A Department of Ecology Report

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Basic American Foods Class II Wastewater Inspection April 27-29, 1998

Abstract

An announced Class II wastewater inspection of the Basic American Foods (BAF) spray irrigation facility was conducted on April 27-29, 1998. The inspection was conducted in conjunction with a Class II groundwater inspection of the BAF facility and in conjunction with Class II wastewater and groundwater inspections of the nearby Moses Lake (Dunes) wastewater treatment plant. The Class II wastewater inspection included sampling of the effluent stream at BAF. Groundwater monitoring results appear in separate study reports.

The 1.52 MGD flow rate measured during the inspection is within the 1.66 MGD permitted monthly average flow rate. The other permit limitation is the stipulation that the system must be operated by the permittee so as to protect the existing and future beneficial uses of the groundwater. The groundwater inspection conducted concurrently with this wastewater inspection found that BAF wastewater disposal practices have degraded groundwater quality in the vicinity of its spray fields. An agronomic analysis shows that agronomic rates for nitrogen uptake were exceeded before BAF more than doubled the land area irrigated by its wastewater since 1996. BAF irrigation on increased acreage is within agronomic rates calculated on an annual basis for potatoes and corn but not for wheat. This assumes that any additional fertilizer used is not over-applied. BAF irrigates continuously all year, as allowed by the permit. Whether this causes an exceedance of agronomic rates needs to be determined.

Summary

Flow Measurements

Flow to the spray fields is measured by one main propeller meter. The effluent totalizer reading indicated an average flow of 1.52 MGD (1,057 gpm) measured during the inspection.

State Waste Discharge Permit Compliance/General Chemistry

The 1.52 MGD flow rate measured during the inspection was within the 1.66 MGD permitted monthly average flow rate. The other permit limitation is the stipulation that the system must be operated by the permittee so as to protect the existing and future beneficial uses of the

groundwater. The groundwater inspection conducted concurrently with this wastewater inspection found that BAF wastewater disposal practices have degraded groundwater quality in the vicinity of its sprayfields.

Sprayfield Discharge

BAF applies wastewater to land owned by BAF and to adjacent farmland. Boron, HCO_3, pH, and adj R_{Na} results for the effluent sample indicate no practical degree of restriction on the use of the effluent for irrigation for the conditions encountered during the inspection. A slight to moderate degree of restriction on use were indicated for the effluent irrigation water salinity (EC_w) and TDS. A slight to moderate or greater degree of restriction on use was indicated for sodium in the effluent sample. A severe degree of restriction on use was indicated for total Kjeldahl nitrogen based on concentration.

An agronomic analysis showed that with BAF irrigating 470 acres in grass and 1,845 acres in crops, agronomic rates calculated on an annual basis would not be exceeded for potatoes or corn but would be exceeded for wheat. BAF irrigates with its wastewater continuously throughout the year, as allowed by the permit. It can be expected that during months when grass or crops are not growing, there will be little uptake of nutrients and nutrients may percolate into the soil, entering the groundwater. A crop management plan should take this into account.

Agronomic rates were exceeded by BAF before 1996, when wastewater was applied to 470 acres of grass. The Class II Groundwater Inspection of the BAF facility conducted in conjunction with this wastewater Class II Inspection, confirmed the historic exceedance of agronomic rates for nitrogen application. The groundwater inspection found elevated nitrate concentrations in groundwater beneath the BAF sprayfields.

A BAF engineering report by Gardel contains estimates of nutrient uptake for corn and alfalfa that are considerably higher than established estimates. The report cites no references for the estimates. If BAF is using the fertilizer loading rates specified in Gardel's report to manage irrigation application rates, excessive nutrient loading from wastewater irrigation may be the result.

Split Samples

Split samples were compared to evaluate Ecology and BAF laboratory results. There was reasonable agreement between most of the Ecology and BAF samples. Differences in sample concentration were not consistent across the range of parameters, indicating no consistent error in sampling. The relative percent differences between samples were within greater than 10 percent for several parameters, indicating less than good agreement between Ecology and BAF samples.

Ortho-P results showed the greatest disparity between Ecology and BAF analyses as they did in the concurrent BAF Class II Groundwater Inspection. This is being looked into by the Ecology Laboratory Accreditation Unit. There was also a considerable disparity between the two laboratory's Total-P and NH_3-N results, and less so with the alkalinity, COD and TKN results.

Recommendations

- BAF should submit to Ecology a revised engineering report addressing management of crops and grasses within agronomic rates so as to protect groundwater quality. The report should contain reasonable estimates of nutrient loading rates and should consider seasonal variations in plant uptake of nutrients. If no sound crop management plan is feasible, options for wastewater disposal should be considered.

- BAF's sample handling and analytical procedures for ortho-phosphate, Total P, and NH_3-N should be evaluated to determine the reasons for disparity between Ecology and BAF analytical results. Alkalinity, COD, and TKN test procedures should also be reviewed.

- Careful attention should be paid to BAF wastewater management over the next few years to determine whether the substantial additional acreage added this year is sufficient to assimilate the facility wasteload without further adverse impacts to area groundwater quality.

Introduction

An announced Class II wastewater inspection of the Basic American Foods (BAF) potato processing facility with spray irrigation was conducted on April 27-29, 1998. The inspection was conducted in conjunction with a Class II groundwater inspection of the BAF facility and in conjunction with Class II wastewater and groundwater inspections of the nearby Moses Lake (Dunes) wastewater treatment plant. The Class II wastewater inspection included sampling of the effluent stream at BAF. Groundwater monitoring results appear in separate study reports (Sinclair, 1998; 1999a). Wayne Peterson of Ecology's Eastern Regional Office requested the inspection.

Facility Description

BAF operates a potato processing facility approximately 5 miles southeast from the City of Moses Lake (Figure 1). The facility applies wastewater to land via spray irrigation for final treatment. The site is adjacent to the Moses Lake (Dunes) wastewater treatment plant. Wastewater from the BAF facility consists of process water originating from the washing of potatoes and beans and the steam peeling of potatoes. A relatively small amount of water is generated from routine cleaning of the processing equipment. Process water is filtered and used to spray irrigate year round, 24 hours per day. Wastewater is applied to approximately 325 acres of BAF land in grass hay. Wastewater is applied to an additional 1,430 acres of privately owned and leased land farmed in rotational crops including potatoes, corn and wheat. Waste solids from the filtering of process water are fed to cattle.

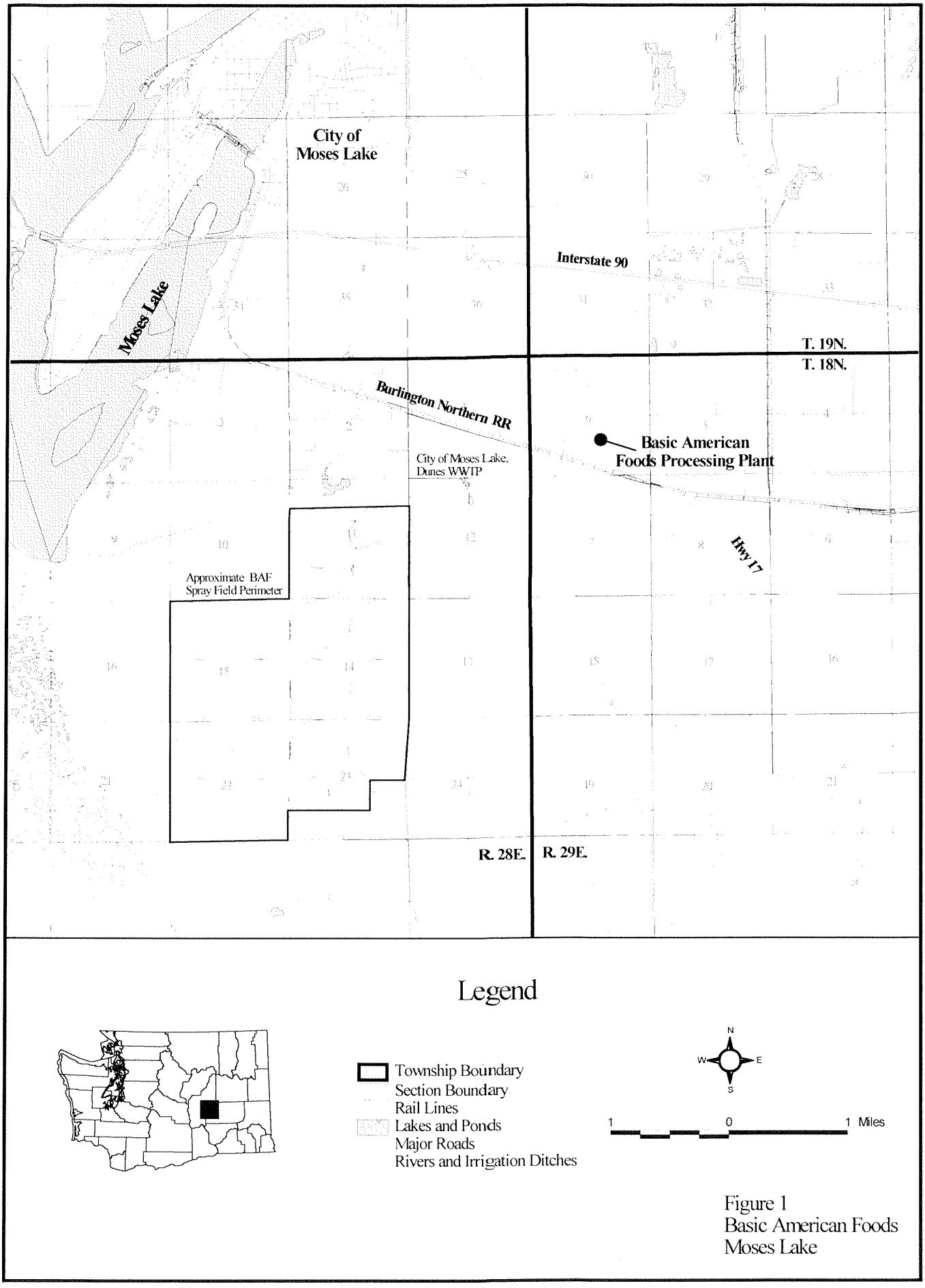

Figure 1
Basic American Foods
Moses Lake

Objectives

Objectives of the inspection included:

- Evaluate BAF NPDES permit compliance
- Evaluate Moses Lake WWTP sampling procedures with split samples
- Perform agronomic analysis of BAF spray irrigation operations and calculate adjusted Sodium Adsorption Ratio (SAR)

Procedures

Ecology collected BAF effluent samples to determine parameters included in the State Waste Discharge Permit. Additional parameters for analysis include boron and bicarbonate (HCO_3) for agronomic analyses. Ecology collected BAF effluent (Eff) as grab samples and as 24-hour composite samples. BAF also collected a 24-hour composite effluent sample (Eff-B).

A more detailed description of sampling procedures appears in Appendix A. Sampling station descriptions appear in Table 1. The sampling schedule, parameters analyzed, and sample splits are included in Appendix B. Ecology analytical methods and laboratories performing the analyses are summarized in Appendix C. Ecology field and laboratory QA/QC are summarized in Appendix D. Quality assurance cleaning procedures are included in Appendix E. A glossary appears in Appendix F.

Results and Discussion

Flow Measurements

Flow to the spray fields is measured by one main propeller meter. Because the meter was of this type, the accuracy of the meter could not be verified during the inspection. The effluent totalizer reading from 1,127 on April 28 to 0740 on April 29 indicated an average flow of 1.52 MGD (1,057 gpm). Instantaneous flow was 1,142 gpm at 1127 on April 28 and 1,084 gpm at 0740 on April 29.

State Waste Discharge Permit Compliance

The 1.52 MGD flow rate measured during the inspection was greater than the 1.35 MGD permitted annual average but less than the 1.66 MGD permitted monthly average flow rate. Other than flow rate, there is a permit effluent limitation stipulating that the system must be operated by the permittee so as to protect the existing and future beneficial uses of the groundwater.

Table 1. Sampling Station Descriptions - BAF, April 1998

Station	Type	Collector	Description
Eff-1,2	grab	Ecology	Effluent was collected through the compositor intake line. The line was inserted in a hose connected to the BAF effluent line.
Eff-E	comp	Ecology	Effluent was collected with the compositor intake line inserted in a hose connected to the BAF effluent line.
Eff-B	comp	BAF	Effluent was collected through an effluent line leading to the compositor.

The effluent flow rate (1.52 MGD) and strength (1,110 mg/L BOD_5) at the time of the inspection were close to the averages for the two years of self-monitoring data from September 1, 1997 to December 1, 1998 (1.64 MGD; 1,071 mg/L BOD_5). Flow rates and effluent strengths during the two years of self-monitoring data were of moderate variability but there was no evident seasonal variability. For all but two of the 24 months, flow rate was between 1.2 MGD and 1.6 MGD and BOD_5 was between 700 and 1,600 mg/L (Ecology, 1999).

The groundwater inspection conducted concurrently with this wastewater inspection found that BAF wastewater disposal practices have degraded groundwater quality in the vicinity of its sprayfields (Sinclair, 1998). Of the 12 wells sampled, nearly two-thirds exceeded drinking water standards for nitrate/nitrite (10 mg/L) and total dissolved solids (500 mg/L).

Spray Field Discharge

The spray field discharge is comprised of the effluent sampled in this inspection. Results of analyses of the effluent appear in Table 2. A comparison of effluent sample results to water quality guidelines for irrigation was made from inspection effluent parameters and information provided in Wastewater Engineering: Treatment, Disposal, Reuse (Metcalf and Eddy, 1991). Results of the comparison appear in Table 3. The adjusted sodium absorption ratio (adj R_{Na}) is used to predict potential problems with reduced infiltration rates. Boron, HCO_3, pH, and adj R_{Na} results for the effluent sample indicate no practical degree of restriction on the use of the effluent for irrigation for the conditions encountered during the inspection. A slight to moderate degree of restriction on use were indicated for the effluent irrigation water salinity (EC_w) and TDS. A slight to moderate or greater degree of restriction on use was indicated for sodium in the effluent sample. A severe degree of restriction on use was indicated for total Kjeldahl nitrogen based on concentration.

A better evaluation of acceptable rates of nitrogen application can be made for nutrient uptake of selected crops. Table 3 shows nutrient loading based on the 2,315 total acres irrigated by BAF and 1.35 MGD annual average flow as specified in the permit. Grass (represented by rye), potatoes, corn, and wheat are among the crops grown on land irrigated with BAF effluent. A

Table 2. General Chemistry Results - BAF, April 1998

Parameter	Location:	Eff-1	Eff-2	Eff-E	Eff-B
	Type:	grab	grab	comp	comp
	Date:	4/28	4/28	4/28-29	4/28-29
	Time:	1050	1520	1000-1000	1000-1000
	Lab Log #:	188155	188156	188157	188158
GENERAL CHEMISTRY					
Conductivity (umhos/cm)		1230	1200	1200	1220
Alkalinity (mg/L CaCO3)				146	176
Hardness (mg/L CaCO3)				62.7	59.2
TS (mg/L)				2790	3190
TNVS (mg/L)				1170	1260
TSS (mg/L)		1630	2110	1310 J	1560 J
TNVSS (mg/L)				559 J	507 J
TDS (mg/L)				1280	1180
Sodium (mg/L)				133	
Potassium (mg/L)				186	
Calcium (mg/L)				8.26	
Magnesium (mg/L)				10.8	
Boron (mg/L)				0.081	
HCO3 (mg/L)				10 U	
OXYGEN DEMAND PARAMETERS					
BOD5 (mg/L)				1110	1060
COD (mg/L)				1700	1400
TOC (water mg/L)		490	587	561	518
NUTRIENTS					
Total Kjeldahl Nitrogen (TKN - mg/L)				67.5	63.8
NH3-N (mg/L)		4.25	4.76	8.44	13.4
NO2+NO3-N (mg/L)		1.35	1.39	0.354	0.531
NO2-N (mg/L)				0.010 U	0.506
Total-P (mg/L)		8.81	9.47	10.2	10.4
Ortho-PO4-P (mg/L)				4.21	4.49
FIELD OBSERVATIONS					
Temperature (C)		35.6	37.5		
Temp-cooled (C)				12.4	11.4
pH		7.66	7.48	6.98	6.41
Conductivity (umhos/cm)		1285	1241	1291	1293

Eff - Effluent sample
grab - grab sample
comp - composite sample

E - Ecology sample
B - BAF sample
J - estimated value
U - The analyte was not detected at or above the reported result.

Table 3. Comparison of Effluent to Water Quality Guidelines for Irrigation - BAF, April 1998

Parameter	Location: Eff-E Type: comp Date: 4/28-29 Time: 1000-1000 Lab Log #: 188157	Degree of Practical Restriction on Use None	Slight to Moderate	Severe
Specific Ion Toxicity - Sprinkler Irrigation (affects sensitive crops)				
Boron (mg/L)	0.081	< 0.7	0.7-3.0	> 3.0
Sodium (mg/L)	133	< 70	> 70	
Salinity (affects crop water availability)				
ECw (mmhos/cm)	1.2	< 0.7	0.7-3.0	> 3.0
TDS (mg/L)	1280	< 450	< 450-2,000	> 2,000
Miscellaneous Effects (affects susceptible crops)				
PH	7.57*	Normal range 6.5 - 8.4		
HCO3 (mg/L)	< 10	< 90	90 - 500	> 500
Total Kjeldahl Nitrogen (mg/L)	67.5	< 5	5 - 30	> 30
Permeability (affects infiltration rate of wastewater into soil)				
Adj R_{Na} (evaluated using ECw and adj R_{Na})	3.74	(& Ecw > 0.7)		

Nutrient Loading and Uptake for Selected Crops		Rye	Potatoes	Corn	Wheat
N (lb/acre-yr) (for 1,970 acres, 1.35 MGD)	120	180-250	205	155-172	50-81
P (lb/acre-yr) (for 1,970 acres, 1.35 MGD)	18.1	55-75	20	17-25	15

* average of Eff-1 and Eff-2 grab samples.
< -less than
> -greater than
> -greater than or equal to

crop can be grown without potential contamination of groundwater when the uptake rates exceed the nutrient application rate. If all 2,315 acres were planted in rye, plant uptake of nitrogen and phosphorus would exceed the nutrients in the effluent irrigated by about a factor of two (based on the effluent sampled during this inspection). If the land were planted in potatoes or corn, nitrogen uptake would safely exceed the nitrogen applied by the irrigation of wastewater but phosphorus uptake would approach or equal the phosphorus applied by wastewater irrigation. If the land were planted in wheat, the nutrient uptake rate for both nitrogen and phosphorus would be exceeded. When nutrient uptake is equal to or exceeded by the application rate, careful management of irrigation of wastewater is called for.

In practice, BAF applies the wastewater to both grass and crops. Table 4 shows annual nutrient loads and uptake for BAF's irrigation of 470 acres of grass and 1,845 acres of crops. Nutrient loads are based on nutrient concentrations measured during this inspection and the permitted flow rate of 1.35 MGD.

Table 4. Nutrient Loadings and Annual Uptake Rates (total lb) - BAF, April 1998

	Nutrient Loading (total lb)	Uptake Rates (total lb)		
		Potatoes	Corn	Wheat
Nitrogen	277,000	463,000 - 496,000	371,000 - 435,000	177,000 - 267,000
Phosphorus	41,917	62,800 - 72,200	57,000 - 81,400	53,500 - 62,900

When wastewater irrigation nutrient loadings exceed the annual uptake rates, the potential for groundwater contamination exists. Table 4 shows that nutrient loadings do not exceed the annual uptake rates for potatoes and corn. The nitrogen loading exceeds the annual uptake rate for wheat, indicating the potential for groundwater contamination if wheat is the crop grown.

The analysis reflected in the table assumes that any additional fertilizer used is not over-applied. The analysis also assumes that nutrients are taken up by plants at a constant rate throughout the year. A variance from a constant uptake rate would favor the increased potential for excessive application rates. With BAF's irrigation of wastewater continuously throughout the year, it can be expected that during months outside of the growing season, particularly in the winter, there will be little uptake of nutrients and nutrients may percolate into the soil, entering the groundwater. A crop management plan should take this into account. If no sound crop management plan is feasible, options for wastewater disposal should be considered.

Another factor that can be expected to contribute to the contamination of groundwater by BAF's wastewater irrigation is that application rates were higher until recently. The irrigated area has more than doubled since 1996 with the irrigation of additional crop land on an adjacent farm (Nelson, 1997). Before irrigation was begun on this additional acreage, BAF was permitted to irrigate lands with an annual average flow of 1.35 MGD. The average effluent concentration of TKN from April 1, 1993 to December 1, 1997 was 81 mg/L (Luce, 1998). Representing the pre-1996 irrigation regime by these numbers we find that nitrogen was applied at a rate of 708 pounds per acre per year, over 470 acres of grass (Nelson, 1997). According to Metcalf and Eddy (1991), the nitrogen uptake for rye grass from 180 to 250 grasses and up to 600 pounds per year for other grasses. This indicates that agronomic rates were exceeded. Further, nitrogen uptake by grasses can be expected to not have been uniform throughout the year, creating conditions for infiltration and contamination of groundwater during seasons of lesser plant growth.

The Class II Groundwater Inspection of the BAF facility conducted in conjunction with this wastewater Class II Inspection, confirmed the historic exceedance of agronomic rates for nitrogen application. The groundwater inspection found degraded groundwater quality in the vicinity of the

BAF sprayfields. Drinking water standards for nitrate-nitrite as N and TDS were exceeded in the groundwater sampled, with nitrate/nitrite increasing downgradient (Sinclair, 1998).

A BAF engineering report contains unsupported, elevated estimates of crop nutrient uptake. In the report it is stated that "on an annual basis, the corn needs 450 pounds of nitrogen per acre per year." (Gardels, 1994). It is also stated that "the alfalfa has the potential to utilize 600 pounds of nitrogen per acre per year if available from commercial or other fertilizer sources." There is no citation or reference given in the report in support of these numbers. Metcalf and Eddy (1991) lists the nitrogen uptake rate for corn as 155-172 pounds of nitrogen per acre per year and the uptake rate for alfalfa as 200-480 pounds of nitrogen per acre per year. It is possible that the rates given by Gardels are commonly applied rates, but any rates in excess of uptake rates can result in application above the rate used by the crop, with the attendant possibility of groundwater contamination.

If BAF is using the fertilizer loading rates specified in Gardel's report to manage irrigation application rates, excessive nutrient loading from wastewater irrigation may be the result. BAF should submit to Ecology a revised engineering report addressing management of crops and grasses within agronomic rates throughout the year, so as to protect groundwater quality. The report should contain reasonable estimates of nutrient loading rates.

Split Samples

Split samples were compared to evaluate Ecology and BAF laboratory results (Table 5) Relative percent differences between Ecology and BAF samples and between Ecology and BAF analyses appear in Table 5. The relative percent difference is the numeric difference between sample pairs divided by their mean, expressed as a percentage.

There was reasonable agreement between most of the Ecology and BAF samples. While there were in some cases major differences in sample concentration, the differences were not consistent across the range of parameters, suggesting that the high suspended solids content of the wastewater contributed to uneven splitting as well as differences between the Ecology and BAF samples. With some exceptions, the relative percent differences (RPDs) between samples were greater than 10 percent for several parameters, indicating less than good agreement between Ecology and BAF samples. NH_3-N, Nitrate-N, Nitrite-N, and Nitrate/Nitrite-N had RPDs of greater than 30 percent. These parameters were found in relatively low concentrations. RPD can overestimate the importance of differences for parameters in low concentration ranges.

Ortho-P, Total P, and NH_3-N showed the greatest differences as expressed by RPD between Ecology and BAF laboratory analyses (Table 5). The RPD for Ortho-P results was 118 percent. In the concurrent BAF Class II Groundwater Inspection, the average RPD was 103.5 percent. Perry Brake of the Ecology Laboratory Accreditation Unit is investigating the discrepancies between Ecology and BAF analyses for Ortho-P (Sinclair, 1999b). BAF laboratory analyses were performed by Soiltest farm consultants, inc. Soiltest should review its procedures for sample handling and analyses for Total-P and NH_3-N. RPDs between Ecology and BAF analyses for alkalinity, COD, and TKN were also greater than 20 percent, indicating less than good agreement.

Table 5. Split Sample Results Comparison - BAF, April 1998

		Ecology Analyses		BAF Analyses			
	Location:	Eff-E	Eff-B	Eff-E	Eff-B		
	Type:	comp	comp	comp	comp	avg.	avg.
	Date:	4/28/29	4/28/29	4/28/29	4/28/29	RPD	RPD
	Time:	1000-1000	1000-1000	1000-1000	1000-1000	between	between
	Lab Log #:	188157	188158	188157	188158	samples	analyses
Parameter	Sampled by:	Ecology	BAF	Ecology	BAF	(%)	(%)
Conductivity (umhos/cm)		1200	1220	1277	1301	2	6
Alkalinity (mg/L)		146	176	107	136	21	28
TS (mg/L)		2790	3190	2545	2415	9	18
TSS (mg/L)		1310 J	1560 J	1407	1169	18	18
TDS (mg/L)		1280	1180	1406	1362	6	12
Settleable Solids (mg/L)		--	--	18	16	12	--
BOD5 (mg/L)		1110	1060	1276	1161	7	11
COD (mg/L)		1700	1400	1978	2030	11	26
TKN (mg/L)		67.5	63.8	86	88	4	28
NH3-N (mg/L)		8.44	13.4	16.0	19.0	31	48
Nitrate-N (mg/L)		--	--	2.4	1.3	59	--
Nitrite-N (mg/L)		--	--	0.39	0.60	42	--
Nitrate/Nitrite-N (mg/L)		0.354	0.531	--	--	40	--
Total P (mg/L)		10.2	10.4	6.0	4.8	12	63
Ortho-P (mg/L)		4.21	4.49	17.3	16.6	6	118
pH		6.98	6.41	5.2	5.5	NA	NA

Eff - effluent sample
E - Ecology sample
B - BAF sample
comp - composite sample
J - estimated value
RPD - relative percent difference
NA - not applicable

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Appendix A. Sampling Procedures - BAF, April 1998

An Ecology Isco composite sampler was set up to collect equal volumes of sample every 30 minutes for 24 hours. The sample was then divided into subsamples for analysis. The compositor was iced to preserve samples. The BAF composite sampler was set to sample equal volumes of sample every 30 minutes

Ecology and BAF effluent composite samples were split for both Ecology and BAF laboratory analysis. Sampler configurations and locations are summarized in Figure 2 and Table 1.

Appendix B. Sampling Schedule - BAF, April 1998

Parameter	Location:	Eff-1	Eff-2	Eff-E	Eff-B
	Type:	grab	grab	comp	comp
	Date:	4/28	4/28	4/28-29	4/28-29
	Time:	1050	1520	1000-1000	1000-1000
	Lab Log #:	188155	188156	188157	188158
GENERAL CHEMISTRY					
Conductivity (umhos/cm)		E	E	EB	EB
Alkalinity (mg/L CaCO3)				EB	EB
Hardness (mg/L CaCO3)				E	E
TS (mg/L)				EB	EB
TNVS (mg/L)				E	E
TSS (mg/L)		E	E	EB	EB
TNVSS (mg/L)				E	E
TDS (mg/L)				EB	EB
Sodium (mg/L)				E	
Potassium (mg/L)				E	
Calcium (mg/L)				EB	EB
Magnesium (mg/L)				E	
Boron (mg/L)				E	
HCO3 (mg/L)				E	
OXYGEN DEMAND PARAMETERS					
BOD5 (mg/L)				EB	EB
COD (mg/L)				EB	EB
TOC (water mg/L)		E	E	E	E
NUTRIENTS					
Total Kjeldahl Nitrogen (TKN - mg/L)				E	E
NH3-N (mg/L)		E	E	EB	EB
NO2 + NO3-N (mg/L)		E	E	E	E
NO2-N (mg/L)				EB	EB
Total-P (mg/L)		E	E	EB	EB
Ortho-PO4-P (mg/L)				EB	EB
FIELD OBSERVATIONS					
Temperature (C)		E	E		
Temp-cooled (C)				E	E
pH		E	E	E	E
Conductivity (umhos/cm)		E	E	E	E

Eff - Effluent sample
grab - grab sample
comp - composite sample
J - estimated value
U - The analyte was not detected at or above the reported result.

E - Ecology sample
B - BAF sample
- E - Ecology analysis
- B - BAF analysis

Appendix C. Ecology Analytical Methods - BAF, April 1998

Laboratory Analysis	Method Used for Ecology Analysis	Laboratory Performing Analysis
Conductivity	EPA, Revised 1983: 120.1	Ecology Manchester Laboratory
Alkalinity	EPA, Revised 1983: 310.1	Ecology Manchester Laboratory
Hardness	EPA, Revised 1983: 130.2	Ecology Manchester Laboratory
TS	EPA, Revised 1983: 160.3	Ecology Manchester Laboratory
TNVS	EPA, Revised 1983: 160.3	Ecology Manchester Laboratory
TSS	EPA, Revised 1983: 160.2	Ecology Manchester Laboratory
TNVSS	EPA, Revised 1983: 160.2	Ecology Manchester Laboratory
TDS	EPA, Revised 1983: 160.1	Ecology Manchester Laboratory
Sodium	EPA, Revised 1983: 200.7	Ecology Manchester Laboratory
Potassium	EPA, Revised 1983: 200.7	Ecology Manchester Laboratory
Calcium	EPA, Revised 1983: 200.7	Ecology Manchester Laboratory
Magnesium	EPA, Revised 1983: 200.7	Ecology Manchester Laboratory
Boron	EPA, Revised 1983: 200.7	Ecology Manchester Laboratory
HCO3	EPA, Revised 1983: 310.2	Ecology Manchester Laboratory
BOD5	EPA, Revised 1983: 405.1	Ecology Manchester Laboratory
COD	EPA, Revised 1983: 410.1	Sound Analytical
TOC (water)	EPA, Revised 1983: 160.2	Ecology Manchester Laboratory
Total Kjeldahl Nitrogen (TKN)	EPA, Revised 1983: 351.3	Ecology Manchester Laboratory
NH3-N	EPA, Revised 1983: 350.1	Ecology Manchester Laboratory
NO2+NO3-N	EPA, Revised 1983: 353.2	Ecology Manchester Laboratory
NO2-N	APHA, 1992a: 4500NO2(B)	Ecology Manchester Laboratory
Total-P	EPA, Revised 1983: 365.3	Ecology Manchester Laboratory
Ortho-PO4-P	EPA, Revised 1983: 365.3	Ecology Manchester Laboratory

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Appendix D. Quality Assurance/Quality Control (QA/QC) - BAF, April 1998

SAMPLING QA/QC

Ecology quality assurance procedures for sampling included cleaning of sampling equipment for priority pollutant analyses prior to the inspection to prevent sample contamination (Appendix E). Chain-of-custody procedures were followed to assure the security of the samples (Ecology, 1994).

General Chemistry Analyses

The data generated by the analysis of these samples can be used noting the qualifications that appear in Table 2 (General Chemistry Results). Total non-volatile solids (TNVSS) and total suspended solids (TSS) samples 188157 (Eff-E) and 188158 (Eff-B) are estimates.

Holding times, instrument calibration, procedural blanks, spiked sample analyses, and spike and duplicate sample results, and laboratory control sample analyses were all within established regulatory quality assurance guidelines.

Appendix E. Priority Pollutant Metals Cleaning Procedures – BAF, April 1998

PRIORITY POLLUTANT SAMPLING EQUIPMENT CLEANING PROCEDURES

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

Appendix F. Glossary of Terms – BAF, April 1998

B - BAF

BAF - Basic American Foods

BOD_5 - five day biochemical oxygen demand

COD - chemical oxygen demand

comp - composite sample

E - Department of Ecology

Eff - effluent

EPA - United States Environmental Protection Agency

g - gram

grab - grab sample

mg - milligram

mg/L - milligram per liter

pH - $-\log_{10}$ (hydrogen ion concentration)

QA - quality assurance

QC - quality control

TNVS - total nonvolatile solids

TNVSS - total nonvolatile suspended solids

TOC - total organic carbon

TS - total solids

TSS - total suspended solids

WWTP - wastewater treatment plant