Research Report

Research Project

Using Vegetated Strips to Improve Water Quality

CONTAMINANT DETENTION IN HIGHWAY GRASS FILTER STRIPS

By

David Yonge, Professor
Department of Civil and Environmental Engineering
Washington State University
Pullman, WA 99164-2910

Washington State Transportation Center (TRAC)
Department of Civil and Environmental Engineering
Washington State University
Pullman, WA 99164-2910

Washington State Department of Transportation
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Edward Molash

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16. ABSTRACT

A 17-month sampling campaign was initiated to investigate the potential for vegetated highway shoulders to retain suspended solids, metals, and total petroleum hydrocarbons. A site along SR 8 in Western Washington was selected and three full-scale test plots constructed for evaluation of contaminant retention capability. The data indicated that TPH and suspended solids were effectively removed. Metal concentration reduction was also effective when consideration was given to inadvertent pretreatment afforded by the highway runoff collection system. Consequently, the vegetated highway shoulder, located along hundreds of miles of highway can afford a cost effective means of contaminant retention.

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EXECUTIVE SUMMARY

The potential impact of non-point source pollution from highway runoff has been a concern for over 25 years. In that time, related research has evolved from defining pollutant type, concentration and load to developing cost effective and reliable best management practices to minimize environmental impact. The research reported herein was a study designed to evaluate the ability of vegetated highway shoulders to retain suspended solids and metals from highway runoff. Since there are hundreds of miles of these "filter strips" along highways, the potential benefit is significant.

In order to evaluate the potential for these highway shoulder filter strips to retain contaminants, a full-scale field site was designed and constructed along SR 8 in Western Washington. Three test plots were constructed and filled with non-soil compost, on-site native soil, and topsoil. Samples were collected over a 17- month period that represented direct highway runoff and surface and subsurface runoff from each test plot. The samples were quantified for metals, nutrients, suspended solids, and organic carbon. A second sampling period was initiated in November 1997 and was concluded in January 1998 to obtain additional information on metal and suspended solids retention.

The major findings are summarized below.

- The three test plots exhibited good solids retention with an overall average of 72 percent. No significant difference in solids retention was observed between test plots.
- Total petroleum hydrocarbon retention in each test plot was excellent; with only four occurrences of TPH values greater than 1 mg/L in the test plot discharge over the duration of the study.
- Metal concentration data yielded anomalous results in that the metal concentrations exiting the test plots were often greaten than those entering. The metal concentrations were, nonetheless, quite low; the overall average for Pb, for example, was 0.0086 mg/L. Based on results of the second sampling period, it was concluded that the *appearance* of a metal concentration increase from the filter strip influent to the discharge was the result of the slot drain collection system inadvertently trapping sediment. This resulted in low suspended solids

and metal concentration in the aqueous phase samples that were used to define the test plot influent.

- Based on the overall performance of the filter strips, a vegetated highway shoulder that meets the criteria set forth in the WSDOT Highway Runoff Manual should afford reasonable reductions in metal, suspended solids, and TPH concentration in a very cost effective manner.

1 INTRODUCTION

1.1 Problem Statement

Investigations regarding the introduction of contaminants to the aquatic environment through highway runoff began in the late 1970's. Interest in this area of study has continued to increase, particularly in the area of design, operation, and effectiveness of contaminant mitigation devices (WADOE, 1992). Several studies have been conducted to quantify contaminants found in highway runoff and to examine the best management practices (BMPs) for their removal (Taylor, 1991; Pittman, 1991; Yousef, 1985; Yousef, 1991, Wang, 1980). Because of the site-specific nature of stormwater quality and BMP efficiency, WADOE has requested that WSDOT develop and implement a stormwater monitoring program as part of their NPDES stormwater management plan. This monitoring program will include the effectiveness of grassy strips (highway shoulder grass filter strips) on retention of highway runoff contaminants.

Contaminants of concern in highway runoff include certain metals (Cd, Cu, Pb, Zn), polycyclic aromatic hydrocarbons (PAH), and suspended solids. Although several management practices have been utilized, their implementation can be prohibitively expensive and logistically difficult. These difficulties result from space limitations, runoff volume quantity and quality variations, and from the larger number of areas generating runoff. These factors can preclude the installation of BMPs at many locations. Consequently, two projects have been undertaken by WSDOT to define the contaminant retention potential of vegetated highway shoulders (VHS). These structures are located along hundreds of miles of highway.

The first project was initiated in 1994 and employed a full scale model that allowed simulated stormwater to be applied at pre-selected slopes and flows. Vegetative filter strip discharge was monitored for metals and an inert tracer to determine metal retention and average hydraulic detention time across the grass strip (Newberry, G. P. and Yonge, D. R. 1996). The largest portion of metals were retained within the initial 1 m of the grass strip and 1.0 cm of depth. These analytical findings were supported by visual observations that indicated that the stormwater sediment was retained in the upper 1 m of the grass strip. Overall metal retention was estimated by mass balance and it was determined that 84% of zinc, 93% of lead, and >99% of cadmium and copper applied to the grass strip was retained. Based on these results and because of the potential for contaminant retention along many miles of highway, further investigation through field validation was warranted. This final report presents the efforts of an 18-month field sampling campaign of a VHS site in Western Washington.

2 OBJECTIVE

The primary objective of the proposed work was to generate a data base regarding the fate and transport of stormwater contaminants through VHS's. This information was used to assess the contaminant removal potential of these highway appurtenances, to gain a better understanding of contaminant removal mechanisms, and to supply data that can be used in assessing applicability to NPDES criteria. The project objective was realized by performing the following specific project tasks.

- A VHS site was selected for storm event monitoring.
- A test strip design was developed that afforded a means of collecting runoff directly from the highway and from two locations ("upper" surface runoff and "lower" subsurface runoff) in each of three VHS test plots.
- Each filter strip was constructed using a different fill material, (i) Nutra Mulch compost, (ii) Everett sand, and (iii) local site fill material.
- A rain gauge, flow monitoring and sample collection equipment was designed and installed.
- Numerous constituents were quantified in the samples collected, including solids, nutrient, metal, organic carbon, and PAH concentrations.

3 REVIEW OF PREVIOUS WORK

3.1 Constituents of Concern in Highway Runoff

Several studies have been performed to quantify the pollutants found in highway runoff. Much of the resulting data has been compiled in summary reports. For example, Field (Field, R. 1993) compiled highway runoff pollutant concentrations from a wide range of locations including, Northhampton, England; Durham, North Carolina; and Syracuse, New York. Barrett *et al.*, also compiled an extensive literature review listing measured average ranges for many known highway contaminants (Table 1). Driscoll *et* *al.*, compiled contaminant concentration data based on highway type and geographic location (Driscoll, E. D. et al., 1990). The information provided was a direct result of the National Urban Runoff Project (NURP) and the summary data for Wasington is presented in Table 2. All the data collected to date indicate a high degree of variability in constituent concentration. This variability, the intermittent nature of the storm events, and the significant volume of highway runoff generated at widely varied locations present significant treatment challenges.

3.2 Present Treatment Mechanisms for Highway Runoff

Until recently, stormwater control systems have been designed solely on hydraulic considerations, such as retention times and applied flow rates. Thus, the removal of pollutants was a consequential occurrence. The first options examined for possible contaminant removal were the hydraulic controls presently in use at many locations. The treatment practices currently in use include detention basins (wet and dry ponds), infiltration galleries and ponds, engineered wetlands, grassy swales, and vegetated filter strips. Here, a brief overview of the biofiltration swale and VFS is presented.

3.2.1 Grassy Swales

Swales are trenches located along highways, such as the median of major interstate freeways. Swales were the first type of continuous flow, contaminant removal mechanism studied that treated relatively large volumes of runoff from major highway sections. Yousef *et al.* determined that pollutants could be retained in a swale by adsorption, precipitation, and/or biological uptake (Yousef, Y. A. et al., 1985). He also discovered better removal with a newly constructed swale prior to the establishment of vegetation. His conclusion was that soluble metals are mainly removed by adsorption due to the adsorptive capacity of soil. Plant material growing in the swale, decreased the contact area between the metals and the soil, thus reducing the number of adsorptive sites. In contrast, a study completed by Bell and Wanielista determined that an increased concentration of organic material (mainly humic substances) and vegetation increased the removal of metals from runoff (Bell, J. H. and Wanielista, M. P. 1979). Therefore, the presence of decaying plant material in a swale may increase the removal potential by the addition of a greater number of adsorption sites for metals.

3.2.2 Vegetated Filter Strips

A VFS can be considered any sloped section of grassed or forested ground that provides stormwater treatment of pollutants. They differ from the grassy swale in that the applied flow is generally less than the flow in a swale and the depths of flow do not normally top the vegetation in a VFS. VHS differ from VFS in that they often have a shorter flow path (flow distance parallel to flow direction) than does a VFS. Also, VFS's have been used as remediation devices by the mining and construction industry in addition to transportation.

Vegetated filter strips are often used as a preliminary treatment for an infiltration gallery, detention basin, or other water quantity BMP. Albrecht and Barfield have determined that VFS can have effective removals of fine sediment of up to 99% (Albrecht, S. C. and Barfield, B. J. 1982). Dillaha *et al.*, determined that the most significant factor affecting the removal efficiencies was the flow regime (Dillaha, T. A. et al., 1986). Flow pathways for highway runoff are surface channels and pools, seepage through a shallow 'muck' layer, or transport through the soil (Kadlec, R. H. 1990). The significance of each mechanism will depend on the soil moisture content, the grass type and density, the roughness, slope, etc.

Current design criteria of a biofiltration swale as a best management practice (BMP) have been outlined by WSDOT in the *Highway Runoff Manual* (WSDOT ,1995). Design is based on the shape, size, and expected flow as follows: length of 61 m, maximum width of 3 m, and maximum 10 cm depth under 6-month storm condition. Vegetation should be fine, close-growing and water-resistant grasses. General maintenance (including mowing, sediment removal, periodic inspection, and liter removal) of the swale is required to insure the continuing effectiveness of the vegetation as a filtering mechanism. Based on the limiting depth of flow criteria set forth by WSDOT, many sites are not amenable to the grassy swale BMP.

Table 1. Range of average values for stormwater contaminant concentrations for selected highway contaminants (Barrett, M. E. et al., 1993).

Constituent	Concentration (mg/L unless noted)	Load (kg/ha/year)	Load (kg/ha/event)
SOLIDS			
Total	437-1147		58.2
Dissolved	356	148	
Suspended	45-798	314-11,862	84-107.6
Volatile, dissolved	131		
Volatile, suspended	4.3-79	45-961	0.89-28.4
Volatile, total	57-242	179-2518	10.5
METALS (total)			
Zn	0.056-0.929	0.22-10.40	0.004-0.025
Cd	ND-0.04	0.0072-0.037	0.002
As	0.058		
Ni	0.053	0.07	
Cu	0.022-7.033	0.030-4.67	0.0063
Fe	2.429-10.3	4.37-28.81	0.56
Pb	0.073-1.78	0.08-21.2	0.008-0.22
Cr	ND-0.04	0.012-0.010	0.0031
Mg	1.062		
Hg (x 10^{-3})	3.22	0.007	0.0007
NUTRIENTS			
Ammonia, as N	0.07-0.22	1.03-4.60	
Nitrite, as N	0.013-0.25		
Nitrate, as N	0.306-1.4		
Nitrite + Nitrate	0.150-1.636	0.8-8.00	0.078
Organic, as N	0.965-2.3		
TKN	0.335-55.0	1.66-31.95	0.17
Nitrogen, as N	4.10	9.80	0.02-0.32
Phosphorous, as P	0.113-0.998	0.6-8.23	
MISCELLANEOUS			
Total coliforms number/100 mL	570-6200		
Fecal coliforms number/100 mL	50-590		
Sodium		1.95	
Chloride		4.63-1344	
pH	7.1-7.2		
Total Organic Carbon	24-77	31.3-342.1	0.88-2.35
COD	14.7-272	128-3868	2.90-66.90
BOD_5	12.7-37	30.60-164	0.98
Polynuclear Aromatic Hydrocarbons (PAH)		0.005-0.018	
Oil and Grease	2.7-27	4.85-767	0.09-0.16
Specific Conductance (µmohs/cm @ 25 °C)	337-500		
Turbidity (JTU)	84-127		

Table 2. Highway contaminant concentrations for various locations in Washington (Driscoll, E. D. et al., 1990). Site median concentrations expressed in mg/L.

State Code	Location Description	SS	VSS	TOC	COD	TKN	PO_4-P	Cu	Pb	Zn
WA-5	Montsano SR-12	126	21	3	46	0.64	0.168	0.036	0.175	0.100
WA-6	Pasco SR-12	101	25	10	114	3.32	0.476	0.025	0.101	0.325
WA-9	Pullman SR-270E	104	21	17	60	0.75	0.428	0.026	0.130	0.099
WA-1	Seattle I-5	93	26	13	106	0.9	0.217	0.037	0.451	0.382
WA-2	Seattle SR-520	244	59	33	145	1.09	0.415	0.072	1.065	0.280
WA-4	Snoqualmie Pass I-90	43	9	2	41	0.38	0.123	0.025	0.065	0.071
WA-7	Spokane I-90	119	29	10	156	1.69	0.865	0.041	0.173	2.892
WA-3	Vancouver I-205	34	9	7	32	0.60	0.098	0.017	0.046	0.040

3.3 Use of Highway Shoulders as a BMP

Highway shoulders are designed for the safety of motorists with the degree of slope ranging from 5% to 25% depending on the location of the roadway. Their width is mostly grassed averaging around 3 m down gradient of a paved or graveled region that is directly adjacent to the roadway. Areas in which a VHS and a VFS can differ are in the application of flow and their roadway ADT. The runoff can come directly from the roadway, or a higher volume of runoff may channel to a common discharge location. From design storm hydrographs for the Olympia/Seattle area, the runoff is generally less than 8 L/min based on a type IA storm event, 40.5 m^2 total runoff area (4 lane highway) and assuming all runoff flows directly from the highway to the shoulder (WSDOT ,1995). Some sections of highway shoulders will be of greater slope than specified for a VHS BMP. Contaminants may still be retained in the soils of the shoulder under this condition, however, the contaminant retention capability at these higher slopes would be expected to decrease (Newberry, G. P. and Yonge, D. R. 1996).

WSDOT has specified the use of the VHS as a BMP for rural highways (Average Daily Traffic, ADT, less than 30,000, WSDOT 1995). The runoff must not be from more than two lanes of traffic and it should be applied to the shoulder as sheet flow (evenly distributed onto the VHS). Criteria for the use of a VHS as a BMP are:

- The filter strip must be at least 3 m in width (distance perpendicular to the roadway) with a transverse slope no greater than 15 percent.
- The longitudinal slope of the roadway must not be more than 5% due to the difficulty in maintaining uniform sheet flow.
- After treatment, the stormwater must be conveyed to a stormwater quantity BMP.

3.4 Contaminant Retention Mechanisms in a VHS and VFS

3.4.1 Flow Paths

One of the primary factors affecting contaminant retention can be the runoff flow path down the VHS. As the water travels down the grass strip the flow regime can change dramatically and is dependent on the soil moisture, soil type, and grass density. The possible flow paths are:

1. Percolation into and movement through the subsurface in a saturated or unsaturated state,
2. overland flow, and/or
3. flow through a shallow surface ‘muck’ layer (Kadlec, R. H. 1990).

Stout classified five sequential steps in the shallow overland flow encountered by a grass strip:

1. the surface becomes completely saturated,
2. depressions are filled,
3. concentrated flow initiates through preexisting flow paths,
4. these small flow paths converge forming shallow sheet flow, and
5. as the storm event decreases sheet flow reduces and a reversal in the sequential steps is realized (Stout, D. 1995; Newberry, G. P. and Yonge, D. R. 1996).

If overland flow predominates, contaminant retention would likely be lower than under the other flow conditions. The overland flow condition would dominate in a low permeability soil, such as a hard-packed clay, or highly saturated soils.

3.4.2 Heavy Metal Retention and Migration

Highway shoulders have been shown to contain metals from highway runoff (Hewitt, C. H. and Rashed, M. B. 1992; Bell, J. H. and Wanielista, M. P. 1979). Metals are deposited along the highway shoulder either by wind-blown dust particles or by stormwater washing the highway surface. Once onto the shoulder, metals can be retained by filtration (Maestri, B. et al., 1988), partitioning onto the soils and grasses (Motto, H. L. et al., 1970; Wigington, P. J., Jr. et al., 1986), be taken up by the biota in the grass strip (Fergusson, J. E. 1990; Motto, H. L. et al., 1970), or migrate through the soil with the infiltrating runoff (Wang, T. S. et al., 1980; Bell, J. H. and Wanielista, M. P. 1979). Subsequent storm events have the potential to move the pre-existing metals down gradient, as well as adding more metals to the grass strip. In the field, all these possible pathways of metal transport or retention exist, but are very difficult to define. In addition, the metal previously applied to the grass strip can affect the local equilibrium within the grass strip and thus the performance of the entire system. Eventually a 'steady-state' is expected to exist so that the concentration of metals entering the grass strip would be equivalent to the exit concentration.

Metal species found in highway runoff are primarily associated with particulates (Cole, W. C. and Yonge, D. R. 1993). This metal bound particulate matter is exposed to continually changing conditions and complex local equilibrium conditions. The metal can remain partitioned to the particulate matter, desorb into the aqueous phase, partition onto the soil of the grass strip, sorb to organic material (humic and fulvic acids) in the soil, or be taken up by the vegetation. It is assumed that any one or a combination of these conditions can occur during a runoff event, depending on flow intensity, soil type, metal species, organic content, grass density and type, and existing metal concentration.

3.4.3 Lateral Movement of Heavy Metals

Studies have been completed on the movement of metals along grass-lined channels and swales (Yousef, Y. A. et al., 1985), but examination into the migration through shorter grass strips and highway shoulders is more limited (Newberry, G. P. and Yonge, D. R. 1996; Wang, T. S. et al., 1980). Lagerwerff and Specht determined that metal concentrations in roadside soils decreased consistently for all metals tested at 8, 16, and 32 m from the roadway, with the following order from greatest concentration to the least, Cd>Pb>Zn>Ni (Lagerwerff, J. V. and Specht, A. W. 1970). Gish and Christensen determined similar results over a distance of 50 m from the roadway (Gish, C. D. and Christensen, R. E. 1973). A highway grass strip is stated to average 3 to 4 m in width from the roadway (WSDOT ,1995). The concentrations determined by Gish and Christensen were, on average, 50% greater within the grass strip width than at any greater distance from the roadway. Lateral movement of metals is an apparent phenomenon in vegetated areas adjacent to highways, but to what extent the movement occurs in a grass strip and if a 'steady-state' condition is reached, remains undetermined under field conditions.

3.4.4 Vertical Migration of Metals

Metals can migrate vertically as stormwater infiltration occurs. The rate of migration will be dependent upon metal type and concentration and the nature of the soil in the root zone. Factors that control lateral migration will also control vertical migration. Vertical metal migration has been discovered to be limited to within the first foot of depth, depending on the metal and soil type. Laxen and Harrison stated that Pb is generally retained within the top 15 cm of soil (Laxen, D. P. H. and Harrison, R. M. 1977). Whereas, Cd usually has a less distinct concentration gradient even beyond 15 cm of depth (Wang, T. S. et al., 1980). Lagerwerff and Specht and Motto *et al.*, also completed vertical migration studies concluding that Pb has a rapidly decreasing concentration gradient with increasing depth (Lagerwerff, J. V. and Specht, A. W. 1970; Motto, H. L. et al., 1970). Lagerwerff and Specht also examined soil cores for Zn, Ni, and Cd, discovering that these metals also decreased in concentration with increased depth. Zinc maintained a gradient similar to Pb, while the Cd gradient was much less pronounced. These sampling studies were completed over 30 to 50 m distances from the roadway. This distance included both a highway grass strip and a grassed swale.

Therefore, their conclusions may not accurately represent the vertical gradients within initial 3 m highway grass strip adjacent to the source of the metal-laden runoff.

3.4.5 Plant Uptake of Metals

Plants rely on the soil to supply nutrients for survival. Metals found in the soil have the potential to be adsorbed into and onto plant material. Some metals are considered micronutrients (Zn and Cu) with fairly high phytotoxic levels. Whereas, other metals have no biological significance and low phytotoxic levels (Pb and Cd). The excess, or unnecessary metals, once adsorbed, are stored in various parts of the plant depending on metal and plant species. For example, cadmium is generally found in the leaves. However, lead has been found to remain primarily in the root zone (Fergusson, J. E. 1990).

Plants have been divided into three categories, as far as metal uptake and the toxic effects of the metals on the plant are concerned: (i) accumulators, (ii) indicators, and (iii) excludors (Davis, B. E. 1992). Accumulators are those plants that will concentrate metals in their tissues, regardless of the soil concentration. Indicators will maintain a closely correlated concentration of metals in their tissue with the concentration in the soil. Excludors will only contain a low concentration of metal in their tissue due to a natural enzymatic exclusion mechanism at the soil-root interface. The exclusion will occur until the restrictive mechanism breaks down, a phenomenon that occurs above a certain concentration (Davis, B. E. 1992). Chamberlain studied lead uptake in plants and developed a concentration factor (CF) to help classify plant metal uptake, which is the ratio of the metal concentration in dry weight of plant material to the total metal concentration in the dry weight of soil (Chamberlain, A. C. 1983).

Highway shoulders are presently planted with native grass species that require low maintenance, are hearty, and maintain a good root system to limit erosion. Past studies in plant uptake of metals have generally been concerned with the introduction of metals into the food chain. The WSDOT seed mix for western Washington includes perennial rye grass, red fescue, colonial bent grass, and white Dutch clover. Jones *et al.*, studied perennial rye grass in 16 different soils, all with an average soil solid phase Pb concentrations of 50 mg/g dry weight (Jones, L. P. et al., 1973). He determined that the lead in the plants poorly correlated to that in either the total or extractable lead in the soils. Newberry and Yonge concluded that, under the conditions studied, the WSDOT seed mix resulted in vegetation that behaved as an excluder (Newberry, G. P. and Yonge, D. R. 1996).

3.4.6 Nutrient Fate in Vegetated Filter Strips

The nutrients nitrogen and phosphorous can have sources and sinks similar to the metals, dependent upon the form of the nutrient. For example, NH_4^+ has a relatively high soil partition coefficient while NO_3^- does not partition onto the soil but can have a high plant uptake rate. Nutrients, unlike most heavy metals, can be significantly impacted by micro and macrobiological activity. As a result, nitrogen and phosphorous compounds will tend to "cycle" in a system, especially in temperate zones that experience annual growth, death, and decay cycles. Plants can act as a sink of nutrients during growth and dead vegetation will act as a source during the bacterial decay process. The net flux of nutrients in the vadose zone will be a function of plant type, soil type, time of year, moisture content, bacterial activity, etc.

4 EXPERIMENTAL METHODOLOGY

4.1 VHS Test Site

Data regarding the fate and transport of highway runoff constituents of concern in a VHS was collected over an 18-month period (March 1996 through August 1997) at a field site located on SR 8 in Western Washington. An additional short-term sampling campaign was carried out over a three-month period (November 1998 through January 1999) to collect additional information regarding suspended solids and metal retention.

A schematic diagram of the experimental site is shown in Figure 1 and a cross sectional view of a test plot is presented in Figure 2. Each test plot (filter strip) was constructed using a different media. Test plot 1 (TP1) contained biosolids compost manufactured under the name of Nutra Mulch. Test plot 2 was filled with on-site native soil and TP3 was filled with topsoil from off sight. Each test plot was lined with a geotextile liner, 0.6 m (2 ft) below grade. An under drain system was placed on top of the liner to collect the infiltrated runoff and then the appropriate fill material was added to the plot. A berm was constructed at the down gradient end of each test plot that diverted surface flow into a surface or "upper" collection pipe. Water from both the upper and lower collection systems was transported by gravity to the appropriate collection vault (Figure 1). Water that represented untreated highway runoff was collected in two slot drains and transported by gravity to a collection vault. A site photograph is presented in Figure 3.

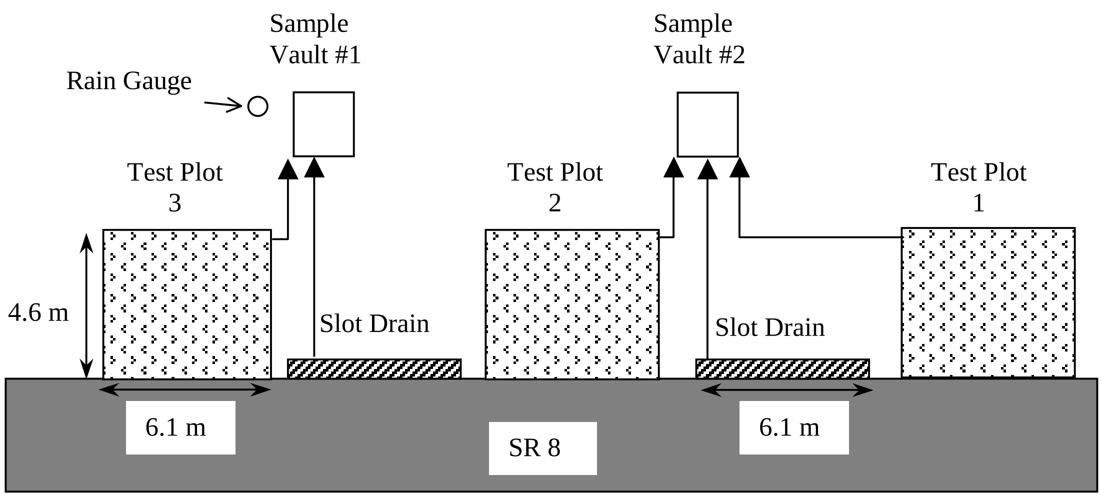


Figure 1. Plan view simplified schematic diagram of experimental site lovsyrf on SR8 (not to scale).

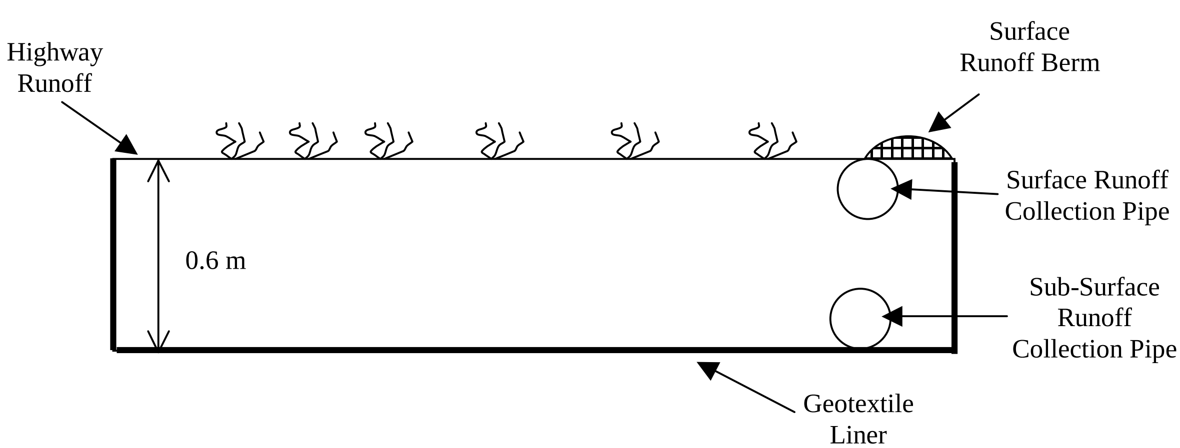


Figure 2. Cross sectional view of a test plot showing the surface runoff diversion berm and collection pipes (not to scale).

4.2 Sample Collection and Analysis

Each sample collection vault contained an ISCO sampler that was used to monitor flow and collect composite samples from the slot drains during precipitation events. Composite samples from the lower (infiltrated runoff) and upper (surface runoff) test plot drain system was collected in separate 114 L (30 gal) plastic carboys (Figure 4). Prior to sample collection for subsequent constituent analysis, the volume collected was recorded and the contents were mixed. After sample collection, the carboys were emptied and the date and time recorded.

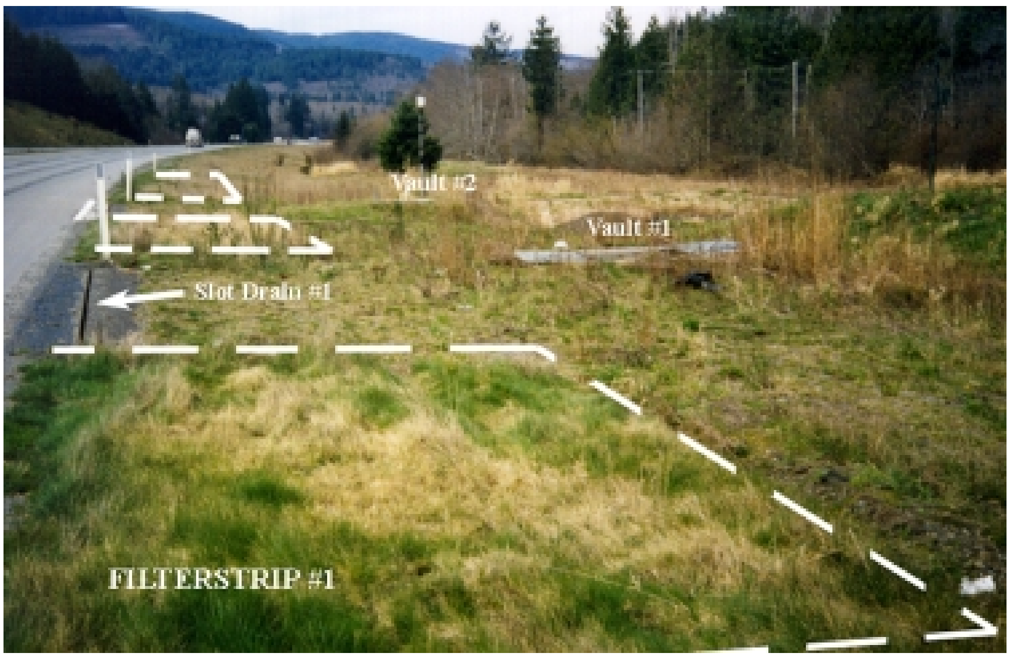


Figure 3. Photograph of the test site along SR 8 showingthe sample vaults, test plots, and slot drain #1.

Figure 4. Photograph of sampling vault A with the ISCO sampler and plastic composite containers.

Composite slot drain and test plot samples were analyzed for the constituents listed in Table 3.

Table 3. Constituents monitored in the highway runoff and VHS discharge.

Constituent	EPA Method
Metals	6010
Cadmium (dissolved & total)	
Copper (dissolved & total)	
Lead (dissolved & total)	
Zinc (dissolved & total)	
Organic Carbon	
Biochemical Oxygen Demand (BOD)	
Chemical Oxygen Demand (COD)	
Nutrients	300.0
Nitrate Nitrogen	
Nitrate + Nitrite	
Ortho-phosphate	
Total Phosphorus	
Miscellaneous	
Total Suspended Solids (TSS)	160.1
Total Dissolved Solids (TDS)	160.2
Harness	130.2
Total Petroleum Hydrocarbons (TPH)	418.1

During the first sampling campaign (March 1996 through August 1997), sample analysis was performed in WSDOT laboratories for all constituents except metals and TPH. These analyses were performed by a certified laboratory (Sound Analytical Inc., Tacoma, Washington).

4.2.1 Sample Analysis for Second Sampling Campaign

Samples for the second sampling campaign (November 1998 through January 1999) were sent to the Department of Civil and Environmental Engineering (CEE) for analysis. The sediment that had collected in the slot drains over several months was collected in November and shipped to the CEE laboratory. Liquid samples from precipitation events were shipped in November and January.

Upon receipt, the sediment sample was well mixed, spread out on a plastic tray and allowed to air dry to a constant weight. Four replicate samples were collected, one in each corner of the tray, for sieve analysis (US Standard sieve series 4, 10, 60, 200). The original mass and the mass retained on each sieve was weighed and recorded. Sediment from sieve numbers 60, 200, and <200 was prepared for metal extraction (US EPA method 6001).

Aqueous phase samples received on 11/15/98 and 1/6/99 are summarized in Table 4. These samples were analyzed for total and soluble metals (Ca, Mg, Fe, Cd, Cu, Zn, and Pb) and total suspended solids (TSS). In addition, a settling column test was performed on the slot drain samples in an effort to estimate the metal partitioning on particles less than 3 μm.

Table 4. Aqueous sample collection history for the November - January sampling campaign.

Date Received	Slot Drain	Test Plot 1		Test Plot 2		Test Plot 3	
		Surface	Sub-surface	Surface	Sub-surface	Surface	Sub-surface
11/15/98	✔		✔	✔	✔		✔
1/6/99	✔		✔	✔	✔	✔	✔

5 RESULTS AND DISCUSSION

5.1 Test Plot Characteristics

The fill material for east test plot was characterized with regard to basic soil composition and background metal concentration. These data are presented in Table 5 and Table 6. The data in Table 5 indicate that the topsoil has a 6 percent higher silt fraction and 4 percent lower sand fraction which could result in more surface flow and a corresponding lower subsurface flow during runoff events.

Table 5. Test plot soil properties.

Fill Material	Sand (%)	Clay (%)	Silt (%)
Nutra Mulch (TP1)	N/A*	N/A	N/A
Native Soil (TP2)	77	7	16
Topsoil (TP3)	73	5	22

*** Not Applicable**

Table 6. Test plot background metal concentrations (mg/Kg) and state wide averages.

Metal	Region			State Avg.	Test Plots		
	Western WA	Eastern WA	Puget Sound		TP1	TP2	TP3
Cd	1.20	0.81	0.77	0.93	0.2	0.1	0.1
Cu	43.2	28.4	36.4	36.0	15.5	6.2	3.2
Pb	20.4	13.1	16.8	16.8	5.1	5.8	4.0
Zn	98.4	80.9	85.1	88.1	45.0	8.4	3.0

The data in Table 7 support the flow path hypothesis, indicating that the topsoil test plot produced 47 percent subsurface flow and 53 percent surface flow while the native soil test plot produced 70 percent subsurface flow (averages calculated over the entire time of recorded flow). The Nutra Mulch apparently had the highest rate of infiltration as no surface flow was recorded during the study period.

Table 7. Percent flow path for the three fill material (average percentages calculated over the entire time of recorded flow).

	Nutra Mulch (TP1)	Native Soil (TP2)	Topsoil (TP3)
Surface Flow (%)	0	30	53
Subsurface Flow (%)	100	70	47
TOTAL	100	100	100

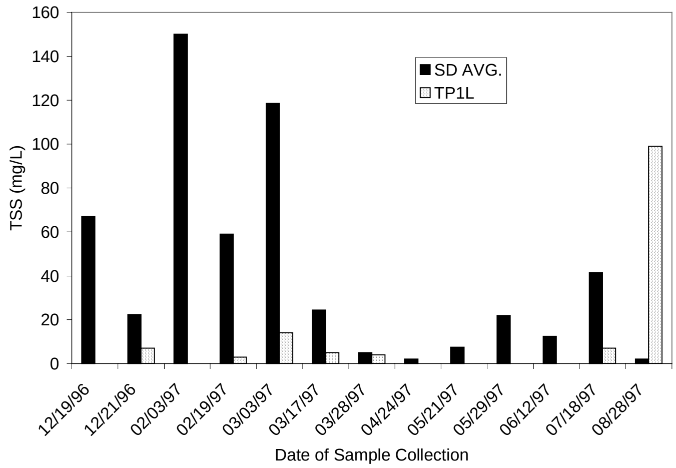
5.2 Total Suspended Solids

The data presented in Figure 5a, b, and c indicate that, in general, each test plot achieves reduction in TSS concentration, although negative concentration reductions are observed on an infrequent basis. Higher TSS concentrations in the surface runoff could be expected, however, this occurrence would be less likely in the subsurface due to the "filtration" ability of the subsurface soil. The TSS concentration in TP1L was approximately 100 mg/L on 8/28/97 while the slot drain TSS was 2 mg/L. On all other sampling dates, the TSS concentration in TP1L was in the range of 3 to 14 mg/L with an average of 6.7 mg/L (± 3.15 mg/L, $\alpha = 0.05$). This compares to a slot drain average TSS concentration of 41 mg/L (± 26.7 mg/L). Percent concentration reduction, excluding the 8/28/97 event, varied between 20 to 80 percent with an average reduction of 72 percent for all test plots. No statistically significant difference in TSS concentration reduction between the surface and subsurface collection points was observed.

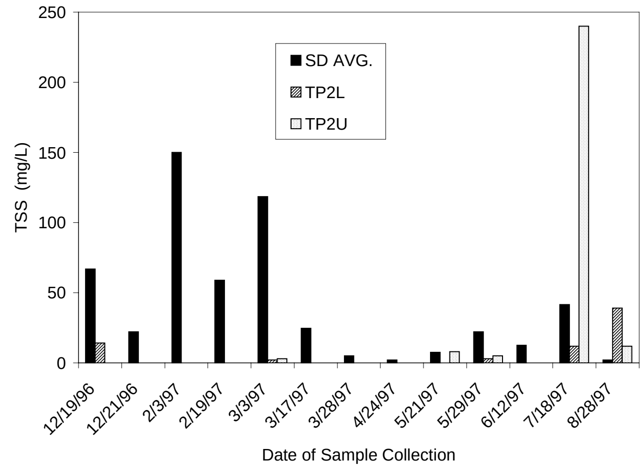
5.3 Chemical Oxygen Demand (COD)

Chemical oxygen demand (COD) was measured on the test plot influent (slot drain) and discharge (surface and subsurface collection points) samples. COD analysis gives an indication of the "gross" organic carbon present in the sample. Although the procedure is limited in that it has a minimum detection limit of approximately 5 mg/L and it does not define individual organic compounds, COD data can yield useful information. For example, metal transport in the subsurface can be significantly impacted by the presence of natural organic matter (primarily humic and fulvic acids), the result of decaying vegetation (Jordan, R. N. et al., 1997; Igloria, R. V. 1995; Newman,

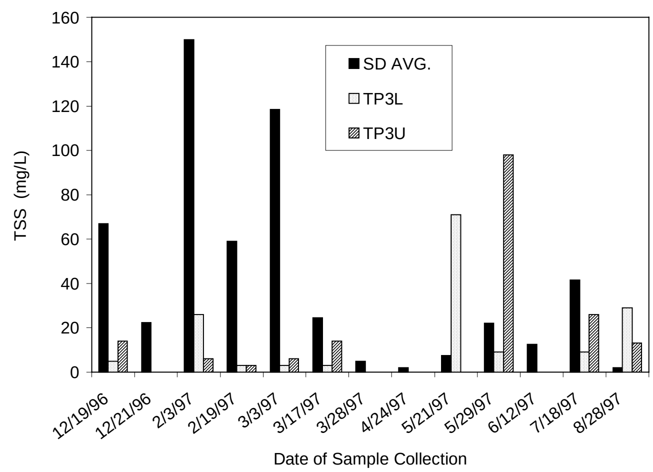
M. E. et al., 1993; Oden, W. I. et al., 1993). If the concentration of natural organic matter is above 5 mg/L, COD data could correlate to soluble or total aqueous phase metal concentration.



(a)



(b)



(c)

Figure 5. TSS values for test plot 1, 2, and 3 compared to the slot drain (test plot influent) averages. TP2L and TP2U refers to test plot 2 lower (subsurface) collection and upper (surface) collection points, respectively.

The data presented in Figure 6a indicate that test plot 1, containing Nutra Mulch, has a statistically significant, greater average COD concentration in the subsurface discharge than the other test plots. The average COD in TP1L over the duration of the study was 29.6 mg/L ± 14.2 mg/L compared to an average of 6.7 mg/L ± 2.5 mg/L and 9.4 mg/L ± 4.0 mg/L for TP2L and TP3L, respectively. It is not unexpected that TP1 yields the greatest COD concentration since the test plot is filled with an organic compost material that could contribute significantly to dissolved organic matter in the infiltrating water. These data also indicate that there is no significant difference in the average COD concentration in the subsurface discharge for test plot 1 and 2 over the entire study period. The data in Figure 6b show that, in general TP1 and TP2 surface runoff COD concentration is less than the test plot influent (slot drain) concentration.

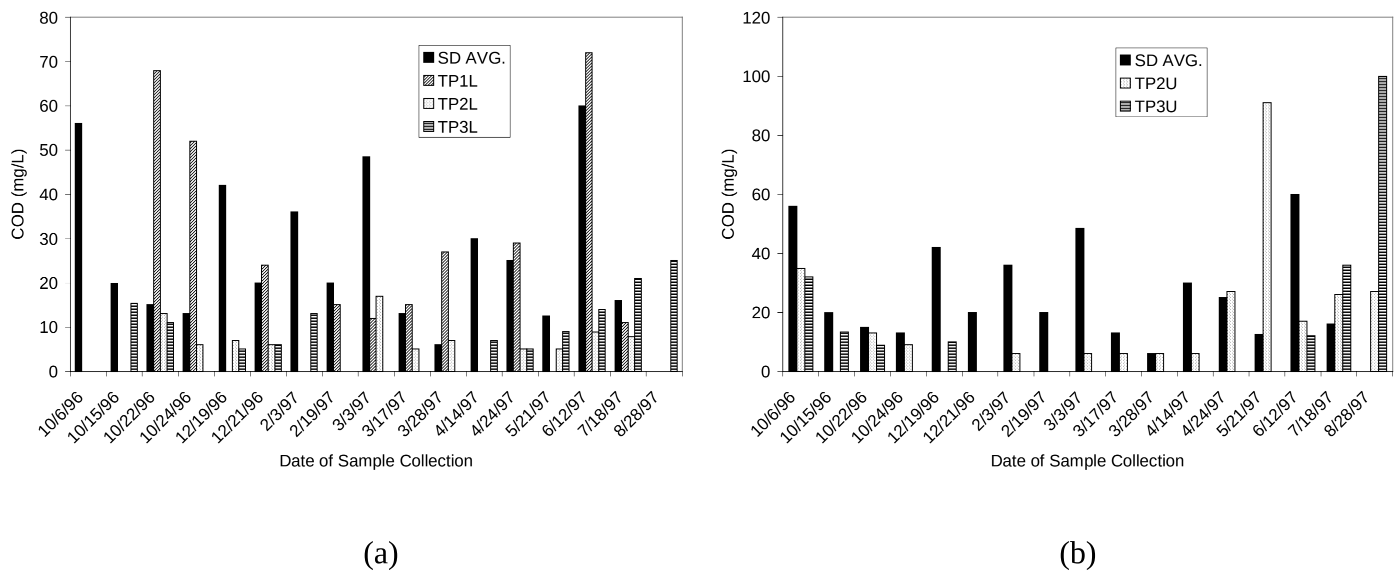
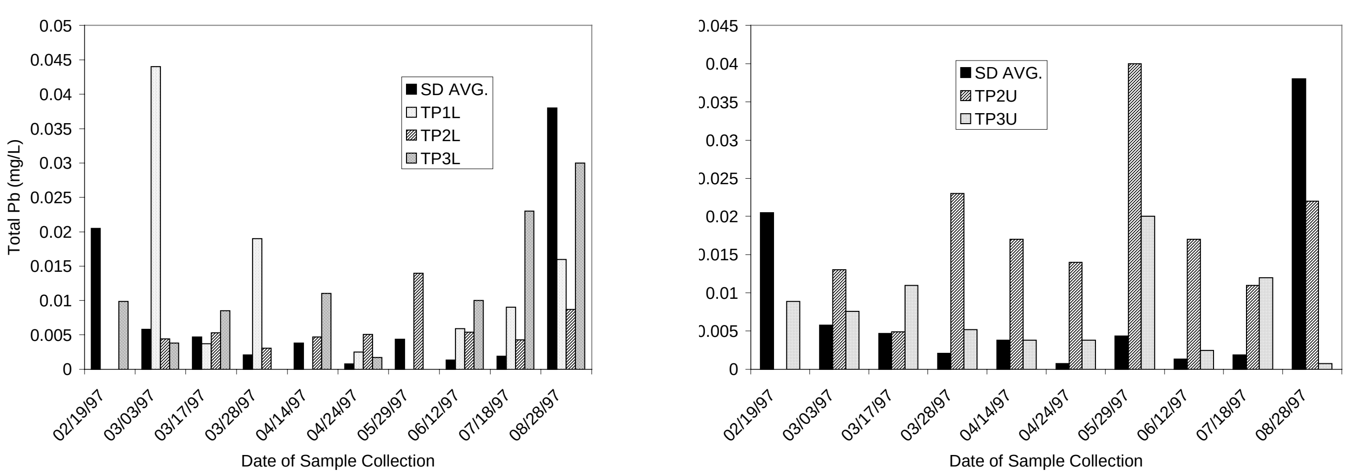


Figure 6. COD concentrtion in the test plot influent, suface and subsurface collection points: (a) subfurace COD concentrations, (b) surface COD concentrations.

5.4 Metals

The metals (Cd, Cu, Pb, and Zn) data appear somewhat anomalous in that the slot drain concentrations are generally *less* than the test plot discharge concentrations over the entire sampling period. As an example, the data in Figure 7 indicate that during most sampling events, the total lead concentrations in the surface and subsurface sample collection points are greater than the average slot drain concentration. The average total Pb concentration in the slot drain samples was 0.0083 mg/L ± 0.0074 mg/L compared to an average total Pb concentration of 0.0143 mg/L ± 0.0107 mg/L in TP1L, for example. When consideration is given to the overall test plot TSS removal of 72 percent and the high partitioning of most metals on solids, the *increase* in metal concentration from the test plot influent to discharge is unexpected. Two points are important in the data interpretation, however. The metal concentrations are (i) low (maximum of 45 μg/L) and (ii) highly variable. Note that the confidence intervals for the cited Pb concentrations are very broad. In fact, the differences between the influent and discharge concentrations for most sampling events are not statistically significant ($\alpha = 0.05$).

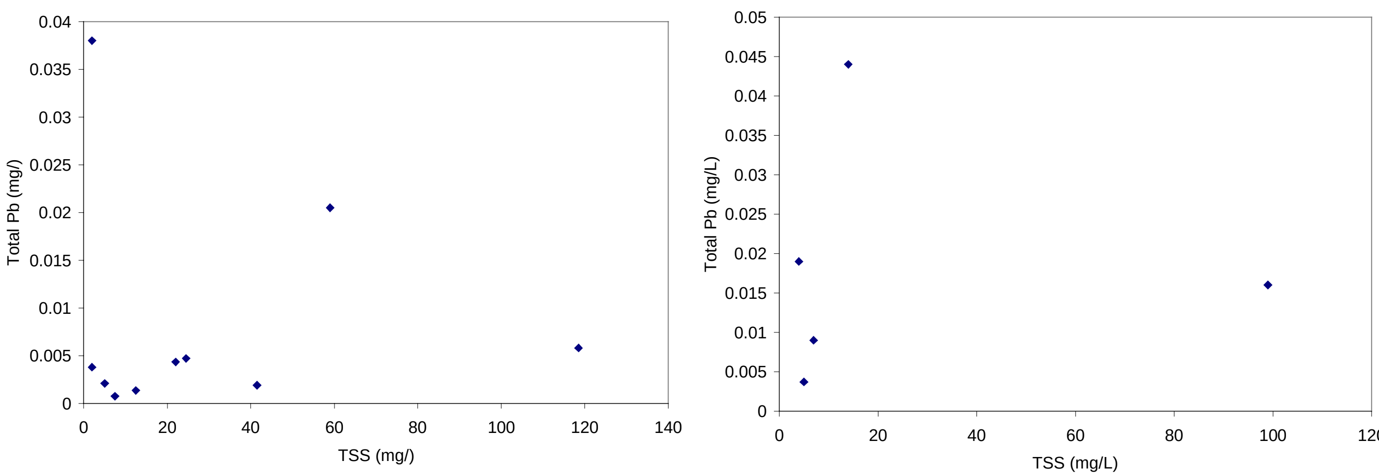


(a) (b)

Figure 7. Total Pb concentration in the test plot influent (slot drain) and test plot subsurface (lower) collection points (a) and surface (upper) collection points (b).

An additional factor that should be considered is that the slot drains (yielding samples that represent test plot influent) trapped a significant amount of sediment within the collection system. This sediment was not, therefore, transported to the composite sample container and resulted in artificially low influent TSS and metal concentrations. In turn, this resulted in low estimates of percent concentration reduction and could have been the primary cause of the observed negative metal reductions. Additional discussion regarding this impact is presented in section 5.4.1.

In general, metal concentrations in the low μg/L range can be significantly affected by the presence of trace concentrations of solids or dissolved organic matter. Consequently, correlations of total metal concentration with TSS and COD were investigated. The data in Figure 8a indicate that no apparent correlation exists between slot drain (test plot influent) total Pb concentration and TSS. A similar lack of correlation was observed for Cd, Cu, and Zn. The data in Figure 8b also indicate a lack of correlation between test plot subsurface discharge (TP1L) total Pb concentration and TSS. Similarly, no metal-TSS correlation was found for Cd, Cu, and Zn in the three test plots. The same lack of correlation with metal concentration and COD was also observed for the slot drain and test plots. A representative plot of total Pb - COD correlation is presented in Figure 9.



(a) (b)

Figure 8. Total Pb concentration as a function of TSS for test plot influent (slot drain) (a) and TP1 subsurface discharge (b).

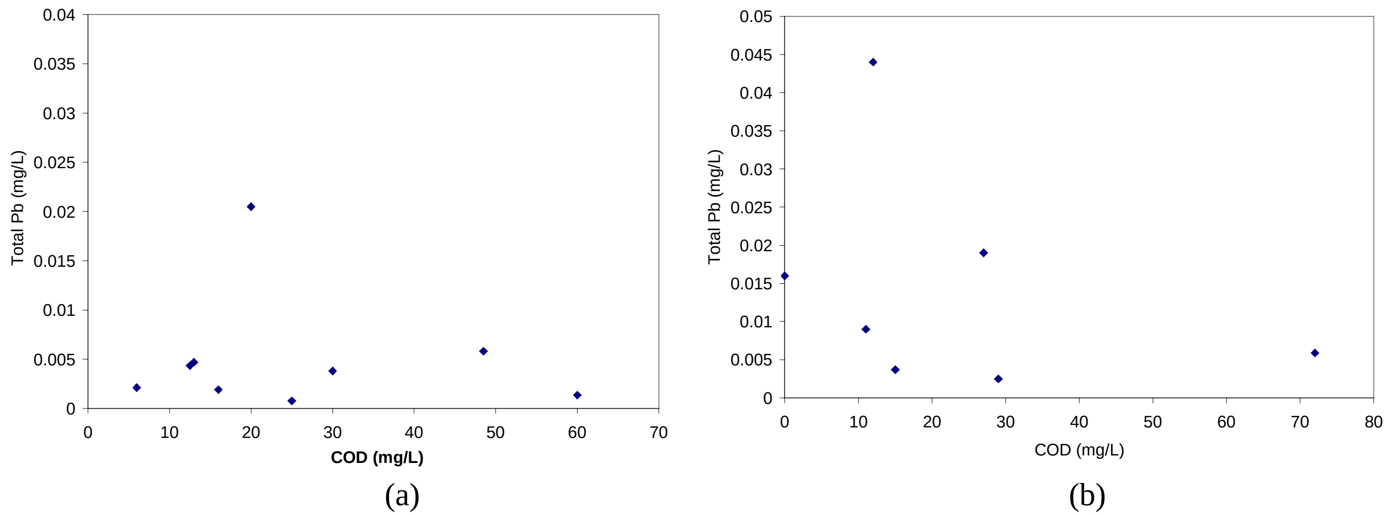


Figure 9. Total Pb concentration as a function of COD for test plot influent (slot drain) (a) and TP1 subsurface discharge (b).

5.4.1 Second Sampling Campaign (November 1998 - January 1999)

Additional samples were collected during a second sampling campaign in an effort to explain the apparent lack of metal retention in the test plots. The slot drain collection system was observed to "trap" a significant quantity of highway runoff sediment. The sediment that accumulated in each of the two slot drains was cleaned out before the initiation of the second sampling campaign and approximately 2 Kg of this material was shipped to Washington State University for analysis. Sieve analysis yielded the information presented in Table 8. This data was used to develop the particle size distribution presented in Figure 10.

Table 8. Percent (w/w) retained on each sieve for the slot drain sediment.

Sieve Number	Opening Size (mm)	Percent Retained
4	4.76	19.16
10	2.00	17.90
60	0.25	38.43
200	0.074	16.52
<200	--	8.00

Metal analysis of the material retained on sieve number 60, 200 and <200 is presented in Figure 11. These data show that the smallest size fraction of soil contain the highest concentration of metals. This finding is consistent with findings from numerous researchers (Roger, S. et al., 1998; Characklis, G. W. and Wiesner, M. R. 1997; Greb, S. R. and Banner, R. T. 1997; Sansalone, J. J. and Buchberger, S. G. 1997; Cole, W. C. and Yonge, D. R. 1993). In fact, the slot drain sediment data show that the smallest size fraction (<0.074mm) constitute only 8 percent of the total mass of material but contains 48.6, 46.2, and 50.5 percent of the Zn, Cu, and Pb, respectively (Table 9). Note that Cd is not presented, as it was not detected above the method detection limit of approximately 0.04 mg/L for aqueous samples and 2.5 mg/Kg for sediment samples.

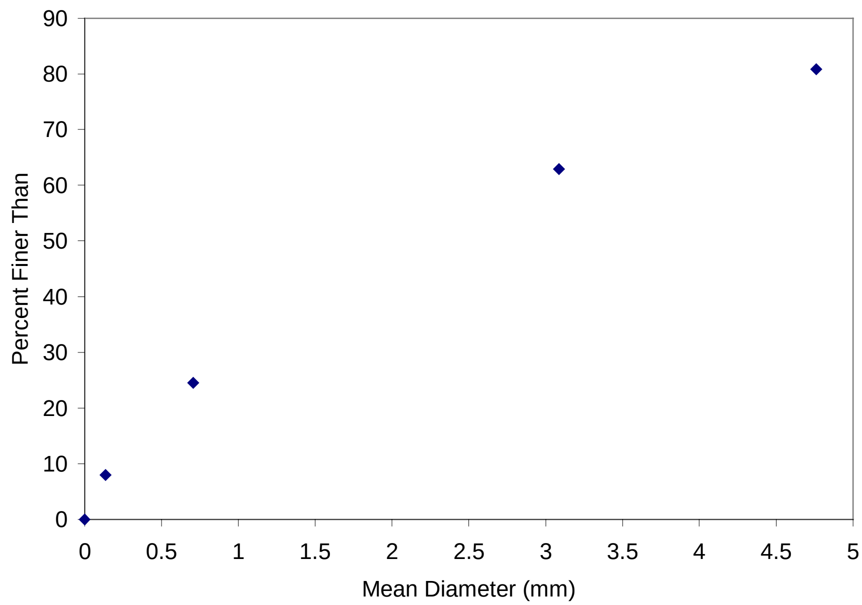


Figure 10. Particle size distribution for the sediment retained in the slot drain collection system.

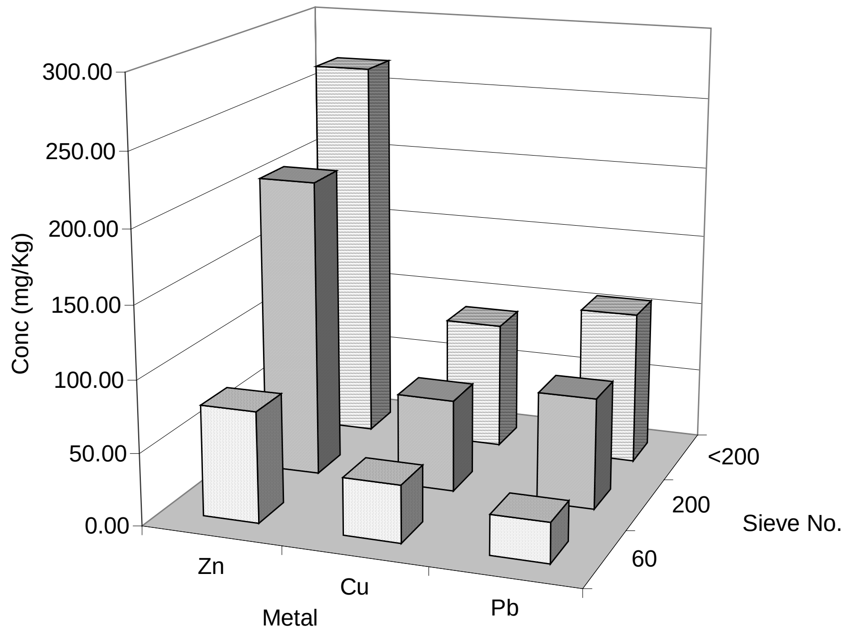


Figure 11. Metal concentration for material retained on sieve number 60, 200, and <200. Note: Cd is not listed as it was below the method detection limit of approximately 2.5 mg/Kg.

Table 9. Percent metal partitioned on sediment retained on three sieve sizes.

Sieve Number	Cu (%)	Pb (%)	Zn (%)
60	20.5	13.1	13.9
200	33.3	36.3	37.5
<200	46.2	50.5	48.6

Total suspended solids and metal analysis was also performed on test plot samples received in November 1998 and January 1999 (Table 10). The TSS values were relatively low in the slot drain samples, yielding values of 15.4 mg/L and 44.2 mg/L for the two sampling periods. The test plot TSS values were also low, and when compared to the slot drain TSS, yielded overall concentration reductions of 93.5 percent and 96.5 percent for the respective November and January sampling periods. The percent concentration reduction was higher during the second sampling campaign than the first, which yielded an overall TSS concentration reduction of 72 percent.

Table 10. TSS values (mg/L) for the second sampling campaign.

Date Received	Slot Drain	Test Plot 1		Test Plot 2		Test Plot 3	
		Surface	Sub-surface	Surface	Sub-surface	Surface	Sub-surface
11/15/98	15.4 ±2.9	--	0.73 ±0.06	0.85 ±0.06	0.65 ±0.17		1.75 ±0.30
1/6/99	44.2 ±1.4	--	2.57 ±0.13	1.60 ±0.20	1.93 ±0.64	0.62 ±0.36	1.05 ±0.11

Note: Confidence intervals are calculated at $\alpha = 0.05$ for three replicates

Settling column tests performed on the slot drain discharge samples indicated that approximately 60 percent of the solids had a diameter greater than 0.0023 mm and the remaining 40 percent had a diameter less than 0.0023. Based on the slot drain sediment sample analysis, this indicates that the slot drain captured sediment and prevented a representative test plot influent sample from being collected. Had representative samples been collected, percent metal concentration reduction would have likely been positive instead of the negative values calculated during the first sampling campaign. This argument is supported by the data in Table 8 that indicate almost 63 percent (62.95 %) of the sediment unintentionally trapped in the slot drain had a particle diameter of 0.25 mm or less and contained the following mass of metals (Table 11).

Table 11. Mass of metals trapped in the slot drain collection system per Kg of sediment.

Metal	Mass trapped per Kg of sediment (mg)
Cu	193
Pb	212
Zn	553

As can be seen, this could constitute a significant decrease in the metal concentration reported in the aqueous phase slot drain samples (representing the influent to the test plots), resulting in extremely conservative estimates of metal retention in the test plots.

Unfortunately, however, it is not possible to determine the total mass of sediment retained in the slot drains over the duration of the study with the available data.

A summary of the total metal concentration data for the slot drain and test plot discharge are presented in Table 12. The only metal that yielded concentrations above the method detection limit (approximately 0.04 mg/L for Cu, Cd, Zn, and 0.07 mg/L for Pb) was Zn. The data in Table 12 indicate that test plot 1 (Nurtra Mulch) yielded greater Zn discharge concentrations than the slot drain (test plot influent). All other test plot samples were below the method detection limit. The relatively high Zn concentrations exiting test plot 1 may be a result of the high background Zn concentration (45.0 mg/Kg) of the Nurtra Mulch. Test plot 2 and test plot 3 had respective background concentrations of 8.4 mg/Kg and 3.0 mg/Kg.

Table 12. Summary of total Zn concentration during the second sampling campaign.

Date	SD	TP1L[1]	TP2L	TP2U[2]	TP3L	TP3U
11/15/97	0.408	0.539	ND[3]	ND	ND	ND
1/6/98	0.051	0.106	ND	ND	ND	ND

[1] "L" denotes subsurface runoff collection point
[2] "U" denotes surface runoff collection point
[3] ND denotes below method detection limit of approximately 0.04 mg/L.

5.5 Total Petroleum Hydrocarbons

The data in

Figure 12 indicate that TPH was detected relatively few times over the study period and that TPH concentration in the slot drain is significantly greater than the test plot discharge concentration during most sampling events. There were only four test plot discharge samples with TPH concentration greater than or equal to the detection limit of 1 mg/L while slot drain concentrations were as high as 9 mg/L.

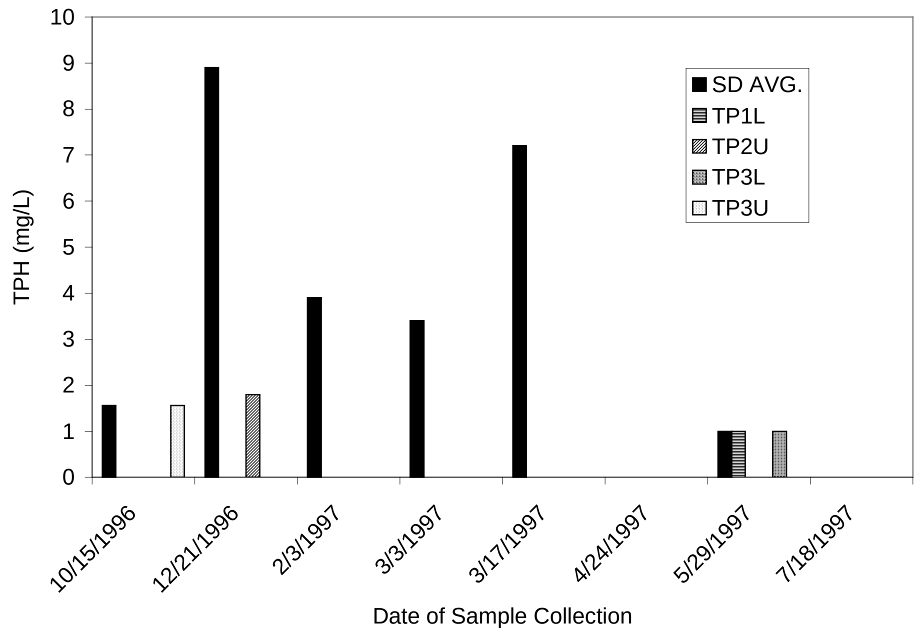
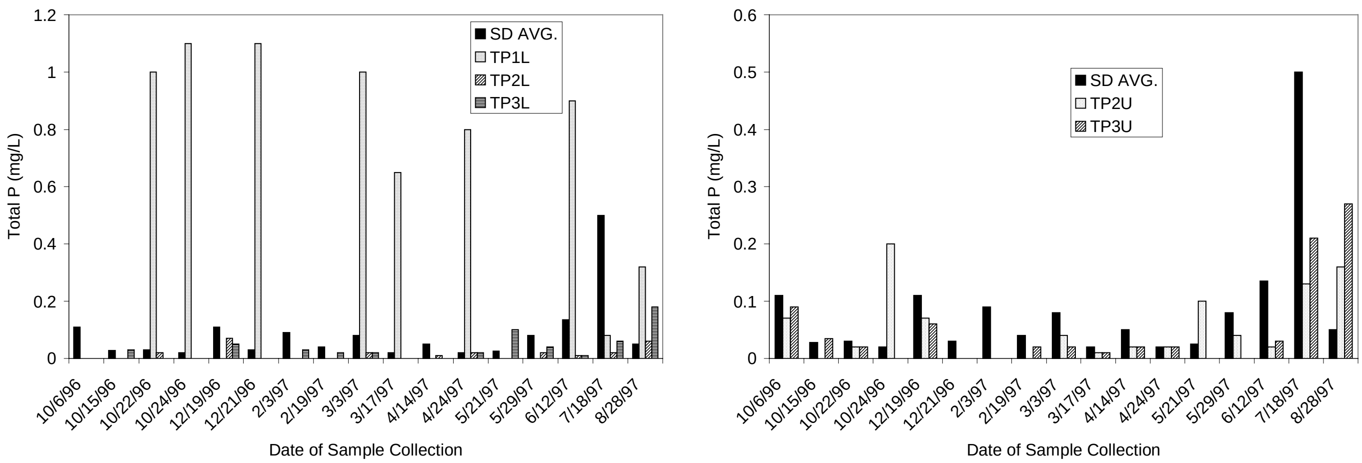


Figure 12. Total petroleum hydrocarbon concentrations over the entire study period.

5.6 Nutrients

Although HVS (referred to as a vegetative filter strip in the WSDOT Highway Runoff Manual) is not designed for nutrient control, information can be gained from the nutrient data collected over the course of this study (WSDOT ,1995). The data in Figure 13a indicate that test plot 1 subsurface P concentration is significantly greater than the other test plots as well as the slot drain average. Over the study period, average P concentration in the slot drain, and subsurface of test plot 1, 2, and 3 was 0.08 mg/L ±0.05 mg/L, 0.36 mg/L ±0.22 mg/L, 0.02 mg/L ±0.01 mg/L, and 0.05 mg/L ± 0.03 mg/L, respectively. The data in Figure 13b allow comparison of the slot drain average P concentration to the surface runoff P concentration from test plot 2 and 3. No statistically significanct difference between surface and subsurface P concentration was detected. Additionally, no apparent trend in season concentration was observed.



(a) (b)

Figure 13. Total phosphorous data for the slot drains and subsurface (a) and surface runoff (b).

Average nitrate concentration in the slot drain and test plot discharge concentrations are presented in Figure 14. No apparent seasonal trend or trend between test plots was observed.

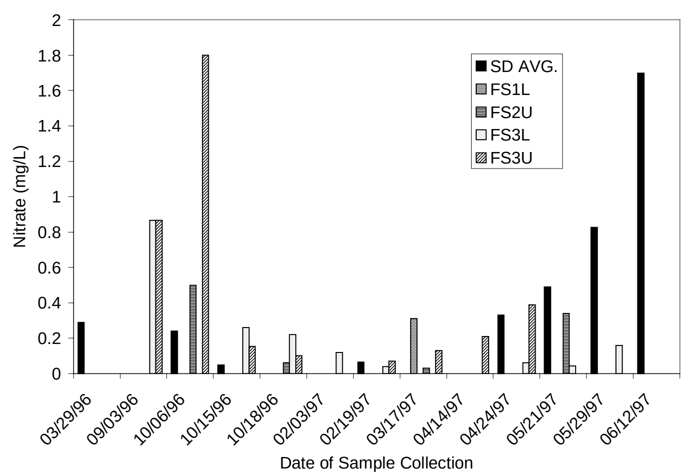


Figure 14. Nitrate concentration data for the slot drain average and test plots.

6 CONCLUSIONS

The three test plots behaved as expected hydraulically, based on the test plot material sand, silt and clay fractions. Test plot 1, containing a non-soil compost (Nutra Mulch) exhibited the highest permeability and never generated measurable surface flow. Test plot 2, having a higher sand and lower silt content than test plot 3, exhibited higher levels of subsurface flow and lower surface flow than test plot 3. The test plots all exhibited background metal concentrations within the range of values determined for Washington State soils.

All the test plots exhibited good TSS concentration reduction with an overall average of 72 percent. No significant difference in TSS concentration reduction was observed between the subsurface and surface test plot samples. In general, it would be expected that subsurface flow would exhibit a lower TSS concentration than surface flow due to the filtering ability of the test plot soil. The vegetated surface can also act as a filter but, given sufficient time, runoff sediment could build up and begin migrating to the down gradient end of the filter strip.

The test plots exhibited an excellent ability to reduce TPH concentration. In fact, there were only four samples from the test plot discharge that had concentrations equal to or greater than the detection limit of 1 mg/L. Metal concentration reduction data, however, did not turn out as expected. Normally, it can be safely assumed that if effective suspended solids removal is attained, effective metal removal will also be realized; a result of the high partition coefficient for most metals (the exception often being Zn) on soil/sediment. However, almost all the samples exhibited greater metal concentrations in the test plot discharge points when compared to the average slot drain concentration. Possible explanations for this anomalous behavior were investigated. Correlations of metal concentration to TSS and COD were evaluated to see if the total metal concentration increased as TSS or COD increased. No such correlation was observed, however.

An additional sampling campaign was initiated in November 1997 in an effort to gain a better understanding of the observed metal retention phenomenon. Sediment that had collected in the slot drain was removed and a representative sample analyzed. This analysis indicated that a significant percentage of particles trapped in the slot drain were

<0.25 mm and possessed relatively high metal concentrations, yielding 193 mg Cu, 212 mg Pb, and 553 mg Zn per Kg of sediment. The mass of metals being unintentionally retained in the slot drain were not transported to the composite collection bucket and resulted in lower TSS and metal concentrations in the liquid phase composite, slot drain samples. This is a likely explanation of the anomalous metal results. With the slot drain acting, in essence, as a pretreatment device, the measured metal concentrations representing the test plot inflow, were unrealistically low (e.g., an overall average slot drain concentration of 0.0083 mg/L for Pb and 0.084 mg/L for Zn (total metal)). This resulted in low (in most cases negative) concentration reduction values across the test plots. It should be noted, however, that the test plot discharge concentrations for Cd, Cu, and Pb never exceeded 0.045 mg/L. In fact, the overall average Pb concentration for all test plot discharge samples was 0.0086 mg/L and Zn (often found in relatively high concentrations in WA) was only 0.28 mg/L. The magnitude of the metal concentrations entering and exiting the test plots, combined with known national averages and the measured mass of metals retained within the slot drain collection system, strongly suggests that sediment entrapment within the slot drain system caused the anomalous metal data. Based on this analysis, the VHS yields concentration reductions for metals that are greater than the data indicate.

7 ACKNOWLEDGEMENTS

The author expresses his appreciation for the opportunity to be a part of this project. WSDOT personnel were heavily involved in the sample collection during both sampling campaigns and without their diligence over many months of field sampling, the project would not have been possible. Special thanks go to Edward Molash for his perseverance and ability to keep the project on track. The author would also like to recognize the contributions of Kevin Timmins and Steven King, students from WSU who participated in many phases of the project.

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9 APPENDIX I - RAW DATA FOR THE 1996 - 1997 SAMPLING PERIOD

Location	Slot Drain #1 (SD1)				Slot Drain #1 (SD1)				Slot Drain #2 (SD2)				(SD2)				FS3	
Date	3/29/96				6/14/1996				6/14/1996				6/18/1996				9/3/1996	
Analyses	**Standard (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**	**Method**
Metals																		
Cadmium																		
dissolved	--	6010	ND	0.050	--	6010	0.000554	0.000100	--	6010	0.000500	0.000100	--	6010 / 7000	0.000416	0.000100	--	7131A
particulate	--	calc.	ND	--	--	calc.	0.000047	--	--	calc.	0.000151	--	--	calc.	0.000026	--	--	--
total	0.0002	6010	ND	0.050	NA	6010	0.000601	0.000100	NA	6010	0.000651	0.000100	NA	6010 / 7000	0.000442	0.000100	0.0003	7131A
Copper																		
dissolved	--	6010	ND	0.025	--	6010	0.05980	0.00100	--	6010	0.06200	0.00100	--	6010 / 7000	0.03230	0.00100	--	7211
particulate	--	calc.	> 0.005	--	--	calc.	0.01200	--	--	calc.	0.03100	--	--	calc.	0.01420	--	--	calc.
total	0.0023	6010	0.030	0.025	NA	6010	0.07180	0.00100	NA	6010	0.09300	0.00100	NA	6010 / 7000	0.04650	0.00100	0.0036	7211
Lead																		
dissolved	--	6010	ND	0.050	--	6010	0.00810	0.00200	--	6010	0.00221	0.00200	--	6010 / 7000	ND	0.00200	--	7421
particulate	--	calc.	ND	--	--	calc.	0.00470	--	--	calc.	0.02389	--	--	calc.	0.00490	--	--	calc.
total	0.0025	6010	ND	0.050	NA	6010	0.01280	0.00200	NA	6010	0.02610	0.00200	NA	6010 / 7000	0.00690	0.00200	0.0047	7421
Zinc																		
dissolved	--	6010	0.060	0.020	--	6010	0.2410	0.0200	--	6010	1.3600	0.0200	--	200	0.1450	0.0200	--	6010A
particulate	--	calc.	0.070	--	--	calc.	-0.0080	--	--	calc.	-0.1700	--	--	calc.	-0.0020	--	--	calc.
total	0.0152	6010	0.130	0.020	NA	6010	0.2330	0.0200	NA	6010	1.1900	0.0200	NA	200	0.1430	0.0200	0.0230	6010A
General & Wet Chemistry	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)	
Biological Oxygen Demand	--	--	--	--	--	--	--	--	--	--	--	--	--	--	13.1	1.00	--	405.1
Chemical Oxygen Demand	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	410.4
Hardness	--	130.2	12	13	--	--	--	--	--	--	--	--	--	--	--	--	--	SM2340B
Nitrate Nitrogen	10	300.0	0.29	0.05	10	--	--	--	10	300.0	--	0.05	10	--	--	--	10	300.0
Nitrate + Nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Orthophosphate	--	300.0	ND	0.05	--	--	--	--	--	300.0	--	0.05	--	--	--	--	--	365.1
Total Phosphorus	4	300.0	0.03	0.01	4	--	--	--	4	300.0	--	0.01	4		--	--	4	365.1
Physical	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)	
Total Suspended Solids	45	160.2	62	10	45	160.2	50	5.0	45	160.2	140	5.0	45	--	36	5.0	45	160.2
Total Dissolved Solids	--	160.1	110	10	--	160.1	290	10	--	160.1	200	10		160.1	120	10	--	160.1
Total Solids	--	calc.	172	--	--	calc.	340	--	--	calc.	340	--	--	calc.	156	--	--	calc.
Hydrocarbons	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)	
Total Petroleum Hydrocarbons	12	418.1	2.90	1.00	12	418.1	1.23	1.00	12	418.1	ND	1.00	--	--	--	--	12	--

1. First flush sample collected into 5 gallon bucket during first 30 minutes of rain event.

2. Composite sample collected into 5 gallon bucket. Sample collected after rain event. Possible overflow of sample.

3. Composite sample collected into 5 gallon bucket. A portion of the flow stream was diverted into a collection bucket using a notched tube inserted vertically into the flow stream.

4. SD refers to slot drain collection system samples

5. FS refers to filter strip or test plot samples

6. L refers to the subsurface runoff

7. U refers to the surface ruonff

Location			(SD1)				FS2U				FS3U				SD1			
Date			10/6/96				10/6/1996				10/6/1996				10/15/96			
Analyses	Result	PQL	Standard	Method	Result	PQL	Standard	Method	Result	PQL	Standard	Method	Result	PQL	Standard	Method	Result	PQL
Metals	(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)
Cadmium																		
dissolved	ND	0.000100	--	6010	ND	0.01	--	6010	ND	0.01	--	6010	ND	0.01	--	7131A	0.000366	0.000100
particulate	--	--	--	calc.	ND	--	--	--	--	--	--	--	--	--	--	calc.	0.000475	--
total	ND	0.000100	0.0001	6010	ND	0.01	0.0002	6010	ND	0.01	0.0003	6010	ND	0.01	0.0001	7131A	0.000841	0.000100
Copper																		
dissolved	0.01610	0.00100	--	6010	ND	0.025	--	6010	ND	0.025	--	6010	ND	0.025	--	7211	0.00728	0.00100
particulate	0.01020	--	--	calc.	>.010	--	--	--	--	--	--	--	--	--	--	--	0.00402	--
total	0.02630	0.00100	0.0017	6010	0.034	0.025	0.0024	6010	ND	0.025	0.0030	6010	ND	0.025	0.0008	7211	0.0113	0.00100
Lead																		
dissolved	ND	0.00200	--	6010	ND	0.05	--	6010	ND	0.050	--	6010	ND	0.05	--	7421	ND	0.00200
particulate	>0.01910	--	--	calc.	ND	--	--	--	--	--	--	--	--	--	--	--	>0.00780	--
total	0.02110	0.00200	0.0017	6010	ND	0.05	0.0028	6010	ND	0.050	0.0037	6010	ND	0.05	0.0007	7421	0.00980	0.00200
Zinc				calc.				calc.										
dissolved	ND	0.0200	--	6010	0.0460	0.0200	--	6010	0.34	0.02	--	6010	0.074	0.020	--	6010A	0.0697	0.0200
particulate	>0.0427	--	--	calc.	0.0940	--	--	calc.	0.05	--	--	calc.	0.360	--	--	--	--	--
total	0.0627	0.0200	0.0117	6010	0.1400	0.0200	0.0162	6010	0.39	0.02	0.0194	6010	0.110	0.020	0.0062	6010	0.0719	0.0200
General & Wet Chemistry	(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)
Biological Oxygen Demand	26.5	1.00	--	--	--	--	--	405.1	4	4	--	405.1	ND	4	--	405.1	4.81	1.00
Chemical Oxygen Demand	130	20.0	--	410.1	56	5	--	410.1	35	5	--	410.1	32	0.05	--	410.4	19.9	10.0
Hardness	19.6	0.0500	--	130.2	9	2	--	130.2	13	2	--	130.2	16	2	--	2340B	4.17	1.0
Nitrate Nitrogen	0.867	0.0500	10	300.0	0.24	0.05	10	300.0	0.5	0	10	300.0	1.8	0.05	10	300.0	<.0500	0.0500
Nitrate + Nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Orthophosphate	ND	0.00300	--	300.0	ND	0.05	--	300.0	ND	0	--	300.0	ND	0.05	--	365.2	<.00200	0.00200
Total Phosphorus	0.362	0.0100	4	365.1	0.11	0.01	4	365.1	0.07	0	4	365.1	0.09	0.01	4	365.1	0.0278	0.00500
Physical	(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)
Total Suspended Solids	40	10	45	160.2	76	5	45	160.2	10	5	45	160.2	8	5	45	160.2	82	5.0
Total Dissolved Solids	110	10	--	160.1	ND	10	--	160.1	16	5	--	160.1	17	5	--	160.1	15	10
Total Solids	150	--	--	calc.	<86	--	--	calc.	26	--	--	calc.	25	--	--	160.3	89	10
Hydrocarbons	(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)
Total Petroleum Hydrocarbons	ND	1.00	12	--	--	--	12	418.1	ND	1.1	12	418.1	ND	1.0	12	418.1	1.56	1.00

1. First flush sample collected into 5 gallon bucket during first 30 minutes of rain event.

2. Composite sample collected into 5 gallon bucket. Sample collected after rain event. Possible overflow of sample.

3. Composite sample collected into 5 gallon bucket. A portion of the flow stream was diverted into a collection bucket using a notched tube inserted vertically into the flow stream.
4. SD refers to slot drain collection system samples
5. FS refers to filter strip or test plot samples
6. L refers to the subsurface runoff
7. U refers to the surface ruonff

Location	FS3U				FS3L				FSRG				FS1L				FS2U	
Date	**10/15/1996**				**10/15/1996**				**10/15/1996**				**10/18/1996**				**10/18/1996**	
Analyses *Metals*	**Standard (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**	**Method**
Cadmium																		
dissolved	--	7131A	0.000428	0.000100	--	7131A	0.000641	0.000100	--	7131A	<.000300	0.000100	--	6010	ND	0.01	--	6010
particulate	--	calc.	--	--	--	calc.	--		--	--	--	--	--	--	--	--	--	--
total	0.0000	7131A	0.000780	0.000100	0.0004	7131A	0.000916	0.000100	NA	--	--	--	0.0008	6010	ND	0.01	0.0001	6010
Copper																		
dissolved	--	7211	0.00156	0.00100	--	7211	0.00228	0.00100	--	7211	0.00232	0.00100	--	6010	ND	0.025	--	6010
particulate	--	calc	--	--	--	calc.	--		--	--	--	--	--	calc.	>0.0310	--	--	--
total	0.0006	7211	0.0031	0.00100	0.0038	7211	0.00371	0.00100	NA	--	--	--	0.0073	6010	0.056	0.025	0.0012	6010
Lead																		
dissolved	--	7421	ND	0.00200	--	7421	ND	0.00200	--	7421	<.00200	0.00200	--	6010	ND	0.05	--	6010
particulate	--	calc	--	--	--	calc.	--		--	--	--	--	--	calc.	--	--	--	--
total	0.0005	7421	0.0102	0.00200	0.0051	7421	0.00305	0.00200	NA	--	--	0.002	0.0125	6010	0.079	0.05	0.0010	6010
Zinc																		
dissolved	--	6010A	ND	0.0200	--	6010A	0.0441	0.0200	--	6010A	ND	0.0200	--	6010	0.026	0.02	--	6010
particulate	--	calc	--	--	--	calc.	--		--	--	--	--	--	calc.	0.023	--	--	calc.
total	0.0049	6010A	0.0217	0.0200	0.0243	6010A	0.0589	0.0200	NA	--	--	--	0.0438	6010	0.049	0.02	0.0084	6010
General & Wet Chemistry	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)	
Biological Oxygen Demand	--	405.1	2.36	1.00	--	405.1	1.78	1.00	--	--	--	--	--	405.1	4.1	4	--	405.1
Chemical Oxygen Demand	--	410.4	13.3	10.0	--	410.4	15.4	10.0	--	--	--	--	--	410.1	85	5	--	410.1
Hardness	--	2340B	3.15	1.00	--	2340B	20.9	1.00	--	--	--	--	--	130.2	42	3	--	130.2
Nitrate Nitrogen	10	300.0	0.154	0.0500	10	300.0	0.261	0.0500	10	--	--	--	10	300.0	ND	0.05	10	300.0
Nitrate + Nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		--	--
Orthophosphate	--	365.2	0.00323	0.00200	--	365.2	<.00200	0.00200	--	--	--	--	--	300.0	0.88	0.05	--	300.0
Total Phosphorus	4	365.1	0.0345	0.00500	4	365.1	0.0293	0.00500	4	--	--	--	4	365.1	0.94	0.1	4	365.1
Physical	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)	
Total Suspended Solids	45	160.2	8.0	5.0	45	160.2	28	5.0	45	--	--	--	45	160.2	16	5	45	160.2
Total Dissolved Solids	--	160.1	20	10	--	160.1	75	10	--	--	--	--	--	160.1	100	5	--	160.1
Total Solids	--	160.3	15	10	--	160.3	79	10	--	--	--	--	--	calc.	116	--	--	calc.
Hydrocarbons	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)	
Total Petroleum Hydrocarbons	12	418.1	1.56	1.00	12	418.1	<1.00	1.00	--	--	--	--	12	418.1	ND	1.0	12	418.1

1. First flush sample collected into 5 gallon bucket during first 30 minutes of rain event.

2. Composite sample collected into 5 gallon bucket. Sample collected after rain event. Possible overflow of sample.

3. Composite sample collected into 5 gallon bucket. A portion of the flow stream was diverted into a collection bucket using a notched tube inserted vertically into the flow stream.
4. SD refers to slot drain collection system samples
5. FS refers to filter strip or test plot samples
6. L refers to the subsurface runoff
7. U refers to the surface ruonff

Location			FS2L				FS3U				FS3L				FS1L			
Date			**10/18/1996**				**10/18/1996**				**10/18/1996**				**10/22/1996**			
Analyses *Metals*	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**
Cadmium																		
dissolved	ND	0.01	--	6010	ND	0.01	--	6010	ND	0.01	--	6010	ND	0.01	--	6010	ND	0.01
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	ND	0.01	0.0005	6010	ND	0.01	0.0001	6010	ND	0.01	0.0004	6010	ND	0.01	NA	--	--	--
Copper																		
dissolved	ND	0.025	--	6010	ND	0.025	--	6010	ND	0.025	--	6010	ND	0.025	--	6010	0.034	0.025
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	ND	0.025	0.0048	6010	ND	0.025	0.0010	6010	ND	0.025	0.0040	6010	ND	0.025	NA	--	--	--
Lead																		
dissolved	ND	0.05	--	6010	ND	0.05	--	6010	ND	0.05	--	6010	ND	0.05	--	6010	ND	0.05
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	ND	0.05	0.0071	6010	ND	0.05	0.0008	6010	ND	0.05	0.0055	6010	ND	0.05	NA	--	--	--
Zinc																		
dissolved	0.052	0.02	--	6010	0.024	0.02	--	6010	0.021	0.02	--	6010	ND	0.02	--	6010	0.024	0.02
particulate	0.020	--	--	calc.	0.012	--	--	calc.	0.007	--	--	--	--	--	--	--	--	--
total	0.072	0.02	0.0301	6010	0.036	0.02	0.0072	6010	0.028	0.02	0.0253	6010	ND	0.02	NA	--	--	--
General & Wet Chemistry	(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)
Biological Oxygen Demand	ND	4	--	405.1	ND	4	--	405.1	ND	4	--	405.1	ND	4	--	405.1	ND	4
Chemical Oxygen Demand	19	5	--	410.1	10	5	--	410.1	11	5	--	410.1	12	5	--	410.1	68	5
Hardness	6	2	--	130.2	27	2	--	130.2	5	2	--	130.2	22	2	--	--	--	--
Nitrate Nitrogen	0.06	0.05	10	300.0	ND	0.05	10	300.0	0.10	0.05	10	300.0	0.22	0.05	10	--	--	--
Nitrate + Nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	300.0	ND	0.10
Orthophosphate	ND	0.05	--	300.0	ND	0.05	--	300.0	ND	0.05	--	300.0	ND	0.05	--	300.0	1.1	0.05
Total Phosphorus	0.04	0.01	4	365.1	0.02	0.01	4	365.1	0.01	0.01	4	365.1	0.02	0.01	4	365.1	1.0	0.1
Physical	(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)
Total Suspended Solids	8	5	45	160.2	6	5	45	160.2	6	5	45	160.2	12	5	45	160.2	12	5
Total Dissolved Solids	7	5	--	160.1	34	5	--	160.1	30	5	--	160.1	50	5	--	160.1	61	5
Total Solids	15	--	--	calc.	40	--	--	calc.	36	--	--	calc.	62	--	--	calc.	73	--
Hydrocarbons	(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)
Total Petroleum Hydrocarbons	ND	1.0	12	418.1	ND	1.0	12	418.1	ND	1.0	12	418.1	ND	1.0	12	418.1	ND	1.0

1. First flush sample collected into 5 gallon bucket during first 30 minutes of rain event.

2. Composite sample collected into 5 gallon bucket. Sample collected after rain event. Possible overflow of sample.

3. Composite sample collected into 5 gallon bucket. A portion of the flow stream was diverted into a collection bucket using a notched tube inserted vertically into the flow stream.
4. SD refers to slot drain collection system samples
5. FS refers to filter strip or test plot samples
6. L refers to the subsurface runoff
7. U refers to the surface ruonff

Location	FS2U				FS2L				FS3U				FS3L				SD1	
Date	10/22/1996				10/22/1996				10/22/1996				10/22/1996				10/22/1996	
Analyses *Metals*	Standard (ppm)	Method	Result (ppm)	PQL (ppm)	Standard (ppm)	Method	Result (ppm)	PQL (ppm)	Standard (ppm)	Method	Result (ppm)	PQL (ppm)	Standard (ppm)	Method	Result (ppm)	PQL (ppm)	Standard (ppm)	Method
Cadmium																		
dissolved	--	6010	ND	0.01	--	6010	ND	0.01	--	6010	ND	0.01	--	6010	ND	0.01	--	6010
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	NA	--	--	--	NA	--	--	--	NA	--	--	--	NA	--	--	--	NA	--
Copper																		
dissolved	--	6010	ND	0.025	--	6010	ND	0.025	--	6010	ND	0.025	--	6010	ND	0.025	--	6010
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	NA	--	--	--	NA	--	--	--	NA	--	--	--	NA	--	--	--	NA	--
Lead																		
dissolved	--	6010	ND	0.05	--	6010	ND	0.05	--	6010	ND	0.05	--	6010	ND	0.05	--	6010
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	NA	--	--	--	NA	--	--	--	NA	--	--	--	NA	--	--	--	NA	--
Zinc																		
dissolved	--	6010	0.061	0.02	--	6010	ND	0.02	--	6010	ND	0.02	--	6010	ND	0.02	--	6010
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	NA	--	--	--	NA	--	--	--	NA	--	--	--	NA	--	--	--	NA	--
General & Wet Chemistry	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)	
Biological Oxygen Demand	--	405.1	ND	4	--	405.1	ND	4	--	405.1	ND	4	--	405.1	ND	4	--	405.1
Chemical Oxygen Demand	--	410.1	13	5	--	410.1	13	5	--	410.1	8.9	5.0	--	410.1	11	5	--	410.1
Hardness	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrate Nitrogen	10	--	--	--	10	--	--	--	10	--	--	--	10	--	--	--	10	--
Nitrate + Nitrite	--	300.0	ND	0.10	--	300.0	ND	0.10	--	300.0	ND	0.10	--	300.0	0.32	0.10	--	300.0
Orthophosphate	--	300.0	ND	0.05	--	300.0	ND	0.05	--	300.0	ND	0.05	--	300.0	ND	0.05	--	300.0
Total Phosphorus	4	365.1	0.02	0.01	4	365.1	0.02	0.01	4	365.1	0.02	0.01	4	365.1	ND	0.01	4	365.1
Physical	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)	
Total Suspended Solids	45	160.2	ND	5	45	160.2	ND	5	45	160.2	6	5.0	45	160.2	20	5	45	160.2
Total Dissolved Solids	--	160.1	ND	5	--	160.1	22	5	--	160.1	ND	5	--	160.1	16	5	--	160.1
Total Solids	--	--	--	--	--	calc.	<27	--	--	calc.	<11	--	--	calc.	36	--	--	calc.
Hydrocarbons	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)	
Total Petroleum Hydrocarbons	12	418.1	ND	1.0	12	418.1	ND	1.0	12	418.1	ND	1.0	12	418.1	ND	1.0	12	418.1

1. First flush sample collected into 5 gallon bucket during first 30 minutes of rain event.

2. Composite sample collected into 5 gallon bucket. Sample collected after rain event. Possible overflow of sample.

3. Composite sample collected into 5 gallon bucket. A portion of the flow stream was diverted into a collection bucket using a notched tube inserted vertically into the flow stream.

4. SD refers to slot drain collection system samples

5. FS refers to filter strip or test plot samples

6. L refers to the subsurface runoff

7. U refers to the surface ruonff

Location			FS1L				FS2U				FS2L				SD1			
Date			**10/24/1996**				**10/24/1996**				**10/24/1996**				**10/24/1996**			
Analyses	**Result**	**PQL**	**Standard**	**Method**	**Result**	**PQL**	**Standard**	**Method**	**Result**	**PQL**	**Standard**	**Method**	**Result**	**PQL**	**Standard**	**Method**	**Result**	**PQL**
Metals	**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**
Cadmium																		
dissolved	ND	0.01	--	6010	ND	0.01	--	6010	ND	0.01	--	6010	ND	0.01	--	6010	ND	0.01
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
total	--	--	NA	6010	ND	0.01	NA	6010	ND	0.01	NA	6010	ND	0.01	NA	6010	ND	0.01
Copper																		
dissolved	ND	0.025	--	6010	ND	0.025	--	6010	ND	0.025	--	6010	ND	0.025	--	6010	ND	0.025
particulate	--	--	--	calc.	--	--	--	--	--	--	--	--	--	--	--	--		
total	--	--	NA	6010	0.039	0.025	NA	6010	ND	0.025	NA	6010	ND	0.025	NA	6010	ND	0.025
Lead																		
dissolved	ND	0.05	--	6010	ND	0.05	--	6010	ND	0.05	--	6010	ND	0.05	--	6010	ND	0.05
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
total	--	--	NA	6010	ND	0.050	NA	6010	ND	0.05	NA	6010	--	0.05	NA	6010	ND	0.05
Zinc																		
dissolved	0.025	0.02	--	6010	ND	0.02	--	6010	0.06	0.02	--	6010	0.03	0.02	--	6010	0.03	0.02
particulate	--	--	--	--	--	--	--	calc.	0.01	--	--	calc.	0.00	--	--	calc.	0.00	
total	--	--	NA	6010	ND	0.02	NA	6010	0.07	0.02	NA	6010	0.03	0.02	NA	6010	0.03	0.02
General & Wet Chemistry	(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)
Biological Oxygen Demand	ND	4	--	405.1	ND	4	--	405.1	ND	4	--	405.1	ND	4	--	405.1	ND	4
Chemical Oxygen Demand	15	5	--	410.1	52	5	--	410.1	9	5	--	410.1	6	5	--	410.1	13	5
Hardness	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrate Nitrogen	--	--	10	300.0	ND	0.05	10	300.0	ND	0.05	10	300.0	ND	0.05	10	300.0	ND	0.05
Nitrate + Nitrite	ND	0.10	--	300.0	ND	0.10	--	300.0	ND	0.10	--	300.0	ND	0.10	--	300.0	0.10	0.10
Orthophosphate	ND	0.05	--	300.0	0.54	0.05	--	300.0	ND	0.05	--	300.0	ND	0.05	--	300.0	ND	0.05
Total Phosphorus	0.03	0.01	4	365.1	1.1	0.1	4	365.1	0.2	0.01	4	365.1	ND	0.01	4	365.1	0.02	0.01
Physical	(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)
Total Suspended Solids	18	5	45	160.2	6	3	45	160.2	ND	3	45	160.2	ND	3	45	160.2	13	3
Total Dissolved Solids	ND	5	--	160.1	120	5	--	160.1	26	5	--	160.1	50	5	--	160.1	16	5
Total Solids	<23	--	--	calc.	126	--	--	calc.	<29	--	--	calc.	<53	--	--	calc.	29	--
Hydrocarbons	(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)
Total Petroleum Hydrocarbons	ND	1.0	12	418.1	ND	1.0	12	418.1	ND	1.0	12	418.1	ND	1.0	12	418.1	ND	1.0

1. First flush sample collected into 5 gallon bucket during first 30 minutes of rain event.

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Location	RG1				FS2U				FS2L				FS3U				FS3L		
Date	12/1/1996				12/19/1996				12/19/1996				12/19/1996				12/19/1996		
Analyses *Metals*	Standard (ppm)	Method	Result (ppm)	PQL (ppm)	Standard (ppm)	Method	Result (ppm)	PQL (ppm)	Standard (ppm)	Method	Result (ppm)	PQL (ppm)	Standard (ppm)	Method	Result (ppm)	PQL (ppm)	Standard (ppm)	Method	Result (ppm)
Cadmium																			
dissolved	--	6020	ND	0.2	--	6020	ND	0.01	--	6020	ND	0.01	--	6020	ND	0.01	--	6020	ND
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	NA	--	--	--	NA	6020	ND	0.01	NA	6020	ND	0.01	NA	6020	ND	0.01	NA	6020	ND
Copper																			
dissolved	--	6020	ND	0.012	--	6020	ND	0.025	--	6020	ND	0.025	--	6020	ND	0.025	--	6020	ND
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	NA	--	--	--	NA	6020	ND	0.025	NA	6020	ND	0.025	NA	6020	ND	0.025	NA	6020	ND
Lead																			
dissolved	--	6020	ND	0.038	--	6020	ND	0.05	--	6020	ND	0.05	--	6020	ND	0.05	--	6020	ND
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	NA	--	--	--	NA	6020	ND	0.05	NA	6020	ND	0.05	NA	6020	ND	0.05	NA	6020	ND
Zinc																			
dissolved	--	6020	ND	0.015	--	6020	0.15	0.02	--	6020	ND	0.02	--	6020	0.064	0.02	--	6020	ND
particulate	--	--	--	--	--	calc.	0	--	--	calc.	>0.004	--	--	calc.	0.017	--	--	--	--
total	NA	--	--	--	NA	6020	0.15	0.02	NA	6020	0.024	0.02	NA	6020	0.081	0.02	NA	6020	ND
General & Wet Chemistry	(ppm)		(ppm)		(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)
Biological Oxygen Demand	--	--	--	--	--	405.1	ND	4	--	405.1	ND	4	--	405.1	ND	4	--	405.1	ND
Chemical Oxygen Demand	--	--	--	--	--	410.1	ND	5	--	410.1	7	5	--	410.1	10	5	--	410.1	5
Hardness	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrate Nitrogen	10	--	--	--	10	--	--	--	10	--	--	--	10	--	--	--	10	--	--
Nitrate + Nitrite	--	--	--	--	--	300.0	0.1	0.1	--	300.0	ND	0.1	--	300.0	ND	0.1	--	300.0	0.1
Orthophosphate	--	--	--	--	--	300.0	ND	0.05	--	300.0	ND	0.05	--	300.0	ND	0.05	--	300.0	ND
Total Phosphorus	4	--	--	--	4	365.1	0.07	0.01	4	365.1	0.07	0.01	4	365.1	0.06	0.01	4	365.1	0.05
Physical	(ppm)		(ppm)		(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)
Total Suspended Solids	45	--	--	--	45	160.2	ND	5	45	160.2	14	5	45	160.2	14	5	45	160.2	5
Total Dissolved Solids	--	--	--	--	--	160.1	6	5	--	160.1	34	5	--	160.1	7	5	--	160.1	30
Total Solids	--	--	--	--	--	calc.	<11	--	--	calc.	48	--	--	calc.	21	--	--	calc.	35
Hydrocarbons	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)
Total Petroleum Hydrocarbons	--	--	--	--	12	418.1	ND	1.0	12	418.1	ND	1.0	12	418.1	ND	1.0	12	418.1	1.4

1. First flush sample collected into 5 gallon bucket during first 30 minutes of rain event.

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Location		SD2				SD1				SD2				FS1L				FS2U
Date		12/19/1996				12/21/1996				12/21/1996				12/21/1996				12/21/1996
Analyses *Metals*	PQL (ppm)	Standard (ppm)	Method	Result (ppm)	PQL (ppm)	Standard (ppm)	Method	Result (ppm)	PQL (ppm)	Standard (ppm)	Method	Result (ppm)	PQL (ppm)	Standard (ppm)	Method	Result (ppm)	PQL (ppm)	Standard (ppm)
Cadmium																		
dissolved	0.01	--	6020	ND	0.01	--	6020	ND	0.01	--	6020	ND	0.01	--	6020	ND	0.01	--
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	0.01	NA	6020	ND	0.01	NA	6020	ND	0.01	NA	6020	ND	0.01	NA	6020	ND	0.01	NA
Copper																		
dissolved	0.025	--	6020	ND	0.025	--	6020	ND	0.025	--	6020	ND	0.025	--	6020	ND	0.025	--
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	0.025	NA	6020	ND	0.025	NA	6020	ND	0.025	NA	6020	ND	0.025	NA	6020	ND	0.025	NA
Lead																		
dissolved	0.05	--	6020	ND	0.05	--	6020	ND	0.05	--	6020	ND	0.05	--	6020	ND	0.05	--
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	0.05	NA	6020	ND	0.05	NA	6020	ND	0.05	NA	6020	ND	0.05	NA	6020	ND	0.05	NA
Zinc																		
dissolved	0.02	--	6020	0.023	0.02	--	6020	0.031	0.02	--	6020	ND	0.02	--	6020	0.021	0.020	--
particulate	--	--	calc.	0.019	--	--	calc	0.013	--	--	calc.	>0.012	--	--	calc.	0.01	--	calc.
total	0.02	NA	6020	0.042	0.02	NA	6020	0.044	0.02	NA	6020	0.032	0.02	NA	6020	0.031	0.020	NA
General & Wet Chemistry	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)
Biological Oxygen Demand	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chemical Oxygen Demand	5	--	410.1	42	5	--	410.1	9	5	--	410.1	31	5	--	410.1	24	5	--
Hardness	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrate Nitrogen	--	10	--	--	--	10	--	--	--	10	--	--	--	10	--	--	--	10
Nitrate + Nitrite	0.1	--	300.0	ND	0.1	--	300.0	ND	0.1	--	300.0	0.1	0.1	--	300.0	ND	0.1	--
Orthophosphate	0.05	--	300.0	ND	0.05	--	300.0	ND	0.05	--	300.0	ND	0.05	--	300.0	0.84	0.05	--
Total Phosphorus	0.01	4	365.1	0.11	0.01	4	365.1	0.02	0.01	4	365.1	0.04	0.01	4	365.1	1.1	0.1	4
Physical	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)
Total Suspended Solids	5	45	160.2	67	5	45	160.2	8.5	5.0	45	160.2	36	5	45	160.2	7	5	45
Total Dissolved Solids	5	--	160.1	ND	5	--	160.1	ND	5	--	160.1	ND	5	--	160.1	31	5	--
Total Solids	--	--	calc.	<72	--	--	calc.	<13.5	--	--	calc.	<41	--	--	calc.	38	--	--
Hydrocarbons	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)
Total Petroleum Hydrocarbons	1.0	12	--	--	--	12	418.1	ND	1.0	12	418.1	8.9	1.0	12	418.1	ND	1.0	12

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Location				FS3U				FS2L				FS3L			
Date				12/21/1996				12/21/1996				12/21/1996			
Analyses	**Method**	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**
Metals															
Cadmium															
dissolved	6020	ND	0.01	--	6020	ND	0.01	--	6020	ND	0.01	--	6020	ND	0.01
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	6020	ND	0.01	NA	6020	ND	0.01	NA	6020	ND	0.01	NA	6020	ND	0.01
Copper															
dissolved	6020	ND	0.025	--	6020	ND	0.025	--	6020	ND	0.025	--	6020	ND	0.025
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	6020	ND	0.025	NA	6020	ND	0.025	NA	6020	ND	0.025	NA	6020	ND	0.025
Lead															
dissolved	6020	ND	0.05	--	6020	ND	0.05	--	6020	ND	0.05	--	6020	ND	0.05
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	6020	ND	0.05	NA	6020	ND	0.05	NA	6020	ND	0.05	NA	6020	ND	0.05
Zinc															
dissolved	6020	0.032	0.02	--	6020	0.025	0.02	--	6020	ND	0.02	--	6020	0.026	0.02
particulate	calc.	0.003	--	--	calc.	-0.005	--	--	--	--	--	--	calc	0.004	--
total	6020	0.035	0.02	NA	6020	0.02	0.02	NA	6020	ND	0.02	NA	6020	0.03	0.02
General & Wet Chemistry		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)
Biological Oxygen Demand	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chemical Oxygen Demand	410.1	ND	5	--	410.1	ND	5	--	410.1	6	5	--	410.1	6	5
Hardness	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrate Nitrogen	--	--	--	10	--	--	--	10	--	--	--	10	--	--	--
Nitrate + Nitrite	300.0	ND	0.1	--	300.0	ND	0.1	--	300.0	ND	0.1	--	300.0	0.2	0.1
Orthophosphate	300.0	ND	0.05	--	300.0	ND	0.05	--	300.0	ND	0.05	--	300.0	ND	0.05
Total Phosphorus	365.1	ND	0.01	4	365.1	ND	0.01	4	365.1	ND	0.01	4	365.1	ND	0.01
Physical		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)
Total Suspended Solids	160.2	ND	5	45	160.2	ND	5	45	160.2	ND	5	45	160.2	ND	5
Total Dissolved Solids	160.1	ND	5	--	160.1	ND	5	--	160.1	ND	5	--	160.1	ND	5
Total Solids	calc.	0	--	--	calc.	0	--	--	calc.	0	--	--	--	--	--
Hydrocarbons		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)
Total Petroleum Hydrocarbons	418.1	1.8	1.0	12	418.1	ND	1.0	12	418.1	ND	1.0	12	418.1	ND	1.0

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Location	SD2			FS3U			FS3L			FS2U			FS1L				FS3U		
Date	2/3/1997			2/3/1997			2/3/1997			2/3/1997			2/19/1997				2/19/1997		
Analyses	**Method**	**Result (ppm)**	**PQL (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**	**Method**	**Result (ppm)**	***MDL* (ppm)**	**Standard (ppm)**	**Method**	**Result (ppm)**
Metals																			
Cadmium																			
dissolved	6010	ND	0.05	6010	ND	0.05	6010	ND	0.05	6010	ND	0.05	--	6020	0.0017	0.0002	--	6020	0.00065
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	calc.	0.0022	--	--	calc.	-0.00002
total	6010	ND	0.05	6010	ND	0.05	6010	ND	0.05	6010	ND	0.05	0.00038	6020	0.0039	0.0002	0.00028	6020	0.00063
Copper																			
dissolved	6010	ND	0.02	6010	ND	0.02	6010	ND	0.02	6010	ND	0.02	--	6020	0.007	0.00057	--	6020	0.0012
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	calc.	0.021	--	--	calc.	0.0128
total	6010	0.022	0.02	6010	ND	0.02	6010	0.021	0.02	6010	ND	0.02	0.00399	6020	0.028	0.00057	0.00313	6020	0.014
Lead																			
dissolved	6010	ND	0.05	6010	ND	0.05	6010	ND	0.05	6010	ND	0.05	--	6020	0.0021	0.00027	--	6020	0.002
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	calc.	0.0077	--	--	calc.	0.007
total	6010	ND	0.05	6010	ND	0.05	6010	ND	0.05	6010	ND	0.05	0.00548	6020	0.0098	0.00027	0.00395	6020	0.0089
Zinc																			
dissolved	6010	ND	0.02	6010	0.18	0.02	6010	0.24	0.02	6010	0.36	0.02	--	6020	0.017	0.0015	--	6020	0.14
particulate	--	--	--	calc.	0.03	--	calc.	0.27	--	calc.	0.04	--	--	calc.	0.011	--	--	calc.	0.020
total	6010	0.07	0.02	6010	0.21	0.02	6010	0.51	0.02	6010	0.40	0.02	0.02535	6020	0.028	0.0015	0.02037	6020	0.16
General & Wet Chemistry		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)
Biological Oxygen Demand	405.1	ND	4	405.1	ND	4	--	--	--	405.1	ND	4	--	405.1	ND	4	--	405.1	ND
Chemical Oxygen Demand	410.1	36	5	--	--	--	410.1	13	5	410.1	6	5	--	410.1	15	5	--	410.1	ND
Hardness	--	--	--	--	--	--	--	--	--	--	--	--	--	130.2	22	2	--	130.2	17
Nitrate Nitrogen	300.0	ND	0.06	--	--	--	300.0	0.12	0.06	300.0	ND	0.06		300.0	ND	0.03		300.0	0.07
Nitrate + Nitrite	300.0	ND	0.06	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Orthophosphate	300.0	ND	0.03	300.0	ND	0.03	--	--	--	300.0	ND	0.03	--	300.0	0.92	0.03	--	300.0	ND
Total Phosphorus	365.1	0.09	0.1	--	--	--	365.1	0.03	0.01	365.1	ND	0.01		365.1	0.84	0.05		365.1	0.02
Physical		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)
Total Suspended Solids	160.2	150	5	160.2	6	3	160.2	26	5	160.2	ND	2	45	160.2	3	2	45	160.2	3
Total Dissolved Solids	160.1	ND	5	160.1	ND	5	160.1	47	5	160.1	21	5	--	160.1	48	5	--	160.1	38
Total Solids	*calc.*	*150*	--	*calc.*	*6*	--	*calc.*	*73*	--	*calc.*	*21*	--	--	*calc.*	*51*	--	--	*calc.*	*41*
Hydrocarbons		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)
Total Petroleum Hydrocarbons	418.1	3.9	1.0	418.1	ND	1.0	--	--	--	418.2	ND	1	12	418.1	ND	1.0	12	418.1	ND

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7. U refers to the surface ruonff

Location		FS3L				SD1				SD2				SD2			
Date		2/19/1997				2/19/1997				2/19/1997				3/3/1997			
Analyses	***MDL***	**Standard**	**Method**	**Result**	***MDL***	**Standard**	**Method**	**Result**	***MDL***	**Standard**	**Method**	**Result**	***MDL***	**Method**	**Result**	**PQL**	**Method**
Metals	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	
Cadmium																	
dissolved	0.0002	--	6020	ND	0.0002	--	6020	ND	0.0002	--	6020	ND	0.0002	200.8	ND	0.0002	200.8
particulate	--	--	calc.	#VALUE!	--	--	--	--	--	--	--	--	--	--	--	--	--
total	0.0002	#VALUE!	6020	ND	0.0002	#VALUE!	6020	0.00035	0.0002	0.0002	6020	0.00084	0.0002	NA	--	--	200.8
Copper																	
dissolved	0.00057	--	6020	0.0011	0.00057	--	6020	0.0021	0.00057	--	6020	0.00096	0.00057	200.8	0.0037	0.001	200.8
particulate	--	--	calc.	0.0139	--	--	calc.	0.0189	--	--	calc.	0.047	--	--	--	--	calc.
total	0.00057	#VALUE!	6020	0.015	0.00057	#VALUE!	6020	0.021	0.00057	0.0024	6020	0.048	0.00057	NA	--	--	200.8
Lead																	
dissolved	0.00027	--	6020	0.0019	0.00027	--	6020	0.0019	0.00027	--	6020	0.002	0.00027	200.8	ND	0.0005	200.8
particulate	--	--	calc.	0.008	--	--	calc.	0.0101	--	--	calc.	0.027	--	--	--	--	calc.
total	0.00027	#VALUE!	6020	0.0099	0.00027	#VALUE!	6020	0.012	0.00027	0.0028	6020	0.029	0.00027	NA	--	--	200.8
Zinc																	
dissolved	0.0015	--	6020	0.069	0.0015	--	6020	0.038	0.00027	--	6020	0.016	0.0015	200.8	0.058	0.002	200.8
particulate	--	--	calc.	0.014	--	--	calc.	0.016	--	--	calc.	0.076	--	--	--	--	calc.
total	0.0015	#VALUE!	6020	0.083	0.0015	#VALUE!	6020	0.054	0.0015	0.0162	6020	0.092	0.0015	NA	--	--	200.8
General & Wet Chemistry	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)	
Biological Oxygen Demand	4	--	405.1	ND	4	--	405.1	ND	4	--	405.1	ND	4	405.1	ND	4	405.1
Chemical Oxygen Demand	5	--	410.1	ND	5	--	410.1	7	5	--	410.1	33	5	410.1	36	5	410.1
Hardness	2	--	130.2	ND	2	--	130.2	ND	2	--	130.2	13	2	--	--	--	--
Nitrate Nitrogen	0.03	--	300.0	0.04	0.03		300.0	0.05	0.03	--	300.0	0.08	0.03	300.0	ND	0.06	--
Nitrate + Nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	300.0	ND	0.03	300.0
Orthophosphate	0.03	--	300.0	ND	0.03	--	300.0	ND	0.03	--	300.0	ND	0.03	300.0	ND	0.05	--
Total Phosphorus	0.01	--	365.1	0.02	0.01		365.1	0.02	0.01	--	365.1	0.06	0.01	365.1	0.09	0.1	365.1
Physical	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)	
Total Suspended Solids	3	45	160.2	3	2	45	160.2	36	4	45	160.2	82	4	160.2	210	5	160.2
Total Dissolved Solids	5	--	160.1	16	5	--	160.1	33	5	--	160.1	20	5	160.1	75	5	160.1
Total Solids	--	--	*calc.*	*19*	--	--	*calc.*	*69*	--	--	*calc.*	*102*	--	*calc.*	*285*	--	*calc.*
Hydrocarbons	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)	
Total Petroleum Hydrocarbons	1.0	12	418.1	ND	1.0	12	418.1	ND	1.0	12	418.1	ND	1.0	--	--	--	--

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Location	FS3U		FS3L			SD1			FS1L			FS2U			FS2L			FS1L	
Date	3/3/1997		3/3/1997			3/3/1997			3/3/1997			3/3/1997			3/3/1997			3/17/1997	
Analyses	**Result**	**PQL**	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**	**Method**	**Result**
Metals	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**
Cadmium																			
dissolved	ND	0.0002	200.8	ND	0.0002	200.8	ND	0.0002	200.8	ND	0.002	200.8	ND	0.0002	200.8	ND	0.0002	200.8	ND
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	ND	0.0002	200.8	ND	0.0002	200.8	ND	0.0002	200.8	ND	0.002	200.8	ND	0.0002	200.8	ND	0.0002	200.8	ND
Copper																			
dissolved	0.0075	0.001	200.8	0.0080	0.001	200.8	0.013	0.001	200.8	0.0069	0.001	200.8	0.0036	0.001	200.8	0.0031	0.001	200.8	0.0096
particulate	0.0055	--	calc.	-0.0035	--	calc.	0.007	--	calc.	0.0141	--	calc.	-0.0014	--	calc.	0.0018	--	calc.	-0.0003
total	0.013	0.001	200.8	0.0045	0.001	200.8	0.02	0.001	200.8	0.021	0.001	200.8	0.0022	0.001	200.8	0.0049	0.001	200.8	0.0093
Lead																			
dissolved	0.0027	0.0005	200.8	0.0011	0.0005	200.8	0.0025	0.0005	200.8	0.0044	0.0005	200.8	0.007	0.0005	200.8	0.0014	0.0005	200.8	0.0021
particulate	0.0049	--	calc.	0.0027	--	calc.	0.0033	--	calc.	0.0396	--	calc.	0.006	--	calc.	0.003	--	calc.	0.002
total	0.0076	0.0005	200.8	0.0038	0.0005	200.8	0.0058	0.0005	200.8	0.044	0.0005	200.8	0.013	0.0005	200.8	0.0044	0.0005	200.8	0.0037
Zinc																			
dissolved	0.10	0.002	200.8	0.13	0.002	200.8	0.13	0.002	200.8	0.16	0.002	200.8	0.064	0.002	200.8	0.029	0.002	200.8	0.045
particulate	0.03	--	calc.	0.010	--	calc.	0.05	--	calc.	0.14	--	calc.	0.025	--	calc.	0.005	--	calc.	0.004
total	0.13	0.002	200.8	0.14	0.002	200.8	0.18	0.002	200.8	0.3	0.002	200.8	0.089	0.002	200.8	0.034	0.002	200.8	0.049
General & Wet Chemistry	(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)
Biological Oxygen Demand	ND	4	405.1	ND	4	405.1	6	4	405.1	ND	4	405.1	ND	4	405.1	7	4	--	--
Chemical Oxygen Demand	ND	5	410.1	ND	5	410.1	61	5	410.1	12	5	410.1	6	5	410.1	17	5	410.1	15
Hardness	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrate Nitrogen	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	300.0	0.31
Nitrate + Nitrite	0.07	0.03	300.0	0.06	0.03	300.0	0.63	0.06	300.0	0.04	0.03	300.0	0.06	0.06	300.0	0.03	0.03	--	--
Orthophosphate	--	--	300.0	ND	0.03	300.0	0.06	0.03	300.0	0.93	0.03	300.0	ND	0.03	300.0	ND	0.03	300.0	0.80
Total Phosphorus	0.02	0.01	365.1	0.02	0.01	365.1	0.07	0.01	365.1	1.0	0.1	365.1	0.04	0.01	365.1	0.02	0.01	365.1	0.65
Physical	(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)
Total Suspended Solids	6	2	160.2	3	2	160.2	27	5	160.2	14	5	160.2	3	2	160.2	2	2	160.2	5
Total Dissolved Solids	36	5	160.1	31	5	160.1	110	5	160.1	49	5	160.1	27	5	160.1	54	5	160.1	30
Total Solids	*42*	*--*	*calc.*	*34*	*--*	*calc.*	*137*	*--*	*calc.*	*63*	*--*	*calc.*	*30*	*--*	*calc.*	*56*	*--*	*calc.*	*35*
Hydrocarbons	(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)
Total Petroleum Hydrocarbons	--	--	--	--	--	418.1	3.4	1.0	418.1	ND	1.0	418.1	ND	1.0	418.1	ND	1.0	418.1	ND

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Location			SD1			FS2U			FS2L			FS3U			FS3L			SD2	
Date			**3/17/1997**			**3/17/1997**			**3/17/1997**			**3/17/1997**			**3/17/1997**			**3/17/1997**	
Analyses	**PQL**	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**
Metals	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**
Cadmium																			
dissolved	0.0002	200.8	ND	0.0002	200.8	ND	0.0002	200.8	ND	0.0002	200.8	0.00048	0.0002	200.8	ND	0.0002	200.8	ND	0.0002
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	0.0002	200.8	ND	0.0002	200.8	ND	0.0002	200.8	ND	0.0002	200.8	0.00075	0.0002	200.8	ND	0.0002	200.8	0.00035	0.0002
Copper																			
dissolved	0.001	200.8	0.0093	0.001	200.8	0.01	0.001	200.8	0.022	0.001	200.8	0.0028	0.001	200.8	0.043	0.001	200.8	0.0044	0.001
particulate	--	calc.	-0.0046	--	calc.	0.0010	--	calc.	0.0040	--	calc.	0.0047	--	calc.	0.0020	--	calc.	0.0066	--
total	0.001	200.8	0.0047	0.001	200.8	0.011	0.001	200.8	0.0260	0.001	200.8	0.0075	0.001	200.8	0.045	0.001	200.8	0.011	0.001
Lead																			
dissolved	0.0005	200.8	0.00079	0.0005	200.8	0.0026	0.0005	200.8	0.0026	0.0005	200.8	ND	0.0005	200.8	0.0051	0.0005	200.8	ND	0.0005
particulate	--	calc.	0.000	--	calc.	0.002	--	calc.	0.003	--	calc.	#VALUE!	--	calc.	0.003	--	calc.	#VALUE!	--
total	0.0005	200.8	0.0011	0.0005	200.8	0.0049	0.0005	200.8	0.0053	0.0005	200.8	0.011	0.0005	200.8	0.0085	0.0005	200.8	0.0083	0.0005
Zinc																			
dissolved	0.002	200.8	0.036	0.002	200.8	0.021	0.002	200.8	0.015	0.002	200.8	0.89	0.002	200.8	0.15	0.002	200.8	0.045	0.002
particulate	--	calc.	0.008	--	calc.	-0.004	--	calc.	0.005	--	calc.	0.410	--	calc.	0.010	--	calc.	0.085	--
total	0.002	200.8	0.044	0.002	200.8	0.017	0.002	200.8	0.02	0.002	200.8	1.3	0.002	200.8	0.16	0.002	200.8	0.130	0.002
General & Wet Chemistry	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)
Biological Oxygen Demand	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chemical Oxygen Demand	5	410.1	14	5	410.1	6	5	410.1	5	5	410.1	ND	5	410.1	ND	5	410.1	12	5
Hardness	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrate Nitrogen	0.03	--	--	--	300.0	0.03	0.03	--	--	--	300.0	0.13	0.06	--	--	--	--	--	--
Nitrate + Nitrite	--	300.0	0.35	0.03	--	--	--	300.0	ND	0.06	--	--	--	300.0	0.07	0.03	300.0	0.16	0.03
Orthophosphate	0.03	300.0	ND	0.03	300.0	ND	0.03	300.0	0.04	0.03	300.0	ND	0.03	300.0	ND	0.03	300.0	ND	0.03
Total Phosphorus	0.05	365.1	0.02	0.01	365.1	0.01	0.01	365.1	ND	0.01	365.1	0.01	0.01	365.1	ND	0.01	365.1	ND	0.01
Physical	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)
Total Suspended Solids	2	160.2	4	2	160.2	ND	2	160.2	ND	2	160.2	14	2	160.2	3	2	160.2	45	5
Total Dissolved Solids	5	160.1	14	5	160.1	ND	5	160.1	18	5	160.1	26	5	160.1	ND	5	160.1	29	5
Total Solids	*--*	*calc.*	*18*	*--*	*calc.*	*0*	*--*	*calc.*	*18*	*--*	*calc.*	*40*	*--*	*calc.*	*3*	*--*	*calc.*	*74*	*--*
Hydrocarbons	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)
Total Petroleum Hydrocarbons	1.0	418.1	ND	1.0	418.1	ND	1.0	418.1	ND	1.0	418.1	ND	1.0	418.1	ND	1.0	418.1	7.2	1.0

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Location	**SD1**			**FS1L**			**FS2U**			**FS2L**			**SD2**			**FS3U**			**FS3L**
Date	**3/28/1997**			**3/28/1997**			**3/28/1997**			**3/28/1997**			**3/28/1997**			**3/28/1997**			**3/28/1997**
Analyses	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**	**Method**
Metals		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	
Cadmium																			
dissolved	200.8	0.00029	0.0002	200.80	0.00087	0.0002	200.8	ND	0.2	200.8	0.0004	0.0002	--	--	--	--	--	--	--
particulate	calc.	0.0000	--	calc.	#VALUE!	--	calc.	#VALUE!	--	calc.	#VALUE!	--	calc.	#VALUE!	--	calc.	#VALUE!	--	calc.
total	200.8	0.00031	0.0002	200.8	ND	0.0002	200.8	ND	0.0002	200.8	ND	0.0002	200.8	0.0013	0.0002	200.8	ND	0.002	200.8
Copper																			
dissolved	200.8	0.0027	0.001	200.8	0.021	0.001	200.8	0.068	0.001	200.8	0.009	0.001	--	--	--	--	--	--	--
particulate	calc.	0.0029	--	calc.	0.0070	--	calc.	0.0050	--	calc.	0.0040	--	calc.	#VALUE!	--	calc.	#VALUE!	--	calc.
total	200.8	0.0056	0.001	200.8	0.028	0.001	200.8	0.073	0.001	200.8	0.013	0.001	200.8	0.011	0.001	200.8	0.014	0.01	200.8
Lead																			
dissolved	200.8	ND	0.0005	200.8	0.00063	0.0005	200.8	0.021	0.0005	200.8	0.0011	0.0005	--	--	--	--	--	--	--
particulate	calc.	#VALUE!	--	calc.	0.0184	--	calc.	0.0020	--	calc.	0.0020	--	calc.	#VALUE!	--	calc.	#VALUE!	--	calc.
total	200.8	0.0023	0.0005	200.8	0.019	0.0005	200.8	0.023	0.0005	200.8	0.0031	0.0005	200.8	0.0019	0.0005	200.8	0.0052	0.005	200.8
Zinc																			
dissolved	200.8	0.053	0.002	200.8	0.079	0.002	200.8	0.017	0.002	200.8	0.034	0.002	--	--	--	--	--	--	--
particulate	calc.	0.0150	--	calc.	0.0610	--	calc.	0.0110	--	calc.	-0.0030	--	calc.	#VALUE!	--	calc.	#VALUE!	--	calc.
total	200.8	0.068	0.002	281	0.14	0.002	200.8	0.028	0.002	200.8	0.031	0.002	200.8	0.084	0.002	200.8	1.5	0.02	200.8
General & Wet Chemistry		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)	
Biological Oxygen Demand	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chemical Oxygen Demand	410.1	6	5	410.1	27	5	410.1	6	5	410.1	7	5	--	--	--	--	--	--	--
Hardness	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrate Nitrogen	--	--	--	--	--	--	300.0	ND	0.06	300.0	ND	0.06	--	--	--	--	--	--	--
Nitrate + Nitrite	--	--	--	300.0	ND	0.06	--	--	--	--	--	--	--	--	--	--	--	--	--
Orthophosphate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Phosphorus	--	--	--	365.1	0.65	0.01	365.1	0.02	0.01	300.0	0.02	0.01	--	--	--	--	--	--	--
Physical		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)	
Total Suspended Solids	160.2	5	2	160.2	4	2	160.2	ND	2	160.2	ND	2	--	--	--	--	--	--	--
Total Dissolved Solids	160.1	31	5	160.1	59	5	160.1	26	5	160.1	30	5	--	--	--	--	--	--	--
Total Solids	*calc.*	*36*	--	*calc.*	*63*	--	*calc.*	*26*	--	*calc.*	*30*	--	*calc.*	*0*	--	*calc.*	*0*	--	*calc.*
Hydrocarbons		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)	
Total Petroleum Hydrocarbons	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

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Location			FS2L				FS2U				FS3U				SD1				FS3L
Date			4/14/1997				4/14/1997				4/14/1997				4/14/1997				4/14/1997
Analyses	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**	**Method**	**Result (ppm)**	**PQL (ppm)**	**Standard (ppm)**
Metals																			
Cadmium																			
dissolved	--	--	--	200.8	ND	0.0002	--	200.8	ND	0.0002	--	--	--	--	--	--	--	--	--
particulate	#VALUE!	--	--	calc.	#VALUE!	--	--	calc.	#VALUE!	--	--	--	--	--	--	--	--	--	--
total	ND	0.002	0	200.8	ND	0.0002	0	200.8	ND	0.0002	0	200.8	ND	0.002	0	200.8	0.00021	0.0002	0
Copper																			
dissolved	--	--	--	200.8	0.027	0.001	--	200.8	0.083	0.001	--	--	--	--	--	--	--	--	--
particulate	#VALUE!	--	--	calc.	0.0090	--	--	calc.	0.0050	--	--	--	--	--	--	--	--	--	--
total	37	0	0	200.8	0.036	0.001	0	200.8	0.088	0.001	0	200.8	0.0043	0.001	0	200.8	0.0098	0.001	0
Lead																			
dissolved	--	--	--	200.8	0.0023	0.0005	--	200.8	0.012	0.001	--	--	--	--	--	--	--	--	--
particulate	#VALUE!	--	--	calc.	0.0024	--	--	calc.	0.0050	--	--	--	--	--	--	--	--	--	--
total	20	0	0	200.8	0.0047	0.0005	0	200.8	0.017	0.0005	0	200.8	0.0038	0.0005	0	200.8	0.0038	0.0005	0
Zinc																			
dissolved	--	--	--	200.8	0.0087	0.002	--	200.8	0.033	0.002	--	--	--	--	--	--	--	--	--
particulate	#VALUE!	--	--	calc.	0.0013	--	--	calc.	-0.0040	--	--	--	--	--	--	--	--	--	--
total	1700	0	0	200.8	0.01	0.002	0	200.8	0.029	0.002	0	200.8	1.6	0.002	0	200.8	0.063	0.002	0
General & Wet Chemistry	(ppm)	(ppm)																	
Biological Oxygen Demand	--	--	--	405.1	ND	4	--	405.1	ND	4	--	--	--	--	--	--	--	--	--
Chemical Oxygen Demand	--	--	--	410.1	ND	5	--	410.1	6	5	--	410.1	ND	5	--	410.1	30	5	--
Hardness	--	--	--	130.2	35	4	--	130.2	10	2	--	130.2	26	2	--	130.2	7	2	--
Nitrate Nitrogen	--	--	--	300	ND	0.3	--	300	ND	0.3	--	300	0.21	0.15	--	300	ND	0.3	--
Nitrate + Nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Orthophosphate	--	--	--	300	ND	0.03	--	300	ND	0.03	--	--	--	--	--	--	--	--	--
Total Phosphorus	--	--	--	365.1	0.01	0.01	--	365.1	0.02	0.01	--	365.1	0.02	0.01	--	365.1	0.05	0.01	--
Physical	(ppm)	(ppm)																	
Total Suspended Solids	--	--	--	160.2	ND	2	--	160.2	ND	2	--	--	--	--	--	--	--	--	--
Total Dissolved Solids	--	--	--	160.1	44	10	--	160.1	ND	10	--	--	--	--	--	--	--	--	--
Total Solids	*0*	--		*calc.*	*44*		*#VALUE!*	*calc.*	*0*	--	--	*calc.*	*0*	--	--	--	--	--	--
Hydrocarbons	(ppm)	(ppm)																	
Total Petroleum Hydrocarbons	--	--	--	418.1	ND	1	--	418.1	ND	1	--	--	--	--	--	--	--	--	--

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Location				SD1
Date				4/24/1997
Analyses	**Method**	**Result**	**PQL**	**Standard**
Metals		**(ppm)**	**(ppm)**	**(ppm)**
Cadmium				
dissolved	200.8	ND	0.0002	--
particulate	calc.	#VALUE!	--	--
total	200.8	ND	0.0002	0
Copper				
dissolved	200.8	0.069	0.001	--
particulate	calc.	0.0090	--	--
total	200.8	0.078	0.001	0
Lead				
dissolved	200.8	0.0063	0.0005	--
particulate	calc.	0.0047	--	--
total	200.8	0.011	0.0005	0
Zinc				
dissolved	200.8	0.14	0.002	--
particulate	calc.	0.0300	--	--
total	200.8	0.17	0.002	0
General & Wet Chemistry				(ppm)
Biological Oxygen Demand	405.1	ND	4	--
Chemical Oxygen Demand	410.1	7	5	--
Hardness	130.2	19	2	--
Nitrate Nitrogen	300	ND	0.3	--
Nitrate + Nitrite	--	--	--	--
Orthophosphate	300	ND	0.03	--
Total Phosphorus	365.1	0	0.01	--
Physical				(ppm)
Total Suspended Solids	160.2	7	2	--
Total Dissolved Solids	160.1	17	10	--
Total Solids	*calc.*	*24*	--	--
Hydrocarbons				(ppm)
Total Petroleum Hydrocarbons	418.1	ND	1	12

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Location				FS1L				FS2U				FS2L				FS3U			
Date				4/24/1997				4/24/1997				4/24/1997				4/24/1997			
Analyses	**Method**	**Result**	**PQL**	**Standard**	**Method**	**Result**	**PQL**	**Standard**	**Method**	**Result**	**PQL**	**Standard**	**Method**	**Result**	**PQL**	**Standard**	**Method**	**Result**	**PQL**
Metals		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**
Cadmium																			
dissolved	200.8	ND	0.0002	--	200.8	ND	0.0002	--	200.8	ND	0.0002	--	200.8	ND	0.0002	--	--	--	--
particulate	calc.	#VALUE!	--	--	calc.	#VALUE!	--	--	calc.	#VALUE!	--	--	calc.	#VALUE!	--	--	calc.	#VALUE!	--
total	200.8	0.00025	0.0002	0	200.8	ND	0.0002	0	200.8	ND	0.0002	0	200.8	ND	0.0002	0	200.8	0.00029	0.0002
Copper																			
dissolved	200.8	0.0075	0.001	--	200.8	0.014	0.001	--	200.8	0.062	0.001	--	200.8	0.033	0.001	--	--	--	--
particulate	calc.	0.0025	--	--	calc.	0.0030	--	--	calc.	0.0200	--	--	calc.	0.0120	--	--	calc.	#VALUE!	--
total	200.8	0.01	0.001	0.0002	200.8	0.017	0.001	0	200.8	0.082	0.001	0	200.8	0.045	0.001	0	200.8	0.011	0.001
Lead																			
dissolved	200.8	0.00056	0.0005	--	200.8	0.0019	0.0005	--	200.8	0.011	0.0005	--	200.8	0.003	0.0005	--	--	--	--
particulate	calc.	0.0002	--	--	calc.	0.0006	--	--	calc.	0.0030	--	--	calc.	0.0021	--	--	calc.	#VALUE!	--
total	200.8	0.00075	0.0005	0.0001	200.8	0.0025	0.0005	0	200.8	0.014	0.0005	0	200.8	0.0051	0.0005	0	200.8	0.0038	0.0005
Zinc																			
dissolved	200.8	0.063	0.002	--	200.8	0.029	0.002	--	200.8	0.034	0.002	--	200.8	0.025	0.002	--	--	--	--
particulate	calc.	0.0210	--	--	calc.	-0.0060	--	--	calc.	-0.0190	--	--	calc.	-0.0090	--	--	calc.	#VALUE!	--
total	200.8	0.084	0.002	0.0015	200.8	0.023	0.002	0.0001	200.8	0.015	0.002	0.0001	200.8	0.016	0.002	0.0001	200.8	1.9	0.002
General & Wet Chemistry		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)
Biological Oxygen Demand	405.1	ND	3	--	405.1	ND	3	--	405.1	ND	3	--	405.1	ND	3	--	--	--	--
Chemical Oxygen Demand	410.2	25	5	--	410.2	29	5	--	410.2	27	5	--	410.2	5	5	--	410.2	ND	5
Hardness	130.2	18	2	--	130.2	35	2	--	130.2	6	2	--	130.2	36	2	--	130.2	23	2
Nitrate Nitrogen	300	0.33	0.15	--	300	ND	2	--	300	ND	0.06	--	300	ND	0.18	--	300	0.39	0.3
Nitrate + Nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Orthophosphate	300	ND	0.03	--	300	0.85	0.03	--	300	ND	0.03	--	300	ND	0.03	--	--	--	--
Total Phosphorus	365.1	0.02	0.01	--	365.1	0.8	0.05	--	365.1	0.02	0.01	--	365.1	0.02	0.01	--	365.1	0.02	0.01
Physical		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)
Total Suspended Solids	160.2	2	2	--	160.2	ND	2	--	160.2	ND	2	--	160.2	ND	2	--	--	--	--
Total Dissolved Solids	160.1	21	10	--	160.1	35	10	--	160.1	ND	10	--	160.1	32	10	--	--	--	--
Total Solids	*calc.*	*23*	--	--	*calc.*	*35*	--	--	*calc.*	*0*	--	--	*calc.*	*32*	--	--	--	--	--
Hydrocarbons		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)
Total Petroleum Hydrocarbons	418.1	ND	1	12	418.1	ND	1	12	--	ND	1	12	--	ND	1	--	--	--	--

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Location	FS3L				FS2U				FS3L				SD1				SD2		
Date	**4/24/1997**				**5/21/1997**				**5/21/1997**				**5/21/1997**				**5/21/1997**		
Analyses	**Standard**	**Method**	**Result**	**PQL**	**Standard**	**Method**	**Result**	**PQL**	**Standard**	**Method**	**Result**	**PQL**	**Standard**	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**
Metals	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**
Cadmium																			
dissolved	--	200.8	ND	0.0002	--	200.8	0.24	0.0002	--	200.8	0.00073	0.0002	--	200.8	ND	0.0002	200.8	0.26	0.0002
particulate	--	calc.	#VALUE!	--	--	calc.	#VALUE!	--	--	calc.	0.0002	--	--	calc.	#VALUE!	--	calc.	-0.2596	--
total	0	200.8	ND	0.0002	--	200.8	ND	0.0002	--	200.8	0.00093	0.0002	--	200.8	0.00031	0.0002	200.8	0.00041	0.0002
Copper																			
dissolved	--	200.8	0.0026	0.001	--	201	0.061	0.001	--	200.8	0.018	0.001	--	200.8	0.006	0.001	200.8	0.0026	0.001
particulate	--	calc.	0.0015	--	--	calc.	0.0030	--	--	calc.	0.0010	--	--	calc.	0.0009	--	calc.	0.0003	--
total	0	200.8	0.0041	0.001	--	200.8	0.064	0.001	--	200.8	0.019	0.001	--	200.8	0.0069	0.001	200.8	0.0029	0.001
Lead																			
dissolved	--	200.8	0.00079	0.0005	--	200.8	0.0082	0.0005	--	200.8	0.005	0.0005	--	200.8	ND	0.0005	200.8	ND	0.0005
particulate	--	calc.	0.0009	--	--	calc.	0.0028	--	--	calc.	-0.0012	--	--	calc.	#VALUE!	--	calc.	#VALUE!	--
total	0	200.8	0.0017	0.0005	--	200.8	0.011	0.0005	--	200.8	0.0038	0.0005	--	200.8	ND	0.0005	200.8	ND	0.0005
Zinc																			
dissolved	--	200.8	0.39	0.002	--	200.8	0.048	0.002	--	200.8	1.4	0.002	--	200.8	0.05	0.002	200.8	0.2	0.002
particulate	--	calc.	0.1400	--	--	calc.	-0.0150	--	--	calc.	0.1000	--	--	calc.	0.0120	--	calc.	0.0500	--
total	0.0001	200.8	0.53	0.002	--	200.8	0.033	0.002	--	200.8	1.5	0.002	--	200.8	0.062	0.002	200.8	0.25	0.002
General & Wet Chemistry	(ppm)		(ppm)	(ppm)															
Biological Oxygen Demand	--	405.1	ND	5	--	405.1	28	4	--	405.1	ND	2.4	--	405.1	ND	2.4	405.1	ND	2.4
Chemical Oxygen Demand	--	410.2	5	5	--	410.2	91	5	--	410.2	9	5	--	410.2	14	5	410.2	11	5
Hardness	--	130.2	11	2	--	130.2	15	2	--	130.2	40	2	--	130.2	8	2	130.2	29	2
Nitrate Nitrogen	--	300	0.06	0.06	--	300	0.34	0.3	--	300	44	3	--	300	0.61	0.3	300	0.38	0.3
Nitrate + Nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Orthophosphate	--	300	ND	0.03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Phosphorus	--	365.1	0.02	0.01	--	365.1	0.1	0.01	--	365.1	0.1	0.01	--	365.1	0.02	0.01	365.1	0.03	0.01
Physical	(ppm)		(ppm)	(ppm)															
Total Suspended Solids	--	160.2	ND	2	--	160.2	8	4	--	160.2	71	10	--	160.2	ND	2	160.2	15	10
Total Dissolved Solids	--	160.1	ND	10	--	160.1	97	10	--	160.1	97	10	--	160.1	52	10	160.1	71	10
Total Solids	--	*calc.*	*0*	--	--	*calc.*	*105*	--	--	*calc.*	*168*	--	--	*calc.*	*52*	--	*calc.*	*86*	--
Hydrocarbons	(ppm)		(ppm)	(ppm)															
Total Petroleum Hydrocarbons	12	--	ND	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

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Location	SD2				FS3U				FS3L				SD1				FS2U		
Date	5/29/1997				5/29/1997				5/29/1997				5/29/1997				5/29/1997		
Analyses	**Standard**	**Method**	**Result**	**PQL**	**Standard**	**Method**	**Result**	**PQL**	**Standard**	**Method**	**Result**	**PQL**	**Standard**	**Method**	**Result**	**PQL**	**Standard**	**Method**	**Result**
Metals	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**
Cadmium																			
dissolved	--	200.8	0.00077	0.0005	--	200.8	0.0015	0.0005	--	200.8	ND	0.0005	--	200.8	0.00087	0.0005	--	200.8	ND
particulate	--	calc.	#VALUE!	--	--	calc.	#VALUE!	--	--	calc.	#VALUE!	--	--	calc.	#VALUE!	--	--	calc.	#VALUE!
total	--	200.8	ND	0.0005	--	200.8	ND	0.0005	--	200.8	ND	0.5	--	200.8	ND	0.5	--	200.8	ND
Copper																			
dissolved	--	200.8	0.0054	0.001	--	200.8	0.037	0.001	--	200.8	0.094	0.001	--	200.8	0.011	0.001	--	200.8	0.1
particulate	--	calc.	0.0056	--	--	calc.	0.0360	--	--	calc.	149.9060	--	--	calc.	13.9890	--	--	calc.	0.0400
total	--	200.8	0.011	0.001	--	200.8	0.073	0.001	--	200.8	150	1	--	200.8	14	1	--	200.8	0.14
Lead																			
dissolved	--	200.8	0.00071	0.0005	--	200.8	0.0063	0.0005	--	200.8	0.016	0.0005	--	200.8	0.0023	0.0005	--	200.8	0.029
particulate	--	calc.	0.0066	--	--	calc.	0.0137	--	--	calc.	30.9840	--	--	calc.	1.3977	--	--	calc.	0.0110
total	--	200.8	0.0073	0.0005	--	200.8	0.02	0.0005	--	200.8	31	0.5	--	200.8	1.4	0.5	--	200.8	0.04
Zinc																			
dissolved	--	200.8	0.001	0.002	--	200.8	1.2	0.002	--	200.8	0.25	0.002	--	200.8	0.18	0.002	--	200.8	0.043
particulate	--	calc.	0.3090	--	--	calc.	0.4000	--	--	calc.	229.7500	--	--	calc.	149.8200	--	--	calc.	0.0030
total	--	200.8	0.31	0.002	--	200.8	1.6	0.002	--	200.8	230	2	--	200.8	150	2	--	200.8	0.046
General & Wet Chemistry	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)					(ppm)		(ppm)
Biological Oxygen Demand	--	405.1	35	33	--				--	405.1	ND	3.3	--	405.1	ND	3.3	--	405.1	5.5
Chemical Oxygen Demand	--	410.2	53	5	--	410.2	28	5	--	410.2	20	5	--	410.2	49	5	--	410.2	40
Hardness	--	130.2	52	2	--	130.2	43	2	--	--	--	--	--	130.2	24	2	--	130.2	11
Nitrate Nitrogen	--	300	0.65	0.15	--	300	0	0.15	--	300	0.16	0.15	--	300	1	0.2	--	300	ND
Nitrate + Nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Orthophosphate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Phosphorus	--	365.1	0.08	0.01	--	365.1	0	0.01	--	365.1	0.04	0.01	--	365.1	0	0	--	365.1	0.04
Physical	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)					(ppm)		(ppm)
Total Suspended Solids	--	160.2	40	10	--	160.2	98	10	--	160.2	9	2	--	160	4	3	--	160.2	5
Total Dissolved Solids	--	160.1	26	10	--	160.1	29	10	--	160.1	31	10	--	160	33	10	--	160.1	21
Total Solids	*--*	*calc.*	*66*	*--*	*--*	*calc.*	*127*	*--*	*--*	*calc.*	*40*	*--*	*--*	*calc.*	*37*	*--*	*--*	*calc.*	*26*
Hydrocarbons	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)					(ppm)		(ppm)
Total Petroleum Hydrocarbons	--	--	--	--	--	--	--	--	--	ND	1	--	--	ND	1	--	--	19	1

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Location		FS2L				SD1				SD2				FS1L				FS2U	
Date		5/29/1997				6/12/1997				6/12/1997				6/12/1997				6/12/1997	
Analyses	**PQL**	**Standard**	**Method**	**Result**	**PQL**	**Standard**	**Method**	**Result**	**PQL**	**Standard**	**Method**	**Result**	**PQL**	**Standard**	**Method**	**Result**	**PQL**	**Standard**	**Method**
Metals	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**	
Cadmium																			
dissolved	0.0005	--	200.8	ND	0.0005	--	200.8	ND	0.001	--	200.8	ND	0.001	--	200.8	ND	0.001	--	200.8
particulate	--	--	calc.	#VALUE!	--	--	calc.	#VALUE!	--	--	calc.	#VALUE!	--	--	calc.	#VALUE!	--	--	calc.
total	0.5	--	200.8	ND	0.0005	--	200.8	ND	0.001	--	200.8	ND	0.001	--	200.8	ND	0.001	--	200.8
Copper																			
dissolved	0.001	--	200.8	0.048	0.001	--	200.8	0.016	0.002	--	200.8	0.013	0.002	--	200.8	0.03	0.002	--	200.8
particulate	--	--	calc.	0.0300	--	--	calc.	0.0010	--	--	calc.	0.0080	--	--	calc.	0.0020	--	--	calc.
total	0.001	--	200.8	0.078	0.001	--	200.8	0.017	0.002	--	200.8	0.021	0.002	--	200.8	0.032	0.002	--	200.8
Lead																			
dissolved	0.0005	--	200.8	0.0052	0.0005	--	200.8	ND	0.001	--	200.8	ND	0.001	--	200.8	0.0051	0.001	--	200.8
particulate	--	--	calc.	0.0088	--	--	calc.	#VALUE!	--	--	calc.	#VALUE!	--	--	calc.	0.0008	--	--	calc.
total	0.0005	--	200.8	0.014	0.0005	--	200.8	0.001	0.001	--	200.8	0.0017	0.001	--	200.8	0.0059	0.001	--	200.8
Zinc																			
dissolved	0.002	--	200.8	0.02	0.002	--	200.8	0.13	0.004	--	200.8	0.025	0.004	--	200.8	0.038	0.004	--	200.8
particulate	--	--	calc.	0.0060	--	--	calc.	0.0300	--	--	calc.	0.0220	--	--	calc.	-0.0050	--	--	calc.
total	0.002	--	200.8	0.026	0.002	--	200.8	0.16	0.004	--	200.8	0.047	0.004	--	200.8	0.033	0.004	--	200.8
General & Wet Chemistry	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)	
Biological Oxygen Demand	3.3	--	405	ND	3	--	405.1	ND	3	--	--	--	--	--	405.1	ND	3.8	--	405.1
Chemical Oxygen Demand	5	--	410.2	12	5	--	410.1	41	5	--	410.1	79	5	--	410.1	72	5	--	410.1
Hardness	2	--	130.2	34	2	--	130	26	4	--	130.2	92	4	--	130.2	64	4	--	130.2
Nitrate Nitrogen	0.15	--	300	ND	0.15	--	300	1.7	0.15	--	--	--	--	--	--	--	--	--	--
Nitrate + Nitrite	--	--	--	--	--	--	--	--	--	--	300	0.63	0.15	--	300	ND	0.15	--	300
Orthophosphate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Phosphorus	0.01		365.1	0.02	0.01	--	365.1	0.06	0.01	--	365.1	0.21	0.01	--	365.1	0.9	0.1	--	365.1
Physical	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)	
Total Suspended Solids	4		160.2	3	2	45	160.2	4	3	--	160.2	21	10	--	160.2	ND	2	--	160.2
Total Dissolved Solids	10	--	160.1	34	10	--	160.1	48	10	--	160.1	89	10	--	160.1	110	10	--	160.1
Total Solids	--	--	*calc.*	*37*	--	--	*calc.*	*52*	--	--	*calc.*	*110*	--	--	*calc.*	*110*	--	--	*calc.*
Hydrocarbons	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)	
Total Petroleum Hydrocarbons	--	--	ND	1	--	--	--	ND	1.3	--	--	--	--	--	--	--	--	--	--

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Location			FS2L				FS3U				FS3L				SD1			SD2	
Date			**6/12/1997**				**6/12/1997**				**6/12/1997**				**7/18/1997**			**7/18/1997**	
Analyses	**Result**	**PQL**	**Standard**	**Method**	**Result**	**PQL**	**Standard**	**Method**	**Result**	**PQL**	**Standard**	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**	**Method**	**Result**
Metals	**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**
Cadmium																(ug/L)			(ug/L)
dissolved	ND	1	--	200.8	ND	0.001	--	200.8	ND	0.001	--	200.8	ND	0.001	--	--	--	200.8	ND
particulate	#VALUE!	--	--	calc.	#VALUE!	--	--	calc.	#VALUE!	--	--	calc.	#VALUE!	--	--	--	--		
total	ND	1	--	200.8	ND	0.001	--	200.8	ND	0.001	--	200.8	ND	0.001	200.8	0.001	0.0005	200.8	ND
Copper															200.8	(ug/L)			(ug/L)
dissolved	86	2	--	200.8	0.036	0.002	--	200.8	0.017	0.002	--	200.8	0.13	0.002	--	--	--	200.8	3.5
particulate	44.0000	--	--	calc.	0.0120	--	--	calc.	0.0080	--	--	calc.	0.0100	--	--	--	--	--	--
total	130	2	--	200.8	0.048	0.002	--	200.8	0.025	0.002	--	200.8	0.14	0.002	200.8	0.014	0.001	200.8	4.8
Lead															200.8	(ug/L)			(ug/L)
dissolved	11	2	--	200.8	0.0029	0.001	--	200.8	0.003	0.001	--	200.8	0.0098	0.001	--	--	--	200.8	ND
particulate	6.0000	--	--	calc.	0.0025	--	--	calc.	-0.0005	--	--	calc.	0.0002	--	--	--	--	--	--
total	17	1	--	200.8	0.0054	0.001	--	200.8	0.0025	0.001	--	200.8	0.01	0.001	200.8	0.001	0.001	200.8	0.0028
Zinc															200.8	(ug/L)			(ug/L)
dissolved	35	4	--	200.8	0.023	0.004	--	200.8	0.4	0.004	--	200.8	0.077	0.004	--	--	--	200.8	0.019
particulate	6.0000	--	--	calc.	0.0090	--	--	calc.	0.0000	--	--	calc.	0.0000	--	--	--	--	--	--
total	41	4	--	200.8	0.032	0.004	--	200.8	0.4	0.004	--	200.8	0.077	0.004	200.8	0.11	0.002	200.8	31
General & Wet Chemistry	(ppm)	(ppm)			(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	EPA	(mg/L)	(mg/L)	EPA	(mg/L)
Biological Oxygen Demand	ND	3.4	--	405.1	ND	3.4	--	405.1	ND	3.4	--	405.1	ND	7.6	405.1	6	6	405.1	ND
Chemical Oxygen Demand	17	5	--	410.1	8.9	5	--	410.1	12	5	--	410.1	14	5	--	--	--	410.1	16
Hardness	7	4	--	130.2	34	4	--	130.2	19	4	--	130.2	32	4	--	--	--	130.2	15
Nitrate Nitrogen	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrate + Nitrite	ND	0	--	300	ND	0	--	300	ND	0.15	--	300	ND	0.15	--	--	--	300	ND
Orthophosphate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Phosphorus	0.02	0.01	--	365.1	0.01	0.01	--	365.1	0.03	0.01	4	365.1	0.01	0.01	--	--	--	365.1	0.5
Physical	(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	EPA	(mg/L)	(mg/L)	EPA	(mg/L)
Total Suspended Solids	ND	2	--	160.2	ND	2	--	160.1	ND	10	45	160.2	ND	2	160.2	67	10	160.2	16
Total Dissolved Solids	ND	10	--	160.1	32	10	--	130.2	19	4	--	160.1	28	10	160.1	33	10	160.1	37
Total Solids	*0*	--	--	*calc.*	*32*	--	--	*calc.*	*19*	--	--	*calc.*	*28*	--	calc.	100	--	calc.	53
Hydrocarbons	(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)	EPA	(mg/L)
Total Petroleum Hydrocarbons	--	--	--	--	--	--	--	--	--	--	--	--	ND	1	--	--	--	418.1	ND

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Location		FS1L			FS2U			FS2L			FS3U			FS3L			SD1		
Date		7/18/1997			7/18/1997			7/18/1997			7/18/1997			7/18/1997			8/28/1997		
Analyses	**PQL**	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**	**Method**	**Result**	**PQL**
Metals	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**		**(ppm)**	**(ppm)**
Cadmium			(ug/L)			(ug/L)			(ug/L)			(ug/L)			(ug/L)			(mg/L)	
dissolved	0.0005	200.8	ND	0.0005	--	--	--	200.8	0.00067	0.0005	200.8	0.00052	0.0005	200.8	0.00059	0.0005	200.8	ND	0.0005
particulate		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	0.0005	200.8	ND	0.0005	200.8	ND	0.0005	200.8	ND	0.0005	200.8	ND	0.0005	200.8	ND	0.0005	200.8	ND	0.0005
Copper			(ug/L)			(ug/L)			(ug/L)			(ug/L)			(ug/L)			(mg/L)	
dissolved	0.001	200.8	0.0044	0.001	--	--	--	200.8	0.03	0.001	200.8	0.055	0.001	200.8	0.091	0.001	200.8	0.0037	0.001
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	0.001	200.8	0.0067	0.001	200.8	0.1	0.001	200.8	0.023	0.001	200.8	0.072	0.001	200.8	0.1	0.001	200.8	0.11	0.001
Lead			(ug/L)			(ug/L)			(ug/L)			(ug/L)			(ug/L)			(mg/L)	
dissolved	0	200.8	0.00058	0.0005	--	--	--	200.8	0.03	0.0005	200.8	0.0036	0.0005	200.8	0.011	0.0005	200.8	ND	0.0005
particulate	0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	0.0005	200.8	0.009	0.0005	200.8	0.011	0.0005	200.8	0.0043	0.0005	200.8	0.012	0.0005	200.8	0.023	0.0005	200.8	0.038	0.0005
Zinc			(ug/L)			(ug/L)			(ug/L)			(ug/L)			(ug/L)			(mg/L)	
dissolved	0.002	200.8	0.21	0.002	--	--	--	200.8	0.032	0.002	200.8	0.64	0.002	200.8	0.048	0.002	200.8	0.038	0.002
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	2	200.8	0.27	0.002	200.8	0.019	0.002	200.8	0.024	0.002	200.8	0.78	0.002	200.8	0.058	0.002	200.8	0.34	0.002
General & Wet Chemistry	(mg/L)	EPA	(mg/L)	(mg/L)	EPA	(mg/L)	(mg/L)	EPA	(mg/L)	(mg/L)	EPA	(mg/L)	(mg/L)	EPA	(mg/L)	(mg/L)	EPA	(mg/L)	(mg/L)
Biological Oxygen Demand	2	405.1	4	2	405.1	ND	5	405.1	ND	2	405.1	5	2	405.1	ND	2	405.1	ND	3.4
Chemical Oxygen Demand	5	410.1	11	5	410.1	26	5	410.1	7.8	5	410.1	36	5	410.1	21	5	410.1	ND	5
Hardness	2	130.2	27	2	130.2	13	2	130.2	36	2	130.2	36	2	130.2	21	2	130.2	7	3
Nitrate Nitrogen	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrate + Nitrite	0.3	300	0.39	0.15	300	0.15	0.15	300	ND	0.06	300	0.38	0.15	300	0.15	0.15	300	0.68	0.3
Orthophosphate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Phosphorus	0	365.1	0.08	0.01	365.1	0.13	0.01	365.1	0.02	0.01	365.1	0.21	0.01	365.1	0.06	0.01	365.1	0.05	0.01
Physical	(mg/L)	EPA	(mg/L)	(mg/L)	EPA	(mg/L)	(mg/L)	EPA	(mg/L)	(mg/L)	EPA	(mg/L)	(mg/L)	EPA	(mg/L)	(mg/L)	EPA	(mg/L)	(mg/L)
Total Suspended Solids	5	160.2	7	3	160.2	240	10	160.2	12	2	160.2	26	10	160.2	9	2	160.2	2	2
Total Dissolved Solids	10	160.1	68	10	160.1	27	10	160.1	69	10	160.1	64	10	160.1	59	10	160.1	44	10
Total Solids	--	calc.	75	--	calc.	267	--	calc.	81	--	calc.	90	--	calc.	68	--	calc.	46	--
Hydrocarbons		EPA	(mg/L)		EPA	(mg/L)		EPA	(mg/L)		EPA	(mg/L)		EPA	(mg/L)		EPA	(mg/L)	
Total Petroleum Hydrocarbons	1	481.1	ND	1	481.1	ND	1	481.1	ND	1	481.1	ND	1	481.1	ND	1	481.1	ND	1

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Location	FS2U			FS2L			FS3U			FS3L			FS1L		
Date	8/28/1997			8/28/1997			8/28/1997			8/28/1997			8/28/1997		
Analyses	Method	Result	PQL	Method	Result	PQL	Method	Result	PQL	Method	Result	PQL	Method	Result	PQL
Metals		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)		(ppm)	(ppm)
Cadmium		(mg/L)			(mg/L)			(mg/L)			(ug/L)			(ug/L)	
dissolved	200.8	ND	0.0005	200.8	ND	0.0005	200.8	ND	0.0005	200.8	ND	0.0005	200.8	ND	0.0005
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	200.8	ND	0.0005	200.8	ND	0.0005	200.8	ND	0.0005	200.8	ND	0.0005	200.8	ND	0.0005
Copper		(mg/L)			(mg/L)			(mg/L)			(ug/L)			(ug/L)	
dissolved	200.8	0.11	0.001	200.8	0.039	0.001	200.8	0.083	0.001	200.8	0.17	0.001	200.8	0.01	0.001
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	200.8	0.12	0.001	200.8	0.051	0.001	200.8	0.0097	0.001	200.8	0.3	0.001	200.8	0.011	0.001
Lead		(mg/L)			(mg/L)			(mg/L)			(ug/L)			(ug/L)	
dissolved	200.8	0.016	0.0005	200.8	0.0022	0.0005	200.8	0.019	0.0005	200.8	0.0056	0.0005	200.8	######	0.0005
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	200.8	0.022	0.0005	200.8	0.0087	0.0005	200.8	0.00074	0.0005	200.8	0.03	0.0005	200.8	0.016	0.0005
Zinc		(mg/L)			(mg/L)			(mg/L)			(ug/L)			(ug/L)	
dissolved	200.8	0.036	0.002	200.8	0.033	0.002	200.8	0.32	0.002	200.8	0.081	0.002	200.8	0.058	0.002
particulate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
total	200.8	0.034	0.002	200.8	0.046	0.002	200.8	0.035	0.002	200.8	0.62	0.002	200.8	0.28	0.002
General & Wet Chemistry	EPA	(mg/L)	(mg/L)	EPA	(mg/L)	(mg/L)	EPA	(mg/L)	(mg/L)	EPA	(mg/L)	(mg/L)	EPA	(mg/L)	(mg/L)
Biological Oxygen Demand	405.1	7	3.4	405.1	ND	3.4	405.1	19	7.6	405.1	6	3.4	--	--	--
Chemical Oxygen Demand	410.1	27	5	410.1	ND	5	410.1	100	5	410.1	25	5	410.1	ND	5
Hardness	130.2	7	3	130.2	25	3	130.2	23	3	130.2	35	3	130.2	35	3
Nitrate Nitrogen	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrate + Nitrite	300	ND	0.3	300	0.15	0.15	300	0.16	0.15	300	0.3	0.15	300	4.1	0.3
Orthophosphate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Phosphorus	365.1	0.16	0.01	365.1	0.06	0.01	365.1	0.27	0.01	365.1	0.18	0.01	365.1	0.32	0.01
Physical	EPA	(mg/L)	(mg/L)	EPA	(mg/L)	(mg/L)	EPA	(mg/L)	(mg/L)	EPA	(mg/L)	(mg/L)	EPA	(mg/L)	(mg/L)
Total Suspended Solids	160.2	12	4	160.2	39	4	160.2	13	5	160.2	29	5	160.2	99	10
Total Dissolved Solids	160.1	81	10	160.1	91	10	160.1	150	10	160.1	85	10	160.1	110	10
Total Solids	calc.	93	--	calc.	130	--	calc.	163	--	calc.	114	--	calc.	*209*	--
Hydrocarbons	EPA	(mg/L)		EPA	(mg/L)		EPA	(mg/L)		EPA	(mg/L)		EPA	(mg/L)	
Total Petroleum Hydrocarbons	481.1	ND	1.1	481.1	ND	1	481.1	ND	1.1	481.1	ND	4.3	481.1	ND	4.3

1. First flush sample collected into 5 gallon bucket during first 30 minutes of rain event.

2. Composite sample collected into 5 gallon bucket. Sample collected after rain event. Possible overflow of sample.

3. Composite sample collected into 5 gallon bucket. A portion of the flow stream was diverted into a collection bucket using a notched tube inserted vertically into the flow stream.
4. SD refers to slot drain collection system samples
5. FS refers to filter strip or test plot samples

6. L refers to the subsurface runoff

7. U refers to the surface ruonff

10 APPENDIX II - TSS DATA FOR FIGURE 5

		TSS DATA SUMMARY FOR THE 1996 - 1997 SAMPLING PERIOD											
Date	SD1	SD2	SD AVG.	TP1L	%R	TP2L	%R	TP2U	%R	TP3L	%R	TP3U	%R
12/19/96		67.0	67			14	79.1			5	92.5	14	79.1
12/21/96	8.5	36.0	22.25	7	68.5								
02/03/97		150.0	150							26	82.7	6	96.0
02/19/97	36.0	82.0	59	3	94.9					3	94.9	3	94.9
03/03/97	27.0	210.0	118.5	14	88.2	2	98.3	3	97.5	3	97.5	6	94.9
03/17/97	4.0	45.0	24.5	5	79.6					3	87.8	14	42.9
03/28/97	5.0		5	4	20.0								
04/24/97	2.0		2										
05/21/97	0.0	15.0	7.5					8	-6.7	71	-846.7		
05/29/97	4.0	40.0	22			3	86.4	5	77.3	9	59.1	98	-345.5
06/12/97	4.0	21.0	12.5										
07/18/97	67.0	16.0	41.5	7	83.1	12	71.1	240	-478.3	9	78.3	26	37.3
08/28/97	2.0		2	99	-4850.0	39	-1850.0	12	-500.0	29	-1350.0	13	-550.0
		average	41.06	6.67	72.4	7.75	83.7	64.00	-77.6	16.13	-31.7	23.86	14.2
		standard deviation	47.19	3.93	1860.7	14.95	864.8	104.26	301.2	22.36	536.7	31.33	248.8
		n	12	6	7.0	5	5.0	5	5.0	9	9.0	8	8.0
		confidence interval	26.70	3.15	1378.4	13.10	758.1	91.38	264.1	14.61	350.7	21.71	172.4

LEGEND

SD1	composite slot drain 1 sample
SD AVG	arithmetic average of SD1 and SD2
TP	test plot
TP1L	composite sample from the subsurface collection system in test plot 1
TP2U	composite sample from the surface collection system in test plot 2
%R	percent concentration reduction relative to SD AVG
confidence interval	the confidence interval is calculated at the 95% level for the number of observations, n

No concentration entry indicates that a measurement was not taken
An entry of "0" concentration indicates that the concentration was below the method detection limit (MD

11 APPENDIX III - COD DATA FOR FIGURE 6

		COD DATA SUMMARY FOR THE 1996 - 1997 SAMPLING PERIOD											
Date	SD1	SD2	SD AVG.	TP1L	%R	TP2L	%R	TP2U	%R	TP3L	%R	TP3U	%R
10/6/1996	56		56					35	37.50			32	42.86
10/15/1996	19.9		19.9							15.4	22.61	13.3	33.17
10/22/1996	15		15	68	-353.33	13	13.33	13	13.33	11	26.67	8.9	40.67
10/24/1996	13		13	52	-300.00	6	53.85	9	30.77				
12/19/1996	42		42			7	83.33	0	100.00	5	88.10	10	76.19
12/21/1996	9	31	20	24	-20.00	6	70.00	0	100.00	6	70.00	0	100.00
2/3/1997		36	36					6	83.33	13	63.89		
2/19/1997	7	33	20	15	25.00					0	100.00	0	100.00
3/3/1997	61	36	48.5	12	75.26	17	64.95	6	87.63	0	100.00	0	100.00
3/17/1997	14	12	13	15	-15.38	5	61.54	6	53.85	0	100.00	0	100.00
3/28/1997	6		6	27	-350.00	7	-16.67	6	0.00				
4/14/1997	30		30			0	100.00	6	80.00	7	76.67	0	100.00
4/24/1997	25		25	29	-16.00	5	80.00	27	-8.00	5	80.00	0	100.00
5/21/1997	14	11	12.5		100.00	5	60.00	91	-628.00	9	28.00		
6/12/1997	41	79	60	72	-20.00	8.9	85.17	17	71.67	14	76.67	12	80.00
7/18/1997		16	16	11	31.25	7.8	51.25	26	-62.50	21	-31.25	36	-125.00
8/28/1997	0		0	0		0		27		25		100	
		average	25.46	29.55	-76.66	6.75	58.90	18.33	-2.89	9.39	61.64	16.32	62.32
		standard deviation	17.4228	24.0223	170.665	4.57723	32.2772	22.8619	186.016	7.70553	39.2475	27.923	64.5333
		n	17	11	11.00	13	13.00	15	15.00	14	14.00	13	13.00
		confidence interval	8.28209	14.196	100.855	2.48816	17.5458	11.5695	94.1354	4.03632	20.5587	15.1788	35.08

LEGEND

SD1	composite slot drain 1 sample
SD AVG	arithmetic average of SD1 and SD2
TP	test plot
TP1L	composite sample from the subsurface collection system in test plot 1
TP2U	composite sample from the surface collection system in test plot 2
%R	percent concentration reduction relative to SD AVG
confidence interval	the confidence interval is calculated at the 95% level for the number of observations, n

No concentration entry indicates that a measurement was not taken

An entry of "0" concentration indicates that the concentration was below the method detection limit (MDL)

12 APPENDIX IV - TOTAL Pb DATA FOR FIGURE 7

TOTAL Pb DATA SUMMARY FOR THE 1996 - 1997 SAMPLING PERIOD

Date	SD1	SD2	SD AVG.	TP1L	TP2L	TP2U	TP3L	TP3U	
10/15/96	0.0719	0.026					0.0589	0.0217	
10/18/96				0.079	0	0	0	0	
10/24/96	0			0		0			
Date	SD1	SD2	SD AVG.	TP1L	TP2L	TP2U	TP3L	TP3U	
02/19/97	0.012	0.029	0.0205				0.0099	0.0089	
03/03/97	0.0058		0.0058	0.044	0.0044	0.013	0.0038	0.0076	
03/17/97	0.0011	0.0083	0.0047	0.0037	0.0053	0.0049	0.0085	0.011	
03/28/97	0.0023	0.0019	0.0021	0.019	0.0031	0.023		0.0052	
04/14/97	0.0038		0.0038		0.0047	0.017	0.011	0.0038	
04/24/97	0.00075		0.00075	0.0025	0.0051	0.014	0.0017	0.0038	
05/29/97	0.0014	0.0073	0.00435		0.014	0.04		0.02	
06/12/97	0.001	0.0017	0.00135	0.0059	0.0054	0.017	0.01	0.0025	
07/18/97	0.001	0.0028	0.0019	0.009	0.0043	0.011	0.023	0.012	
08/28/97	0.038		0.038	0.016	0.0087	0.022	0.03	0.00074	
		average	0.008325	0.0143	0.006111	0.017989	0.012238	0.007554	
		standard deviation	0.011882	0.014476	0.003324	0.009929	0.009558	0.005716	0.008601
		n	10	7	9	9	8	10	
		confidence interval	0.007365	0.010724	0.002172	0.006487	0.006623	0.003543	
		upper limit	0.01569	0.025024	0.008283	0.024475	0.018861	0.011097	
		lower limit	0.00096	0.003576	0.00394	0.011502	0.005614	0.004011	

LEGEND

SD1 composite slot drain 1 sample
SD AVG arithmetic average of SD1 and SD2
TP test plot
TP1L composite sample from the subsurface collection system in test plot 1
TP2U composite sample from the surface collection system in test plot 2
%R percent concentration reduction relative to SD AVG
confidence interval the confidence interval is calculated at the 95% level for the number of observations, n

No concentration entry indicates that a measurement was not taken
An entry of "0" concentration indicates that the concentration was below the method detection limit (MDL)

13 APPENDIX V - TOTAL P DATA FOR FIGURE 13

Total P DATA SUMMARY FOR THE 1996 - 1997 SAMPLING PERIOD

Date	SD1	SD2	SD AVG	TP1L	%R	TP2L	%R	TP2U	%R	TP3L	%R	TP3U	%R
10/6/1996	0.11		0.11					0.07	36.364			0.09	18.18
10/15/1996	0.0278		0.0278						100	0.03	-5.40	0.03	-24.10
10/22/1996	0.03		0.03	1	-3233.3	0.02	33.3	0.02	33.333			0.02	33.33
10/24/1996	0.02		0.02	1.1	-5400			0.2	-900				
12/19/1996		0.11	0.11			0.07	36.4	0.07	36.364	0.05	54.55	0.06	45.45
12/21/1996	0.02	0.04	0.03	1.1	-3566.7				100				
2/3/1997		0.09	0.09						100	0.03	66.67		
2/19/1997	0.02	0.06	0.04						100	0.02	50.00	0.02	50.00
3/3/1997	0.07	0.09	0.08	1	-1150	0.02	75	0.04	50	0.02	75.00	0.02	75.00
3/17/1997	0.02		0.02	0.65	-3150			0.01	50			0.01	50.00
4/14/1997	0.05		0.05			0.01	80	0.02	60			0.02	60.00
4/24/1997	0.02		0.02	0.8	-3900	0.02	0	0.02	0	0.02	0.00	0.02	0.00
5/21/1997	0.02	0.03	0.025					0.1	-300	0.10	-300.00		
5/29/1997		0.08	0.08			0.02	75	0.04	50	0.04	50.00		
6/12/1997	0.06	0.21	0.135	0.9	-566.67	0.01	92.6	0.02	85.185	0.01	92.59	0.03	77.78
7/18/1997		0.5	0.5	0.08	84	0.02	96	0.13	74	0.06	88.00	0.21	58.00
8/28/1997	0.05		0.05	0.32	-540	0.06	-20	0.16	-220	0.18	-260.00	0.27	-440.00
		average	0.0834	0.77	-2380.3	0.03	52	0.069	-32.04	0.0508	-8.054	0.067	0.303896
		standard deviation	0.1135	0.36	1884.7	0.02	41.7	0.061	249.82	0.0497	138.3	0.0847	141.8469
		n	18	10	10	10	10	14	14	12	12	14	14
		confidence interval	0.05	0.22	1168.15	0.01	25.84	0.03	130.86	0.03	78.25	0.04	74.30

LEGEND

SD1	composite slot drain 1 sample
SD AVG	arithmetic average of SD1 and SD2
TP	test plot
TP1L	composite sample from the subsurface collection system in test plot 1
TP2U	composite sample from the surface collection system in test plot 2
%R	percent concentration reduction relative to SD AVG
confidence interval	the confidence interval is calculated at the 95% level for the number of observations, n

No concentration entry indicates that a measurement was not taken
An entry of "0" concentration indicates that the concentration was below the method detection limit (MDL

14 APPENDIX VI - NITRATE DATA FOR FIGURE 14

NITRATE DATA SUMMARY FOR THE 1996 - 1997 SAMPLING PERIOD

Date	SD1	SD2	SD AVG.	FS1L	FS2L	FS2U	FS3L	FS3U
03/29/96	0.29		0.29					
09/03/96							0.87	0.867
10/06/96	0.24		0.24			0.5		1.8
10/15/1996	0.05		0.05				0.26	0.154
10/18/96						0.06	0.22	0.1
02/03/97							0.12	
02/19/97	0.05	0.08	0.065				0.04	0.07
03/17/97				0.31		0.03		0.13
04/14/97								0.21
04/24/97	0.33		0.33				0.06	0.39
05/21/97	0.6	0.38	0.49			0.34	0.04	
05/29/97	1	0.65	0.825				0.16	
06/12/97	1.7		1.7					
		average	0.50	0.31		0.23	0.22	0.47
		standard deviation	0.54			0.23	0.27	0.60
		n	8	1		4	9	8
		confidence interval	0.38			0.22	0.18	0.42

LEGEND

SD1	composite slot drain 1 sample
SD AVG	arithmetic average of SD1 and SD2
TP	test plot
TP1L	composite sample from the subsurface collection system in test plot 1
TP2U	composite sample from the surface collection system in test plot 2
%R	percent concentration reduction relative to SD AVG
confidence interval	the confidence interval is calculated at the 95% level for the number of observations, n

No concentration entry indicates that a measurement was not taken
An entry of "0" concentration indicates that the concentration was below the method detection limit (MDL

15 APPENDIX VII - DATA FROM NOVEMBER 1997 - JANUARY 1998 SAMPLING PERIOD

METAL ANALYSIS FOR THE NOVEMBER 1997 - JANUARY 1998 SAMPLING PERIOD

Label	Sieve Size	Date Rec'd	Sample Type	Mg	Ca	Fe	Cu	Zn	Pb	Cd
				(mg/Kg)	(mg/Kg)	(mg/Kg)	(mg/Kg)	(mg/Kg)	(mg/Kg)	(mg/Kg)
20 ppm std			Soil	20.4	20.44	20.44	20.36	20.46	20.38	20.66
1.1	#60		Soil	2582	7230	14485	25.55	70.00	23.35	ND
2.1	#60		Soil	3790.5	6850	19845	40.60	106.95	38.86	ND
3.1	#60		Soil	1865	3227.5	10475	19.69	55.30	21.28	ND
4.1	#60		Soil	3486	7305	14875	72.50	75.85	28.22	ND
1.1	#200		Soil	4647.5	5000	23215	59.20	166.10	65.90	ND
2.1	#200		Soil	4604.5	4916.5	22095	63.10	178.35	77.20	ND
3.1	#200		Soil	4983.5	5960	24485	68.15	194.80	80.45	ND
4.1	#200		Soil	5250	7040	25520	67.00	291.30	85.25	ND
1.1	<200		Soil	5135	6045	24435	88.00	262.70	104.75	ND
2.1	<200		Soil	5185	6255	24820	85.20	259.75	104.75	ND
3.1	<200		Soil	5535	6740	26295	92.85	275.70	109.60	ND
4.1	<200		Soil	5570	7335	25235	91.00	276.35	110.25	ND
20 ppm std			Soil	20.97	21.58	20.88	20.50	21.21	21.22	21.22
SD		11/15/98	TOTAL	0.516	2.125	1.303	0.030	0.408	ND	ND
SD		11/15/98	SOLUBLE	0.158	3.064	ND	ND	ND	ND	ND
SD		1/6/99	TOTAL	1.890	3.568	1.636	ND	0.051	ND	ND
SD		1/6/99	SOLUBLE	1.019	4.912	ND	ND	ND	ND	ND
FS1L		11/15/98	TOTAL	0.769	8.758	ND	ND	0.539	ND	ND
FS1L		11/15/98	SOLUBLE	0.542	13.740	ND	ND	0.721	ND	ND
FS1L		1/6/99	TOTAL	0.833	6.634	0.127	ND	0.106	ND	ND
FS1L		1/6/99	SOLUBLE	0.422	7.034	ND	ND	ND	ND	ND
FS2U		1/6/99	TOTAL	0.204	0.802	0.043	ND	ND	ND	ND
FS2U		1/6/99	SOLUBLE	0.103	0.841	ND	ND	ND	ND	ND
FS2L		1/6/99	TOTAL	0.619	4.220	0.150	ND	ND	ND	ND
FS2L		1/6/99	SOLUBLE	0.305	4.556	ND	ND	ND	ND	ND
FS3U		1/6/99	TOTAL	0.188	0.607	0.041	ND	ND	ND	ND
FS3U		1/6/99	SOLUBLE	0.098	0.618	ND	ND	ND	ND	ND
FS3L		1/6/99	TOTAL	0.367	1.279	ND	ND	ND	ND	ND
FS3L		1/6/99	SOLUBLE	0.226	1.635	ND	ND	ND	ND	ND
FS2U		2/7/99	TOTAL	0.684	6.046	ND	ND	1.311	ND	ND
				average of replicate sieve fractions						
	Mg			Ca			Fe			
	Avg	Stdev	Con Int	Avg	Stdev	Con Int	Avg	Stdev	Con Int	
#60	2930.9	876.5	859.0	6153.1	1960.6	1921.3	14920.0	3838.6	3761.8	
#200	4871.4	304.0	297.9	5729.1	993.9	974.0	23828.8	1491.5	1461.6	
<#200	5356.3	228.0	223.4	6593.8	573.5	562.0	25196.3	802.0	786.0	
#60	Cu			Zn			Pb			
#200	Avg	Stdev	Con Int	Avg	Stdev	Con Int	Avg	Stdev	Con Int	
<#200	39.6	23.6	23.2	77.0	21.7	21.3	27.9	7.8	7.7	
	64.4	4.1	4.0	207.6	57.0	55.9	77.2	8.2	8.1	
	89.3	3.4	3.3	268.6	8.6	8.5	107.3	3.0	2.9	

LEGEND

SD	composite slot drain 1 sample
TOTAL	total metal concentration
SOLUBLE	filterable metal concentration
confidence interval	the confidence interval is calculated at the 95% level for the number of observations, n
ND	Below method detection limit: Liquid Phase Cu, Cd, Zn = 0.04 mg/L; Liquid phase Pb = 0.08 m
	Solid phase Cu, Cd, Zn = 2.0 mg/Kg; Solid phase Pb = 4.0 mg/Kg

No concentration entry indicates that a measurement was not taken

SIEVE ANALYSIS FOR THE NOVEMBER 1997 - JANUARY 1998 SAMPLING PERIOD

Sample location	Rep No.	sample weight (g)	sieve no.	Sieve size (mm)	sieve wt (g)	size fraction retained (%)	Rep No.	sieve wt (g)	size fraction retained (%)	Rep No.	sieve wt (g)	size fraction retained (%)	Avg (%)
1	1	72.55	4	4.76	9.52	13.22	2	11.61	17.88	3	16.74	25.32	18.81
			10	2	11.25	15.62		12.41	19.11		11.06	16.73	17.15
			60	0.25	29.31	40.69		24.28	37.39		22.79	34.47	37.52
			200	0.074	14.98	20.80		10.75	16.56		9.76	14.76	17.37
			<200	<0.074	6.97	9.68		5.88	9.06		5.76	8.71	9.15
			total recov		72.03	100		64.93	100		66.11	100	100
2	1		4	4.76	10.25	15.09	2	16.35	20.16	3	14.11	17.85	17.70
			10	2	12.89	18.97		18.15	22.38		13.85	17.52	19.63
			60	0.25	27.83	40.96		30.09	37.11		31.38	39.70	39.26
			200	0.074	11.76	17.31		11.33	13.97		13.63	17.24	16.18
			<200	<0.074	5.21	7.67		5.17	6.38		6.07	7.68	7.24
			total recov		67.94	100		81.09	100		79.04	100	100
3	1		4	4.76	13.79	20.24	2	11.68	14.73	3	17.50	24.90	19.96
			10	2	13.86	20.34		14.4	18.16		12.08	17.19	18.56
			60	0.25	25.22	37.01		31.76	40.06		24.82	35.32	37.46
			200	0.074	10.25	15.04		14.57	18.38		10.75	15.30	16.24
			<200	<0.074	5.02	7.37		6.87	8.67		5.12	7.29	7.77
			total recov		68.14	100		79.28	100		70.27	100	100
4	1		4	4.76	12.2	19.73	2	9.28	17.15	3	12.95	23.60	20.16
			10	2	9.12	14.75		9.7	17.92		8.82	16.07	16.25
			60	0.25	24.38	39.42		21.88	40.43		21.16	38.56	39.47
			200	0.074	10.72	17.34		9.06	16.74		8.11	14.78	16.29
			<200	<0.074	5.42	8.76		4.2	7.76		3.83	6.98	7.84
			total recov		61.84	100		54.12	100		54.87	100	100

Size Distribution Calculations

Sieve size (mm)	Geometric Mean Diameter (mm)	Overall Average (%)	% finer than
4.76	4.76	19.15594	81
2	3.08545	17.89825	63
0.25	0.707107	38.4283	25
0.074	0.136015	16.51809	8
0		7.999423	0
		100	