreased across the aeration lagoon and nitrite&nitrate nitrogen increased dramatically indicating extensive nitrification. These results were attributed to a combination of seasonal algae growth, low influent BOD_5 concentrations, and extended retention time in the lagoon.

Retention time in the polishing lagoons was estimated to be 278 days. Large reductions in BOD_5, ammonia nitrogen, total nitrogen, and TSS occurred across the polishing lagoons. Chloride increased substantially, although this may be the result of previous high influent loads. Sedimentation of suspended BOD_5 and TSS are believed to have removed these constituents from the effluent. There is evidence that a portion of dissolved BOD_5 reduction was due to algae dependent microorganism production in the polishing lagoons. It is believed that algae was impounded primarily in the first lagoon, which prevented a large contribution to the BOD_5 concentration in the effluent. Denitrification was indicated by reductions in nitrite&nitrate ammonia and concurrent increases in alkalinity. Denitrification would likely result from anoxic conditions within the polishing lagoons. Algae uptake must also account for some of the decrease in nitrite&nitrate concentration. BOD_5 and ammonia nitrogen removal are temperature dependent and may display lower removal efficiencies at different times of the year.

State Discharge Permit Comparisons

All flows, influent loads, and effluent loads were within permit limits.

Sprayfield Discharge

Most constituents of the effluent were found to have no potential impact on crop cultivation in the sprayfields. The exceptions were specific ion toxicity for sodium concentration and high pH. The suggested degree of restrictions on use of irrigation water for these parameters ranged from slight to severe. Nitrogen and phosphorous loads were much lower than the nutrient uptake rates of several potential sprayfield crops. Alfalfa, the principle crop under cultivation, had nutrient uptake rates for nitrogen and phosphorous that exceeded the effluent load by a factor of more than 39 and 2 respectively.

Split Samples

Due to the nature of Loon Lake's double influent sample, splits of the same influent source were not possible. Agreement between Ecology and Loon Lake analytical results were generally good. A non-parametric statistical analysis using Wilcoxon Signed Ranks Test found a significant difference between laboratories for their analysis of ammonia nitrogen. The Loon Lake laboratory ammonia nitrogen results were biased higher than the Ecology results. This systematic difference in Loon Lake's analysis tends towards a conservative estimate of ammonia concentration. Loon Lake nitrite&nitrate nitrogen and total nitrogen results also differed from Ecology results, with differences across stations varying randomly.

Wastewater Detected Metals

Boron, cadmium, calcium, copper, lead, magnesium, mercury, sodium, and zinc were all detected in the effluent. A site specific criteria limiting the impact of effluent metal concentrations on ground water was not available due to a lack of sufficient information on ground water characteristics. Future well placement and monitoring is expected to correct this problem. Although metals contamination of ground water is unlikely, continuing the monitoring of metals concentrations would assist future evaluation of their impact.

Well Monitoring

A separate evaluation of the effectiveness of Loon Lake's well monitoring program is included in a companion report by Denis Erickson.

Recommendations

It is recommended that the Loon Lake facility:

Flow Measurements

- Regularly calibrate influent flow meter to ensure consistency in meter performance.
- Install an effluent flow meter to monitor effluent discharge to the sprayfield.

General Chemistry

- Investigate techniques for controlling algae growth and optimizing nitrification/denitrification across the aeration lagoons.
- Evaluate temperature dependent treatment processes such as nitrification and BOD_5 reduction under conditions of reduced temperature and algae growth during the irrigation season.

Sprayfield Discharge

- Investigate the impact of sodium ion toxicity and high pH on crop cultivation.

Split Samples

- Perform concurrent sampling of both Loon Lake and Deer Lake influent contributions, or mix influents prior to sampling.
- Review analytical protocols for ammonia nitrogen, nitrite&nitrate nitrogen, and total nitrogen to ensure more accurate results.

Introduction

A Class II Inspection and Ground Water Monitoring Evaluation was conducted at the Loon Lake Sewer District #4 Sewage Treatment Plant (STP) on August 23-25, 1994. Denis Erickson and Guy Hoyle-Dodson, both of the Washington State Department of Ecology's Toxic Investigations Section, conducted the investigation. Lisa Olson, municipal permit manager for the Department of Ecology's Eastern Regional Office, provided background information on facility operation. Jean Russell, Sewer District Manager, and Keith VanEtten, Maintenance Foreman, provided information and assistance on site.

The Loon Lake Sewer District #4 STP serves the communities of Loon Lake and Deer Lake in Stevens County, Washington. These communities have a maximum permanent population of approximately 2200, consisting mainly of private residences and small retail businesses. During the summer a large temporary recreational population exists, estimated in excess of 20,000 day-use visitors per year. Effluent discharge is applied to 65 acres of cropland adjacent to the facility. A State Waste Discharge Permit, No. ST 8019, was issued December 30, 1991 with an expiration date of December 30, 1996. Areas of regulation include effluent limitations, irrigation rates, and well monitoring.

The Class II inspection was initiated by the Department of Ecology to assess permit compliance, evaluate treatment effectiveness, and provide information about facility loading to the sprayfield and ground water. The efficacy of the permittee's ground water monitoring program was of particular concern. Specific objectives of the inspection included:

1. Assess State Waste Discharge permit compliance;

2. Assess wastewater toxicity with priority pollutant metal scans;

3. Assess Loon Lake self-monitoring program;

4. Evaluate sprayfield nitrogen loading and agronomic needs;

5. Evaluate treatment facility performance during the irrigation season;

Setting

The Loon Lake treatment facility is located in Stevens County, Washington, 26 miles north of the city of Spokane (*Figure 1*). The Loon Lake and Deer Lake collection systems consist of a septic tank effluent pump (STEP) design. Residential wastewater is collected in interceptor tanks (tanks intercepting wastewater from a cluster of residences) or individual septic tanks, and is pumped to a pressurized collection main. A main pump station pumps the wastewater through a force main to the treatment plant's influent vault. The facility uses an aerated lagoon treatment system, followed by two storage/polishing lagoons. In the summer the plant discharges treated effluent to cropland via spray irrigation. In the winter effluent is held in a final storage lagoon, pending land application during the next irrigation season.

The treatment system consists of an influent chamber with an inline flow meter, a mechanically aerated primary lagoon (2 million gallons), wetwell and pump for effluent from the aerated lagoon, two storage/polishing lagoons (10 and 20 million gallons) operated in series, and a system of movable spray irrigators (*Figure 2*). Raw wastewater from the two collection systems is flow metered separately at the influent vault and then mixed prior to the aerated lagoon.

The aerated lagoon is the principal biological treatment process unit. Three floating agitators provide aeration and also promote counterclockwise flow through the lagoon. Agitators are operated alternately, with two activated at any one time. The biologically degraded wastewater discharges to a wetwell and is pumped to the first of two polishing lagoons.

Storage/polishing lagoons #1 and #2 were primarily designed for settling and storage of wastewater during the non-irrigation season. Some further biological treatment can occur in the lagoon, although this may be partially offset by algae blooms during the summer months. Sludge that accumulates at the bottom of the lagoons is expected to be dredged, although this has not yet occurred. The site for final disposal has not been determined.

Effluent from lagoon #2, the last in the series, is gravity drained to a final effluent wetwell. It is then pumped to the sprayfield and discharged to the cropland for final treatment. Final effluent flow is not directly metered, but pump activation records are compiled from which total sprayfield flow can be estimated. Monitoring wells have been established on the northwest and southeast corners of the sprayfield to evaluate ground water contamination.

Procedures

Ecology collected both grab and composite samples at the STP. Composite samples were collected from wastewater at three stations: the influent chamber, the aerated lagoon effluent wetwell, and the final effluent pump station (*Figure 2 & Appendix A*). Two influent composite samples were collected, one each from valves located on the Loon Lake and Deer Lake flow lines prior to mixing. The two samples were collected concurrently using Ecology's composite sampler for the Loon Lake influent sample and the Loon Lake facility's composite sampler for the Deer Lake influent sample. A composite sample of the Deer Lake influent was also collected by the Loon Lake facility's compositor the day previous to these samples. The final effluent composite sample was collected by directing a steady stream of treated wastewater from an open valve in the effluent line into a priority pollutant cleaned beaker and then sampling directly from the beaker.

All Ecology composite samples were collected using Ecology ISCO composite samplers with equal volumes (approximately 330 mg/L) of the sample collected every 30 minutes over a 24-hour period. The Loon Lake composite of Loon Lake influent was a flow proportional sample of 200 ml for every 3700 gallons of flow. The Loon lake composite sample of Deer Lake influent was a flow proportional sample of 1000 ml for every 3700 gallons of flow.

Grab samples were collected at all composite stations as well as several other sites. Influent grab samples were mixed from equal volumes of Loon Lake influent and Deer Lake influent. Aerated lagoon effluent was collected from the effluent wetwell by a cleaned beaker mounted on a pole. Final effluent was collected directly from a valve on the effluent line in the irrigation pump station. Grabs were also taken from monitoring wells by PVC bailers.

Loon Lake and Deer Lake influent composite samples collected by Loon Lake personnel were split with Ecology for analysis by their respective laboratories. The Ecology sample of Loon Lake influent was not split due to lack of sufficient volume. Aerated lagoon effluent and final effluent composite samples collected by Ecology were split with Loon Lake personnel. Since collection of the two influent composite samples was split between the two influent lines, Loon Lake's sample of Deer Lake influent was not equivalent to Ecology's sample of Loon Lake influent and could not be used for sample comparisons. The Loon Lake samples were believed to be representative of the STP's typical sampling procedure. Parameters analyzed, samples collected, and the sampling schedule appear in Appendix B.

Samples for Ecology analysis were put in appropriate containers and preserved as necessary. The samples were packed in ice and delivered to the Ecology Manchester Laboratory. Chain-of-Custody procedures were observed for all samples (Ecology, 1994), with the exception of nitrite, orthophosphate, and fecal coliform samples sent to the laboratory on August 24,1994. These last samples were shipped by air freight in taped ice chests, but without Chain-of-custody Seals. Since only Horizon Air Cargo personnel and Manchester Laboratory personnel had access to the samples, it's believed that the samples were not compromised. Analytical procedures and laboratories performing the analyses are summarized in Appendix C.

Quality Assurance/Quality Control

Sampling quality assurance included proper cleaning of sampling equipment (*Appendix D*). One duplicate of a composite sample was analyzed to assess sample splitting and analytic consistency. Sampling in the field followed all protocols for holding times and preservation set forth in the Manchester Lab Laboratory Users Manual (Ecology, 1991).

Laboratory QA/QC including holding times, spike and duplicate spike sample analyses, precision data, and control sample (LCS) analyses were within appropriate ranges with several exceptions. Initial and continuing calibration verification standards were within relevant USEPA (CLP) control limits. Procedural blanks were free from contamination with the exception of zinc for the metals samples. Qualifiers are included in the data table where appropriate. Specific QA/QC concerns are noted in Appendix D.

Results and Discussion

Flow Measurements

Influent flows were measured by a Fisher Porter flow meter, consisting of inline pressure transducers measuring pressure differentials across a constriction in the influent pipe. Due to its inline configuration, independent verification of the meter's accuracy was not performed. It is advised that the Loon Lake meter be regularly calibrated to ensure consistency in meter performance. At the time of the inspection, the flow recorded by the influent totalizer was used as a measure of aeration lagoon effluent flow for the purpose of State Discharge Permit reporting. The daily flow rate calculated from totalizer values taken over the compositor 24-hour collection period was 0.062 MGD for the Loon Lake influent and 0.046 MGD for the Deer Lake influents. Total influent flow rate was 0.108 MGD.

Loon Lake also estimates effluent flows to the sprayfield through discharge pump records. The accuracy of this method is contingent on many factors including: changes in head loss (i.e. changes in pipe and nozzle diameters, configurations, etc.), pump performance, and effluent specific gravity. Consequentially, pump records were not used as a measure of sprayfield discharge for the purposes of the investigation. The inspection took place during the height of the irrigation season and it is assumed that hydraulic flow across the plant was close to steady state for this period. As a result influent flows are used as an approximation of sprayfield discharge. However, since flows are not always steady state, it is recommended that Loon Lake install an effluent flow measurement device to accurately record sprayfield discharge.

Wastewater General Chemistry and Plant Operation

Influent

Influent composite concentrations were derived from flow weighted calculations combining the two influent sample results. It should be noted that the Loon Lake composite sample's temperature at the end of the collection period was 13.3 °C (Table 1). This temperature is higher than the 4 °C that is recommended for typical sample holding times (Ecology, 1991), and thus the mixed results may be somewhat biased depending on parameter. Since the holding time was less than 24 hours, this effect is not expected to be unacceptably large.

Corrected influent five day Biochemical Oxygen Demand (BOD_5), Total Organic Carbon (TOC), and Total Suspended Solids (TSS) concentrations (102 mg/L, 62 mg/L, and 33 mg/L -*Table 2*) were below the weak value for typical untreated domestic wastewater (Metcalf & Eddy, 1991). BOD_5 /TOC ratio was slightly higher than typical (Metcalf & Eddy, 1991). Weak influent concentrations may affect treatment efficiency.

Nutrient parameters and chloride concentrations were close to medium values for typical domestic influents, while alkalinity exceeded the highest value (Metcalf & Eddy, 1991). Influent Total Solids (TS) and Total Non-Volatile Solids (TNVS) were also close to medium values for typical domestic influents.

Aeration Lagoon

Atypical increases across the aeration lagoon were observed for several parameters (Table 2). BOD_5, TS, and Total Volatile Solids (TVS) loads across the aerated lagoon increased 25%, 29%, and 49% respectively. These increases would not normally be expected for the typical aeration treatment system design. The chloride (Cl^-) load also increased 5%. With the exception of TS, these parameters had weak influent concentrations compared to typical domestic influents.

More predictable changes were also observed. TSS and Total Non-Volatile Suspended Solids (TNVSS) increased 273% and 200% respectively. COD and TOC displayed small decreases (7% and 3% respectively).

In contrast, Total Kjeldahl Nitrogen (TKN) and ammonia nitrogen (NH_3-N) decreased 92% and 81% respectively, with at least a 17 mg/L increase (140,000%) in nitrite&nitrate nitrogen (Table 2). This and a concurrent decrease of alkalinity (65%) indicates that some nitrification occurred across the aeration lagoon. Stoichiometric analysis of the reaction equation indicates that nitrite&nitrate nitrogen concentration formed by the nitrification of ammonia should be approximately 70% greater than the observed concentration (17.2 mg/L). This suggests that extensive ammonia nitrogen uptake by algae also occurs. Denitrification of nitrite&nitrate nitrogen is a less likely explanation for the deficit due to inhibition by oxygen in the aerated lagoon.

Nitrification of NH_3-N in the system may be a function of low BOD_5 influent concentrations and long detention time. The relatively low influent carbonaceous organic concentration represented by BOD_5 would favor the selective increase of nitrifying organisms relative to carbon oxidizing organisms. The plant's BOD_5/TKN ratio predicts a nitrifier fraction (fraction of nitrifying organisms) of at least 12%, compared to a factor of less than 3% associated with typical domestic influents possessing moderate BOD_5 and TKN concentrations (Metcalf & Eddy - Table 11-13, 1991). The elevated average influent temperature (19.9° C), high average ammonia concentration (38 mg/L), and moderate average pH (6.78) would also tend to favor nitrification.

Algae growth must account for the increase of BOD_5 across the aerated lagoon. During the inspection algae was observed in both the aerated lagoon and the polishing lagoons. The aerated lagoon's long retention time (18.5 days), increased nitrate concentration, and elevated temperature would tend to promote such growth. Aeration would inhibit sedimentation, preventing the removal of new algae growth and maintaining original BOD_5 loads across the aeration lagoon in the form of algae cells and bacterial cell bodies. It would also be expected that additional algae in the aeration basin effluent would explain the higher solids concentrations exhibited by the results. One means to control algae growth and limit the increase of BOD_5 would be to reduce detention time across the aeration lagoon. However, since reduction of retention time may adversely affect nitrification, Loon Lake is encouraged to strike a balance that achieves both optimal nitrification and minimal algae growth.

Detention/Polishing Lagoons

Due to the long detention time in the two polishing lagoons ($\cong$ 278 days) effluent quality would tend to be fairly uniform. A uniform influent quality for most parameters is assumed to estimate treatment across the system. It should be noted that seasonal variations in influent loads may exist and this could impact lagoon effluent composition.

Inspection results showed reductions across the polishing lagoons in ammonia, BOD_5, total nitrogen, and TSS of greater than 99%, 91%, 75%, and 54% respectively (*Tables 1&2*). The chloride load increased 31%, probably due to variations in previous influent loads. A large percentage of organics from the aeration lagoon appeared to settle out in the polishing lagoons. Additional BOD_5 degradation likely occurred in aerobic, algae rich zones within the polishing lagoons. The nitrite&nitrate nitrogen concentration was also reduced dramatically, with a concurrent increase in alkalinity indicative of denitrification. Algae uptake of nitrite&nitrate nitrogen was likely another significant source of the reduction. Denitrification normally occurs in anoxic zones within lagoon systems (Metcalf & Eddy, 1991).

These types of facultative lagoon systems typically remove dissolved BOD_5 by a symbiotic relationship between aerobic microorganisms and oxygen producing algae (Metcalf & Eddy, 1991). Algae photosynthesis is integral to this process, and presence of algae in the lagoons is supported by both observation and the high effluent pH (10.57). Since algae is also a source of BOD_5 but remains suspended in the wastewater, it would be necessary to segregate algae from lagoon effluent to achieve the observed BOD_5 reduction. It is likely that the majority of the reduction occurred in the first polishing lagoon, where daily algae blooms were most noticeable and the growing algae would congregate near the surface of the lagoon. Flow from the first lagoon to the final lagoon is via submerged and underground pipe, siphoning from near the bottom of the first lagoon's water column. This would act to impound algae in the lagoon, at least during the day when algae would favor the top layer of the water column. Algae is capable of adjusting its own buoyancy and at night may disperse throughout the water column (Ehinger, Bill, 1995).

In the final polishing lagoon algae growth may be inhibited by previous reductions in those nutrients necessary for algae growth. Reductions in nitrite&nitrate nitrogen of nearly 100% and in total phosphate of more than 46% across the lagoons is evidence of such nutrient depletion (Table 2). Effluent from the final lagoon is siphoned at a point approximately 5 feet below the lagoon's surface, also below the stratum where algae photosynthesis would likely occur. This should further reduce the presence of algae in the final effluent. Overall, the final effluent would be expected to exhibit the reduced BOD_5 concentrations observed.

It should be noted that TSS concentrations, while decreasing across the polishing lagoons, actually increased across the entire treatment system by 70%. This net increase may represent the escape to the effluent of at least some of the algae growth that occurred in both the aeration lagoon and the polishing lagoons. The surface impoundment of algae in the polishing lagoons may not have been completely effective, perhaps due to nighttime dispersion of algae throughout the water column.

Algae mediated BOD_5 removal, nitrification, and denitrification are temperature dependent (Metcalf & Eddy, 1991), and during different times of the year may be significantly reduced. Lower temperatures would inhibit algae growth in the polishing lagoons, limiting BOD_5 reduction. Although increases of BOD_5 across the aeration lagoon would also be curtailed and sedimentation in the polishing lagoons would always remove some BOD_5, reduction of BOD_5 in the effluent may at different times be less than observed during the inspection. Elevated concentrations of BOD_5 in the effluent may affect the sprayfield by the promotion of bacterial growth, soil clogging, and long-term anaerobic conditions (Metcalf & Eddy, 1991). Of even greater concern, lower temperatures may reduce ammonia nitrogen removal across the plant, leading to excessive nitrogen loading in the sprayfield. It is suggested that the plant be further evaluated under conditions of reduced temperature and low algae growth that may occur during the cooler months of the irrigation season.

State Discharge Permit Comparisons

Table 3 compares inspection results to State Discharge permit limits. The facility's flow rate was well within the influent and effluent maximum design limits. The Ecology analysis of ammonia effluent concentration and influent load produced results well below the permitted maximum concentration and load limits. The Ecology BOD_5 influent load result was well below the permit summer influent load limit.

Sprayfield Discharge

Agronomic analysis of effluent constituents was undertaken to determine their impact on crop growth in the sprayfield. Specific ion toxicity was noted for the sodium (70.1 mg/L) concentration (Table 4). The suggested degree of restrictions on use of irrigation water carrying this concentration ranged from slight to moderate (Metcalf & Eddy, 1991). The effluent pH (10.57) also exceed the high end of the normal range (6.5 - 8.4), and may cause more severe damage to crops. It is recommended that Loon Lake evaluate the impact of these constituents on crop cultivation.

The concentrations of chloride and trace metal ions were not found to pose a problem (Table 4). Salinity (EC_W = 0.2 mmho/cm) and Total Dissolved Solids (TDS = 359 mg/L) were also below concentrations of concern. Bicarbonate (HCO_3) and TKN concentrations were well below critical levels. The adjusted Sodium adsorption Ratio (adj RN_a = 1.08), a measure of ion impact on soil permeability, indicated that no restrictions are necessary. Finally, nitrogen and phosphorus loads (5.1 lbs/acre·year and 9.6 lbs/acre·year) were much lower than the nutrient uptake rates of several potential sprayfield crops (Metcalf & Eddy, 1991). These low loads suggest that additional fertilizers may need to be applied to meet the nutrient requirements of the alfalfa crop presently grown.

Split Samples

Sample Comparisons

Due to the nature of Loon Lake's double influent sample, splits of the same influent source were not possible. During the inspection Loon Lake alternated sample collection of Loon Lake influent and Deer Lake influent every 24-hours. It is suggested that Loon Lake either collect concurrent composite samples of both Loon Lake and Deer Lake influents, or modify the headworks to allow sampling of the mixed influents. The collection of a mixed sample would allow a more representative characterization of the influent. Access to the mixed influent would also assist independent compliance monitoring.

Laboratory Comparisons

Agreement between Ecology and Loon Lake analytical results were generally good (*Table 5*). A non-parametric statistical analysis using Wilcoxon Signed Ranks Test found no significant difference between data sets at a critical level of 0.05 for TSS, BOD_5, nitrite&nitrate nitrogen, total nitrogen, total phosphorous, chloride, and pH. This would indicate an absence of systematic bias between laboratory results for these parameters. The one exception was ammonia nitrogen, for which Loon Lake results appeared significantly higher than the Ecology results and tended towards a conservative estimate of ammonia nitrogen concentration. The geometric mean of relative percent differences between laboratories at all stations for ammonia nitrogen, nitrite&nitrate nitrogen, and total nitrogen results were well outside the range of variation in inter-laboratory precision (Ecology, 1991b). For the later two parameters this indicates a random variation between laboratories that exceeds what would be expected from variations in inter-laboratory precision alone. It is recommended that the Loon Lake laboratory review analytic protocols for these three parameters.

Wastewater Detected Metals

Wastewater was analyzed for metals only. Boron, cadmium, calcium, copper, lead, magnesium, mercury, sodium, and zinc were all detected in the effluent (*Table 6*). A site specific criteria limiting the impact of effluent metal concentrations on ground water was not available due to a lack of sufficient information on ground water characteristics. It is likely, however, that these concentrations would have no impact on ground water (Erickson, Denis, 1995). Future well placement and monitoring by The Loon Lake facility is expected to resolve this issue. Although not strictly applicable to effluent discharges to sprayfields, copper and lead concentrations in the Loon Lake effluent did exceed hardness adjusted State of Washington Water Quality Standards for Surface Waters (173-201A WAC, 1992). Continued monitoring of effluent metals will aid in the future determination of metals impact on ground water. Appendix E contains the results of all target metals.

Well Monitoring

A separate evaluation of the effectiveness of Loon Lake's well monitoring program and land treatment system is included in a companion report by Denis Erickson (Erickson, 1995).

References

APHA, AWWA, WPCF. 1989. Standard Methods for the Examination of Water and Wastewater, 17th edition. American Public Health Association. Washington DC.

Ecology, 1991. Manchester Environmental Laboratory, Laboratory Users Manual, Third Revision. Dickey Huntamer and Janet Hyre, Ed. Washington State Department of Ecology, 1991.

Ecology, 1991b. Guidelines and Specifications for Preparing Quality Assurance Project Plans. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Quality Assurance Section. May, 1991.

Ehinger, Bill, 1995. Personal Communication with Bill Ehinger, Environmental Specialist, E.I.L.S., Ambient Monitoring, Washington State Department of Ecology, 1995.

Erickson, Denis, 1995. Loon Lake Class II Inspection Ground Water, Permit No. ST 8019. Washington State Department of Ecology, 1995.

Erickson, Denis, 1995. Personal Communication with Denis Erickson, Hydrogeologist, E.I.L.S., Toxics Investigations Section, Washington State Department of Ecology, 1995.

Metcalf and Eddy. 1991. Wastewater Engineering Treatment Disposal Reuse, Third Edition. McGraw-Hill. New York.

173-201A, WAC, 1992. Water Quality Standards for Surface Waters of the State of Washington, Chapter 173-201A WAC. Washington State Administrative Code, 1992.

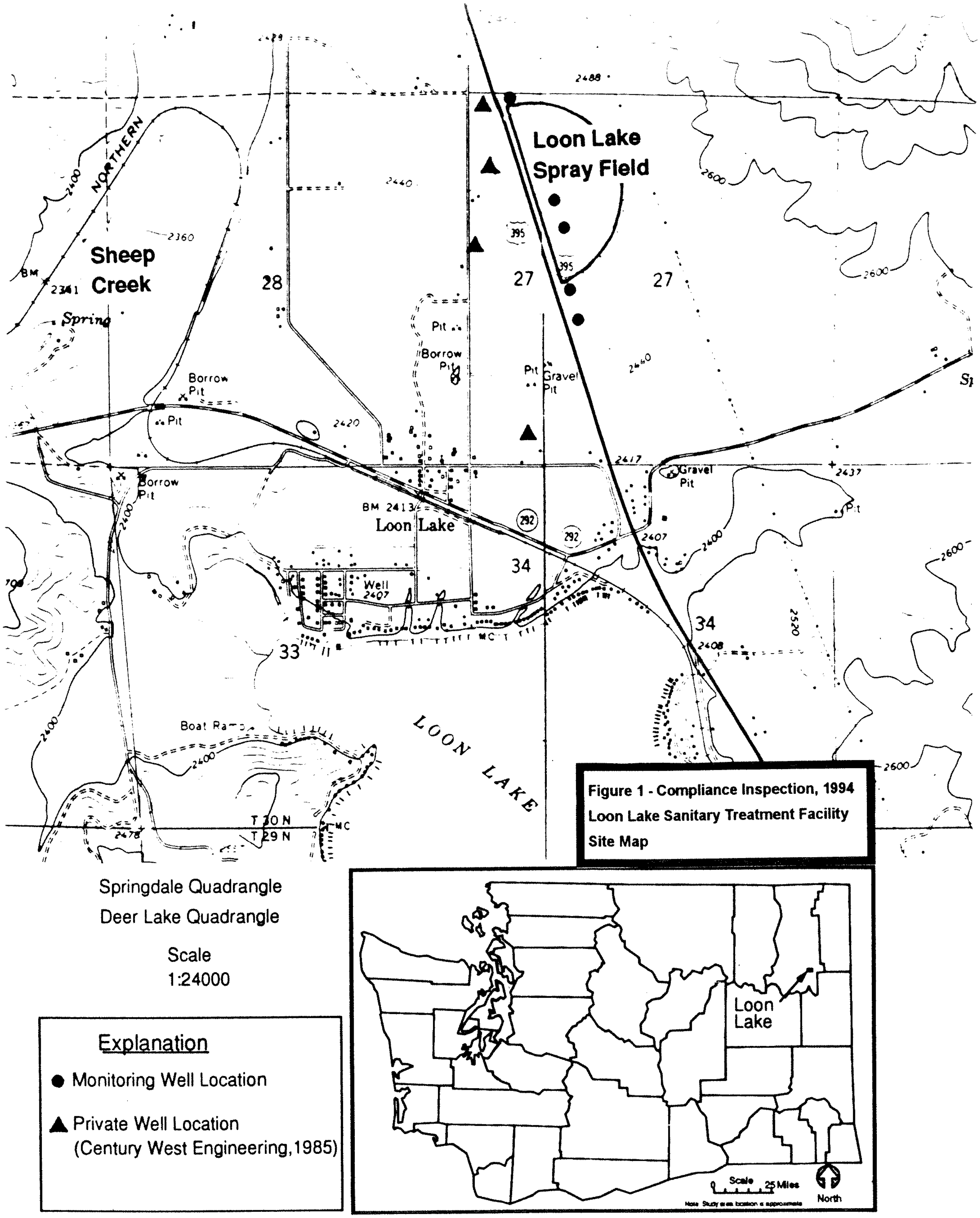

Figure 1. Location and Vicinity Map.

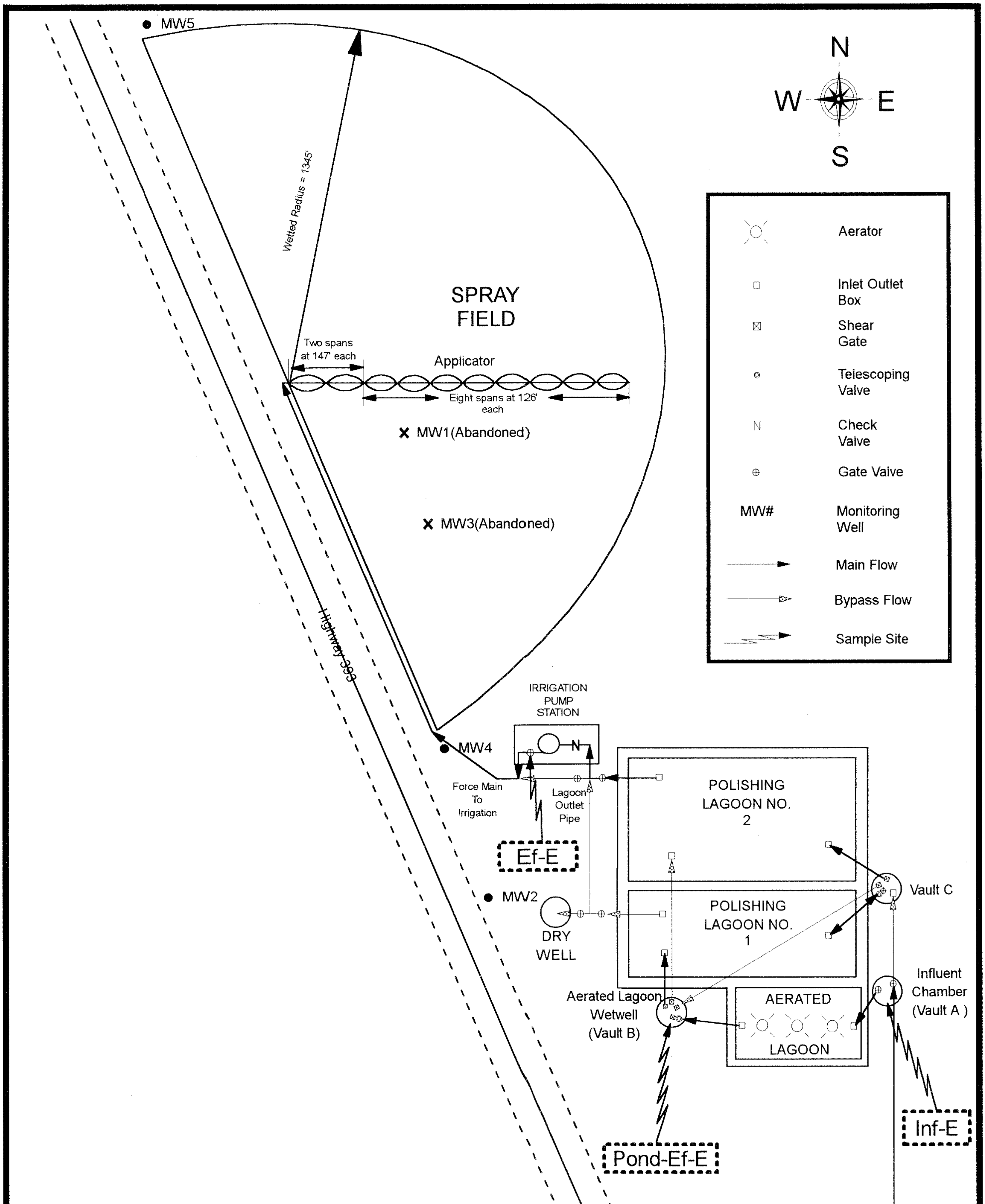

Figure 2 - Compliance Inspection, 1994
Loon Lake Sanitary Treatment Facility
Groundwater Monitoring & Plant Schematic

Table 1 - General Chemistry Results - Loon Lake Class II Inspection, 1994

Parameter	Location:	Inf-E-1	Inf-E-2	Inf-E	Inf-LL	Inf-LL2	Pond-E-Ef-1	Pond-E-Ef-2	Pond-Ef-E
	Type:	grab-comp	grab-comp	comp	comp	comp	grab	grab	comp
	Date:	08/24	08/24	08/24-25	08/24-25	08/23-24	08/24	08/24	08/24-25
	Time:	1025	1440	8:00-8:00	8:00-8:00	8:00-8:00	1042	1505	8:00-8:00
	Lab Log #:	348080	348081	348082	348083	348091	348084	348085	348086
GENERAL CHEMISTRY									
Conductivity (umhos/cm)		782	799	797	765	792	555	554	549
Alkalinity (mg/L CaCO3)		321	328	322	314	328	119	117	112
Hardness (mg/L CaCO3)				103 E*	84.9	103 E*			99.4
Chloride (mg/L)				38.8	34.5	37.4	40.7	39.4	38.9
SOLIDS									
TS (mg/L)				407	363	407			499
TNVS (mg/L)				235	211	234			254
TSS (mg/L)		34	122	33	32	36	125	35	123
TNVSS (mg/L)				7	5	4			18
OXYGEN DEMAND PARAMETERS									
BOD5 (mg/L)				113	87	104			127
COD (mg/L)				290	290	290			270
TOC (water mg/L)		62.9	65.1	67.4	54.2	65.6	67.2	56.8	60.1
NUTRIENTS									
Total Kjeldahl N (mg/L)				52	54	50			4
Total Persulfate N (mg/L)									
NH3-N (mg/L)				36.8 J	39.5 J	40.3 J			7.07 J
NO2+NO3-N (mg/L)				0.01 UJ	0.016 J	0.01 UJ			17.2 J
NO2-N (mg/L)									
Total-P (mg/L)				5.56 J	7.36 J	7.03 J			3.53 J
Ortho-PO4-P (mg/L)									
MISCELLANEOUS									
F-Coliform MF (#/100mL)									
METALS & HCO3									
HC03 (µg/L)				322000	314000	328000			
Boron (µg/L)				212 J	178 J	183 J			
Ca (µg/L)				26000	23300	27400			
Mg (µg/L)				6690	5810	7330			
Na (µg/L)				55200	47600	55200			53300
FIELD OBSERVATIONS									
Temperature (C)		19.8	20.2				20.6	21.2	
Temp-cooled (C)*+				8.7	13.3	5.5			6.2
pH		6.89	6.84	6.97	6.68	6.82	7.02	6.91	7.01
Conductivity (umhos/cm)		797	833	847	802	871	579	588	594
Water Level Depth (feet)									

Inf-E	Ecology composite sample of Loon Lake influent taken 08/24-25/94
Inf-LL	Loon Lake composite sample of Deer Lake influent taken 08/24-25/94
Inf-LL2	Loon Lake composite sample of Loon Lake influent taken 08/23-24/94 and stored until 08/25/94
Inf-E-#	Influent grab sample: 50% Deer lake influent and 50% Loon lake influent
Ef	Effluent sample
Pond	Effluent from aerated lagoon
grab	Grab sample
comp	composite sample
LL	Loon Lake
*+	Refrigerated sample
E*	Result is an estimate because of the presence of interference.
E	Ecology
J	The analyte was positively identified. The associated numerical result an estimate.
UJ	The analyte was not detected at or above the reported result.

Table 1 - General Chemistry Results - Loon Lake Class II Inspection, 1994

Parameter II								
Location	Ef-E-1	Ef-E-2	Ef-E	MW5	MW4	MW2	MW40	Duplicate
Type:	grab	grab	comp	grab	grab	grab	grab	comp
Date:	08/24	08/24	08/24-25	08/24	08/24	08/24	8/24	08/24-25
Time:	1110	1523	8:00-8:00	1030	1100	1200	1115	8:00-8:00
Lab Log #:	348088	348089	348090	348092	348093	348094	348096	348095
GENERAL CHEMISTRY								
Conductivity (umhos/cm)	504	493	482	400	278	208	277	482
Alkalinity (mg/L CaCO3)	136	142	139					141
Hardness (mg/L CaCO3)			60.9					62.9
Chloride (mg/L)			51.1	1.6	2.0	2.6	1.9	51.7
SOLIDS								
TS (mg/L)			415					416
TNVS (mg/L)			237					237
TSS (mg/L)	48	86	56					57
TNVSS (mg/L)			7					13
OXYGEN DEMAND PARAMETERS								
BOD5 (mg/L)			12					12
COD (mg/L)	150							160
TOC (water mg/L)	47.5	53.2	52.1	1.2	2.2	1 U	2.3	55.9
NUTRIENTS								
Total Kjeldahl N (mg/L)	5	9	1					6
Total Persulfate N (mg/L)				0.57 J	0.698 J	0.854 J	0.741 J	
NH3-N (mg/L)	0.03 J	0.030 J	0.041 J	0.010 UJ	0.010 UJ	0.010 UJ	0.036	0.010 J
NO2+NO3-N (mg/L)	0.010 UJ	0.010 UJ	0.020 J	0.040 J	0.644 J	0.822 J	0.663 J	0.023 J
NO2-N (mg/L)	0.010 U	0.010 U		0.010 U	0.010 U	0.010 U	0.010 U	
Total-P (mg/L)	1.44 J	1.74 J	1.90 J					1.80 J
Ortho-PO4-P (mg/L)	0.5	0.59		0.02	0.042	0.022	0.043	
MISCELLANEOUS								
F-Coliform MF (#/100mL)	3 U	3 U						
METALS & HCO3								
HC03 (µg/L)			1 U					
Boron (µg/L)			319 J					
Ca (µg/L)			18500					
Mg (µg/L)			3310					
Na (µg/L)			70100					
FIELD OBSERVATIONS								
Temperature (C)	20.1	19.9		21.6	23.0	23.8		
Temp-cooled (C)*+			9.7					9.7
pH	10.7	10.6	10.57	7.92	6.74	6.80		10.57
Conductivity (umhos/cm)	524	515	491					491
Water Level Depth (feet)				102	86.0	84.7		

E	Ecology sample
LL	Loon Lake sample
Ef	Effluent sample
Duplicate	Duplicate of previous sample for blind analysis
MW	Monitoring Well
grab	Grab sample
comp	Ecology composite sample
*+	Refrigerated sample
J	The analyte was positively identified. The associated numerical result is an estimate.
U	The analyte was not detected at or above the reported result.
UJ	The analyte was not detected at or above the reported estimated result.

Table 2 - Ecology General Chemistry Percent Reduction - Loon Lake Class II Inspection, 1994

Parameter	Location: / Type: / Date: / Time: / Lab Log #:	Inf-E E-comp 08/24-25 8:00-8:00 348082	Inf-LL LL-comp 08/24-25 8:00-8:00 348083	Weigted Combination Inf-E & Inf-LL Relative to Flows	Pond-Ef-E E-comp 08/24-25 8:00-8:00 348086	Percent Reduction Across Aerated Lagoon	Ef-E E-comp 08/24-25 8:00-8:00 348090	Based on Ef-E Sample: Percent Reduction Across Polishing Lagoons	Based on Ef-E Sample: Percent Reduction Across Entire System
GENERAL CHEMISTRY									
Conductivity (umhos/cm)		797	765	783	549	30%	482	12%	38%
Alkalinity (mg/L CaCO3)		322	314	319	112	65%	139	-24%	56%
Chloride (mg/L)		38.8	34.5	37	38.9	-5%	51.1	-31%	-38%
SOLIDS									
TS (mg/L)		407	363	388	499	-29%	415	17%	-7%
TNVS (mg/L)		235	211	225	254	-13%	237	7%	-5%
TSS (mg/L)		33	32	33	123	-273%	56	54%	-70%
TNVSS (mg/L)		7	5	6	18	-200%	7	61%	-17%
OXYGEN DEMAND PARAMETERS									
BOD5 (mg/L)		113	87	102	127	-25%	12	91%	88%
COD (mg/L)		290	290	290	270	7%			
TOC (water mg/L)		67.4	54.2	62	60.1	3%	52.1	13%	16%
NUTRIENTS									
Total Kjeldahl N (mg/L)		52	54	53	4	92%	1	75%	98%
NH3-N (mg/L)		36.8 J	39.5 J	38	7.07 J	81%	0.041 J	99%	100%
NO2+NO3-N (mg/L)		0.01 UJ	0.016 J	0	17.2 J	-140000%	0.020 J	≅ 100%	-60%
Total-P (mg/L)		5.56 J	7.36 J	6	3.53 J	41%	1.90 J	46%	68%
METALS									
HC03 (µg/L)		322000	314000	319000			1 U		≅ 100%
Boron (µg/L)		212 J	178 J	198			319 J		-61%
Ca (µg/L)		26000	23300	24900			18500		26%
Mg (µg/L)		6690	5810	6320			3310		48%
Na (µg/L)		55200	47600	52000	53300	-2%	70100	-32%	-35%
FIELD OBSERVATIONS									
pH		6.97	6.68	6.78 *	7.01	70% #	10.57	360000% #	620000%
Conductivity (umhos/cm)		847	802	828	594	28%	491	17%	41%

Inf-E	Deer Lake composite sample taken 08/24-25/94	E-comp	Ecology composite sample
Inf-LL	Loon Lake composite sample taken 08/24-25/94	LL-comp	Loon Lake composite sample
Pond	Effluent from aerated lagoon	*+	Refigerated sample
Ef	Effluent sample	#	Percent reduction in number of moles hydrogen ions/day. Assumes no buffering capacity
Inf	Influent Sample	*	Influent pH calculated from adding the two composite sample's total load of hydrogen ions (moles) per day. Assumes no buffering capacity.

Table 2 - Ecology General Chemistry Percent Reduction (cont.)- Loon Lake Class II Inspection, 1994

Parameter			Based on Duplicate Sample	
	Location:	Duplicate	Percent Reduction Across Polishing Lagoons	Percent Reduction Across Entire System
	Type:	E-comp		
	Date:	08/24-25		
	Time:	8:00-8:00		
	Lab Log #:	348095		
GENERAL CHEMISTRY				
Conductivity (umhos/cm)		482	12%	38%
Alkalinity (mg/L CaCO3)		141	-26%	56%
Chloride (mg/L)		51.7	-33%	-40%
SOLIDS				
TS (mg/L)		416	17%	-7%
TNVS (mg/L)		237	7%	-5%
TSS (mg/L)		57	54%	-73%
TNVSS (mg/L)		13	28%	-117%
OXYGEN DEMAND PARAMETERS				
BOD5 (mg/L)		12	91%	88%
COD (mg/L)		160		
TOC (water mg/L)		55.9	7%	10%
NUTRIENTS				
Total Kjeldahl N (mg/L)		6	-50%	89%
NH3-N (mg/L)		0.010 J	100%	100%
NO2+NO3-N (mg/L)		0.023 J	100%	-84%
Total-P (mg/L)		1.80 J	49%	70%
METALS				
HC03 (µg/L)				
Boron (µg/L)				
Ca (µg/L)				
Mg (µg/L)				
Na (µg/L)				
FIELD OBSERVATIONS				
pH		10.57	360000% #	620000%
Conductivity (umhos/cm)		491	17%	41%

Duplicate Ecology duplicate of Effluent sample
E-comp Ecology composite sample
*+ Refigerated sample

\# Percent reduction in number of moles hydrogen ions/day. Assumes no buffering capacity
* Influent pH calculated from adding the two composite sample's total load of hydrogen ions (moles) per day. Assumes no buffering capacity.

Table 3 - State Waste Discharge Permit Limits Inspection Results - Loon Lake, 1994

Parameter	STATE WASTE DISCHARGE PERMIT LIMITS		Inspection Data						
			Ecology Composite Data					Ecology Grab data	
	Maximum Limits	Location:	Inf-E	Inf-LL	Combined Inf-E & Inf-LL	Ef-E	Duplicate	Ef-E-1	Ef-E-2
		Type:	comp	comp		comp	comp	grab	grab
		Date:	08/24-25	08/24-25		08/24-25	08/24-25	08/24	08/24
		Time:	8:00-8:00	8:00-8:00		8:00-8:00	8:00-8:00	1110	1523
		Lab Log #:	348082	348083		348090	348095	348088	338089
Flow									
To Storage Cells (MGD)	0.155		0.062	0.046	0.108	0.108	0.108		
Influent Flow (MGD)	0.465		0.062	0.046	0.108	0.108	0.108		
Ammonia									
Effluent (mg/L)	35					0.041 J	0.01 J	0.032	0.030
Influent Concentration (mg/L)			36.8 J	39.5 J	37.9 *				
Summer Influent Load (lbs/day)	45		19.2	15.0	34.2 *				
BOD5									
Influent Concentration (mg/L)			113	87	102 *				
Summer Influent Load (lbs/day)	437		58.8	33.1	91.9 *				

Inf-E Ecology composite sample of Loon Lake influent taken 08/24-25/94
Inf-LL Loon Lake composite sample of Deer Lake influent taken 08/24-25/94
Duplicate Duplicate of composite effluent sample for blind analysis
Ef -E Ecology effluent sample
grab Grab sample
comp Composite sample
* Concentration of combined Inf-E & Inf-LL, flow-weighted
J The analyte was positively identified. The associated numerical result is an estimate.

Table 4 - Comparisons to Water Quality Guidelines for Irrigation - Loon Lake, 1994

Parameter	Location: Ef-E Type: E-comp Date: 08/24-25 Time: 8:00-8:00 Lab Log #: 348090	Degree of Restriction on Use: None	Slight to Moderate	Severe
Specific Ion Toxicity - Sprinkler Irrigation (affects sensitive crops)				
Boron (mg/L)	0.319 J	< 0.7	0.7-3.0	> 3
Chloride (mg/L)	51.1	< 100	> 100	
Sodium (mg/L)	70.1	< 70	> 70	
Trace Elements				
As (arsenic - mg/L)	0015 U	≤ 0.10		
Be (beryllium - mg/L)	0.001 U	≤ 0.10		
Cd (cadmium - mg/L)	0.00011 P	≤ 0.01		
Cr (chromium - mg/L)	0.005 U	≤ 0.10		
Cu (copper - mg/L)	0.011 P	≤ 1.0		
Ni (nickel - mg/L)	0.01 U	≤ 0.20		
Pb (lead - mg/L)	0.0014 P	≤ 5.00		
Se (selenium - mg/L)	0.002 U	≤ 0.02		
Zn (zinc - mg/L)	0.0075 J	≤ 2.0		
Salinity (affects crop water availability)				
EC_W * (mmho/cm)	0.2	< 0.7	0.7-3.0	> 3
TS (mg/L)	415			
TSS (mg/L)	56			
TDS (mg/L)**	359	< 450	450-2,000	> 2000
Miscellaneous Effects (effects susceptible crops)				
pH	10.57		Normal range: 6.5-8.4	
HCO3 (mg/L)	13 U	< 900	90-500	> 500
Total Kjeldahl N (mg/L)	1	< 5	5-30	> 30
Permeability (affects infiltration rate of wastewater into soil)				
Ca (µg/L)	18500			
Mg (µg/L)	3310			
adj R_{Na} (evaluated using EC_W and adj R_{Na})	1.08	and EC ≥ 0.7	0.7-0.2	< 0.2

Nutrient Uptake		Nutrient Uptake, lb/acre·year For Selected Crops: Alfalfa	Barley	Wheat	Fir
Nitrogen (lb/acre·year)	5.1	200-480	63	50-81	135-220
Phosphorus (lb/acre·year)	9.6	20-30	15	15	

EC_W Electrical conductivity of irrigation water
adj RNa Adjusted sodium adsorption ratio
Ef Effluent sample
E-comp Ecology composite sample
J The analyte was positively identified. The associated numerical result is an estimate.

* Represents irrigation water salinity
** TDS = TS - TSS
U The analyte was not detected at or above the reported result.
P The analyte was detected above the instrument detection limit, but below the minimum established quanitation limit.

Table 5 - Split Sample Result Comparison - Loon Lake, 1994

	Location:	Inf-E	Inf-LL	Inf-LL2	Pond-Ef-E	Ef-E	MW5	MW4	MW2
	Type:	E-comp	E-comp	E-comp	E-comp	E-comp	grab	grab	grab
	Date:	08/24-25	08/24-25	08/23-24	08/24-25	08/24-25	08/24	08/24	08/24
	Time:	8:00-8:0	8:00-8:0	8:00-8:0	8:00-8:0	8:00-8:00	1030	1100	1200
	Lab Log #:	348082	348083	348091	348086	348090	348092	348093	348094
Parameter	**Laboratory**								
TSS (mg/L)	Ecology	33	32	36	123	48			
	Loon Lake		22	34	130	52			
BOD5 (mg/L)	Ecology	113	87	104	127	12			
	Loon Lake		126	115	136	13			
NH_3 (mg/L)	Ecology	36.8	39.5	40.3	7.07	0.041	0.010 J	0.010 J	0.010 J
	Loon Lake		51.0	49.0	9.30	0.360	0.33	0.13	0.13
NO_2&NO_3-N (mg/L)	Ecology	0.10 U	0.016 J	0.01 U	17.2	0.02	0.04 J	0.644 J	0.822 J
	Loon Lake		2.22	3.12	18.5	0	0.055 *	0.034	0.203
Total Phosphorus (mg/L)	Ecology	5.56 J	7.36 J	7.03 J	3.53 J	1.9			
	Loon Lake		6.62	7.12	6.50	1.37			
Chloride (mg/L)	Ecology	38.8	34.5	37.4	38.9	51.1	1.6	2.0	2.6
	Loon Lake		29.0	34.0	66.0	61.0	4.0	4.0	4.0
Total Nitrogen (mg/L)	Ecology	52	54	50	4	1	0.57 J	0.70 J	0.85 J
	Loon Lake		37	34	14	6	4.0	4.0	4.0
pH	Ecology	6.97	6.68	6.82	7.01	10.6	7.92	6.74	6.80
	Loon Lake		6.82	6.80	7.92	10.4	7.67	6.65	6.79

Inf-E Ecology composite sample of Loon Lake influent taken 08/24-25/94
Inf-LL Loon Lake composite sample of Deer Lake influent taken 08/24-25/94
Inf-LL2 Loon Lake composite sample of Loon Lake influent taken 08/23-24/94 and stored until 08/25/94.
Ef Effluent sample
Pond Effluent from aerated lagoon
MW Monitoring Well

grab grab composite
Comp composite sample
J The analyte was not detected at or above the reported estimated result.
UJ The analyte was not detected at or above the reported result.
* Less than this result

Table 6 - Detected Metal Scan Results - Loon Lake, 1994.

Location:	Inf-E	Inf-LL	Inf-LL2	PondEf-E	Ef-E	Duplicate	MW5	MW4	MW2	MW40
Type:	comp	comp	comp	comp	comp	comp	grab	grab	grab	grab
Date:	08/24-25	08/24-25	08/23-24	08/24-25	08/24-25	08/24-25	08/24	08/24	08/24	08/24
Time:	8:00-8:00	8:00-8:00	8:00-8:00	8:00-8:00	8:00-8:00	8:00-8:00	1030	1100	1200	1115
Lab Log#:	348082	348083	348091	348086	348086	348095	348092	348093	348094	348096
Metals (Total Recoverable	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Arsenic						1.7 P	1.7 P			
Boron	212 J	178 J	183 J		319 J					
Cadmium	0.42 P	0.29 P	0.37 P	0.32 P	0.11 P					
Calcium	26000	23300	27400		18500					
Copper	83.7	63	121	55.5	11 P	10 P	14 P	14 P	11 P	13 P
Lead	2.6 P	2.3 P	2.3 P	2.7 P	1.4 P	2.3 P				
Magnesium	6690	5810	7330		3310					
Mercury	0.082 P	0.11 P	0.10 P	0.093 P			0.16 P	0.17 P	0.12 P	0.20 P
Sodium	55200	47600	55200	53300	70100					
Zinc	203	177	265	156 B	7.5 J	10 J	54 B	75 B	41 B	69 B

Inf-E	Ecology composite sample of Loon Lake influent taken 08/24-25/94
Inf-LL	Loon Lake composite sample taken 08/24-25/94
Inf-LL2	Loon Lake composite sample taken 08/23-24/94
Inf-E-#	Influent grab sample
Ef	Effluent sample
Pond	Effluent from aerated lagoon
Duplicate	Duplicate composite effluent sample
MW	Monitoring Well

grab	Grab sample
comp	Ecology composite sample
B	Analyte was found in the analytical method blank, indicating the sample may have been contaminated.
J	The analyte was positively identified. The associated numerical result is an estimate.
P	The analyte was detected above the instrument detection limit, but below the established minimum quantitation limits.

Appendices

Appendix A - Sampling Stations Descriptions - Loon Lake, 1994

Inf-E-#	Grab sample of influent wastewater collected at the headworks, in both A.M. and P.M. Sample consists of 50% Deer Lake influent and 50% Loon Lake influent.
Inf-E	Ecology 24-hour composite sample of Loon Lake influent wastewater collected from the influent pipe at the headworks. Collected 08/24-25/94
Inf-LL	Loon Lake 24-hour composite sample of Deer Lake influent wastewater collected from the influent pipe at the headworks. Collected 08/24-25/94
Inf-LL2	Loon Lake 24-hour composite sample of Loon Lake influent wastewater collected from the influent pipe at the headworks. Collected 08/23-24/94 and held until 08/25/94 under refrigeration.
Pond-E-Ef-#	Ecology grab sample of aerated lagoon effluent collected from the effluent vault, just prior to the flow into the polishing/holding lagoons.
Pond-Ef-E	Ecology 24-hour composite sample of aerated lagoon effluent collected from the effluent vault, just prior to the flow into the polishing/holding lagoons.
Ef-#	Ecology grab sample of final effluent collected from a valve in the effluent pipe, prior to being pumped to the sprayfield. - Collected in both A.M. and P.M.
Ef-E	Ecology 24-hour composite sample of final effluent collected from a valve in the effluent pipe, prior to being pumped to the sprayfield.
MW5	Ecology well sample taken from a monitoring located well north-northwest of the sprayfield just past the sprayfield boundary.
MW4	Ecology well sample taken from a monitoring well located south-southwest of the sprayfield just past the sprayfield boundary.
MW2	Ecology well sample taken from a monitoring well located west of the treatment plant.
MW40	Duplicate of the Ecology well (MW4) sample.
Duplicate	Duplicate of Ecology effluent composite sample.

Appendix B - Sample Schedule, Loon Lake Class II, 1994

Parameter	Location:	Inf-E-1	Inf-E-2	Inf-E	Inf-LL	Inf-LL2	Pond-E-Ef-1	Pond-E-Ef-2	Pond-Ef-E
	Type:	grab-comp	grab-comp	comp	comp	comp	grab	grab	comp
	Date:	08/24	08/24	08/25	08/25	08/25	08/24	08/24	08/25
	Time:	1025	1440	1145	1125	1300	1042	1505	1030
	Lab Log #:	348080	348081	348082	348083	348091	348084	348085	348086
GENERAL CHEMISTRY									
Conductivity		E	E	E	E	E	E	E	E
Alkalinity		E	E	E	E	E	E	E	E
Hardness				E	E	E			E
Chloride				E	EL	EL	E	E	EL
SOLIDS-4									
TS				E	EL	EL			E
TNVS				E	E	E			E
TSS		E	E	E	E	E	E	E	EL
TNVSS				E	E	E			E
OXYGEN DEMAND PARAMETERS									
BOD5				E	EL	EL			EL
COD				E	E	E			E
TOC (water)		E	E	E	E	E	E	E	E
NUTRIENTS									
Total Kjeldahl N					EL	EL			EL
Total Persulfate N									
NH3-N				E	EL	EL			EL
NO2+NO3-N				E	EL	EL			EL
NO2-N				E	E	E			E
Total-P				E	EL	EL			EL
Ortho-PO4-P				E	E	E			E
MISCELLANEOUS									
F-Coliform MF									
METALS									
PP Metals (water)				E	E	E			E
As,Cd,Cr,Cu,Hg,Ni,Pb,&Zn									
HC03				E	E	E			E
Boron				E	E	E			E
Ca				E	E	E			E
Mg				E	E	E			E
Na				E	E	E			E
FIELD OBSERVATIONS									
Temperature		E	E				E	E	
Temp-cooled*+				E	E	E			E
pH		E	E	E	EL	EL	E	E	EL
Conductivity		E	E	E	E	E	E	E	E

Inf-E	Ecology composite sample of Loon Lake influent taken 08/24-25/94
Inf-LL	Loon Lake composite sample of Deer Lake influent taken 08/24-25/94
Inf-LL2	Loon Lake composite sample of Loon Lake influent taken 08/23-24/94 and stored until 08/25/94
Inf-E-#	Influent grab sample: 50% Deer lake influent and 50% Loon lake influent
Ef	Effluent sample
Pond	Effluent from aerated lagoon

grab	Grab sample
comp	Composite sample
* +	Refrigerated sample
E	Ecology analysis and sample
LL	Loon Lake analysis
L	Loon Lake sample

Appendix B - Sample Schedule, Loon Lake Class II, 1994

Parameter II		Ef-E-1	Ef-E-2	Ef-E	MW5	MW4	MW2	MW40	Duplicat
	Location	Ef-E-1	Ef-E-2	Ef-E	MW5	MW4	MW2	MW40	Duplicat
	Type:	grab	grab	comp	grab	grab	grab	grab	comp
	Date:	08/24	08/24	08/25	08/24	08/24	08/24	08/24	08/25
	Time:	1110	1523	0945	1030	1100	1200	1115	0945
	Lab Log #:	348088	348089	348090	348092	348093	348094	348096	348095
GENERAL CHEMISTRY									
Conductivity		E	E	E	E	E	E	E	E
Alkalinity		E	E	E					E
Hardness				E					E
Chloride				EL	EL	EL	EL	E	E
SOLIDS-4									
TS				E					E
TNVS				E					E
TSS		E	E	EL					E
TNVSS				E					E
OXYGEN DEMAND PARAMETERS									
BOD5				EL					E
COD				E					E
TOC (water)		E	E	E	E	E	E	E	E
NUTRIENTS									
Total Kjeldahl N		E	E	EL	L	L	L		
Total Persulfate N					E	E	E	E	
NH3-N		E	E	EL	EL	EL	EL	E	E
NO2+NO3-N		E	E	EL	EL	EL	EL	E	E
NO2-N		E	E	E	E	E	E	E	E
Total-P		E	E	EL					E
Ortho-PO4-P		E	E	E	E	E	E	E	E
MISCELLANEOUS									
F-Coliform MF		E	E						
METALS									
PP Metals (water)				E					E
As,Cd,Cr,Cu,Hg,Ni,Pb,&Zn					E	E	E	E	
HC03				E					E
Boron				E					E
Ca				E					E
Mg				E					E
Na				E					E
FIELD OBSERVATIONS									
Temperature		E	E						
Temp-cooled*+				E	E	E	E	E	E
pH		E	E	EL	EL	EL	EL	E	E
Conductivity		E	E	E	E	E	E	E	E

E	Ecology analysis and sample
L	Loon Lake sample
LL	Loon Lake analysis
Ef	Effluent sample
Duplicate	Duplicate of previous sample for blind analysis
MW	Monitoring Well
grab	Grab sample
comp	Composite sample
*+	Refrigerated sample

Appendix C - Laboratory Methods - Loon Lake Class II, 1994

Parameter	Manchester Methods	Lab Used
GENERAL CHEMISTRY		
Conductivity	EPA, Revised 1983: 120.1	Ecology
Alkalinity	EPA, Revised 1983: 310.1	Ecology
Hardness	EPA, Revised 1983: 130.2	Ecology
Chloride	EPA, Revised 1983: 330.0	Ecology
SOLIDS-4		
TS	EPA, Revised 1983: 160.3	Ecology
TNVS	EPA, Revised 1983: 160.3	Ecology
TSS	EPA, Revised 1983: 160.2	Ecology
TNVSS	EPA, Revised 1983: 160.2	Ecology
OXYGEN DEMAND PARAMETERS		
BOD5	EPA, Revised 1983: 405.1	Ecology
COD	EPA, Revised 1983: 410.1	Sound Analytical Services
TOC (water)	EPA, Revised 1983: 415.1	Ecology
NUTRIENTS		
Total Kjeldahl N	EPA, Revised 1983: 351.3	Sound Analytical Services
Total Persulfate N	EPA, Revised 1983: 351.3	Ecology
NH3-N	EPA, Revised 1983: 350.1	Ecology
NO2+NO3-N	EPA, Revised 1983: 353.2	Ecology
NO2-N	EPA, Revised 1983: 353.2	Ecology
Total-P	EPA, Revised 1983: 365.3	Ecology
Ortho-PO4-P	EPA, Revised 1983: 365.3	Ecology
MISCELLANEOUS		
F-Coliform MF	APHA, 1992: 9222D.	Ecology
METALS		
PP Metals (water)	EPA, Revised 1983: 200-299	Ecology
As,Cd,Cr,Cu,Hg,Ni,Pb,&Zn	EPA, Revised 1983: 200-299	Ecology
HC03	EPA, Revised 1983: 120.1	Ecology
Boron	EPA, Revised 1983: 200-299	Ecology
Ca	EPA, Revised 1983: 200-299	Ecology
Mg	EPA, Revised 1983: 200-299	Ecology
Na	EPA, Revised 1983: 200-299	Ecology

APHA-AWWA-WPCF, 1992. Standard Methods for the Exanination of Water and Wastewater, 17th Edition.

EPA, Revised 1983. Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020 .

Appendix D - Quality Assurance/Quality Control - Loon Lake Class II Inspection, 1994

Priority Pollutant Metal Cleaning Procedures for Wastewater Collection Equipment.

1. Wash with laboratory detergent
2. Rinse several times with tap water
3. Rinse with 10% HNO_3 solution
4. Rinse three (3) times with distilled/deionized water
5. Rinse with high purity Hexane
6. Rinse with high purity acetone
7. Allow to dry and seal with aluminum foil

Specific QA/QC Discussions

1. During the storage of nutrient samples at the laboratory the refrigeration unit failed. The samples were found at 32 degrees C approximately three days after being placed in storage. The specific length of time that the samples were stored at this elevated temperature is unknown. The samples were removed from the failed unit and placed in a 4 degree C Cold Room until repairs to the main refrigeration unit were made. All nutrient results have been given the qualifier "J" to indicate estimated values.

2. Procedural blanks for the metal samples showed trace amounts of zinc. Zinc results within ten times the instrument detection limit were qualified with a "J" as estimated. Those at higher levels but within the amount found in the blank were qualified with a "B".

3. The spike recoveries for ammonia in samples 348089 and 348096 were outside the acceptance limits.

4. The spike recoveries for silver and boron were outside of the CLP acceptance limits. Silver results have been qualified with a "N" to indicate unacceptable spike recoveries. Boron results have been qualified with a "J" as estimates due to low spike recovery and no LCS control.

Appendix E - Metal Scan Results - Loon Lake, 1994.

Location:	Inf-E	Inf-LL	Inf-LL2	PondEf-E	Ef-E	Duplicate	MW5	MW4	MW2	MW40
Type:	comp	comp	comp	comp	comp	comp	grab	grab	grab	grab
Date:	08/25-25	08/25-25	08/25-2	08/25-25	08/25-25	08/25-25	08/25	08/25	08/25	08/25
Time:	8:00-8:00	8:00-8:00	8:00-8:0	8:00-8:00	8:00-8:00	8:00-8:0	1030	1100	1200	1115
Lab Log#:	348082	348083	348091	348086	348086	348095	348092	348093	348094	348096
Metals (Total Recoverable	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Antimony	30 U	30 U	30 U	30 U	30 U	30 U				
Arsenic	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.7 P	1.7 P	1.5 U	1.5 U	1.5 U
Beryllium	1 U	1 U	1 U	1 U	1 U	1 U				
Boron	212 J	178 J	183 J		319 J					
Cadmium	0.42 P	0.29 P	0.37 P	0.32 P	0.11 P	0.10 U	3 U	3 U	3 U	3 U
Calcium	26000	23300	27400		18500					
Chromium	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Copper	83.7	63	121	55.5	11 P	10 P	14 P	14 P	11 P	13 P
Lead	2.6 P	2.3 P	2.3 P	2.7 P	1.4 P	2.3 P	20 U	20 U	20 U	20 U
Magnesium	6690	5810	7330		3310					
Mercury	0.082 P	0.11 P	0.10 P	0.093 P	0.50 U	0.50 U	0.16 P	0.17 P	0.12 P	0.20 P
Nickel	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Selenium	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U				
Silver	0.50 UN	0.50 UN	0.50 UN	0.50 UN	0.50 UN	0.50 UN				
Sodium	55200	47600	55200	53300	70100					
Thallium	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U				
Zinc	203	177	265	156 B	7.5 J	10 J	54 B	75 B	41 B	69 B

Inf-E	Ecology composite sample taken 08/24-25/94	grab	Grab sample
Inf-LL	Loon Lake composite sample taken 08/24-26/94	E-comp	Ecology composite sample
Inf-LL2	Loon Lake composite sample taken 08/23-24/94	*+	Refrigerated sample
Inf-E-#	Influent grab sample	B	Analyte was found in the analytical method blank, indicating the sample may have been contaminated.
Ef	Effluent sample	J	The analyte was positively identified. The associated numerical result is an estimate.
Pond	Effluent from aerated lagoon	N	The spike sample recovery is not within control limits
Duplicate	Duplicate composite sample	P	The analyte was detected above the instrument detection limit, but below the established minimum quantitation limits.
MW	Monitoring Well	U	The analyte was not detected at or above the reported result..

Appendix F - GLOSSARY - Loon Lake Class II Inspection, 1994

adj R_{Na}	Adjusted sodium adsorption ratio
BOD_5	Five Day Biological Oxygen Demand
CLP	Contract Laboratory Program
COD	Chemical Oxygen Demand
CVAA	Cold Vapor Atomic Absorption
DAF	Dissolved Air Floatation
EC_W	Electrical conductivity of irrigation water
EPA	Environmental Protection Agency
kg	kilogram (1 X 10^3 grams)
L	Liter (1 X 10^3 milliliters)
m^3	Cubic meter (1 X 10^3 liters)
MF	Membrane Filter
mg	milligram (1 X 10^{-3} grams)
ml	Milliliter (1 X 10^{-3} liters)
NH_3	Ammonia
MPN	Most Probable Number
NOEC	No Observable Effect Concentration
NPDES	National Pollution Discharge Elimination System
PCB	Polychlorinated Biphenyl
pH	Hydrogen Ion Concentration
PP	Priority Pollutant
ppb	Parts per billion (1 X 10^{-9}, μg/L, or μ/Kg)
ppm	Parts per million (1 X 10^{-6}, mg/L, or mg/kg)
ppt	Parts per thousand (1 X 10^{-3}, g/L, or g/kg)
QA/QC	Quality Assurance/Quality Control
STP	Sewage Treatment Palnt
TIC	Total Inorganic Carbon or for GCMS Tentatively Identified Compound
TKN	Total Kjeldahl Nitrogen
TNVS	Total Non-Volatile Solids
TNVSS	Total Non-Volatile Suspended Solids
TOC	Total Organic Carbon
TP	Total Phosphorous
TS	Total Solids
TSS	Total Suspended Solids
TVS	Total Volatile Solids
ug	Microgram (1 X 10^{-6} grams)
ug/m^3	Microgram per cubic meter
VOA	Volatile Organic Analysis
VOC	Volatile Organic Carbon