Executive Summary
November 1998

Characterization of Leaching at the Coeur d'Alene Resort Golf Course Floating Green

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The objective of this project is to determine whether modern management practices provide adequate prevention of nitrogen leaching while maintaining the high level of playability required on modern golf facilities. The unique research site at the floating 14th green at the Coeur d'Alene Resort Golf Course allows for complete collection of leachate from the green surface due to its self-contained design. This permits an accurate determination of concentration and quantity of leachate.

An automated flow meter with a sampler line are located in a storage tank beneath the green surface. As water is leached through the soil profile and collected by the drain lines located within the green, the flow meter monitors flow rate and total flow. Every 24 hours, a leachate sample is automatically taken from the drainage water prior to its entering the storage tank. The leachate sample is then stored within the refrigerated sampler until removal for analysis.

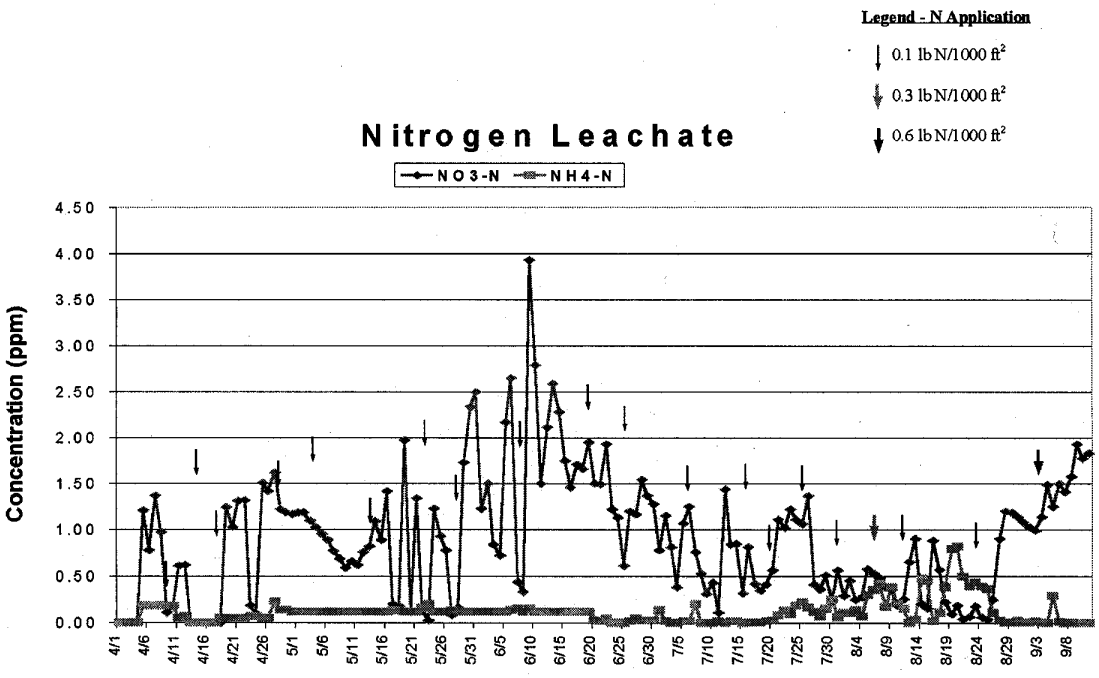
Currently a soluble 20-0-20 fertilizer is being applied at 0.1 lb N/1000 ft^2 every 7 to 10 days throughout the growing season. For research purposes, N rate was briefly increased to 0.3 and 0.6 lb N/1000 ft^2 to observe the leachability of higher rates of fertilizer. Future objectives include the use of a granular fertilizer to observe the effect of form on nitrate and ammonia leaching.

Leachate data to date indicates very low concentrations of ammonia and nitrate. Nitrate levels range from 0.11 to 3.97 ppm, well below the EPA limit of 10 ppm (Fig. 1). Ammonia levels ranged from 0.12 to 0.87 ppm (Fig. 1). Following closure of the green to play in November 1998, six micro-lysimeters were placed in the rootzone to allow for additional sampling.

To develop a nitrogen balance, soil and clipping samples are being taken to determine the concentration and form of N present. Clipping samples are taken from daily mowing, weighed, sub-sampled, then frozen for later analysis. Currently clipping samples range from 3.3 and 6.1% N on a oven dry weight basis. (Fig 2.)

Future research includes the formation of a nitrogen balance. In addition, construction of a water balance can be made leading to a better understanding of water use efficiency in the turfgrass environment.

The findings of the project will provide a clearer understanding of how golf course management practices affect the environment. It will allow the public to directly view how management practices on sand-based greens affects groundwater and the environment. It will demonstrate to the public the high level of effort being placed on insuring that the environment is preserved through current golf course practices.


Legend - N Application
0.1 lb N/1000 ft²
0.3 lb N/1000 ft²
0.6 lb N/1000 ft²
Nitrogen Leachate
NO3-N
NH4-N
Concentration (ppm)
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
4/1
4/6
4/11
4/16
4/21
4/26
5/1
5/6
5/11
5/16
5/21
5/26
5/31
6/5
6/10
6/15
6/20
6/25
6/30
7/5
7/10
7/15
7/20
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7/30
8/4
8/9
8/14
8/19
8/24
8/29
9/3
9/8

Fig. 1

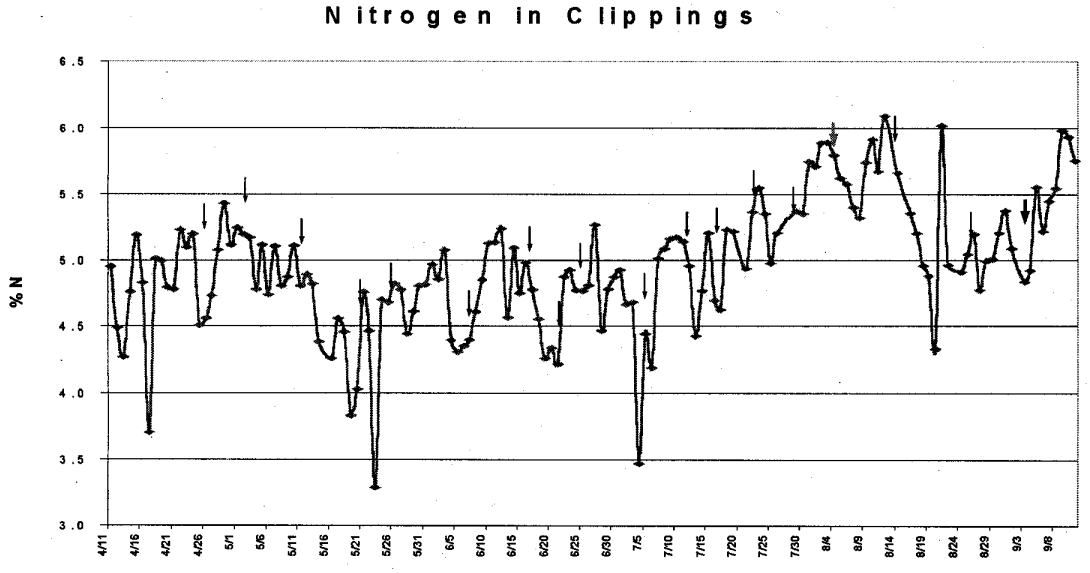

Nitrogen in Clippings
% N
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
4/11
4/16
4/21
4/26
5/1
5/6
5/11
5/16
5/21
5/26
5/31
6/5
6/10
6/15
6/20
6/25
6/30
7/5
7/10
7/15
7/20
7/25
7/30
8/4
8/9
8/14
8/19
8/24
8/29
9/3
9/8

Fig. 2

USGA Annual Report
November 1998

Characterization of Leaching at the Coeur d'Alene Golf Course Floating Green

W. J. Johnston, C. M. Kleene, W. L. Pan, and E. D. Miltner
Washington State University

An increase in environmental concern by the public has led golf course management into the development and implementation of best management practices (BMPs). The chemical inputs necessary for maintaining optimum playability of sand-based putting greens poses potentially detrimental environmental implications. NO_3^--N contamination of ground water has induced the need for leachate monitoring of sand-based putting greens. Few of these studies have been conducted in the Pacific Northwest and none within the Intermountain area.

This study is being conducted on the floating, 14th green at the Coeur d'Alene Resort Golf Course, Coeur d'Alene, Idaho. This site allows for direct observation by the public of research conducted under actual golf course conditions. This project aims to further open lines of communication between the golf course industry and the public and provide valuable information for the subsequent development of BMPs regarding nitrogen and pesticide application in the Pacific Northwest.

Materials and Methods

The project sampling equipment was received during the middle of March and installed on March 30, 1998. During this period, the back green-side bunker was excavated and the leachate storage tank below the bunker was re-examined for drain pipe layout into, and within, the storage tank to determine the best method for installation of the equipment. A reducer was installed into the 8" main drain line of the green and a small 60° trapezoidal flume (Plasti-Fab, Portland, OR) was installed into the system for accurate flow analysis. The flume permits data collection during low flow. Two sampling lines were routed through the vent line and attached to an ISCO model 6700 refrigerated sampler, which is located underneath the floating green in a storage room. The system was then programmed and calibrated to the appropriate flow conditions. Samples are initially stored within the refrigerated sampler, to insure sample stability, then removed and frozen until transport to WSU for chemical analysis.

November 1998, following closure of the golf course, six microlysimeters (Timco, Prairie du Sac, WI) were installed in the 15" putting green rootzone at three different locations. Each location included two microlysimeters placed seven feet from the collar and four feet apart. The locations included high and low contour sites, and a high traffic area located at the entrance to the green. These lysimeters will aid in replication within the

whole green leachate sampling system. They will additionally provide information on spatial variability within the green.

A weather station was installed at the green to record environmental factors such as: precipitation, air temperature, soil temperature, soil moisture, relative humidity, evapotranspiration, etc. In addition to precipitation data, irrigation and supplemental hand watering are being monitored to create a water balance for the putting green.

Three Rainbird Eagle 750 heads dispersing 34 gallons per minute irrigate the green. The irrigation is run in two-minute cycles 3 to 4 times a night. Supplemental hand watering is applied for 10 to 15 minutes at approximately 30 gallons per minute as necessary.

A foliar fertilizer, 24-0-24 Nitro-K Plus II (RSA-Microtech), is currently applied at 0.1 lb N/1000 ft^2 (1.75% ammoniacal N, 3.0% nitrate N, 19.3% urea N) and 0.1 lbs. K/1000 ft^2 (100% K_20) every 7 to 10 days. In addition, Ferromec (15% urea N, 3% sulfur, and 6% iron sulfate) is added to the foliar fertilizer at a rate of 2 oz/1000 ft^2. The total N applied annually is approximately 3.5 lbs. N/1000 ft^2. For research purposes, N rate was increased to 0.3 and 0.6 lb N/1000 ft^2 (one application at each rate) to observe the leachability of higher rates of fertilizer.

Grass clippings are collected daily from the green, weighed, sub-sampled, and then frozen for later tissue analysis. These clipping sub-samples, which contain both bentgrass and sand, are dried in a 60°C oven for 3 days, then weighed. A seed density sorter with 800-grit sandpaper is used to separate topdressing sand from the bentgrass clippings to determine the amount of sand and clipping dry matter in the sample. Clippings are then tested for total N content utilizing a LECO auto-analyzer.

Results

There are differences in weight and total N within the bentgrass clipping samples (Fig. 1 & 2). The bentgrass clipping samples range from 3.3 to 6.1% N on an oven dry weight basis (Fig. 2). These differences are attributed to daily environmental variability.

Analysis for NO_3^--N and NH_4^+-N in the leachates indicate low levels of N. NO_3^--N ranged from 0.11 to 3.97 ppm, well below the EPA limit of 10 ppm (Fig. 3). Ammonia levels ranged from 0.12 to 0.87ppm (Fig. 3). The total water added to the green seems to have inconsistent effects on the NO_3^--N and NH_4^+-N concentrations (Fig. 3 & 4). Low levels of nitrate leaching may be attributed to the low, frequent foliar N applications. The total daily drainage through the putting green ranges from 0 and 2700 gallons (Fig 5.). As the flow increases the total amount of N (NO_3^--N and NH_4^+-N) increases as well (Fig. 5). Flow rate through the drainage line of the green ranges from 0 to approximately 10 gpm (Fig. 6). Peak flow rates and drainage can be attributed to high rainfall events.

Proposed Research Schedule

Nov. 1998 to Feb. 1999 - Site visits as needed. Microlysimeter leachate data collected and analyzed. Sample collection and analysis will continue until green freezes. Data analysis and summarized for the year. Presentations at turfgrass meetings.

Mar. 1999 – June 1999 – Second set of fertilizer rates will be applied, continuation of clipping and leachate collection and analysis. Formulation of water and N balance will begin.

June 1999 – Oct. 1999 – Continuation of sample collection and analysis. Publications and presentations made as necessary.

Publications and Presentations

Johnston, W. J., and C. M. Kleene. 1998. Floating green tour – Research update. Northwest Turfgrass Assoc. annual meeting. Coeur d'Alene, ID. Oct. 5-7.

Kleene, C. M., W. J. Johnston, W. L. Pan, C. T. Golob., M. Monermaker, and J. Anderson. 1998. Characterization of leaching at the Coeur d'Alene Resort Golf Course floating green. Puyallup Turfgrass Field Day. July 28. Poster and presentation.

Kleene, C. M., and W. J. Johnston. 1998. USGA research site visit. Coeur d'Alene, ID. July 9.

Johnston, W. J. 1998. Pesticide and nutrient leaching through turf soil profiles. Peaks & Prairies GCSA. Missoula, MT. March 2.

Kleene, C. M., and W. J. Johnston. 1997. Pesticide and nutrient leaching through turf soil profiles. IEGCSA Trade Show, Spokane, WA. Nov 6.

USGA11-98rptWJJ

Tables and Figures

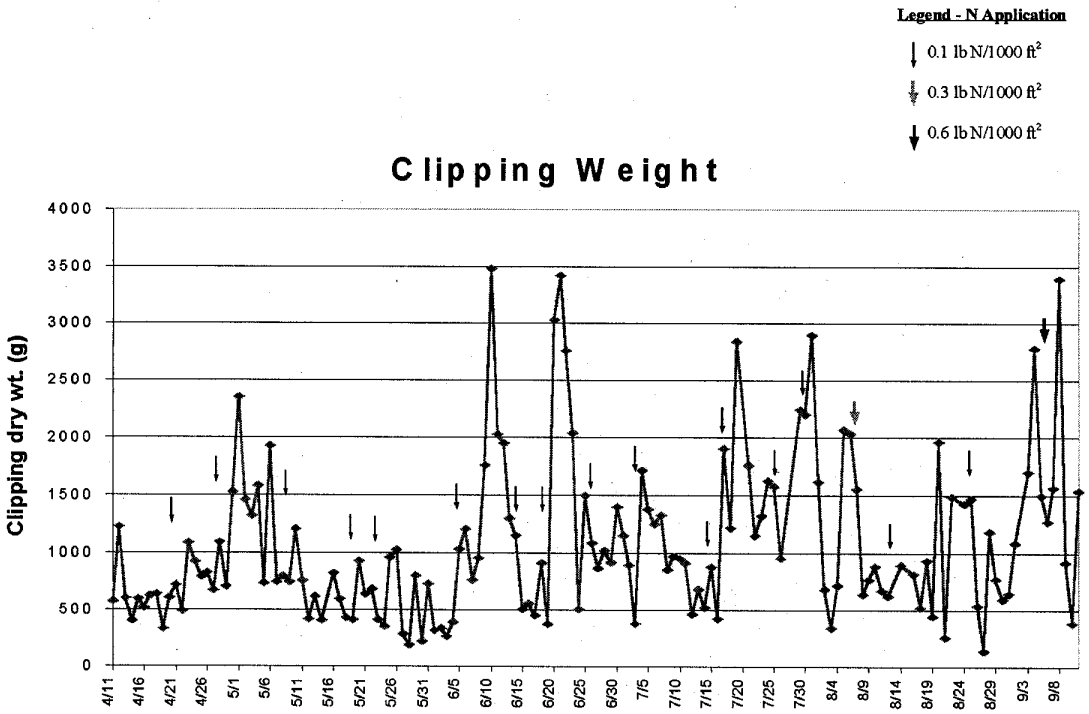


Fig. 1

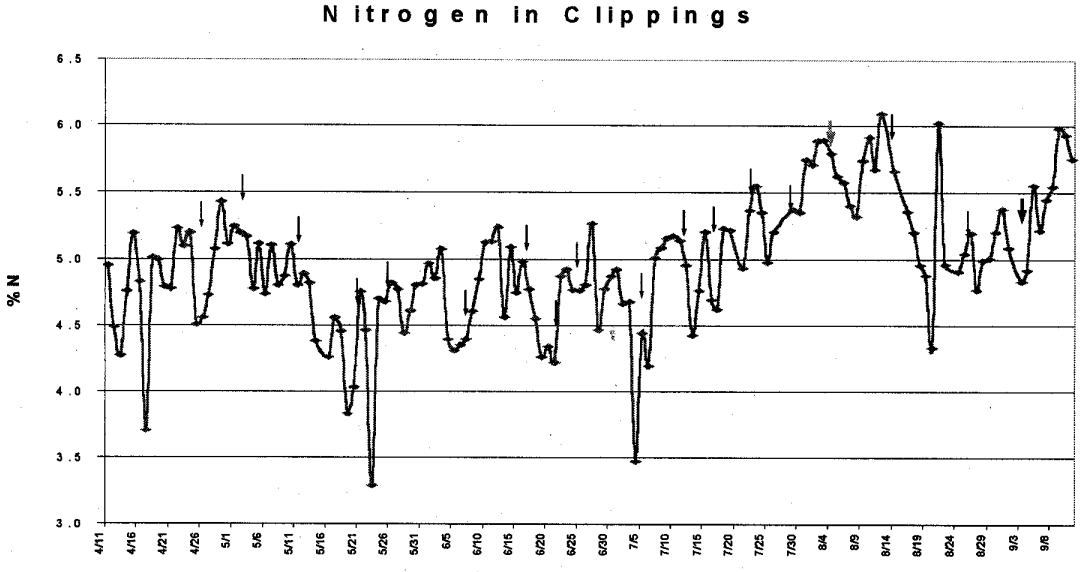
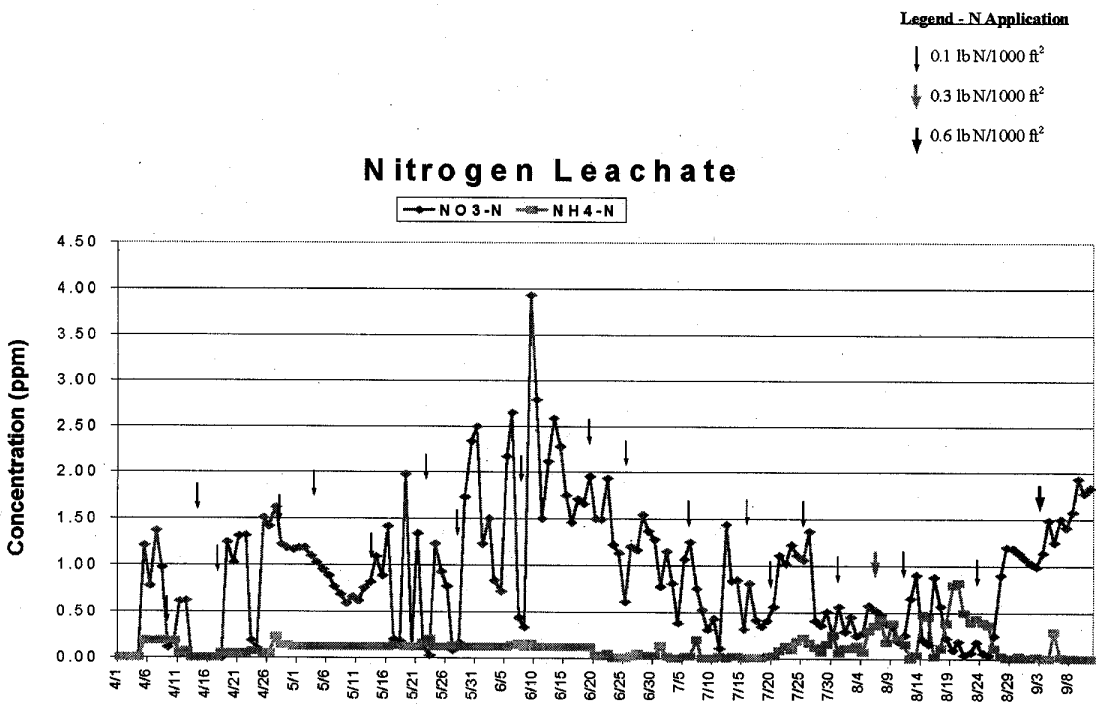


Fig. 2


Legend - N Application
0.1 lb N/1000 ft²
0.3 lb N/1000 ft²
0.6 lb N/1000 ft²
Nitrogen Leachate
NO3-N
NH4-N
Concentration (ppm)
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
4/1
4/6
4/11
4/16
4/21
4/26
5/1
5/6
5/11
5/16
5/21
5/26
5/31
6/5
6/10
6/15
6/20
6/25
6/30
7/5
7/10
7/15
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9/3
9/8

Fig. 3

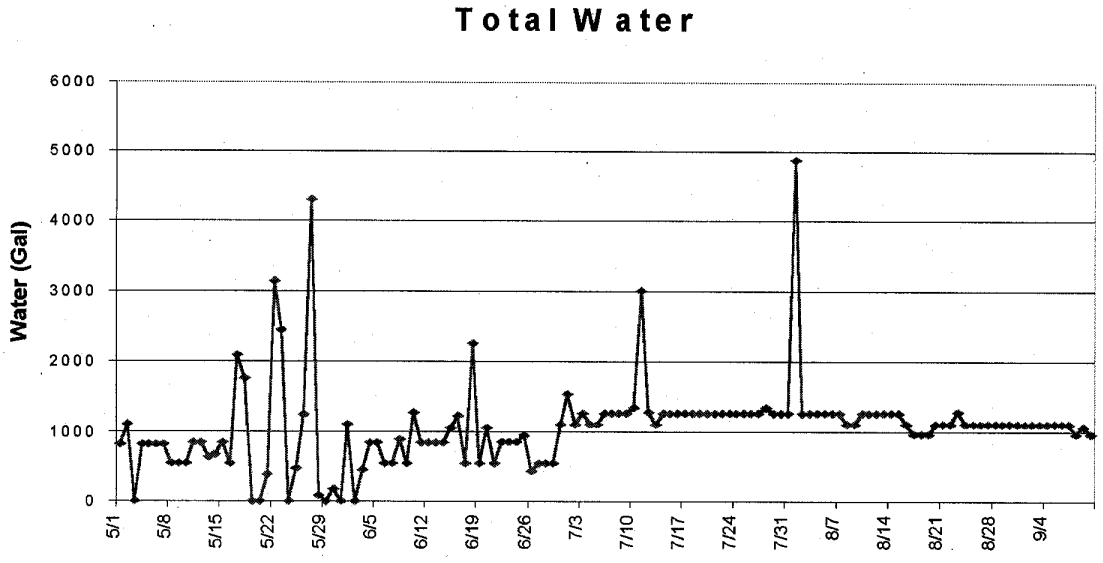
Total Water
Water (Gal)
6000
5000
4000
3000
2000
1000
0
5/1
5/8
5/15
5/22
5/29
6/5
6/12
6/19
6/26
7/3
7/10
7/17
7/24
7/31
8/7
8/14
8/21
8/28
9/4

Fig. 4

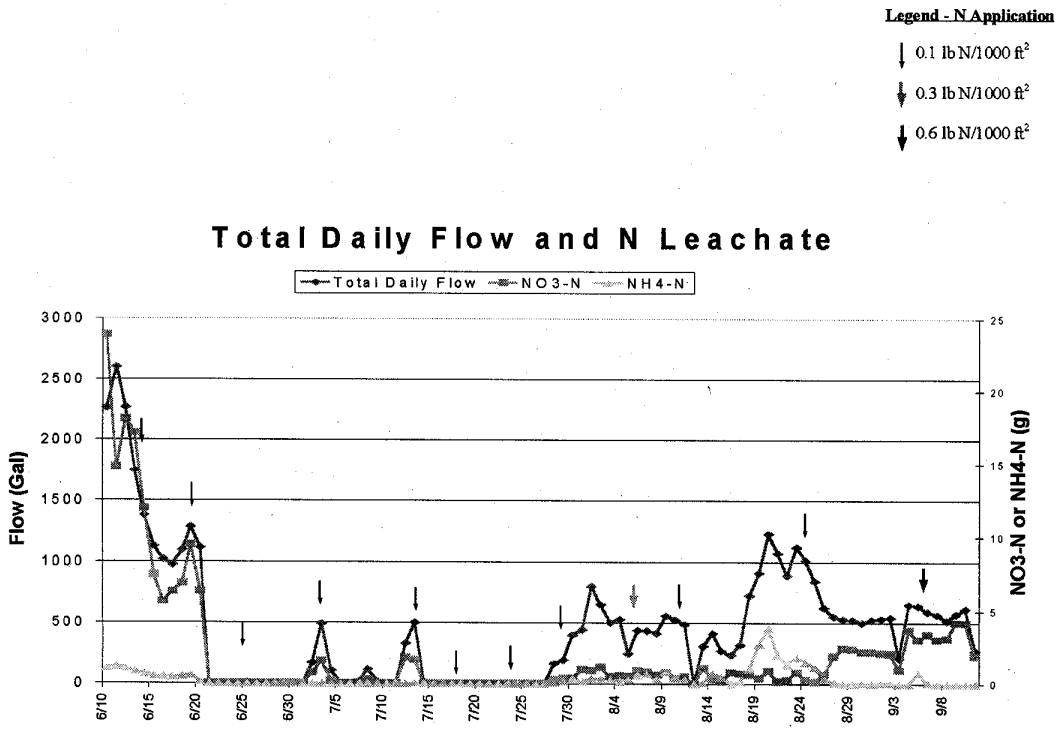
Legend - N Application
0.1 lb N/1000 ft²
0.3 lb N/1000 ft²
0.6 lb N/1000 ft²
Total Daily Flow and N Leachate
Total Daily Flow
NO3-N
NH4-N
Flow (Gal)
NO3-N or NH4-N (g)
3000
2500
2000
1500
1000
500
0
25
20
15
10
5
0
6/10
6/15
6/20
6/25
6/30
7/5
7/10
7/15
7/20
7/25
7/30
8/4
8/9
8/14
8/19
8/24
8/29
9/3
9/8

Fig. 5

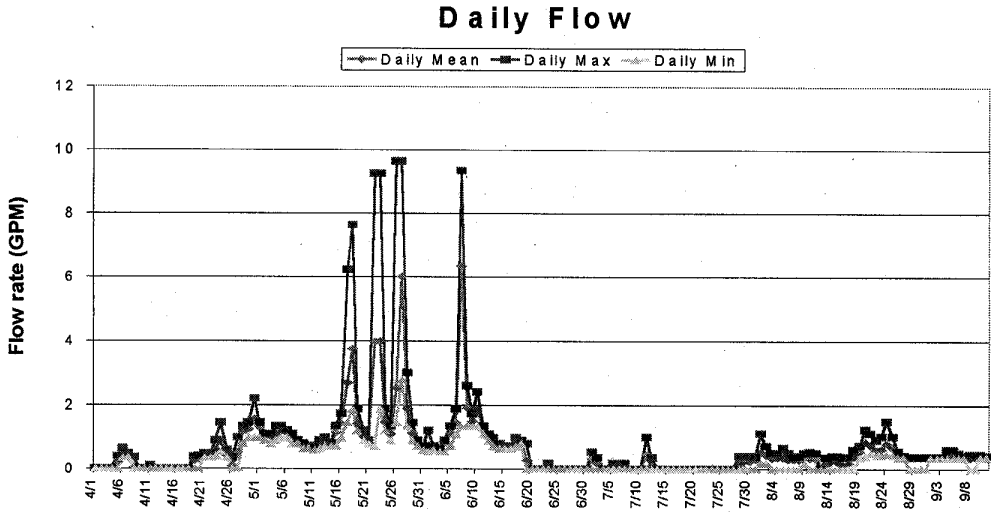
Daily Flow
Daily Mean
Daily Max
Daily Min
Flow rate (GPM)
12
10
8
6
4
2
0
4/1
4/6
4/11
4/16
4/21
4/26
5/1
5/6
5/11
5/16
5/21
5/26
5/31
6/5
6/10
6/15
6/20
6/25
6/30
7/5
7/10
7/15
7/20
7/25
7/30
8/4
8/9
8/14
8/19
8/24
8/29
9/3
9/8

Fig. 6