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16. Abstract

Hot-mixed asphalt overlays including open-graded friction course (OGFC) and ultra-thin NovaChip™ are being used by state transportation agencies for pavement rehabilitation and preservation. This research examined the hydrologic performance and water quality benefits associated with OGFC and NovaChip™ overlays, as compared to conventional asphalt pavement. The environmental benefits of OGFC and NovaChip™ overlays include minimizing the washout of vehicular pollutants onto roadway surface during precipitation events, reducing pollutant loadings discharged to receiving streams, and serving as a stormwater control measure. Resurfacing the entire segment of roadways that are running adjacent to or crossing sensitive water bodies could reduce the discharge of TSS and associated particulate pollutants to protected waters, which apparently provides the functionality of structural stormwater control measures. However, the improvement in TSS reduction should be balanced against the potential increased nutrient concentrations (DTP and several nitrogen fractions) observed in OGFC runoff in relation to conventional pavement. In addition, there appeared to be no significant difference in TSS concentrations between OGFC and conventional pavement runoff after that runoff had moved through adjacent 5-ft grassed shoulder filter strips at each site. No observed water quality benefits could be attributed to the NovaChip™ overlay in relation to conventional pavement surfaces.

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Final Report

Stormwater Characterization from Roadways with Open Graded Friction Course Surfaces

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Executive Summary

Thin hot-mixed asphalt overlays including open-graded friction course (OGFC) and ultra-thin NovaChip™ are being used for pavement rehabilitation and preservation. These overlay types can help reduce hydroplaning with improved visibility and motorist safety during precipitation events. The economic return for resurfacing with OGFC and NovaChip™ in order to prolong the service life of existing paved road is promising. Since 2001, about 1.59% and 0.36% of the North Carolina route miles were resurfaced with OGFC and NovaChip™ overlays, respectively. This research project was initiated by the North Carolina Department of Transportation (NCDOT) to investigate the water quality benefits associated with roadways resurfaced with OGFC and NovaChip™. If these overlays can provide the equivalent functionality of stormwater control measures (SCMs), it will result in significant cost savings in design, installation, and maintenance that would have been required for highway runoff management. Currently, very little information is available on the water quality benefits that might be provided by OGFC and NovaChip™ overlays.

The goal of this research was to assess the water quality benefits of OGFC and NovaChip™ overlays as a potential SCM. A field monitoring program was instituted to characterize surface runoff from roadways resurfaced with OGFC and NovaChip™, as compared to roadways paved with conventional asphalt. Two highway locations along Interstate 77 in Charlotte, Mecklenburg County, and Interstate 85 in Davidson County, NC, were selected for hydrologic and water quality monitoring during the period of August 2011 - November 2012. At the Charlotte location, a highway section of 3/4-inch (20-mm) thick OGFC asphalt overlay was paired with a conventional hot-mix asphalt section that served as the control. The annual average daily traffic (AADT) counts at the Charlotte-OGFC and Charlotte-conventional pavement sites were 75,000 vehicles per day and 88,500 vehicles per day, respectively. The Davidson County location included a 1/2-inch (13-mm) thick NovaChip™ overlay section and a conventional hot-mix asphalt section as the control. AADT along the Davidson County I-85 section was 25,000 vehicles per day. This research also investigated the effectiveness of roadside grassed filter-strips treating runoff from edge-of-pavement to understand if any incremental water quality benefits can be expected.

The total rainfall amounts monitored at each site accounted for 32% to 43% of the annual rainfall measured for each site during the study period. Seventy-two percent or more of the monitored rainfall events were less than 1.3 inches. Hydrologic parameters determined for each event included runoff yield and hydrologic lag time. Runoff quality was measured for selected water quality parameters as event-mean-concentration (EMC) and the particle size distribution of settleable and suspended solids was determined for selected events.

Site-averaged runoff coefficients for the conventional pavement (0.82) and OGFC (0.85) roadway sections at the Charlotte location were not statistically different. However, there was a statistically significant difference between the site-average runoff coefficients for the NovaChip™ surface (0.87) and its respective conventional pavement control (0.78). The 5-ft roadside filter strip provided statistically insignificant reductions in runoff volume at all study sites. The OGFC overlay prolonged the runoff lag time by a factor of 2.4 and the NovaChip™ overlay reduced the lag time by 0.71 in comparison to conventional pavements. The internal porous structure and surface roughness of OGFC overlay appears to allow measurable detention storage that slows down runoff.

Site-averaged TSS EMCs in runoff originating from Charlotte conventional pavement, OGFC overlay, Davidson conventional pavement and NovaChip™ overlay were 59±32 mg/L, 35±27 mg/L, 13±11 mg/L, and 29±20 mg/L, respectively. Runoff from the OGFC pavement can be characterized by significantly lower (≈ 41%) TSS EMC's than its paired conventional site. Runoff from the NovaChip™ surface exhibited higher TSS EMC's than its paired conventional site, possibly due to relatively shorter runoff lag times resulting in a stronger flushing effect of sediments from its overlay surface. TSS EMCs in runoff passing though the grassed filter strips were in the range of 13-16 mg/L for the NovaChip™ and both conventional pavement sites. The filter strip at the Charlotte OGFC site further reduced average TSS EMC from the edge-of-pavement concentration of 35 mg/L to 26 mg/L.

No significant difference was evident for TP EMC's between the Charlotte conventional (0.19 mg/L) and OGFC (0.28 mg/L) edge-of-pavement sites. Median TP EMC concentrations for the Charlotte conventional and OGFC edge-of-pavement sites were 0.17 and 0.16 mg/L, respectively. TP levels from the NovaChip™ (0.09 mg/L) and conventional pavement (0.13 mg/L) sites were statistically different ($P \leq 0.05$). No significant differences in TP runoff concentrations were found between the edge-of-pavement and filter strip runoff at the Charlotte OGFC sites, and between the conventional pavement and OGFC filter strip sites. Conventional pavement TP EMC runoff concentrations were observed to increase at the Davidson County site after passing through its grassed filter strip with no significant differences observed between the NovaChip™ edge-of-pavement and its filter strip sites, nor the conventional pavement and the NovaChip™ filter strip sites.

Significantly higher concentrations of TDN, NO_3-N, NH_4-N, and DON in OGFC runoff as compared to the conventional pavement runoff concentrations was observed at Charlotte monitoring sites. It is also interesting to note that the Charlotte OGFC runoff concentrations for all nitrogen components are higher than that measured for bulk precipitation at this site. A possible source of this ″extra nitrogen″ may come from atmospheric derived particulates, gasses, and aerosols stored within the porous OGFC surface that was mobilized during runoff events. A similar storage pool of N on the conventional pavement is not likely to accumulate owing to a significantly smaller storage volume and deflation from wind and vehicular traffic, which limits pollutant buildup. No significant differences in TDN, NO_3-N, NH_4-N and DON runoff concentrations were measured between the Davidson County conventional and NovaChip™ pavement surfaces.

The OGFC pavement did not exhibit any level of reduction in dissolved metal concentrations, except for Cr. Zn EMC's were markedly higher in Charlotte OGFC runoff as compared to all other sites. Grassed shoulder strips appeared to effectively reduce EMC's for dissolved Zn (40% to 65%) in three of our four study sites, whereas significant increases in dissolved Zn concentrations as runoff moved across grass filter strips was reported from a Permeable Friction Course runoff study in Texas. Our study did not measure total metal concentrations as has been reported by other studies. Given that TSS concentrations declined in OGFC edge-of-pavement runoff in comparison to the conventional pavement runoff, it is reasonable to expect similar reductions in total metal concentrations for our study sites.

Results of grain size analysis are consistent with other research that examined particle size distributions in highway runoff. However, mean TSS grain size was significantly smaller for runoff samples from the Charlotte OGFC pavement and subsequently, OGFC filter strip sites (62.5-125 μm, very fine sand) when compared to the Charlotte conventional edge-of-pavement and the Charlotte conventional pavement filter strip sites (125-250 μm, fine sand). At first, this difference seems counter intuitive given the coarser aggregate size fractions used in the OGFC as compared to conventional pavement. However, we attribute this difference to coarse particulates deposited from vehicles being preferentially retained within the OGFC overlay matrix while some fraction of the finer vehicle-source particulates is transported from the overlay. Total suspended sediment grain size became more uniform after runoff passed through the vegetated shoulders at both Charlotte sites, with skewness and kurtosis not changing significantly. TSS grain sizes for the Davidson County conventional and NovaChip™ edge-of-pavement and filter strip sites tended to be smaller than the Charlotte sites with mean grain size TSS values for all sites falling within the silt-sized class (3.9 μm-62.5 μm). No significant changes in sorting, skewness, or kurtosis were evident between the Davidson County edge-of-pavement and adjacent filter strip sites. An examination of the median TSS particle size distributions reveals that only seven of ninety-three samples (≈ 7.5%) collected during this study exceeded a median particle size of 62 μm.

Settleable solids for Charlotte edge-of-pavement sites were significantly coarser than the mean TSS grain sizes from these same sites, both being classified as medium sand (1/4 to 1/2 mm) as compared to fine sand for the Charlotte conventional edge-of-pavement and filter strip surfaces, and very fine sand for the Charlotte OGFC edge-of-pavement and filter strip surfaces. Sorting was not significantly different between the Charlotte sites but the Charlotte conventional filter strip and the OGFC edge-of-pavement and filter strip sites were significantly more positively skewed and had higher kurtosis values than the Charlotte conventional edge-of-pavement site. Settleable solids were also significantly coarser than TSS mean grain sizes for the Davidson County sites with the NovaChip™ filter strip and the conventional edge-of-pavement and filter strip sites mean grain sizes all classified as fine sands. The Davidson NovaChip™ edge-of-pavement site exhibited mean settleable solid grain sizes in the medium sand classification. Similar to the Charlotte sites, skewness became more positive and kurtosis values increased in comparison to the edge-of-pavement sites. It is apparent that the settleable solids can comprise an appreciable quantity of the total solids flux for the edge-of-pavement sites while generally representing ≤ 30% of the various filter strip runoff totals. Of particular importance is the proportion of the size fraction < 62 μm as this silt and smaller sized fraction is difficult to settle or capture in many traditional SCM's.

In summary, the delayed runoff rate resulting from the use of OGFC overlay helps in reducing the transport of TSS and particulate pollutants. A treatment train consists of OGFC and roadside-grassed filter strip could provide 56% or better in TSS reduction performance (i.e. 41% from OGFC and an additional 26% from the adjacent filter strips), particularly for higher incoming TSS concentrations. A treatment train consists of NovaChip™ and filter strip offers no net TSS reduction when compared to conventional pavement. The increase in TSS concentrations in NovaChip™ surface runoff as compared to conventional pavement runoff is largely offset by the adjacent filter strip, which may result in similar TSS concentration as if runoff was originating from the conventional pavement surface and flowing through the filter strip. Use of OGFC and NovaChip™ helps to reduce splashing and minimizing the washout of vehicular pollutants onto roadway surface during precipitation. Our results and those from other studies indicate that the resurfacing of roadway segments running adjacent to, or crossing sensitive water bodies with an OCFG overlay may reduce the discharge of TSS and particulate pollutant to protected waters, which apparently provide the functionality of structural stormwater control measures. However, the improvement in TSS reduction must be balanced against the potential increased nutrient concentrations (DTP and several nitrogen fractions) observed in OGFC runoff in relation to conventional pavement. Several important questions arise as to the source of elevated nutrient concentrations in OGFC runoff. Is the elevated nutrient concentrations related to the remobilization of nutrients from atmospheric deposition, evaporite deposits or entrained particulates within the OGFC overlay? If so then this material would normally have runoff during precipitation events or would have been deflated from conventional pavement surfaces onto adjacent grassed medians during intra-storm periods and does not in fact represent increased nutrient transport in runoff from OGFC surfaces. No observed water quality benefits could be attributed to the NovaChip™ overlay in relation to conventional pavement surfaces.

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List of Abbreviations and Acronyms

AADT	**A**nnual **A**verage **D**aily **T**raffic (vehicles per day)
BP	**B**ulk **P**recipitation
BPC	**B**ulk **P**recipitation **C**harlotte
BPD	**B**ulk **P**recipitation **D**avidson County
BPO	**B**ulk **P**recipitation **O**GFC
CCR_EOP	Site name for **C**harlotte **C**onventional **R**oad surface runoff at the **E**dge-**o**f-**P**avement of I-77 Northbound
CCR_FS	Site name for **C**harlotte **C**onventional **R**oad surface runoff after it passes through the adjoining grassed **F**ilter **S**trip along I-77 Northbound
COR_EOP	Site name for **C**harlotte **O**GFC **R**oad surface runoff at the **E**dge-**o**f-**P**avement of I-77 Northbound
COR_FS	Site name for **C**harlotte **O**GFC **R**oad surface runoff after it passes through the adjoining grassed **F**ilter **S**trip along I-77 Northbound
CV	**C**oefficient of **V**ariation
DCR_EOP	Site name for **D**avison County **C**onventional **R**oad surface runoff at the **E**dge-**o**f-**P**avement of I-85 Northbound
DCR_FS	Site name for **D**avison County **C**onventional **R**oad surface runoff after it passes through the adjoining grassed **F**ilter **S**trip along I-85 Northbound
DNR_EOP	Site name for **D**avison County **N**ovaChip™ **R**oad surface runoff at the **E**dge-**o**f-**P**avement of I-85 Northbound
DNR_FS	Site name for **D**avison County **N**ovaChip™ **R**oad surface runoff after it passes through the adjoining grassed **F**ilter **S**trip along I-85 Northbound
DOC	**D**issolved **O**rganic **C**arbon
DON	**D**issolved **O**rganic **N**itrogen, given by TDN – (NH_4-N + NO_3-N)
DOP	**D**issolved **O**rganic **P**hosphorus, given by TDP – PO_4-P
EMC	**E**vent-**M**ean-**C**oncentration
EOP	**E**dge-**o**f-**P**avement
IC	**I**on **C**hromatography
MPE	**M**ulti-sensor **P**recipitation **E**stimates
NCDOT	**N**orth **C**arolina **D**epartment of **T**ransportation
NovaChip™	**B**rand name for ultrathin bonded wearing course
NPOC	**N**on-**P**urgeable **O**rganic **C**arbon
OGFC	**O**pen **G**raded **F**riction **C**ourse

PFC	**P**orous **F**riction **C**ourse
PP	**P**articulate **P**hosphorus, given by TP – TDP
ROW	**R**ight-**o**f-**W**ay
RTD	**R**apid **T**ransfer **D**evice
S.D.	**S**tandard **D**eviation
SCM	**S**tormwater **C**ontrol **M**easure
TDN	**T**otal **D**issolved **N**itrogen
TDP	**T**otal **D**issolved **P**hosphorus, given by TP on filtered subsample
TKN	**T**otal **K**jehldahl **N**itrogen
TN	**T**otal **N**itrogen
TP	**T**otal **P**hosphorus
TSS	**T**otal **S**uspended **S**olids
Tx-DOT	**T**exas **D**epartment **o**f **T**ransportation
UBWC	**U**ltrathin **B**onded **W**earing **C**ourse
WSDOT	**W**ashington **S**tate **D**epartment **o**f **T**ransportation

1.0 INTRODUCTION

1.1 Overview

Asphalt paved roads require routine maintenance including crack pouring, surface treatment, milling and overlays of nominal aggregate size to warrant traffic safety. The asphalt industry has developed new materials for building longer lasting and less expensive highways. These include hot mix asphalt, perpetual pavement, stone matrix asphalt, Superpave, and rubblization pavements.

Open-graded friction course (OGFC) is a hot mix without the fines designed to contain a large number of void spaces. Its open texture allows water to disburse laterally and vertically through the pavement, which minimizes hazardous driving conditions by reducing water ponding on road surfaces. OGFC has been used in new construction, major rehabilitation projects, and maintenance overlays. NovaChip™ or ultrathin bonded wearing course (UBWC) is another application of the hot mix technology. It combines the strength of hot mix with the flexibility of thin maintenance treatment as overlays on concrete or asphalt surfaces.

Land based stormwater control measures (SCMs), such as bioretention and dry detention basins, have been employed by North Carolina Department of Transportation (NCDOT) for highway runoff control in high-value water supply and nutrient sensitive watersheds. These SCMs often require additional and costly rights-of-way (ROW) and would most likely saddle NCDOT with long-term maintenance requirements. If OGFC and/or NovaChip™ can be demonstrated to be a viable SCM option for preventing pollutants discharged in highway runoff, it would certainly provide multiple savings in design, installation, and maintenance costs. Then, these pavement types can be integrated into the linear environment of the roadway system and contribute to pollutant removal efficiency applicable to stormwater management.

Water quality and hydrological benefits for OGFC have previously been studied by Barrett et al. (2006) and Winston et al. (2011). However, these studies had some limitations which included the use of passive "first flush" samplers rather than flow weighted sampling in the Barrett et al. (2006) study, and the lack of conventional pavement reference sites for the North Carolina OGFC study reported by Winston et al. (2011). Asphalt porous friction course (PFC) pavement is similar to OGFC. One PFC runoff study site near Austin, Texas investigates the before and after installation of PFC sampling design but includes no concurrent paired conventional pavement and PFC runoff sampling (Bradley et al. 2012). We could not find any reference to studies examining the potential water quality benefits of NovaChip™

and NCDOT has considerable interest to see if the water-quality performance benefits reported from previous studies might also extend to other bonded wearing course treatments.

1.2 Scope of Research

The objective of this research was to assess the hydrologic performance and water quality benefits provided by the OGFC and NovaChip™ pavement types, as compared to conventional asphalt pavement. The research was accomplished through a field-monitoring program to characterize surface runoff from each pavement type in terms of its runoff yield and hydrographic timing, and event-mean-concentrations (EMCs) of selected water quality parameters. The effectiveness of roadside filter strips in conjunction with these pavements was also investigated to determine the incremental water quality benefits as the roadway runoff continues to flow from the pavement edge over a 5-ft (1.5-m) wide filter strip. The scope of research includes the following tasks.

<u>Task1: Literature review and data assessment</u>

a) Literature review to understand the SCM effectiveness of OGFC and NovaChip™ pavements,
b) Literature review to provide physical characteristics and specifications of OGFC and NovaChip™ pavements, and
c) Review of NCDOT survey data for existing OGFC and NovaChip™ roadway lengths and distress conditions.

<u>Task 2: Implementation of a field monitoring and sampling program</u>

a) Site characterization and identification,
b) Monitoring of 12-15 paired storm events at each sampling location,
c) Characterization of runoff water quality from conventional, OGFC, and NovaChip™ pavement surfaces and through an adjacent filter strip, and
d) Performing grain size analysis of highway runoff (TSS) and settleable solids samples.

<u>Task 3: Evaluation of treatment train performance</u>

The field monitoring data are analyzed to determine if a stormwater treatment train consisting of OGFC or NovaChip™ followed by roadside grassed filter-strips can serve as a potential stormwater control measure for roadway runoff management.

2.0 LITERATURE REVIEW

2.1 Background

Open-graded friction course was the earliest porous asphalt overlay used to improve skid resistance on roadways. However, in the 1980s these pavements were found to be susceptible to sudden and catastrophic failures caused by a combination of their mix design, material specifications, and construction issues (Cooley *et al.*, 2009). Raveling and stripping of the asphalt structure were the primary issues with the early OGFC installations because of the asphalt binder draining from the uniform course graded mixtures during transportation and construction.

Subsequent research has demonstrated that the use of modified asphalt binders and stabilizing additives could provide a more durable permeable pavement. In the late 1990s and early 2000s, these mixture modifications, in addition to reduced production temperatures, have become a new generation of OGFC overlay (Cooley *et al.*, 2009). The new OGFC mixture is typically placed in 3/4-inch (19 mm) lifts and has a minimum in-place air void content of 18 percent (NCDOT, 2012). As of 2009, fourteen states had implemented some variation of the newly formulated OGFC (NCHRP, 2009).

NovaChip™ is another type of asphalt surface overlay used to improve traffic safety. It is an ultra-thin bonded wearing course developed in the late 1980s in France for skid resistance and sealing of old pavement surfaces (Cooper and Mohammad, 2004). NovaChip™ was introduced to the United Stated in the early 1990s and first used on Texas and Alabama state highways in 1992 (Uhlmeyer *et al.*, 2003). NovaChip™ is similar to an open-graded mixture in the sense that it has a large percentage of course aggregates; however, NovaChip™ mixtures have a higher percentage of aggregates in the intermediate and fine size ranges than the more uniform open-graded mixtures (Tx-DOT, 2011).

In addition, NovaChip™ installation requires special paving equipment to lay the asphalt mixture directly onto a thick layer of polymer modified asphalt emulsion tack coat (Kandhal and Lockett, 1997). NovaChip™ is typically compacted to 1/4, 3/8, or 1/2-inch (6.4, 9.5, or 12.7-mm) lifts (NCDOT 2012) and has a typical in-place air void content of approximately 12.7 percent (Uhlmeyer *et al.*, 2003). NovaChip™ overlays provide a similar surface texture as OGFC overlay; however, structurally it would not experience raveling and stripping which were characteristic of the early OGFC designs. Kandhal and Loctett (1997) suggest that this is due to the thick asphalt emulsion tack coat creating a very good bond between NovaChip™ and its underlying surface. NovaChip™ is compatible to hot-mix-asphalt (HMA) Class G when analyzed on a total project cost basis, but not on the cost of the overlay (WSDOT, 2008).

The North Carolina Department of Transportation adopted the use of OGFC (FC-2 modified) and NovaChip™ on high traffic volume roadways to increase frictional characteristics. The specified NCDOT job mix formulas for these mixtures, along with conventional dense-graded designs (S-9.5-D and S-12.5-D) are given in Table 2.1 (NCDOT, 2012). Each job mix formula includes specified aggregate gradation (percentage passing), maximum aggregate size, binder grade and content, thickness, tack coat grade and application rate, total percentage of air voids, and compaction effort.

Table 2.1 NCDOT High Traffic Volume Pavement Design Job Mix Formulas

		OGFC FC-2 Modified	NovaChip™	Conventional S9.5D	Conventional S 2.5D
		% Passing	% Passing	% Passing	% Passing
Gradation Sieve Size, inches[1]	0.748	100	-	-	-
	0.492	85-100	100	-	100
	0.374	55-75	85-100	100	90
	0.187	15-25	28-44	90	-
	0.093	5-10	17-34	67	58
	0.024	-	8-18	-	-
	0.012	-	6-13	-	-
	0.006	-	4-10	-	-
	0.003	2-4	3-7	8	8
Nominal Max Aggregate Size, inches		0.492	0.374	0.187	0.374
Maximum Aggregate Size, inches		0.748	0.492	0.335	0.492
Asphalt Binding Grade		PG 76-22	PG 70-28/22	PG 76-22	PG 76-22
Asphalt Binder, %		5.0-8.1	4.6-5.8	5.5	5
Application Depth, in		3/4	1/4, 3/8, 1/2	1.5-2.0	2
Total Mix Air Voids, %		18 min	NA	3.0-5.0	3.0-5.0
Tack Coat		PG 64-23	*	PH 64-23	PG 64-23
Tack Coat Application Rate, gal/sq. yard		0.06-0.08	0.15-0.25	0.04-0.08	0.04-0.08
Compaction		**	***	***	***

*Polymer-Modified Emulsion Membrane
**Max. 2 passes w/ tandem steel roller, max 10 tons
***Max. 2 passes w/ steel double drum roller, min 10 tons
[1]Sieve sizes are equivalent to 19, 12.5, 9.5, 4.75, 2.36, 0.60, 0.30, 0.15, and 0.075 mm, respectively.

2.2 Water Quality

Earlier studies on the effectiveness of porous pavement surfaces were reported on German highways (Stotz and Krauth, 1994). Their findings indicated that the constituent loads of suspended solids, total copper, and total lead from the porous overlay surfaces were 66%, 31%, and 55%, respectively, lower than the runoff from traditional pavement surfaces. Subsequent to that, Berbee *et al.* (1999) reported the quality of runoff generated from porous and non-porous pavement surfaces in the

Netherlands. Porous pavement could achieve reductions in TSS (91%), TKN (84%), COD (88%), and total Cu, Pb, and Zn (67-92%); as compared to non-porous pavement runoff concentrations. However, porous pavement exhibited higher runoff concentrations for the dissolved fractions of Cu and Zn. Note that these two European studies were conducted on roadway segments of different traffic volumes and adjacent land uses.

The Texas Department of Transportation (Barrett, 2006; Barrett et al., 2006) implemented a three-year study on the effectiveness of porous friction course overlay on US highways. The study site was a 20-m^2 roadway segment located on Loop 360 in Austin, Texas. Due to the small drainage area and safety consideration, passive samplers (first flush samplers) were used to collect the initial 5-liter sample volumes. Five storm events were monitored from the conventional pavement, and six events were obtained from the PFC overlays during the period of 2004-2006. Runoff samples were collected at the edge-of-pavement (EOP) and from a distance of 26 ft (8 m) down slope of the edge-of-pavement (EOP) after passing through a vegetated shoulder. Table 2.2 summarizes the averaged event-mean-concentrations (EMCs) from this Texas study. It can be seen from Table 2.2 that EMC's of runoff from the PFC is of significantly better quality than runoff from the conventional asphalt surface, with lower concentrations of TSS, TKN, total metals, and COD. The vegetated filter strip provides no additional water quality benefit, particularly at the measured low concentration ranges of the incoming runoff for most water quality constituents measured during this study.

Table 2.2 Event-Mean-Concentrations of Runoff at EOP and 26 ft (8 m) Down Slope of EOP

Constituents	Mean EMC (EOP)			Mean EMC (Down Slope)		
	Conventional	PFC	Reduction, %	Conventional	PFC	Reduction, %
TSS, mg/L	118	8	93	42	33	21
TKN, mg/L	1.13	0.64	43	2.15	2.08	3
NO_3+NO_2, mg/L	0.43	0.38	12	0.27	0.21	22
TP, mg/L	0.13	0.24	-86	0.29	0.17	41
Dissolved P, mg/L	0.06	0.12	-100	0.18	0.08	55
Total Cu, µg/L	26.8	6.80	75	6.62	5.36	19
Dis Cu, µg/L	5.9	5	18	4.23	3.75	11
Total Pb, µg/L	12.6	0.90	93	1.17	0.71	39
Dis Pb, µg/L	0	0	0	ND	ND	ND
Total Zn, µg/L	167	40	76	102	295	-188
Dis Zn, µg/L	47	31	34	94	233	-147
COD, mg/L	64	35	46	55	54	-1

The Texas study was extended for another three years to assess whether the water quality benefits might persist over the life of the pavement overlay (Eck *et al.*, 2012). The overall data show that TSS concentrations from PFC are more than 90% lower than from conventional pavement. Lower effluent concentrations were observed for total amounts of P, Cu, Pb, and Zn. The authors conclude that PFC's water quality benefits would last through the design life of the pavement and the data trend is consistent with the data collected in eastern North Carolina (Eck *et al.*, 2012); and earlier studies from France (Pagotto *et al.*, 2000), Germany (Stotz and Krauth, 1994) and the Netherlands (Berbee *et al.*, 1999). Table 2.3 summarizes the median pollutant concentrations as reported by Eck *et al.* (2012).

A two-year study on runoff quality from PFC overlay was conducted on four highway sections in the coastal plains of Eastern North Carolina (Winston *et al.,* 2011). Each monitoring site collected runoff from an 80-m^2 PFC overlay of 40-mm thickness; and two of the sites were paired with 6.6-meter wide vegetative filter strips. The authors concluded that mean TSS and phosphorous concentrations from PFC are low compared to standard highway runoff; however, they reported an increase in mean nitrogen concentrations from PFC compared to conventional pavement nitrogen concentrations. They suggest the increase is due to high atmospheric nitrogen deposition in Eastern North Carolina. In addition, Winston *et al.* (2011) report increased concentrations of all pollutants, with the exception of ammonium and nitrate + nitrite when monitored after flowing across vegetated filter strips as compared to those monitored at the edge-of-pavement. Table 2.4 summarizes the mean and median concentrations and normalized pollutant loads reported by Winston *et al*. (2011). Literature pertinent to stormwater quality improvements for NovaChip™ pavement installations was not available.

Table 2.3 Summary of Median Highway Runoff Pollutant Concentrations

Constituents	Conventional Asphalt (Texas)	PFC (Texas)	PFC (North Carolina)
TSS, mg/L	136-166	6.3-12	8-17
TKN, mg/L	1.0-1.7	0.5-0.8	0.8-1.1
NO_3+NO_2, mg/L	0.2-0.3	0.2-0.3	0.4-1.1
Total N, mg/L	NA	1.0	1.3-2.4
NH_4, mg/L	NA	NA	0.4-0.5
Total P, mg/L	0.1-0.2	0.04	0.05-0.1

2.3 Hydrology

Pagotto *et al*. (2000) reported that porous asphalt has different hydrologic characteristics than conventional asphalt. The authors concluded that the available storage capacity in porous pavement delays the generation of stormwater runoff during rainfall, which results in longer response times (2 times longer than conventional), reduced mean maximum flow rates (11%), and increased duration of runoff (1.15 times longer than conventional). In addition, mean runoff coefficients were found to be 0.98 as compared to the conventional pavement mean runoff coefficients of 0.84. The 2009 Texas study reported a porous asphalt runoff coefficient of 0.95 (Stanard *et al.*, 2008). Pagotto *et al*. (2000) attributes higher porous pavement runoff coefficients to reduced splash and spray from the pavement surface when compared to conventional pavement surface. A German PFC study also found reduced maximum flow rates from porous pavement; however, the authors reported that runoff volumes from the porous pavement were significantly smaller than the volumes from impermeable surfaces (Stotz and Krauth, 1994). This finding directly contradicts the Pagotto *et al.* (2000) study.

Table 2.4 Mean and Median Concentrations of Normalized Pollutant Loads

Constitutes	4 PFC Locations			2 PFC/Filter Strip locations		
	Mean, mg/L	Median, mg/L	Normalized loads[1] (lb/ac/yr)	Mean, mg/L	Median, mg/L	Normalized loads[1] (lb/ac/yr)
TSS	9-31	8-17	54-188	26 - 36	17 - 24	107-214
Total N	1.48 - 2.60	1.30 - 2.37	7-24	2.02 - 2.26	145 - 191	7-28
TKN	0.97 - 1.32	0.82 - 1.09	4-11	1.60 - 1.83	1.12 - 1.47	6-23
NO_2/NO_3-N	0.41 - 1.32	0.39 - 1.06	2-13	0.42 - 0.43	0.34 - 0.39	2-5
NH_4-N	0.41 - 0.62	0.34 - 0.46	2-5	0.28 - 0.31	0.13 - 0.17	1-5
Org-N	0.56 - 0.79	0.35 - 0.56	2-7	1.29 - 1.55	0.94 - 1.34	5-18
Total P	0.08 - 0.13	0.05 - 0.10	0.3-1.2	0.27 - 0.36	0.20 - 0.28	1.5-5.1

[1]Multiplied by 1.1208 to convert lb/ac/yr to kg/ha/yr

Hydraulic equations governing the flow through PFC has been proposed to relate the drainage characteristics (depth and residence time) as a function of rainfall intensity, hydraulic conductivity, pavement slope, and maximum drainage path length (Charbeneau and Barrett, 2008). Mathematical solutions have been developed for low and high rainfall intensities, and a point of singularity that divides the high and low intensity cases. The solutions also allow hydraulic computations of flow through the porous structure of PFC drainage plus overland sheet flow on the roadway surface whenever the flow exceeds the storage capacity of the PFC structure.

2.4 Pavement Database

NCDOT maintains a construction and pavement condition database. We have retrieved information pertaining to OGFC and NovaChip™ pavements from this database and reorganized this data into Excel files using procedures shown in Figure 2.1. As of 2010, 1.59% and 0.36% route miles were resurfaced with OGFC and NovaChip™, respectively (Appendix A). The average overall pavement ratings improved from 79 to 91 when an inspection was conducted after 1-3 years of post OGFC installation. The average overall pavement ratings for NovaChip™ improved from 68 to 94 upon inspection after 1-3 years of post-construction.

a) Export data from the NCDOT Construction database. The data included FC-2, J-1 (OGFC), OGFC, and UBWC pavement types that were used for resurfacing and new roadway construction projects between 1992 and 2010.
b) Export pavement condition data by county for the above roads from 1988-2010.
c) Manually sort and match the construction and pavement condition data for each roadway and each roadway segment.
d) Delete pavement condition data that is in excess of 2-3 years prior to new construction or resurfacing and verify resurfacing had not occurred using a different pavement type.

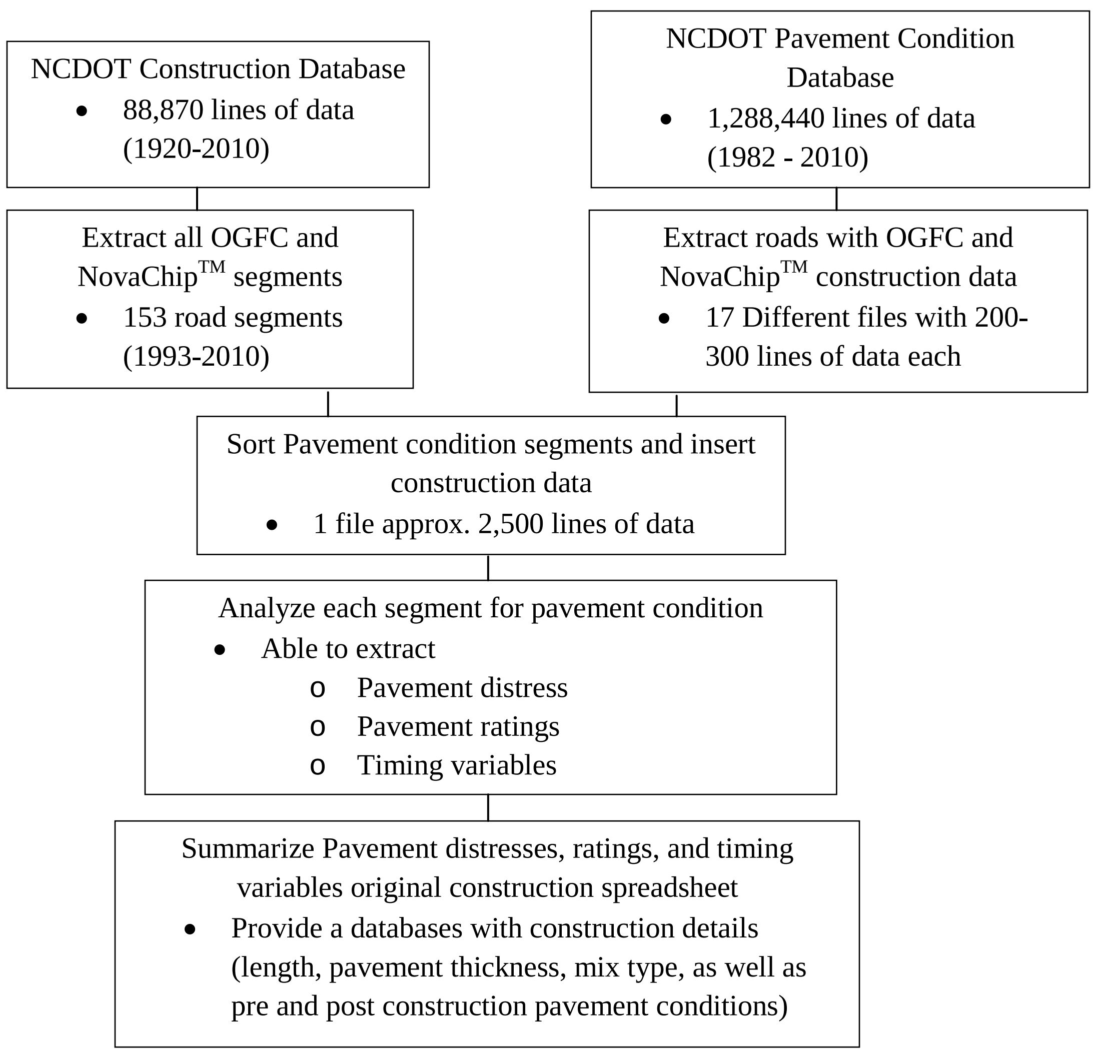


Figure 2.1 Data retrieval from NCDOT Pavement Construction and Condition Database

3.0 MATERIALS AND METHODS

3.1 Site Descriptions

3.1.1 Overview

Two highway locations along Interstate 77 in Charlotte, Mecklenburg, and Interstate 85 in Davidson County, NC, were selected for hydrologic and water quality monitoring during the period of August 2011 - November 2012. At the Charlotte location, a highway section comprised of 3/4-inch (20-mm) thick OGFC asphalt overlay was paired with a conventional hot-mix asphalt section that serves as a reference. The Davidson County location includes a 1/2-inch (13-mm) thick NovaChip™ overlay section and a conventional hot-mix asphalt section as the reference. At each highway section, roadway runoff was intercepted and collected by a concrete trough installed along the pavement edge. At an adjacent site of the same highway section, roadway runoff was allowed to further flow through a grassed filter strip and collected at the downslope edge of the strip. The study thus involves two research locations (Charlotte and Davidson County), four highway sections (Charlotte OGFC, Charlotte-conventional, Davidson County-NovaChip™, and Davidson County-conventional), and eight sampling sites (i.e. two sites per each highway section; for instance, Charlotte-OGFC with runoff directly collected at edge-of-pavement, COR_EOP, and after flowing through a roadside filter strip, COR_FS). See Figures 3.1 for locations of the Charlotte and Davidson paired monitoring sites.

Physical characteristics and average annual daily traffic (AADT) counts from the OGFC and NovaChip™ monitoring sites are similar to their respective paired conventional asphalt sites. The experimental setup provides a direct comparison of runoff hydrology and water quality between OGFC versus conventional pavement, NovaChip™ versus conventional pavement, and the water quality effectiveness of roadside vegetation.

Drainage areas were surveyed using traditional total station and LiDAR laser scanning, see Appendix B. Pavement characteristics were derived from the NCDOT Standard Specifications Manual (NCDOT, 2012) and AADT counts were obtained from the NCDOT's Transportation Planning Branch report on *"2010 Freeway AADT Volumes"* (NCDOT-Trans. Branch, 2010). Surrounding land use data were obtained from Charlotte-Mecklenburg and Davidson County online GIS databases (Charlotte-Mecklenburg, 2012; Davidson County, 2012). Additional data were obtained from field observations. Nomenclatures for the Charlotte and Davidson monitoring sites are as follows:

COR_EOP: Charlotte OGFC Edge-of-Pavement
COR_FS: Charlotte OGFC with Filter Strip

CCR_EOP: Charlotte Conventional Edge-of-Pavement
CCR_FS: Charlotte Conventional with Filter Strip
DNR_EOP: Davidson NovaChip™ Edge-of-Pavement
DNR_FS: Davidson NovaChip™ with Filter Strip
DCR_EOP: Davidson Conventional Edge-of-Pavement
DCR_FS: Davidson Conventional with Filter Strip

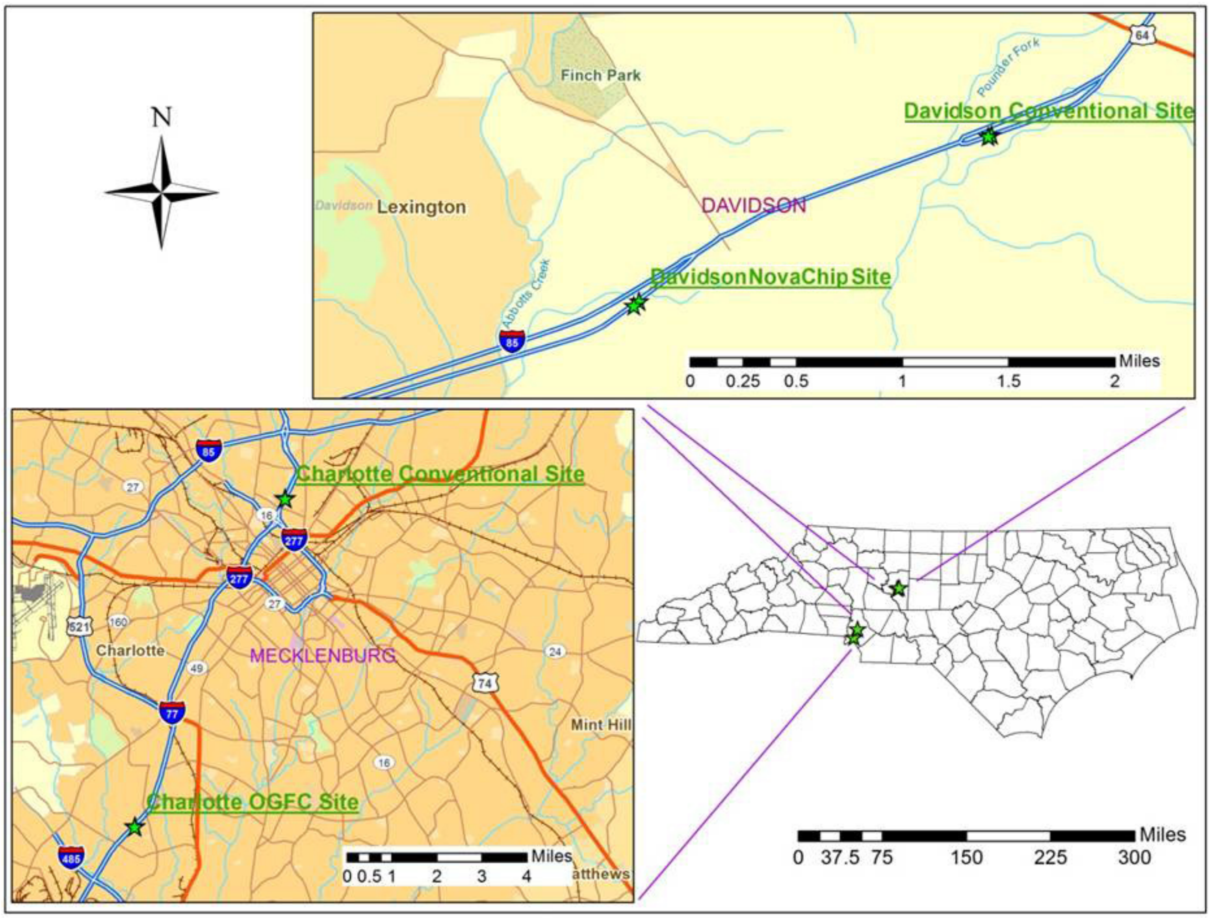


Figure 3.1 Map of the Paired Monitoring Sites in Charlotte, Mecklenburg, and Davidson Counties

3.1.2 Charlotte Monitoring Sites

The Charlotte monitoring sites are located on the northbound lane of Interstate 77 in Mecklenburg County. The OGFC highway section is located in the southern portion of the city, between the ramp of Entrance 3 and the ramp of Exit 4, approximately three miles north of the North Carolina/South Carolina border. The conventional highway section is located to the north of downtown Charlotte, between the Entrance ramp and Exit ramp 12 of I-277, approximately 11.7 miles (19 km) north of the North

Carolina/South Carolina border. The OGFC overlay extends from the North Carolina/South Carolina border approximately 9.8 miles (16 km) into Charlotte, leaving approximately 1.9 miles (3 km) of conventional asphalt between the pavement transition and the conventional monitoring site. Physical characteristics for the Charlotte monitoring sites are given in Tables 3.1.

Table 3.1 Physical Characteristics for the Charlotte Monitoring Sites

Characteristics	COR_EOP	COR_FS	CCR_EOP	CCR_FS
Average Daily Traffic, vehicles/day	75,000	75,000	88,500	88,500
Posted Speed Limit, mph[1]	55	55	55	55
Drainage Area, sq. ft[2]	2,428	2,539	2,567	2,844
Travel Lane Pavement Type	OGFC	OGFC	Conventional	Conventional
No. Travel Lanes	4	4	4	4
Imperviousness, %	100	92	100	90
Longitudinal Slope, %	1.56	1.56	0.29	0.29
Cross Slope, %	2.12	2.12	2.35	2.35
Filter Strip Cross Slope, %	-	11.4	-	13.2
	Drainage Area Composition, %			
OGFC	77.6	70.7	-	-
Conventional Asphalt	17.5	16.7	95.3*	85.9*
Filter Strip	-	7.9	-	9.9
Concrete Channel	4.9	4.7	4.7	4.2
	Surrounding Land Use, %			
Woods	-	-	-	-
Residential	-	-	100	100
Office	20	20	-	-
Business	70	70	-	-
Industrial	10	10	-	-

[1]Multiplied by 1.609 to convert mph to km/hr *includes roadway and shoulder areas
[2]Multiplied by 0.0929 to convert sq. ft to sq. m

The Charlotte-OGFC monitoring site is located on the northbound lanes of I-77 with a 2010 annual average daily traffic count of approximately 72,000 vehicles per day. Accounting for 3% growth per year the estimated AADT during monitoring would range from 74,000 - 76,000 vehicles per day. This section is a major corridor which carries vehicles into and through Charlotte from South Carolina and from the Charlotte Beltway (I-485) located approximately 1.5 miles (2.4 km) south of the monitoring site. The land uses surrounding the site are business (70%), office (20%), and light industrial (10%). The contributing drainage area of the pavement section consists of three 12-ft (3.7 m) OGFC traffic lanes, one 12-ft (3.7 m) OGFC acceleration/deceleration lane, and a 10.5-ft (3.2- m) dense graded asphalt shoulder. Runoff is collected in two separate 40 linear foot concrete troughs; one located at the edge-of-pavement

(COR_EOP) and the other located 5 feet (1.5 m) off of the pavement edge for collected runoff flowing through a 5-ft (1.5-m) grasses filter strip (COR_FS), see Figure 3.2.

The Charlotte conventional monitoring site is also located on I-77. The estimated AADT during monitoring ranged from 87,000 - 90,000 vehicles per day. This section is a major corridor out of downtown Charlotte and receives heavy traffic volumes from the Charlotte downtown beltway (I-277) located approximately 0.25 miles south of the monitoring site. The land uses surrounding the site are single family (90%) and urban (10%) residential. The contributing drainage area of the pavement section consists of four dense graded traffic lanes (12 ft or 3.7 m), a dense-graded asphalt shoulder (10.5 ft or 3.2 m), and a dense-graded asphalt median (4.5 ft or 1.4 m). Runoff is collected in 2 separate 40 linear foot (12.2 m) concrete troughs; one located at the edge-of-pavement (CCR_EOP) and one located 6.75-7.5 feet (2.1-2.3 m) off the pavement edge (CCR_FS), see Figure 3.3.

3.1.3 Davidson County Monitoring Sites

The Davidson County monitoring sites are both located on the northbound of Interstate 85 in Davidson County, N.C. The NovaChip™ site is located 0.5 miles (0.8 km) south of the Exit 94 overpass bridge and approximately 0.7 miles (1.1 km) north of the Lexington City limit; and the conventional site is located 1.4 miles (2.3 km) north of Exit 94 overpass bridge and approximately 2.6 miles (4,2 km) north of the Lexington City limit. The NovaChip™ overlay section is 0.8 miles (1.3 km) in length and extends from I-85 bridge over Abbotts creek (Lexington city limit) to 0.4 miles (0.6 km) south of Exit 94 overpass bridge leaving approximately 1.8 miles (2.9 km) of conventional asphalt between the pavement transition and conventional monitoring site. The traffic counts at Davidson were approximately 1/3 those of the Charlotte sites. Physical characteristics for the Davidson monitoring sites are given in Tables 3.2.

The Davidson NovaChip™ and conventional monitoring sites are located on a section of I-85 with AADT of approximately 25,000 vehicles per day. The surrounding land use of both sites is mainly woods (100%). Both sites have contributing drainage areas to the pavement sections consisting of three traffic lanes (12 ft or 3.7 m) and a dense graded asphalt shoulder (10.0 ft or 3.1m for NovaChip™ and 10.5-ft or 3.2 m for conventional). At each site, runoff is collected in two separate 40 linear foot (12.2 m) concrete troughs; one located at the pavement edge (DNR_EOP, DCR_EOP) and another located 5 feet (1.5 m) off of the pavement edge (DNR_FS, DCR_FS), see Figures 3.4 and 3.5. The DNR_FS drainage area, as shown in Table 3.2, is slightly smaller than that of the DNR_EOP because of its smaller pavement area draining to the filer strip (see Appendix B-3).

Figure 3.2 Charlotte OGFC Monitoring Sites (COR_EOP, COR_FS)

Figure 3.3 Charlotte Conventional Monitoring Sites (CCR_EOP, CCR_FS)

Table 3.2 Physical characteristics for the Davidson County Monitoring Sites

Characteristics	DNR_EOP	DNR_FS	DCR_EOP	DCR_FS
Average Daily Traffic, vehicles/day	25,000	25,000	25,000	25,000
Posted Speed Limit, mph[1]	65	65	65	65
Drainage Area, sq. ft[2]	1,696	1,667	1,984	2,184
Travel Lane Pavement Type	NovaChip™	NovaChip™	Conventional	Conventional
No. Travel Lanes	3	3	3	3
Imperviousness, %	100	88	100	91
Longitudinal Slope, %	2.68	2.36	0.53	0.53
Cross Slope, %	1.53	0.53-1.00	2.17	2.17
Filter Strip Cross Slope, %	-	13.4	-	11.7
	Drainage Area Composition, %			
NovaChip™	69.3	56.9	-	-
Conventional Asphalt	23.6	23.9	94	85.3
Filter Strip	-	12	-	9.2
Concrete Trough	7.1	7.2	6	5.5
	Surrounding Land Use, %			
Woods	100	100	100	100

[1]Multiplied by 1.609 to convert mph to km/hr [2]Multiplied by 0.0929 to convert sq. ft to sq. m

Figure 3.4 Davidson County NovaChip™ Monitoring Sites (DNR_EOP, DNR_FS)

Figure 3.5 Davidson County Conventional Monitoring Sites (DCR_EOP, DCR_FS)

3.2 Monitoring Site Setup

3.2.1 Overview

The runoff collection system was designed by URS-Corporation in early 2011. A drawing consisting of the typical plan and section views of the runoff collection system implemented at each site can be found in Appendix C. Construction began at the Davidson County sites in June 2011 and completion of construction including those in Charlotte was by the end of July 2011. Upon completion, the UNC-Charlotte research team began to install monitoring equipment at each site.

3.2.2 Construction

Each site was configured to separately monitor the runoff directly from the pavement surface and after flowing over a vegetated filter strip. A 40-ft long x 3-ft wide x 1-ft deep (12 m x 0.9 m x 0.3 m) concrete trough was installed at the pavement edge to collect runoff flowing directly off of the pavement surface; another trough of the same dimensions was installed approximately 5 feet (1.5 m) off of the pavement edge to collect the runoff that flows over roadside vegetation. After construction, field observations indicated that each of the filter strips were 5-ft (1.5-m) wide with exception of the Charlotte conventional filter strip which measured 6-ft (1.8 m) wide at one end and 7.5-ft (2.3-m) at the opposite end. Additionally, construction activities at the Charlotte locations had damaged the in-situ roadside vegetation requiring the repair of both filter strips with locally purchased sod.

During construction, a 4-in (10-cm) diameter PVC pipe was grouted into the downstream opening of the concrete channel to collect runoff. The PVC pipe was laid at a minimum slope of 1% and extended from the channel parallel to the roadway where a 90-degree PVC bend was used to divert the flow away from traffic and into a prefabricated stainless steel weir box. A 1½-in (3.8-cm) flexible electrical conduit was buried underground from the weir box to a sampler housing to contain the sampling tube and level indicator cord. After construction, it was found that the buried conduit was only large enough to house the flow meter cord. The sampler housing consisted of a stainless steel cabinet (3 x 4 x 5-ft or 0.9 x 1.2 x 1.5 m) mounted on a 4 x 4-ft (1.2 x 1.2 m) concrete slab and was located on the opposite side of the roadside swale. Additionally, at the Davidson County conventional site, a 6-in (15 cm) tall stainless steel pipe was cemented into the ground next to the sampler housing to hold a tipping bucket recording raingauge. The typical post-construction site setup is illustrated in Figure 3.6.

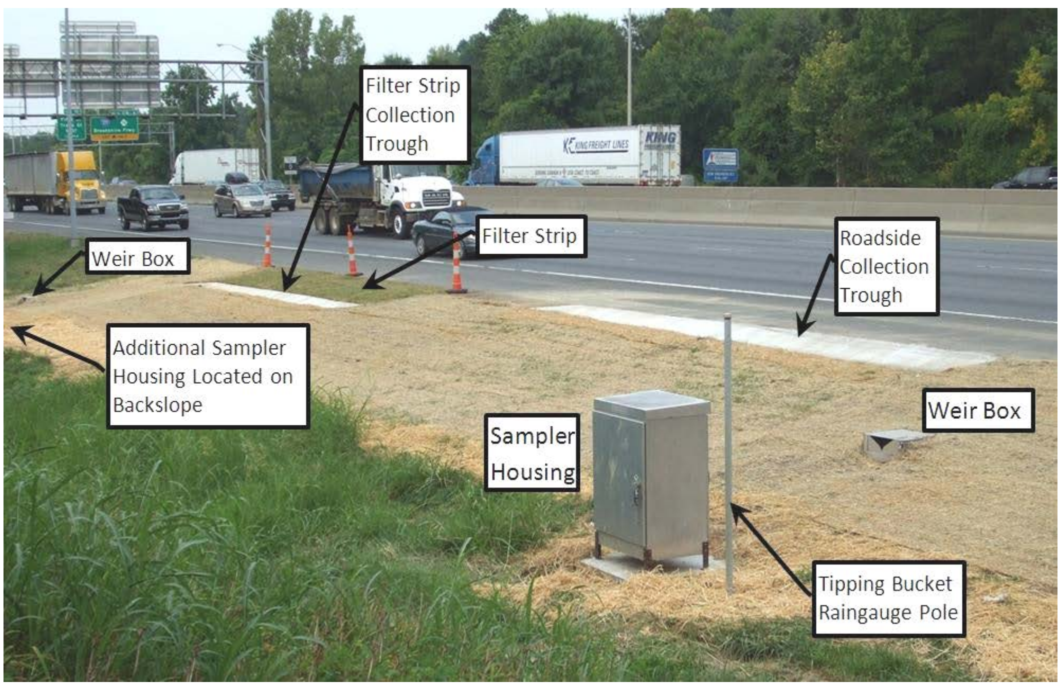


Figure 3.6 Photograph of Post Construction Site Setup

3.2.3 Monitoring Equipment Installation

Upon completion of NCDOT construction activities, UNC-Charlotte researchers initiated the monitoring equipment installation. Each site was equipped with a full-size portable sampler (ISCO 6712), an area velocity module (ISCO 750), a tipping bucket raingauge (ISCO 674), a manual reading raingauge, a 12- volt battery, and various weir box components. Only one tipping bucket raingauge and manual reading raingauge were installed at Davidson County installations. The Davidson sites were deemed to be within close enough proximity of one another to have the same precipitation. For the Davidson County sites, the tipping bucket raingauge was installed at the conventional site and the manual reading raingauge was installed in the median between the northbound of I-85 and Exit ramp 94. The median is located approximately 0.4 miles (0.6 km) north of the NovaChip™ site and 1.5 miles (2.4 km) south of the conventional site. Additionally, only one bulk precipitation collector was installed in each of the Charlotte and Davidson County locations. In Charlotte, the collector was installed at the OGFC site, and in Davidson County, it was installed in the median between northbound I-85 and Exit ramp 94.

The portable sampler, area velocity module and 12-volt battery were installed in the sampler housing and the tipping bucket raingauge was placed on top of the previously installed stainless steel pipe. Each manual reading raingauge was mounted on a 6-ft (1.8 m) high lumber post (4 x 4 inch or 10 x 10 cm) and located an adequate distance from any obstruction (maximum of a 45° angle from top of raingauge to the top of any obstruction). Each weir box was equipped with a compound 70° x 120° aluminum weir plate, a plastic bracket and stilling well to house the area velocity sensor (used as a level indicator), a 4-in (10 cm) diameter PVC coupling, and a 4-in (10 cm) trench drain T-connection to dissipate flow energy at the weir box inlet. Additionally, the inside vertical corners and welds were lined with silicone. A photograph of the weir box components is shown in Figure 3.7.

The area-velocity sensor assembly was installed from the portable sampler, through the previously installed electrical conduit, and attached to the plastic sensor bracket inside of the weir box. Prior to each storm event, a pre-cleaned Teflon sampling tube (3/8 in or 0.95 cm) was installed above ground from the portable samplers to the back of the weir box. A short section of flexible polyethylene tubing with a low flow strainer attachment was coupled to the Teflon tubing and inserted into the back of the weir box. The strainer was inserted through a small hole in the T-connection and into weir box inlet pipe to allow for sampling directly from the runoff flow path. Details of the pre-storm event weir box and overall site setups are shown in Figure 3.8 and Figure 3.9, respectively.

3.3 Monitoring Program

3.3.1 Overview

The specified event criteria included the sampling of rainfall events ranging from 0.25 in (0.6 cm) to 2.0 in (5 cm) in magnitude with 48-hours of antecedent dry conditions. During each rainfall event, the monitoring program required the measurement of rainfall and runoff volumes and the collection of bulk precipitation and composite runoff samples. The Standard Operation Protocol for the collection, processing, and analysis of samples is included Appendix D.

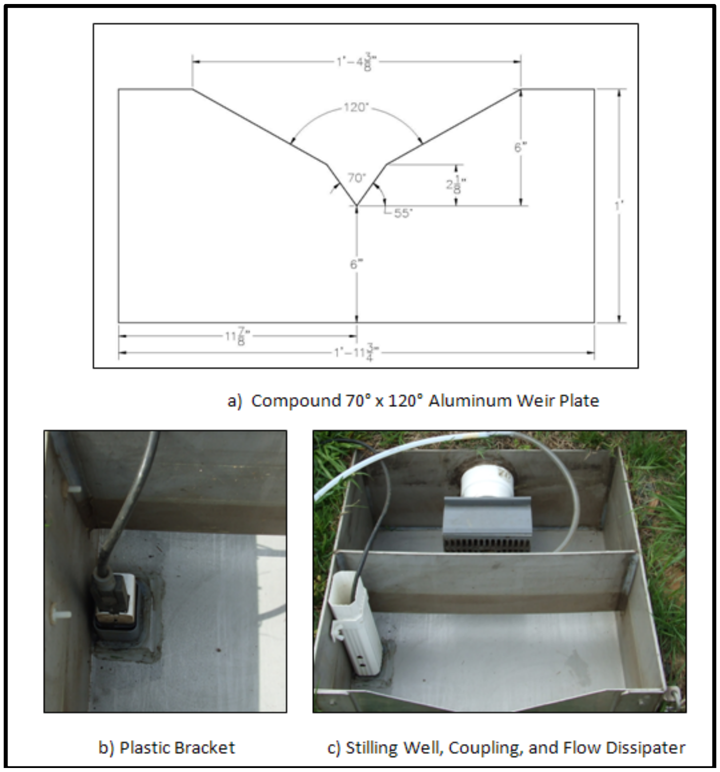


Figure 3.7 Weir Box Components

Figure 3.8 Pre-Storm Event Weir Box Setup

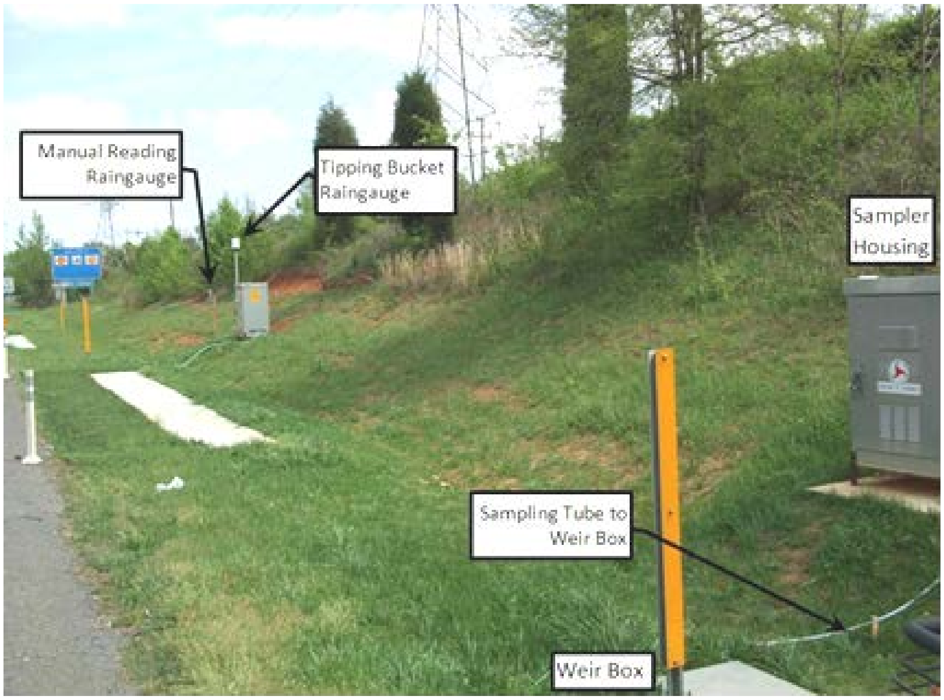


Figure 3.9 Pre-Storm Event Site Setup

3.3.2 Data Collection

The tipping bucket raingauge measured temporal rainfall amounts in one-minute intervals and stored the data inside the ISCO 6712 auto sampler. The manual reading rain gauge was used to measure the total rainfall amounts at each site. The ISCO 750 area velocity module and sensor was used to measure the water level in the weir box and to subsequently convert the level readings to volumetric runoff rates. This data was also stored in the ISCO 6712 auto sampler. The level readings were converted to discharge via the stage-discharge relationship of the compound 70° x 120° weir plate, which was developed in a controlled laboratory environment and programmed into the auto samplers prior to installation; see Appendix E for laboratory calibration procedures.

The auto samplers also used the programmed stage-discharge relationship to measure incremental runoff volumes for composite sampling. Composite sampling was accomplished by pre-programming each auto sampler to collect runoff samples at fixed runoff volume increments. Volume increments were determined based on each site’s drainage area and estimated total runoff volumes produced by rainfall events ranging from 0.25 in (0.6 cm) to 2.0 in (5 cm) in magnitude. Due to the unpredictability of rainfall amounts and intensities, these volume increments were typically left unchanged from event to event to ensure adequate sampling of small events and to prevent oversampling during large events. Occasionally, the pacing increment was adjusted when an extreme event (> 2.0 inch) was forecast.

The composite samples were initially collected in 5-gallon containers lined with plastic bags. In November 2011, the containers were replaced with 5-gallon glass bottles to allow for trace metal analysis of the runoff samples. Additionally, throughout the duration of the project bulk precipitation samples were collected in the 5-gallon containers lined with plastic bags. Within 24-hours after each storm event, the collected runoff and bulk precipitation samples were taken to the Environmental Research Laboratory at the University of North Carolina at Charlotte for processing. Prior to the next rainfall event the recorded auto sampler data was downloaded onto a rapid transfer device (RTD) and subsequently processed. The sediment deposited in each weir box and concrete channel was collected for subsequent drying, weighing, and grain size analysis.

3.3.3 Equipment Programming

The ISCO 6712 auto samplers were programmed to measure and record rainfall (in) and water levels within the weir box (ft); and to subsequently calculate and record runoff flow rates (gpm) and incremental runoff volumes (gallons) based on weir box water levels. The volume-weighted composite sampling program, which included volume paced composite sampling, was set to enable when the water level within the weir box reached 0.130-ft (3.96 cm). This water level is approximately halfway between the crest of the v-notch (0.107-ft or 3.26 cm) and the lowest calibrated weir box elevation (0.164-ft or 4.99 cm) to establish a free falling sheet of water over the weir crest.

The 0.130-ft (3.96 cm) elevation was selected to enable the samplers for two reasons. Firstly, the sampler calculates zero flow in the weir box at this approximate elevation. Coincidentally, this elevation is in the range of water level elevations that the actual flow rate is approximately zero and cannot be accurately predicted due to surface tension at the weir crest. Secondly, water level fluctuations cause false program activation when the sampling program is enabled at the V-notch crest elevation (0.107-ft or 3.26 cm). Based on these two reasons, 0.130 ft (3.96 cm) was the logical elevation to enable the sampling program.

3.4 Water Quality Sample Progressing and Analysis

The water quality samples were processed and analyzed as outlined in *"The Standard Operation Protocol (SOP) for the Collection, Processing, and Analysis of Samples"* found in Appendix D of this report. The UNC-Charlotte Environmental Research Laboratory analyzed the water quality samples for pH, specific conductance, turbidity, total suspended solids (TSS), total phosphorus (TP), total dissolved phosphorus (TDP), phosphate (PO_4), non-purgeable organic carbon (NPOC), total dissolved nitrogen (TDN), ammonium (NH_4), nitrate (NO_3), sulfate (SO_4), sodium (Na), potassium (K), magnesium (Mg), calcium (Ca), chloride (Cl), dissolved chromium (Cr), dissolved nickel (Ni), dissolved copper (Cu), dissolved zinc (Zn), dissolved cadmium (Cd), dissolved lead (Pb), and dissolved platinum (Pt). Results from laboratory water quality analyses were compiled in a Microsoft Excel spreadsheet for subsequent statistical analysis.

3.5 Hydrologic Data Analysis

3.5.1 Overview

The hydrological data was downloaded using the FlowLink software and subsequently imported into a Microsoft Excel spreadsheet. In Excel, the hydrological data was analyzed to ensure practicality and to ensure the monitoring equipment accurately measured and recorded the data. The hydrological data was corrected by adjusting the water levels and re-calculating flow rates and volumes when the water level remained unchanged due to clogging, even if rainfall continued to fall. Various calculations were then performed on the hydrological data to characterize hydrological tendencies. The detailed hydrological data correction methodology is included in Appendix F.

3.5.2 Hydrological Calculations

The hydrological data and calculations for each event included the compilation of antecedent dry periods, event durations, overall rainfall intensities, average rainfall intensities, peak 5-minute rainfall intensities, peak 15-minute rainfall intensities, total runoff volumes, runoff coefficients, peak runoff rates, drainage area normalized peak runoff, times to peak runoff, response times, and total runoff durations. .

Hydrographs together with available temporal rainfall data were analyzed to determine the lag-times of rainfall excess and runoff. The difference in time between rainfall and runoff centroids was calculated to determine the lag time in the runoff process among pavement types.

4.0 HYDROLOGY

4.1 Precipitation

During the monitoring period of November 2011 to October 2012, the regional rainfall totals reported by the Multi-sensor Precipitation Estimates (MPE) were 41 inches (1041 mm) and 45 inches (1143 mm), respectively, at the Charlotte and Davidson County locations. As compared to the average annual rainfall of 43-46 inches (1092-1168 mm), the time span of sampling was within a normal year of precipitation totals in North Carolina. The cumulative rainfall amounts monitored at each site ranged from 32% to 43% of the regional rainfall totals in the study period. Seventy-two percent or more of the rainfall events were less than 1.3 inches (33 mm). Rainfall statistics for monitored precipitation events are summarized in Table 4.1.

At each of the Charlotte monitoring sites, rainfall amounts were recorded using a combination of a recording tipping bucket gage and non-recording rain gauges. Wherever possible, the non-recording gauge was installed at a location free from tree interference within a 45-degree inclined angle of the gauge opening. Tipping bucket gauges were required to be installed close to the auto sampler for data storage even where there was potential interference from nearby tall trees. Rainfall data at the Charlotte sites recorded by the tipping bucket was, on average, 10% lower than the non-recording gage data for the total rainfall amounts monitored. At the Davidson County sites, only one tipping bucket gauge was installed between those two monitoring highway sections, which produced an average 17% lower total than the total rainfall amounts observed by the non-recording gauge. Consequently, the non-recording gauge data was used for event total adjustments and the time distribution data from the tipping bucket gauge was proportionally adjusted to match the event total without altering its temporal precipitation pattern.

4.2 Runoff Yields

Runoff hydrographs for each event were carefully examined to ensure data integrity and consistency. Events having rainfall total less than 0.25 inches (0.64 cm) as well as those that generated runoff volumes significantly larger than rainfall amount were excluded from the data presented Table 4.1. Runoff coefficients for all monitored events at the Charlotte and Davidson study sites are included in Appendix G. Figure 4.1 is an error-bar plot of the event averaged runoff coefficients at each site. Site-averaged runoff coefficients observed at pavement edge for conventional sites are in the range of 0.75-0.87. Site-averaged runoff coefficients for the OGFC and NovaChip™ overlays are 0.85 and 0.87, respectively. Runoff coefficients for the filter strip sites range from 0.74 to 0.79, except for the Charlotte OGFS filter strip site (COR_FS) where it was 0.62. Statistical analysis was performed to compare variances and means of the runoff coefficient between paired sites, i.e. COR_EOP versus CCR_EOP, DNR_EOP versus DCR_EOP, and individual sites with and without filter strip. For the statistical significant test, if the P-value is greater than 0.05 at 95% confidence interval, then the null hypothesis that the means/variances between paired datasets are equal was accepted, and the alterative hypothesis that the means/variances are significantly different was rejected, see Table 4.2.

Table 4.1 Summary of Monitored Rainfall Events

	COR_EOP	COR_FS	CCR_EOP	CCR_FS
# Precipitation Events	20	19	19	17
Rainfall Total, inches	17.70	16.89	16.31	13.94
Average Rainfall, inches	0.87	0.89	0.86	0.82
Rainfall Range, inches	0.29-2.38	0.29-2.38	0.25-1.73	0.25-1.73
Events < 1.30 inches, %	85	84	79	77
Average Event Duration, hrs	11.6	11.6	11.6	12.5
Average Antecedent Dry period, hrs	108	108	123	118
	DNR_EOP	DNR_FS	DCR_EOP	DCR_FS
# Precipitation Events	18	16	20	20
Rainfall Total, inches	18.70	14.43	17.86	19.47
Average Rainfall, inches	1.04	0.9	0.89	0.92
Rainfall Range, inches	0.30-2.85	0.25-2.85	0.27-2.19	0.27-2.85
Events < 1.30 inches, %	72	81	75	80
Average Event Duration, hrs	15.2	13.6	12.8	13.7
Average Antecedent Dry Period, hrs	123	121	122	122

Note: Multiplied by 2.54 to convert inches to cm

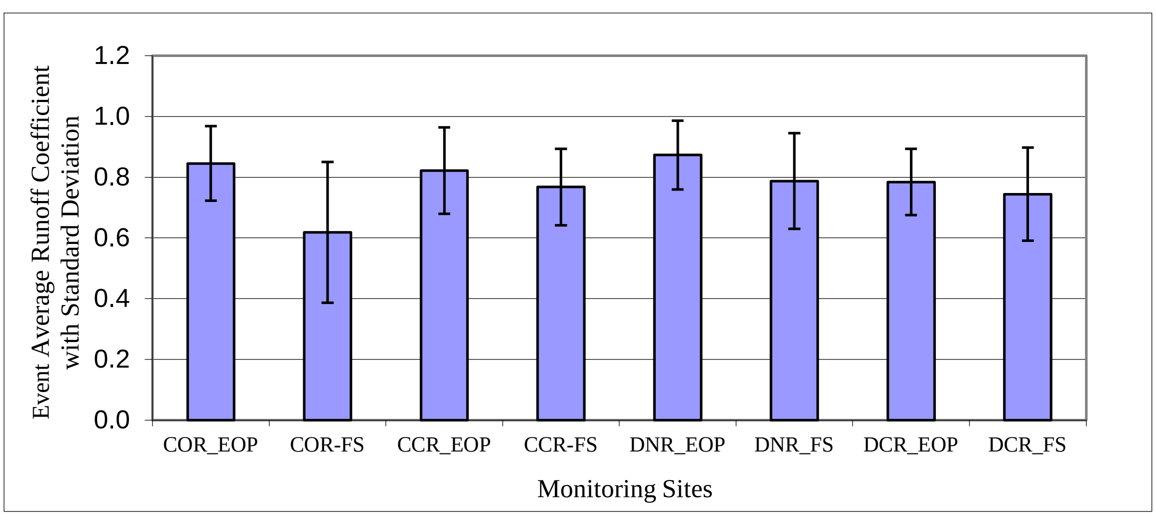


Figure 4.1 Runoff Coefficients at Charlotte and Davidson County Sites

Table 4. 2 Statistical Analysis of Site-averaged Runoff Coefficients

	COR_EOP vs. COR_FS	CCR_EOP vs. CCR_FS	DNR_EOP vs. DNR_FS	DCR_EOP vs. DCR_FS	COR_EOP Vs. CCR_EOP	DNR_EOP vs. DCR_EOP
# of Paired Data	19	16	13	17	16	12
P value (F-test)	0.011	0.871	0.206	0.266	0.739	0.998
Significance of Variances	Different	Not Different	Not Different	Not Different	Not Different	Not Different
P value (T-test)	0.001	0.141	0.075	0.075	0.309	0.015
Significance of Means	Different	Not Different	Not Different	Not Different	Not Different	Different

Note: the t-test is for hypothesis test about the mean of small samples and the F-test is for comparison of variance of any sample size.

The 5-ft (1.5 m) roadside filter strips at the Charlotte and Davidson County conventional sites did not result in statistically significant reduction in runoff volumes when compared to the paired EOP data. This is evident from Table 4.2 where there were no statistical differences between "CCR_EOP vs. CCR_FS" and "DCR_EOP vs. DCR_FS". The same conclusion can be drawn for the filter strip at the Davidson County NovaChip™ paired sites (DNR_EOP vs. DNR_FS). However, an exception to this was found at the OGFC paired site (COR_EOP vs. COR_FS) where the COR_FS has a statistically lower runoff coefficient (0.62) than its paired COR_EOP site (0.85). The infiltration capacity at the OGFC filter strip site was not sufficient to effect the reduction of runoff coefficient; rather the porous structure of the OGFC surface could have provided storage of the initial runoff volumes, particularly for small storms. The fact that the COR_FS standard deviation of its runoff coefficients is twice that of the paired COR_EOP reflects the dynamic impact of porous pavement on the runoff hydrology of the associated vegetative shoulder.

The site-averaged runoff coefficient of 0.85 obtained from the OGFC pavement site is about 4% higher than that of the paired conventional pavement site whose value is 0.82. The probable effect of vehicle induced splashing on the conventional pavement surface might cause water loss from the roadway surface during precipitation events. However, statistical tests could not confirm that the difference in site-averaged runoff yield is significant when comparing runoff yields between OGFC and conventional pavement types.

The site-averaged runoff coefficient of 0.87 measured at the NovaChip™ pavement site is higher (≈ 11%) than the corresponding coefficient of 0.78 observed at its paired conventional pavement site. The difference in site-averaged runoff coefficients is statistically significant although the sample size is smaller than for the other paired-site statistics.

With the exception of the paired COR_EOP vs. COR_FS site, the calculated variances between the other paired-sampling sites are not statistically different implying the hydrologic variability at these paired sites is likely attributable to rainfall inputs.

4.3 Hydrologic Lag Time

Hydrographs with temporal rainfall data available were reviewed and analyzed to gain an understanding of the influences of surface roughness and porous overlay structures acting on the hydrologic response of pavement types. The comparison was based on determining the time lag between the centroid of precipitation (T_{pc}) and the centroid of runoff (T_{qc}), defined as:

$$T_{pc} = \frac{\sum_{i=1}^{n} P_i * t_i}{\sum_{i=1}^{n} P_i}$$

$$T_{qc} = \frac{\sum_{i=1}^{n} Q_i * t_i}{\sum_{i=1}^{n} Q_i}$$

where P_i and Q_i are instantaneous rainfall and runoff rates, respectively. Eight common storm events (storm nos. 3, 4, 11, 12, 13, 15, 16, and 17) at the Charlotte OGFC and conventional sites (COR_EOP versus CCR_EOP) were chosen for analysis. The time-to-centroid calculated by the above equations averaged at 6.27 hour and 7.12 hours, respectively, for T_{pc} and T_{qc} at the COR_EOP site. This represents a time lag of 0.84 hours between T_{pc} and T_{qc}, on the average. The lag time between the centroids of precipitation and runoff at the CCR_EOP site was 0.34 hours. Figure 4.2 provides an illustrative example of hydrograph lags observed at the COR_EOP and CCR_EOP sites for storm no. 16.

Similar calculations were also performed for the Davidson County sites (DNR_EOP vs. DCR_EOP) with a more limited number of events. The fact that only one tipping bucket raingauge was shared by two Davidson sites located 2 miles apart, introduced some uncertainty as to the consistency of rainfall temporal distributions between these two sites. Five sets of storm event data (storm no. 1, 3, 6, 12, and 15) selected for the DNR_EOP site revealed a lag time of 0.25 hrs between the centroids of precipitation and runoff. Two datasets (storm no. 1 and 3) for the DCR_EOP site were found to result in a lag time of 0.35 hrs, which is similar to the CCR_EOP site. The implications from this analysis suggest a delay in OGFC peak runoff rates on the order of 0.5 hours in relation to conventional pavement. In calculating the mean peak runoff rates for sites COR_EOP (0.94-in/hr or 2.39 cm/hr) and CCR_EOP (1.23-in/hr or 3.12 cm/hr), it was found that during the eight events analyzed the OGFC peak runoff rate was ≈ 24% lower than that observed at its paired conventional site.

In summary, the conventional asphalt pavement has an average lag time of 0.35 hours, defined as the difference between the time-to-centroids of precipitation and runoff. The NovaChip™ pavement provides a quicker drainage with an average lag time between precipitation and runoff centroids of 0.25 hours. The OGFC pavement, due to its internal porous structure and surface roughness, has resulted in a lag time between precipitation and runoff centroids of 0.84 hrs. In comparison to conventional pavement, OGFC overlay prolonged the hydrographic lag time by a factor of 2.4 whereas NovaChip™ overlay reduced the lag time by a factor of 0.71.

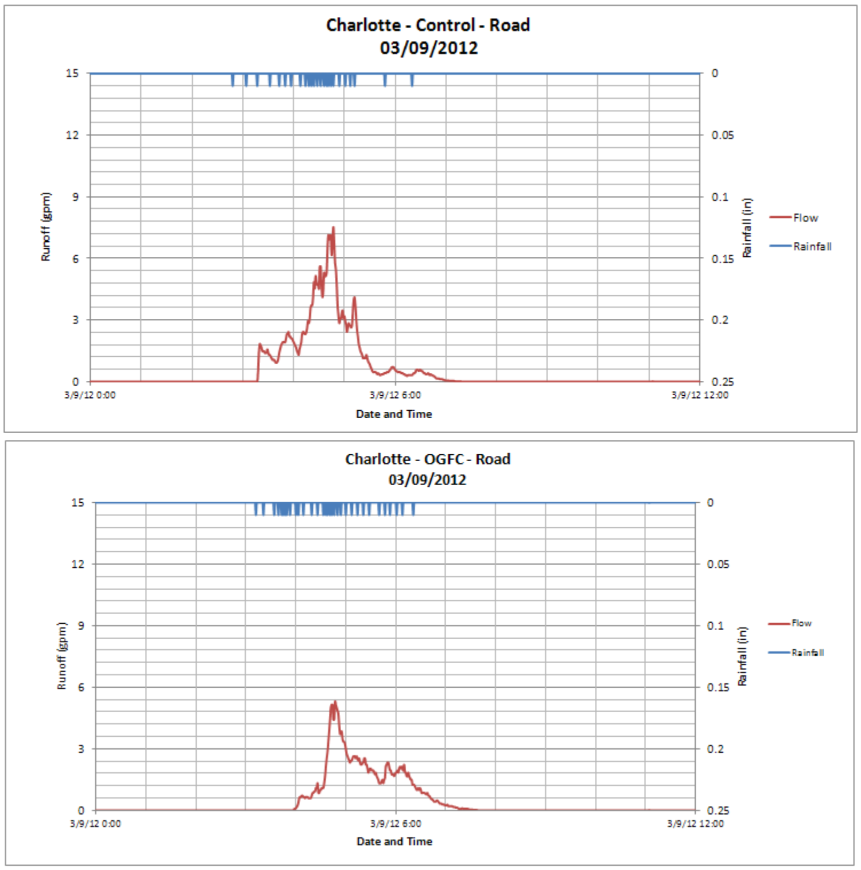


Figure 4.2 Hydrograph Lag Observed at COR_EOP and CCR_EOP Sites for Storm No. 16

5.0 WATER CHEMISTRY AND QUALITY

5.1 Overview of Analytical Methods

Volume-weighted runoff samples were collected with ISCO 6712 automated water samples equipped with pre-cleaned Teflon® sampling line and a glass composite sample collecting bottle. Sampling lines and collecting bottles were swapped out after each runoff event and acid washed prior to installation for sampling. Samples were analyzed for pH, turbidity, total suspended sediment (TSS), and specific conductance immediately after collection at the UNC Charlotte Hydrology and Biogeochemistry Laboratory. Turbidity, pH and specific conductance were analyzed with a calibrated LaMotte turbidity meter, a calibrated Oakley digital pH meter and a calibrated HANNA temperature self-correcting conductivity meter, respectively. TSS concentrations were determined gravimetrically after vacuum filtration of a known sample volume. Subsamples of the filtrate were poured off and frozen for later analysis of major ions and nutrients. The filtrate was analyzed for major anions: chloride (Cl^-), nitrate (NO_3-N), Ortho-Phosphorus (PO_4-P), and sulfate (SO_4^{2-}); major cations: calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+), potassium (K^+), and ammonium (NH_4-N); total dissolved nitrogen (TDN); total phosphorus (DTP); and dissolved organic carbon (DOC). Major anion and cation analyses were performed with a Dionex DX-500 ion chromatography (IC) system with AS14 and CS12 analytical columns. DOC and TDN analyses were performed using a Shimadzu TOC-V analyzer with a TN module. For this study, we report nutrient (NH_4-N, NO_3-N, PO_4-P) and Cl results from the IC analyses. Total phosphorus (TP) concentrations were determined on filtered (TP) and unfiltered samples (TDP) colorimetrically after H_2SO_4/persulfate digestion. Particulate phosphorus (PP) was calculated as: TP - TDP = PP. Dissolved organic phosphorus (DOP) was calculated as: TDP – PO_4-P = DOP. Dissolved organic nitrogen (DON) was calculated as: TDN - (NH_4-N + NO_3-N) = DON.

A further sub-sample was vacuum filtered through a pre-cleaned nylon membrane disposable filter cartridge for trace metal analyses. Samples were stored in pre-cleaned trace metal grade sample bottles and preserved through acidification with ultrapure HCl. Trace dissolved metal analyses for chromium (Cr), cadmium (Cd), copper (Cu), nickel (Ni), lead (Pb), platinum (Pt), and zinc (Zn) were performed with a Thermo Elemental- X5 Quadrupole ICP-MS calibrated to appropriate standards. Analytical uncertainty was determined by analyzing random quintuplet replicates (Table 5.1).

Table 5.1 Summary of Analytical Uncertainty

Parameter	S.D.	CV, %	N	Parameter	S.D.	CV, %	N
pH	0.03	0.43	29	NO_3-N, mg/L	0.01	1.29	30
Conductivity, µS	0.21	0.33	29	PP, mg/L	0	1.31	30
Turbidity, NTU	0.08	0.7	29	DOP, mg/l	0	3.05	29
TSS, mg/L	1.82	10.64	29	DON, mg/L	0.08	8.92	27
TP, mg/L	0.0003	0.28	30	Cr, mg/L	0.271	10.96	3
TDP, mg/L	0.0006	0.55	30	Ni, mg/L	0.086	12.57	3
PO_4-P, mg/L	0.001	13.3	29	Cu, mg/L	0.699	12.54	3
DOC, mg/L	0.23	2.52	30	Zn, mg/L	4.158	14.5	3
Cl^-, mg/L	0.02	1.34	29	Cd, mg/L	0.007	21.17	3
TDN, mg/L	0.02	2.23	30	Pt, mg/L	0.003	23.97	3
NH_4-N, mg/L	0.02	10.75	27	Pb, mg/L	0.016	12.29	3

S.D. = Standard Deviation, CV = coefficient of variation, N = number of quintuplet replicates

5.2 Results

A summary of EMCs and all water quality data collected from the Charlotte and Davidson County sites is presented in Tables 5.2 and 5.3 and Figures 5.1 through 5.4. Statistical differences in EMCs for all data collected from the Charlotte and Davidson County sites are summarized in Tables 5.4 and 5.5. Individual storm EMCs for the Charlotte and Davidson County sites are included in Appendix H, Tables J1-J10. Water quality data are presented in Box and Whisker plots in Figures 5.1 through 5.4 where the centerline of each box depicts the median value for the size distribution and the lower boundary and upper boundary of each box depicts the lower and upper quartile of each grain size distribution. The cap at either end of each box depicts the maximum and minimum value for each size distribution. Outliers beyond 1.5 times the 75^{th} quartile are plotted as solid circles above or below the upper and lower caps. Nonparametric tests were employed in our analysis owing to relatively small sample sizes and to avoid assumptions regarding the normality of the distribution of the data. Comparisons of two groups used the Mann-Whitney test (Mann and Whitney 1947) as all sampling sites were deemed independent. Statistical analyses were performed using the SSPSS software version 17.0.

The organization of the analysis of the water quality will examine the following comparisons for the Charlotte I-77 sites: Charlotte Conventional Road Surface (CCR_EOP) vs. Charlotte OGFC Road Surface (COR_EOP), CCR_EOP vs. Charlotte Conventional Road Surface Filter Strip (CCR_FS); COR_EOP vs. Charlotte OGFC Filter Strip (COR_FS); and CCR_FS vs. COR_FS. Likewise, the analysis of the Davidson County I-85 sites will examine the following site pairs: Davidson County Conventional Road Surface (DCR_EOP) vs. Davidson County NovaChip™ Road Surface (DNR_EOP), DCR_EOP vs. Davidson County Conventional Road Surface Filter Strip (DCR_FS); DNR_EOP vs. Davidson County NovaChip™ Road Surface Filter Strip (DNR_FS); and DCR_FS vs. DNR_FS. We do not directly compare the Charlotte vs. the Davidson County sites, except in a qualitative manner owing to significantly different runoff events that were sampled between the two locations.

Table 5.2 Summary Event-Mean-Concentration Charlotte Bulk Precipitation and Road Surface and Filter Strip Sites

Parameters	BP	CCR_EOP	CCR_FS	COR_EOP	COR_FS
pH	5.58 ± 0.6	6.24 ± 0.3	6.28 ± 0.29	6.34 ± 0.3	6.37 ± 0.29
Conductivity, μS	15.3±11.9	49.7 ± 29.1	95.1 ± 43.6	60.1 ± 23.2	68.0 ± 34.0
Turbidity, NTU	1.96±2.8	18.4 ±7.0	10.4 ±5.9	9.0 ± 5.0	11.1 ± 4.9
TSS, mg/L	5.7 ±9.9	59.2 ± 31.6	15.7 ± 11.6	35.1 ± 26.9	25.6 ± 17.7
TP, mg/L	0.13 ± 0.17	0.19 ± 0.10	0.15 ±0.04	0.28 ± 0.42	0.28 ± 0.25
DTP, mg/L	0.10 ± 0.12	0.06 ± 0.10	0.09 ± 0.03	0.08 ± 0.01	0.16 ± 0.11
PO_4-P, mg/L	0.03 ± 0.07	0.00 ±0.00	0.01 ± 0.02	0.01 ± 0.01	0.03 ± 0.04
PP, mg/L	0.03 ± 0.05	0.13 ± 0.10	0.05 ± 0.03	0.19 ± 0.42	0.11 ± 0.13
DOP, mg/L	0.08 ± 0.12	0.06 ± 0.02	0.08 ± 0.03	0.07 ± 0.01	0.13 ± 0.08
DOC, mg/L	3.76 ± 4.62	6.51 ± 4.78	8.74 ± 4.00	9.99 ± 3.78	10.03 ± 4.90
Cl^-, mg/L	0.76 ± 0.49	3.39 ± 3.73	8.23 ±7.13	2.76 ±1.97	3.39 ± 3.01
TDN, mg/L	1.36 ± 2.32	1.05 ± 0.52	0.79 ± 0.28	2.13 ± 0.85	1.18 ± 1.90
NH_4-N, mg/L	0.42 ± 0.54	0.38 ± 0.21	0.09 ± 0.13	0.68 ± 0.23	0.48 ± 0.46
NO_3-N, mg/L	0.12 ± 0.10	0.18 ± 0.16	0.12 ± 0.11	0.46 ± 0.42	0.22 ± 0.19
DON, mg/L	0.87 ± 1.83	0.49 ± 0.36	0.58 ± 0.29	0.99 ± 0.77	1.18 ± 1.58
Cr, μg/L	NA	2.54 ± 1.12	2.69 ± 1.30	1.19 ± 0.64	1.10 ± 0.58
Cd, μg/L	NA	0.19 ± 0.26	0.26 ± 0.49	0.11 ± 0.08	0.16 ± 0.19
Cu, μg/L	NA	11.32 ± 4.18	16.37 ± 8.03	11.50 ± 4.59	10.26 ± 5.36
Ni, μg/L	NA	1.37 ± 0.68	1.41 ± 0.64	1.99 ± 0.79	1.44 ± 0.78
Pt, μg/L	NA	0.02 ± 0.02	0.01 ± 0.01	0.02 ± 0.01	0.03 ± 0.03
Pb, μg/L	NA	0.27 ± 0.38	0.36 ± 0.29	0.20 ± 0.30	0.28 ± 0.50
Zn, μg/L	NA	42.1 ± 16.7	25.9 ±11.2	76.8 ± 39.4	26.3 ± 17.2

NA = not available

Table 5.3 Summary Event-Mean-Concentration Davidson County-Bulk Precipitation and Road Surface and Filter Strip Sites

Parameters	BP	DCR_EOP	DCR_FS	DNR_EOP	DNR_FS
pH	5.24 ± 0.5	6.21 ± 0.44	6.34 ± 0.37	6.29 ± 0.38	6.31 ± 0.36
Conductivity, µS	11.26± 6.0	39.9 ± 32.8	65.9 ± 57.6	37.9 ± 25.9	93.0 ± 84.0
Turbidity, NTU	1.26± 2.3	9.9 ± 8.3	17.2 ± 15.8	10.1 ± 5.7	20.3 ± 12.3
TSS, mg/L	2.03± 2.84	13.4 ± 11.5	13.4 ± 11.0	29.4 ±19.6	14.8 ± 7.7
TP, mg/L	0.05± 0.02	0.09 ± 0.04	0.16 ± 0.07	0.13 ± 0.07	0.18 ± 0.12
DTP, mg/L	0.04± 0.02	0.05 ± 0.02	0.11 ± 0.05	0.06 ± 0.03	0.12 ± 0.08
PO_4-P, mg/L	0.00± 0.01	0.00 ± 0.00	0.02 ± 0.03	0.00 ± 0.01	0.14 ± 0.49
PP, mg/L	0.01± 0.02	0.03 ± 0.03	0.05 ± 0.05	0.07 ± 0.06	0.06 ± 0.05
DOP, mg/L	0.04± 0.02	0.06 ± 0.02	0.09 ± 0.03	0.06 ± 0.02	0.10 ± 0.05
DOC, mg/L	1.92± 0.82	4.81 ± 3.31	6.22 ± 3.02	5.28 ± 3.34	14.3 ± 25.6
Cl^-, mg/L	0.64± 0.50	4.13 ± 7.23	7.19 ± 9.56	3.41 ± 4.68	8.11 ± 13.48
TDN, mg/L	0.59± 0.42	0.62 ± 0.34	0.60 ± 0.24	0.70 ± 0.42	3.91 ± 12.98
NH_4-N, mg/L	0.46± 0.33	0.25 ± 0.16	0.04 ± 0.08	0.19 ± 0.19	0.18 ± 0.36
NO_3-N, mg/L	0.11± 0.11	0.12 ± 0.12	0.11 ± 0.10	0.11 ± 0.10	0.07 ± 0.07
DON, mg/L	0.06± 0.09	0.28 ± 0.17	0.45 ± 0.25	0.40 ± 0.32	3.67 ± 12.64
Cr, µg/L	NA	1.70 ± 1.00	0.99 ± 0.43	0.90 ± 0.39	1.24 ± 0.45
Cd, µg/L	NA	0.05 ± 0.04	0.06 ± 0.05	0.20 ± 0.43	0.07 ± 0.04
Cu, µg/L	NA	8.21 ± 5.97	7.43 ± 3.60	6.31 ± 2.66	8.05 ± 2.86
Ni, µg/L	NA	0.91 ± 0.72	1.09 ± 0.58	0.83 ± 0.45	1.12 ± 0.50
Pt, µg/L	NA	0.02 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01
Pb, µg/L	NA	0.13 ± 0.12	0.17 ± 0.10	0.12 ± 0.10	0.24 ± 0.17
Zn, µg/L	NA	17.06 ± 9.8	14.1 ± 10.6	23.6 ± 15.0	16.7 ± 6.2

NA = not available

Table 5.4 Event-Mean-Concentration Statistical Differences between Charlotte Road and Filter Strip Runoff Sites

Parameters	CCR_EOP *vs.* COR_EOP	CCR_EOP *vs.* CCR_FS	COR_EOP *vs.* COR_FS	CCR_FS *vs.* COR_FS
pH	NS	NS	NS	NS
Conductivity	NS	**	NS	NS
Turbidity	**	**	NS	NS
TSS	**	**	NS	NS
TP	NS	NS	NS	NS
DTP	**	**	**	*
PP	NS	*	NS	NS
PO_4-P	NS	NS	NS	NS
DOP	NS	NS	**	*
TDN	**	*	NS	**
NH_4-N	**	**	**	**
NO_3-N	*	NS	*	*
DON	NS	NS	NS	NS
DOC	*	NS	NS	NS
Cl	NS	*	NS	*
Cr	**	NS	NS	**
Cd	NS	NS	NS	NS
Cu	NS	NS	NS	**
Ni	NS	NS	NS	NS
Pb	NS	NS	NS	NS
Pt	NS	NS	NS	NS
Zn	*	**	**	NS

NS –No significant difference, * significant difference –two tailed $P \leq 0.05$, ** significant difference- two tailed $P \leq 0.01$

Table 5.5 Event-Mean-Concentration Statistical Differences between Davidson County Road and Filter Strip Runoff Sites

Parameters	DCR_EOP *vs.* DNR_EOP	DCR_EOP *vs.* DCR_FS	DNR_EOP *vs.* DNR_FS	DCR_FS *vs.* DNR_FS
pH	NS	NS	NS	NS
Conductivity	NS	NS	**	NS
Turbidity	NS	NS	*	NS
TSS	*	NS	*	NS
TP	*	**	NS	NS
DTP	NS	**	**	NS
PP	*	NS	NS	NS
PO_4-P	NS	*	NS	NS
DOP	NS	**	**	NS
TDN	*	NS	NS	NS
NH_4-N	NS	**	NS	*
NO_3-N	NS	NS	*	NS
DON	NS	*	NS	NS
DOC	*	*	*	NS
Cl	NS	NS	NS	NS
Cr	NS	*	NS	NS
Cd	NS	NS	NS	NS
Cu	NS	NS	NS	NS
Ni	NS	NS	NS	NS
Pb	NS	NS	*	NS
Pt	NS	NS	NS	NS
Zn	NS	NS	NS	NS

NS –No significant difference, * significant difference –two tailed $P \leq 0.05$, ** significant difference- two tailed $P \leq 0.01$

5.3 Surface Runoff Water Quality for Pavement Types

CCR_EOP vs. COR_EOP

In comparing the CCR_EOP and the COR_EOP sites significant reductions in event-mean-concentrations of TSS and Cr and reductions in the event mean levels of turbidity were measured (Mann-Whitney U test $P \leq 0.05$) (Table 5.4). Significant increases in EMC for TDP, TDN, NH_4-N, NO_3-N, DOC and Zn were measured in COR_EOP runoff in comparison to CCR_EOP runoff during the study. No significant differences in EMC were evident for any other water quality constituents for these two sites.

DCR_EOP vs. DNR_EOP

In comparing the DCR_EOP and the DNR_EOP sites no significant reductions in event-mean-concentrations for any water quality constituents were measured when comparing the conventional road surface runoff with the NovaChip™ overlay surface runoff (Mann-Whitney U test $P \leq 0.05$) (Table 5.5). However, significant increases in EMC for TSS, TP, PP, TDN and DOC were measured in DNR_EOP runoff in comparison to DCR_EOP runoff during the study. No significant differences in EMC were evident for any other water quality constituents for these two sites.

5.4 Surface Runoff Water Quality Comparisons for EOP and FS

CCR_EOP vs. CCR_FS

In comparing the CCR_EOP and the CCR_FS sites significant reductions in event mean levels/concentrations of turbidity, TSS, PP, TDN, NH_4-N, and Zn were measured in conventional road surface runoff after it had passed through the grass filter strip (Mann-Whitney U test $P \leq 0.05$,) (Table 5.4). Significant increases in EMC for conductivity, TDP, and Cl were measured after conventional road surface runoff passed through the adjoining grassed filter strip before sample collection. No significant differences in EMC were evident for any other water quality constituents for these two sites.

COR_EOP vs. COR_FS

In comparing the COR_EOP and the COR_FS sites significant reductions in event mean levels/concentrations of NH_4-N, NO_3-N and Zn were measured in OGFC road surface runoff after it had passed through the adjacent grass filter strip (Mann-Whitney U test $P \leq 0.05$), (Table 5.4). Significant increases in EMC for DTP and DOP were measured after OGFC road surface runoff passed through the adjoining grassed filter strip before sample collection. No significant differences in EMC were evident for any other water quality constituents for these two sites.

DCR_EOP vs. DCR_FS

In comparing the DCR_EOP and the DCR_FS sites significant reductions in event-mean-concentrations of NH_4-N and Cr were measured in conventional road surface runoff after it had passed through the grass filter strip (Mann-Whitney U test P $\leq$ 0.05) (Table 5.5). Significant increases in EMC for conductivity, TP, TDP, ortho-P, DOP, DON, and DOC were measured after conventional road surface runoff passed through the adjoining grassed filter strip before sample collection. No significant differences in EMC were evident for any other water quality constituents for these two sites.

DNR_EOP vs. DNR_FS

In comparing the DNR_EOP and the DNR_FS sites significant reductions in event mean levels/concentrations of TSS and NO_3-N were measured in the NovaChip™ road surface runoff after it had passed through the grass filter strip (Mann-Whitney U test P $\leq$ 0.05) (Table 5.5). Significant increases in EMC/levels for conductivity, turbidity, DTP, DOP, DOC and Pb were measured after the NovaChip™ road surface runoff had passed through the adjoining grassed filter strip before sample collection. No significant differences in EMC were evident for any other water quality constituents for these two sites.

5.5 Surface Runoff Water Quality Comparisons for Filter Strips

CCR_FS vs. COR_FS

In comparing the two Charlotte filter strip sites significantly higher event-mean-concentrations of Cl, Cr an Cu were measured in CCR_FS site runoff in comparison to filter strip runoff draining from the OGFC surface (Mann-Whitney U test P $\leq$ 0.05) (Table 5.4). Significantly higher EMC' for TDP, DOP, TDN, NH_4-N, and NO_3-N were measured in filter strip runoff draining from the OGFC surface in comparison to filter strip runoff draining from the conventional road surface at the Charlotte locations. No significant differences in EMC were evident for any other water quality constituents for these two filter strip sites.

DCR_FS vs. DNR_FS

In comparing the two Davidson County filter strip sites the only significantly different EMC measured between the two sites was for NH_4-N (Mann-Whitney U test P $\leq$ 0.05), (Table 5.5), With EMC's higher for filter strip runoff draining from the NovaChip™ road surface in comparison to the conventional pavement site. No significant differences in EMC were evident for any other water quality constituents for these two filter strip sites.

5.6 Summary

Before comparing the PFC water quality monitoring results from this project with those for Texas and Eastern North Carolina studies (summarized in Eck et al., 2012) it is useful to review the site characteristics and monitoring protocol employed in the three studies. The two Charlotte I-77 sites are characterized by significantly higher traffic volumes (75,000-88,500 AADT) than the Davidson County sites (25,000 AADT, this study), the three Texas sites (TX1 and TX2 50,000 ADT and 40,000ADT TX3) and the four eastern NC sites (NC1-4 17,000 to 20,000 ADT) (Eck et. al, 2012). It has been shown that traffic volume and often surrounding land use also impact pollutant loading rates for a variety of monitoring locations (e.g. Irish et al. 1998, Wu et al. 1998, Wu and Allan 2001, Kayhanian et al. 2007). The Charlotte I-77 locations are surrounded by highly urbanized land uses, while both the Davidson County I-85 and NC I-40 sites are surrounded by more rural land uses. It has also been demonstrated that the type of sampling instrumentation and monitoring infrastructure can significantly impact the representativeness of runoff water quality samples (e.g. Gettel et al. 2011). Runoff samples for the eastern NC and Texas studies utilized slots to collect runoff at the edge of pavement while this study utilized an open paved trough to collect runoff samples. Samples from this study, the eastern NC sites and the TX-1 site were collected as a flow weighted composite while samples from the TX2 and TX3 sites were collected via passive samplers and represent a first flush sample. Finally, the width of the vegetated filter strips monitored from the Texas study was 26 feet (8m) vs. the 5 feet (1.5m) examined in this study.

TSS and Turbidity

As per the Texas study we observe a significant decrease in TSS EMC when comparing the edge-of-road Charlotte conventional EMC (59.2 ± 31.6 mg/L) and the Charlotte OGFC sites (35.1 ± 26.9 mg/L). However, the average percent reduction in TSS EMC for paired events equates to 41%, or significantly lower than the 91% to 96% reductions reported for the Texas study, a lower reduction than a Netherlands PFC study of 91% (Berbee et al. 1999), and lower than the 81% TSS EMC reduction observed by Pagotto et al. (2000) from a before and after PFC installation monitoring study in France. An examination of the median TSS values from the Charlotte Conventional Sites reveals that our median EMC value of 61.3 mg/L is significantly lower than that reported for the three Texas conventional pavement study sites (ranged from 121-166 mg/L). The Charlotte OGFC median EMC of 26.7 mg/L was significantly higher than the three Texas PFC sites, 8.4 mg/L and the four eastern N.C. PFC runoff sites (9.0, 17.0, 8.0, and 8.4 mg/L). An examination of our filter strip runoff data reveals that EMC TSS values decreased significantly (≈ 72%) after conventional pavement runoff passed through its adjacent grassed filter strip. No significant reduction in TSS was observed after Charlotte OCFG edge-of-pavement runoff passed through its adjacent grassed filter strip and no significant difference in EMC TSS concentration was observed between the two Charlotte filter strip sites (Table 5.4).

Our data indicates that NovaChip™ edge-of-road TSS EMC's (29.4 mg/L) were significantly higher than that of the Davidson County conventional pavement site (13.4 mg/L) with both sites, exhibiting lower TSS EMC's than the Charlotte conventional and OGFC runoff sites (Figure 5.1). The adjacent grassed filter strip significantly reduced NovaChip™ edge-of-road TSS EMC's by ≈ 44%, but no

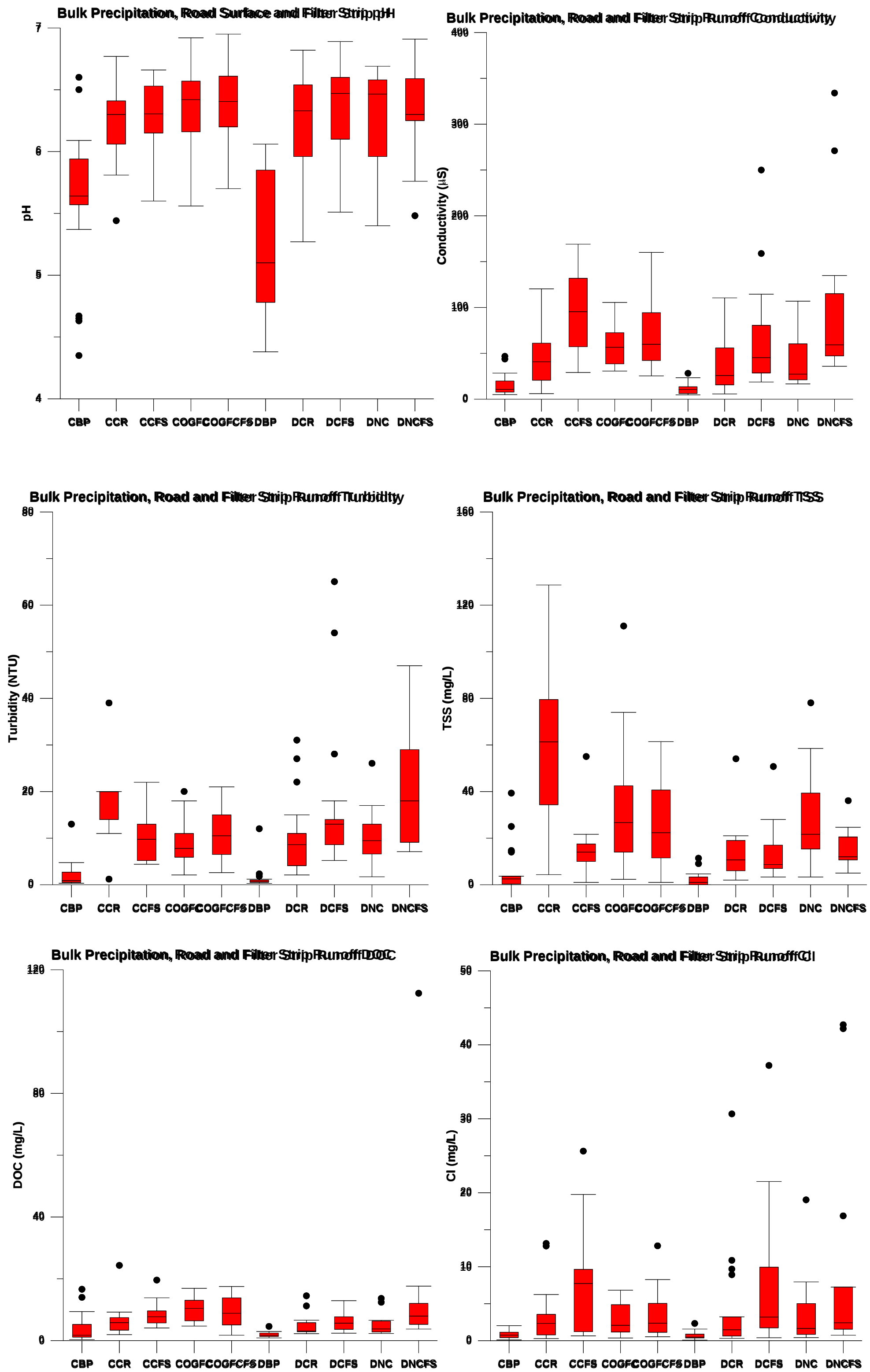


Figure 5.1 pH, Conductivity, Turbidity, TSS, DOC and Cl Bulk Precipitation, Road and Filter Strip Runoff Values

significant reduction in TSS EMC was observed after the Davidson County Conventional edge-of-pavement runoff passed through its adjacent grassed filter strip. As for the two Charlotte sites, no significant differences in EMC TSS concentration were observed between the two Davidson County Filter Strip sites (Table 5.4).

Turbidity levels were not reported for the Texas or Eastern North Carolina PFC runoff studies. Our data indicate that the OGFC pavement (9.0 NTU ± 5.0) significantly reduced conventional surface edge-of-pavement runoff turbidity levels (18.4 NTU ± 7.0) by ≈ 50%. The grassed filter strip receiving conventional edge-of-pavement runoff also reduced turbidity levels by a similar amount (10.4 NTU ± 5.9) with no significant difference in filter strip runoff turbidity levels observed between either Charlotte monitoring sites. From our results we must conclude that the reduction in TSS by the Charlotte OGFC surface is approximately one half that reported from other PFC installations which appeared to receive higher TSS loadings and the differences in TSS runoff concentrations between conventional and OGFC pavements is not discernible after the runoff passes through grassed shoulder strips. The TSS removal benefit would only be realized where road surface runoff drains via curb and gutter into storm drains and/or freely draining bridge deck surfaces. There appears to be no benefit in terms of TSS or turbidity reductions associated with the NovaChip™ overlay as compared to conventional pavement surfaces.

Phosphorus

Eck et al. (2012) report that the Texas TP PFC edge-of-pavement EMC concentrations declined by 75%, 66%, and 78% for the TX1, TX2, and TX3 sites, respectively. We observe no significant difference in TP EMC's between the Charlotte conventional and OGFC edge-of-pavement sites (Table 5.4). Median TP EMC concentrations for the Charlotte conventional and OGFC edge-of-pavement sites 0.17 and 0.16 mg/L, respectively are similar to the median EMC TP values (0.115 to 0.192 mg/L) for the Texas sites but are higher than those reported for the Eastern N.C. sites (0.053 to 0.10 mg/L). TP levels were statistically different between the Davidson County NovaChip™ and conventional pavement sites (Table 5.5), with TP EMC's falling closer to the Eastern NC sites (0.07 to 0.10 mg/L). Results from a subset of the Texas PFC sampling sites reveals that filter strip TP EMC values increased in comparison to conventional edge-of-road runoff values. Filter strip TP EMC concentrations draining conventional pavement decreased by approximately 30% in comparison to PFC edge-of-pavement runoff concentrations in the Texas study (Table 2.2, this report). For this study no significant differences in TP runoff concentrations were found between the edge-of-pavement and filter strip runoff at the Charlotte OGFC sites, or between the conventional pavement and OGFC filter strip sites. Conventional pavement TP EMC runoff concentrations were observed to increase at the Davidson County site after passing through its grassed filter strip, with no significant differences observed between the NovaChip™ edge-of-pavement and its filter strip sites, nor the conventional pavement and the NovaChip™ filter strip sites.

Little if any change in TDP EMC is reported for the Texas PFC study owing to the relatively low TDP levels measured in runoff in that study (< 0.02 to 0.03 mg/L). In comparison, measured TDP levels were higher for the Charlotte and Davidson County sites (0.06 to 0.05 mg/L) Table 5.2 and 5.3. Our data in fact indicates that Charlotte OGFC edge of pavement runoff TDP EMC's were significantly higher than values for the conventional pavement runoff at this site (0.081 vs. 0.063 mg/L) (Figure 5.2), perhaps indicating leaching of evaporites or particulate associated phosphorus held within the pavement surface. Runoff TDP EMC's for all Charlotte and Davidson County sites as well as the Texas conventional site increased after edge-of-road runoff passed through adjacent grassed filter strips (Tables 2.2, 5.4 and 5.5) indicating desorption from roadside soils/highway derived particulates or the dissolution of evaporites deposited from previous rain events. Similar TDP increases in road source runoff moving through shoulders and vegetated BMP treatment has been observed in other N.C. studies (Wu and Allan 2006). No significant differences in TDP EMC runoff concentration was evident between the two Davidson County site filter strips, while TDP EMC concentrations were significantly lower for the Charlotte filter strip draining the conventional pavement site as compared to the OGFC filter strip site.

Nitrogen

Results from the Texas study report no statistically significant differences in PFC and conventional asphalt TKN or NO_3+NO_2 runoff concentrations (Eck et al., 2012). While Berbee et al. (1999) report an 84% reduction in PFC runoff TKN concentrations in their study from the Netherlands. Our data indicates significantly higher TDN, NO_3-N and NH_4-N OGFC runoff concentrations as compared to conventional pavement runoff concentrations at our Charlotte monitoring locations (Figure 5.3, Table 5.4). There is also some suggestion of higher PFC NO_3+NO_2 runoff concentrations as compared to conventional pavement from the Texas data (Eck et al., 2012), but these differences were not statistically significant. It is also interesting to note that the Charlotte OGFC runoff concentrations for all nitrogen components are higher than that measured for Bulk Precipitation at this site (Table 5.2). A possible source of this ″extra" nitrogen is from atmospherically derived particulates, gasses and aerosols stored within the porous OGFC surface that become mobilized during runoff events. A similar storage pool of N on the conventional pavement is not likely to accumulate owing to a significantly smaller storage volume and deflation from wind and vehicular traffic, which limits pollutant buildup. Significantly lower TDN runoff concentrations were measured for the Davidson County conventional pavement runoff as compared to NovaChip™ edge of pavement runoff (Table 5.5, Figure 5.3).

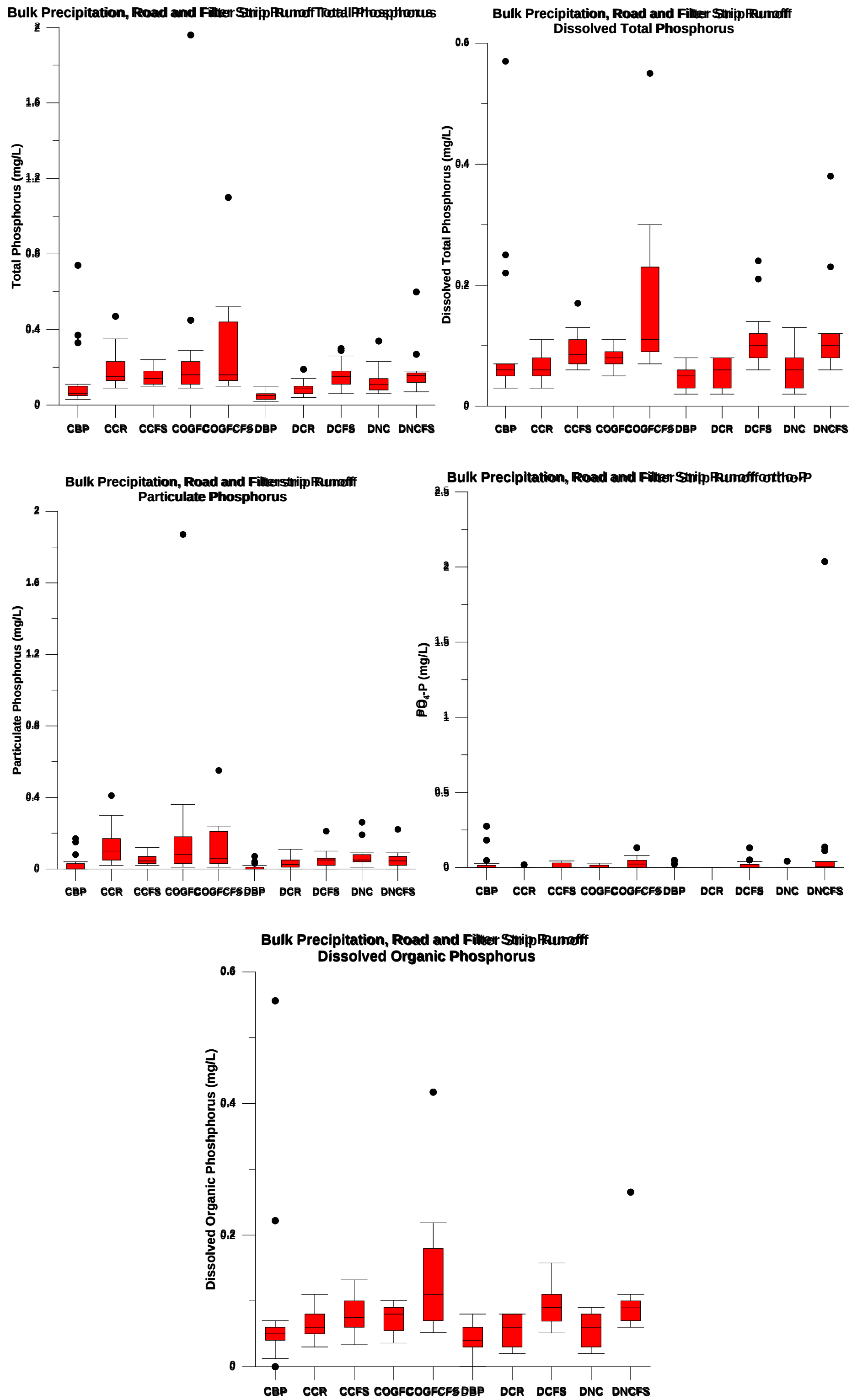


Figure 5.2 Phosphorus Bulk Precipitation, Road and Filter Strip Runoff Concentrations

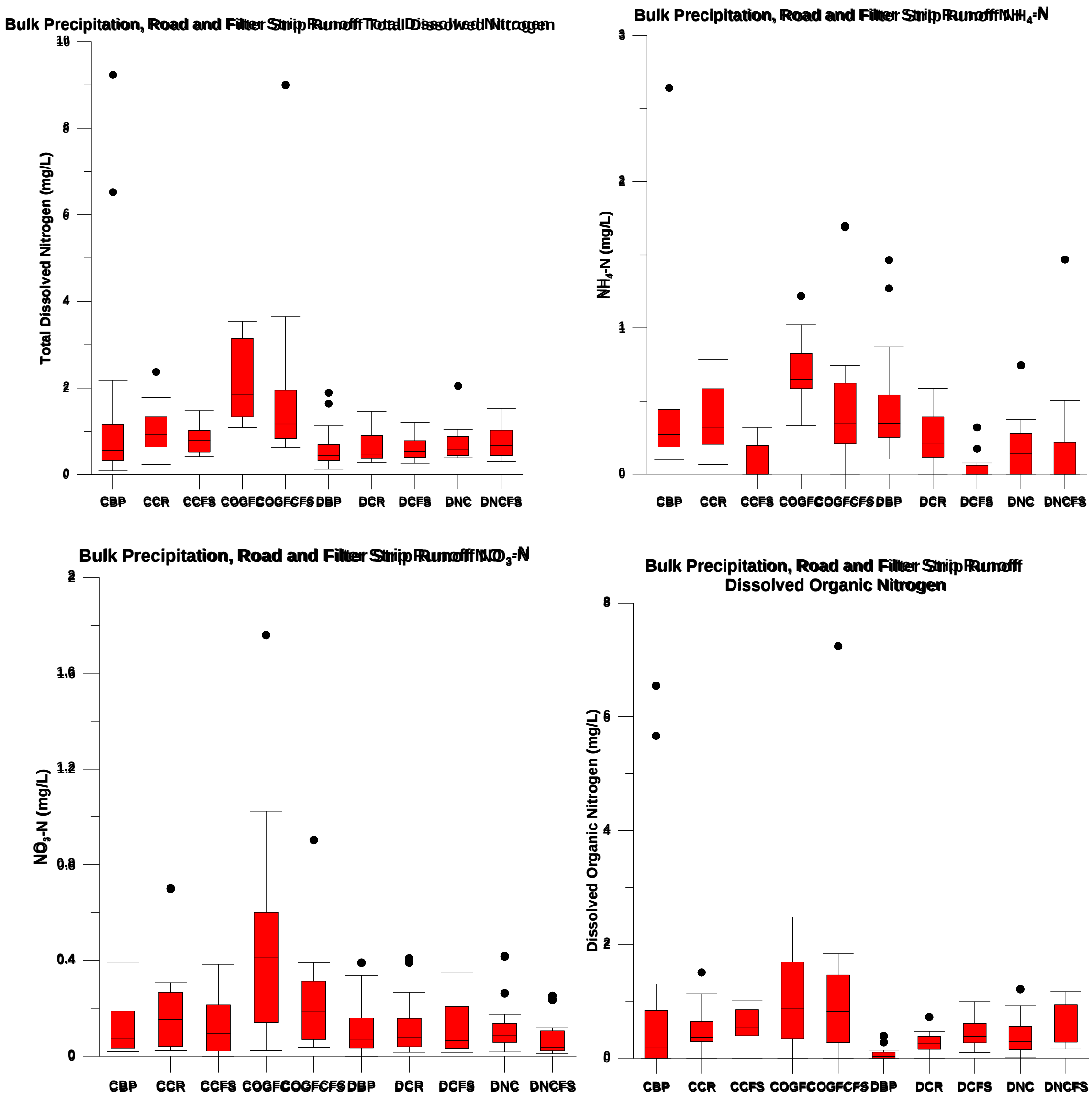


Figure 5.3 Nitrogen Bulk Precipitation, Road and Filter Strip Runoff Concentrations

We can compare N values in this report to the TKN values reported in other studies by adding the DON and NH_4-N concentrations (i.e. TKN ≈ DON + NH_4-N) to calculate the total reduced N concentration. When this comparison is made our Charlotte conventional pavement total reduced N EMC (0.87 mg/L) appear to be lower than the Texas conventional pavement TKN values (1.0 to 1.66 mg/L) and slightly higher than the Texas PFC runoff values (0.50 to 0.79 mg/L). TKN PFC median runoff concentrations from eastern NC range from 0.82 to 1.09 mg/L (Eck et al., 2012). Reduced nitrogen (DON + NH_4-N) EMC concentrations for the Davidson County edge-of-pavement runoff were lower averaging 0.53 and 0.59 mg/L for the conventional pavement and NovaChip™ sites, respectively. The

OGFC edge-of-pavement reduced nitrogen EMC (1.67 mg/L) would appear to be significantly higher than all other locations. Likewise, we can compare our reported NO_3-N results with other reported PFC NO_3+NO_2 runoff data, by correcting our data to account for the molecular weight of NO_3. Nitrite is not likely to comprise a significant component of oxygenated surface runoff. The Charlotte conventional pavement median runoff NO_3 concentrations (0.94 mg/L) are significantly higher than the median runoff concentrations reported for the Texas conventional pavement sites (0.16 to 0.26 mg/L). The Charlotte OGFC pavement median runoff NO_3 concentrations (1.85 mg/L) are significantly higher than all conventional and PFC median runoff concentrations reported for the Texas and eastern North Carolina pavement sites (0.21 to 1.09 mg/L, Eck et al. 2012). The Davidson County conventional pavement and NovaChip™ median runoff NO_3 concentrations 0.26 and 0.34 mg/L, respectively, are similar or slightly higher than the median runoff concentrations reported for the Texas conventional pavement sites but lower than those reported from the eastern N.C. PFC study. As for reduced N, we attribute the higher runoff concentrations observed for the Charlotte OGFC site to the increased storage capacity for the OGFC surface to build up material between runoff events. The higher NO_3+NO_2 runoff levels observed for the eastern N.C. sites are attributed to relatively high levels of atmospheric deposition. Filter strip runoff results from the Charlotte conventional runoff site reveal a significant decrease in TDN, NO_3-N and NH_4-N EMC's as runoff passed through the grassed shoulder (Table 5.4, Figure 5.3). No significant changes in DON concentrations were observed for this sight. Significant decreases in NH_4-N and NO_3-N EMC's were observed as OGFC runoff moved through its adjacent shoulder strip. Conventional filter strip runoff generally had significantly different or lower TDN, NH_4-N, and NO_3-N EMC's as compared to the OGFC filter strip runoff while DON concentrations were not significantly different between the two filter strip sites. Filter strip runoff data from the Texas study indicate higher TKN concentrations after conventional pavement and PFC pavement runoff moved through adjacent grassed shoulders, while minimal reductions in NO_3+NO_2 EMC's were observed (Table 2.2). Our filter strip runoff reveals no significant decrease in the EMC's of TDN at the Davidson County conventional pavement and NovaChip™ monitoring locations (Table 5.5, Figure 5.3). Ammonium EMC concentrations tended to decline as road surface runoff from conventional pavement passed through its grassed shoulder while DON EMC's increased at the Davidson County conventional pavement site and exhibited no significant difference at the NovaChip™ monitoring locations. No significant differences in TDN, DON, and NO_3-N EMC's between Davidson County filter strip runoff were measured while significantly different NH_4-N EMC's were found for these sites.

Overall, our data indicates that significantly higher N EMC's from our Charlotte OGFC edge-of-pavement site in relation to other pavement types monitored in this and other studies. It is likely that the open structure of the OGFC pavement allows for a greater build up of nitrogen compounds between precipitation events and that these compounds become mobilized during runoff events. It is unclear if this actually can result in higher pollutant loading rates as N trans-located from conventional road surfaces to adjacent roadside areas are not accounted for and may become mobilized during rain events as well.

Trace Metals

The trace metal data presented in this report represents total dissolved Cr, Cd, Cu, Ni, Pb, Pt, and Zn. Other studies have reported significant declines in total metal EMC's in PFC runoff. This study focuses on dissolved metals as the NC Department of Environment and Natural Resources (NCDENR) is currently considering changing water quality standards for metals from total recoverable metals to dissolved metals. Previous studies include Berbee et al. (1999) who report reductions in total Cu, Pb, and Zn EMC's ranging from 67 to 92%; Pagotto et al. (2000) report reductions in total Pb (78%), Cd (69%), Zn (66%), and Cu (35%). The same study reports dissolved Zn and Cd decreasing by ≈ 60%. Eck et al. (2012) report reduced median total Cu EMC's between (56% to 69%), total Pb (> 90%), and Total Zn (87% to 90%) in comparison to conventional pavement runoff for three sites in Texas. This same study reported widely variable reduced median dissolved Cu EMC's between (-4% to -62%) and dissolved Zn (-9% to -70%) in comparison to conventional pavement runoff for these same three Texas sites. Our data indicates significant reductions in dissolved Cr (-54%, 2.54±1.12 μg/L vs. 1.19±0.64 μg/L) and increases in dissolved Zn (+75%, 42.1±16.7 μg/L vs. 76.8±39.4 μg/L) in OGFC runoff when compared to conventional pavement at our Charlotte monitoring sites (Table 5.4, Figure 5.4). No other metals exhibited significant differences in EMC concentration differences between OGFC and conventional pavement runoff. No significant differences in dissolved metal concentrations were measured between the Davidson County conventional and NovaChip™ edge of pavement monitoring sites. Median EMC's for Charlotte conventional edge of pavement runoff for dissolved Zn (39.4 μg/L) is within same range of conventional pavement EMC's reported for dissolved Zn (11.3-45 μg/L) while the Charlotte dissolved Cu median concentration (12.3 μg/L) is over double that reported by Eck et al. (2012). The Davidson County conventional pavement and NovaChip™ dissolved Zn median EMC's (11.7 and 23.3 μg/L, respectively) are significantly lower than the Charlotte site but also fall in the range reported for the Texas runoff sites as does dissolved Cu (≈ 5.55 μg/L, both sites). Median dissolved Zn EMC's for Charlotte OGFC runoff (69.1 μg/L) significantly exceeds other reported values for PFC and conventional pavement runoff.

The conventional pavement and PFC filter strip runoff data reported by (Barrett, 2006 and Barrett *et al.*, 2006, Table 2.2) indicate minimal reductions in dissolved Cu median EMC's and significant increases in dissolved Zn concentrations after highway runoff moved through grassed shoulders. Our data indicates that in most instances the vegetated shoulders at both the Charlotte and Davidson County sites were not effective in reducing most dissolved metal concentrations in conventional, OGFC or

NovaChip™ pavement runoff (Tables 5.4 and 5.5). The only dissolved metal species that consistently displayed significant reductions in median EMC's after passing through grassed shoulders was Zn for the two Charlotte locations, with reductions ranging from 40 to 65% (42.1±16.7 vs. 25.9±11.2 μg/L and 76.8±39.4 vs. 26.3±17.2 μg/L).

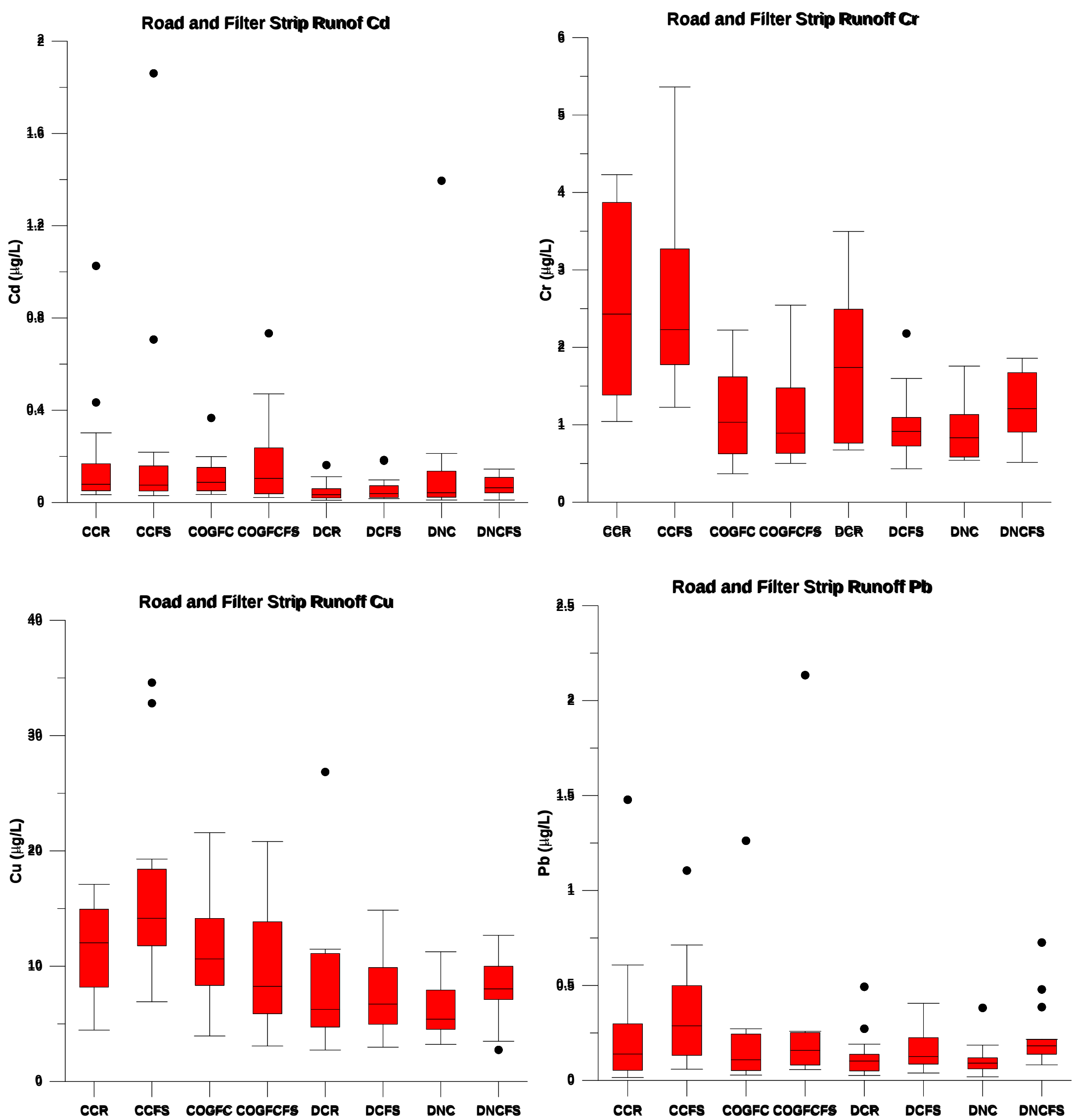


Figure 5.4 Dissolved Trace Metal Road and Filter Strip Runoff Concentrations

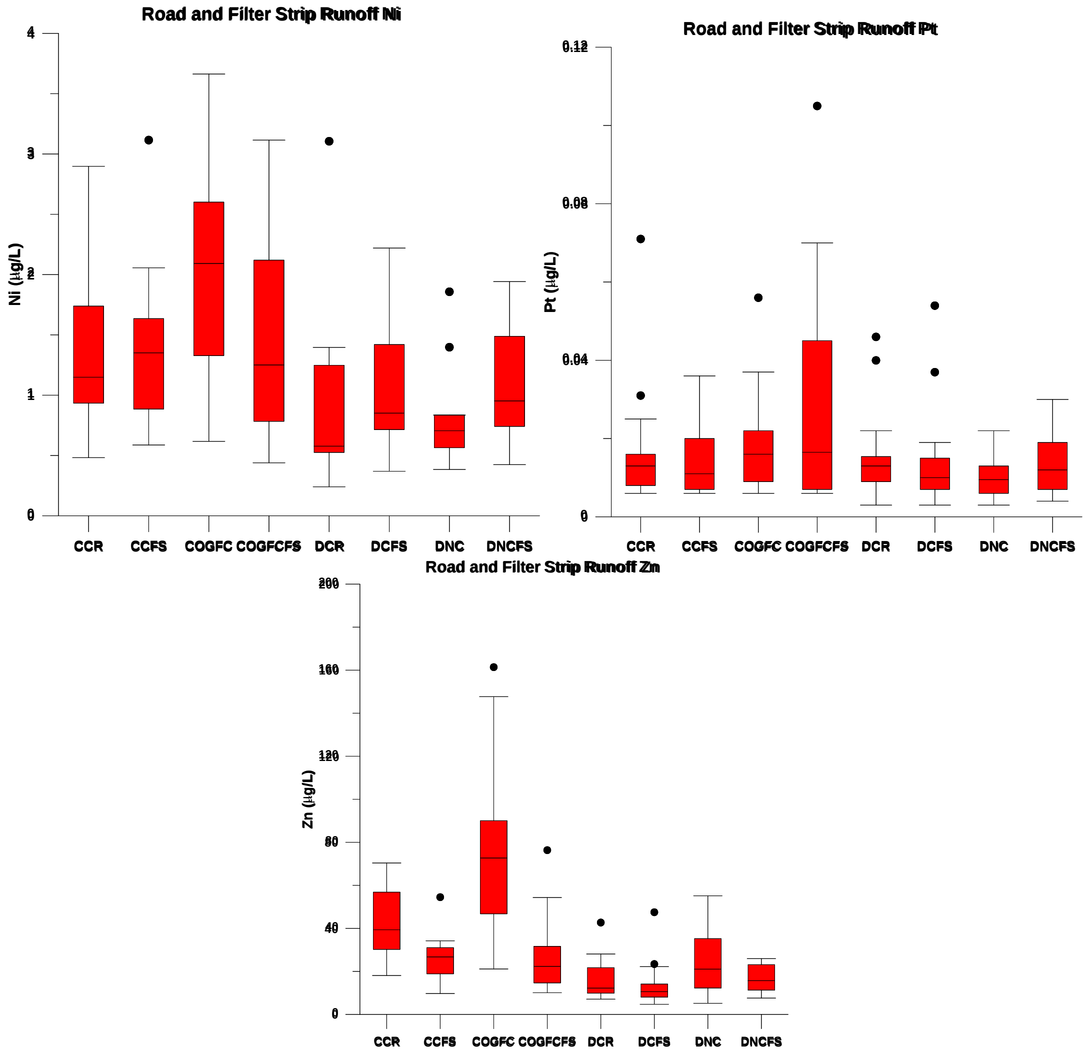


Figure 5.4 (Contd.) Dissolved Trace Metal Road and Filter Strip Runoff Concentrations

In summary, our data does not indicate that OGFC pavement reduces dissolved metal concentrations. Our results also do not reflect the dissolved metal reductions in PFC runoff observed by Pogatto et al. (2000) and Eck et al. (2012). The results from this study are particularly striking for dissolved Zn, which was markedly higher in Charlotte OGFC runoff as compared to other sites. Grassed shoulder strips appear effective in reducing EMC's for dissolved Zn (40% to 65%) whereas significant increases in dissolved Zn concentrations were measured as highway runoff moved across grass filter strips in the Texas study. This study did not measure total metal concentrations as has been reported for other studies. Given that TSS concentrations declined in OGFC edge-of-pavement runoff in comparison to conventional pavement runoff, it is reasonable to expect similar reductions in total metal concentrations.

6.0 SEDIMENT AND POLLUTANT LOADING

Precipitation and runoff sediment and pollutant loadings for the Charlotte I-77 and Davidson County I-85 sites are presented in Tables 6.1 and 6.2. Summary Data in Tables 6.1 and 6.2 represent 28% and 19% of the average annual precipitation totals for Charlotte (43.51inches or 110 cm) and Davidson County (Lexington, N.C., 43.14 inches or 109 cm), respectively. Precipitation and runoff sediment and pollutant loadings for individual runoff events are presented in Tables I-1through I-38 in Appendix I.

6.1 Atmospheric Deposition

In examining the contributions of atmospheric deposition to stormwater runoff, it is apparent that significant retention/neutralization of atmospherically deposited H^+ occurred at all monitored locations as indicated in Tables 6.1 and 6.2. This feature has also been observed in other highway monitoring studies and is attributed to rainwater reactions with alkaline pavement materials and particulates on or within the pavement surface. Atmospheric deposition also appeared to be the source of a significant amounts of the TP runoff export that occurred in the edge-of-pavement monitoring, potentially comprising 50-52% of the total runoff load for the Charlotte conventional pavement, Charlotte OGFC and Davidson County NovaChip™ sites and up to 92% of the TP exported from the Davidson County conventional pavement site. Likewise, atmospheric deposition appeared to be similarly important as a source of TDN stormwater export with measured atmospheric deposition exceeding runoff totals for the Davidson County and the Charlotte conventional pavement sites and atmospheric deposition potentially accounting for 88% and 50% of the TDN measured in runoff from the Davidson NovaChip™ and Charlotte, OGFC sites, respectively (Tables 6.1 and 6.2). It is unlikely that the conventional pavement sites were actually retaining nitrogen, rather the excess deposition reflects the loss of material through the deflation of dry deposition from the road surface by wind and vehicle generated turbulence between precipitation events.

Table 6.1 Summary of Charlotte Sites Precipitation and Runoff Loadings

	BPC	CCR_EOP	CCR_FS	BPO	COR_EOP	COR_FS
	(1)	(2)	(3)	(4)	(5)	(6)
H^+, eq/acre	3115	831	663	3080	497	437
			Runoff Loadings, lbs/acre			
TSS	19	126	30	11	75	41
TDP	0.18	0.15	0.17	0.19	0.21	0.20
TP	0.20	0.40	0.28	0.21	0.42	0.26
PP	0.02	0.25	0.11	0.02	0.21	0.09
DOC	10.2	12.3	15.1	6.9	20.6	11.8
TDN	4.09	2.21	138	2.18	4.40	1.93
NH_4	1.76	1.07	0.28	1.15	2.02	1.02
Cl	1.83	6.05	14.09	2.02	5.31	4.13
NO_3	1.28	1.66	0.97	1.44	3.98	1.82
PO_4	0.33	0.01	0.07	0.17	0.09	0.09
DON	2.50	1.01	0.95	1.09	1.95	0.87
			Runoff Loadings, g/acre			
Cr		1.86	1.78		0.75	0.47
Ni		0.93	0.86		1.21	0.56
Cu		7.61	10.67		7.31	4.18
Zn		30.4	17.3		46.6	11.8
Cd		0.14	0.13		0.08	0.07
Pt		0.01	0.01		0.01	0.01
Pb		0.19	0.27		0.11	0.09
Relative Retention, %	CCR_EOP (2) vs. (1)	CCR_FS (3) vs. (2)	COR_EOP (5) vs. (2)	COR_EOP (5) vs. (4)	COR_FS (6) vs. (5)	COR_FS (6) vs. (3)
H^+	73	20	40	84	12	34
TSS	-560	76	41	-589	46	-36
TDP	21	-16	-42	-10	4	-18
TP	-97	30	-6	-103	37	5
PP	-1005	57	15	-797	57	15
DOC	-21	-22	-68	-200	43	21
TDN	46	38	-99	-102	56	-40
NH_4	39	73	-88	-76	50	-257
Cl	-231	-133	12	-163	22	71
NO_3	-30	41	-139	-177	54	-87
PO_4	98	-1025	-1191	49	-9	-25
DON	59	7	-93	-79	55	8
Cr	NS	5	60	NS	37	73
Ni	NS	7	-30	NS	54	35
Cu	NS	-40	4	NS	43	61
Zn	NS	43	-53	NS	75	32
Cd	NS	9	43	NS	9	43
Pt	NS	-8	-16	NS	-0	-8
Pb	NS	-44	41	NS	18	67

NS - No Sample
NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples.
Note: Multiplied by 2.2×10^{-3} to convert g/ac to lbs/ac

Table 6.2 Summary of Davidson County Sites Precipitation and Runoff Loadings

	BPC	CCR_EOP	CCR_FS	BPO	COR_EOP	COR_FS
	(1)	(2)	(3)	(4)	(5)	(6)
H^+, eq/acre	9732	902	373	9732	766	551
			Runoff Loadings, lbs/acre			
TSS	2	16	14	2	47	24
TDP	0.08	0.07	0.13	0.08	0.09	0.16
TP	0.08	0.09	0.19	0.08	0.15	0.21
PP	0.01	0.03	0.07	0.01	0.07	0.06
DOC	3.12	4.59	7.59	3.12	6.38	10.10
TDN	0.71	0.60	0.62	0.71	0.81	0.89
NH_4	0.52	0.37	0.04	0.52	0.41	0.22
Cl	0.66	2.70	5.31	0.66	2.56	4.38
NO_3	0.85	0.66	0.57	0.85	0.82	0.48
PO_4	0.00	0.00	0.05	0.00	0.00	0.07
DON	0.26	0.30	0.51	0.26	0.43	0.65
			Runoff Loadings, gram/acre			
Cr		0.48	0.25		0.39	0.40
Ni		0.25	0.31		0.32	0.37
Cu		2.05	2.04		2.46	2.89
Zn		5.61	3.71		9.07	5.86
Cd		0.02	0.01		0.03	0.02
Pt		0.01	0.00		0.00	0.00
Pb		0.06	0.06		0.05	0.08
Relative Retention, %	CCR_EOP (2) vs. (1)	CCR_FS (3) vs. (2)	COR_EOP (5) vs. (2)	COR_EOP (5) vs. (4)	COR_FS (6) vs. (5)	COR_FS (6) vs. (3)
H^+	90	58	15	92	28	-48
TSS	-725	10	-197	-2347	48	-70
TDP	10	-71	-25	-13	-65	-21
TP	-8	-107	-69	-83	-34	-9
PP	-152	-153	-154	-539	10	10
DOC	-48	-65	-39	-105	-58	-33
TDN	16	-5	-36	-14	-10	-43
NH_4	28	89	-11	21	46	-430
Cl	-307	-96	5	-286	-71	17
NO_3	22	14	-24	3	41	15
PO_4	*	*	*	*	*	-38
DON	-12	-74	-47	-64	-50	-27
Cr	NS	47	20	NS	-4	-58
Ni	NS	-25	-27	NS	-17	-19
Cu	NS	1<	-20	NS	-17	-42
Zn	NS	34	-62	NS	36	-58
Cd	NS	40	-38	NS	18	-89
Pt	NS	15	39	NS	-43	-2
Pb	NS	1<	5	NS	-57	-50

NS- No Sample * Division by Zero

NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples

Note: Multiplied by $2.2x10^{-3}$ to convert g/ac to lbs/ac.

6.2 Conventional Pavement *vs*. OGFC and NovaChip™ Runoff Pollutant Loadings

Given the similarity of the average runoff coefficients for the Charlotte OGFC (0.85) and Conventional Pavements sites (0.82) it is not surprising to observe differences in pollutant loading following the same trends displayed by differences in event-mean-concentration as discussed in Chapter 5.

Significantly lower exports of H^+ (-40%), TSS (-41%), Cr (-60%), Cd(-43%), and Pb (-41%) were measured in OGFC pavement runoff in comparison to conventional pavement runoff. Runoff loadings for TDP (1.42x), DOC (1.68x), TDN (1.99x), NH_4-N (1.88x), NO_3-N (1.39x), PO_4-P (9.0x), DON (1.93x), and Zn (1.53x) were all significantly higher in OGFC runoff in comparison to conventional pavement runoff at the Charlotte sites during the study period (Table 6.1).

Unlike, the two Charlotte monitoring sites the average runoff coefficients for the Davidson Conventional Pavement (0.78) and the Davidson NovaChip™ Pavement (0.87) were somewhat different during the period of study (Appendix G). Only Pt stormwater loadings (39%) appeared to be somewhat lower in NovaChip™ pavement runoff when compared to conventional pavement runoff (Table 6.2). NovaChip™ stormwater runoff loadings for TSS (2.7x), TP (1.7x), PP (2.3x), DOC (1.4x), TDN (1.35x), DON (1.43x), and Zn (1.6x), all appeared to be significantly higher than loadings for the adjacent Davidson County conventional pavement site.

6.3 Pavement *vs.* Filter Strip pollution Loadings

Average runoff coefficients for the Charlotte conventional pavement site (0.82) and its paired filter strip site (0.77) were within 5% of each other while the average runoff coefficient for the Charlotte OGFC filter strip site (0.62) was significantly lower than the OGFC edge-of-pavement site (Average 0.85) (Table H1 and H2). Similarly, the average runoff coefficient for the Davidson County conventional pavement site (0.78) was comparable to its paired filter strip site (0.74), while the average runoff coefficient for the NovaChip™ filter strip site (0.79) was somewhat lower than the NovaChip™ edge-of-pavement site (0.87).

The vegetated shoulder at the Charlotte conventional pavement site appeared to retain significant (>40%) of the TSS (76%), PP (57%), NH_4-N (73%), NO_3-N (41%) and Zn (43%) from the pavement stormwater loadings that flowed into it. Conversely, this same filter strip exported significantly more Cl^- (2.3x), PO_4-P (7x), dissolved Cu (1.4x), and dissolved Pb (1.4x) than flowed into it from the conventional pavement. Similar to the conventional pavement site the vegetated shoulder at the Charlotte OGFC pavement site also appeared to effectively retain significant (>40%) of the TSS (46%), PP (56%), NH_4-N (50%), NO_3-N (54%) and Zn (75%) from the pavement stormwater loadings that flowed into it. In addition to these runoff constituents, the OGFC filter strip also appeared to effectively retain DOC (43%), TDN (56%), DON (55%), dissolved Ni (54%), and dissolved Cu (43%). Unlike the conventional pavement site, the grassed shoulder at the OGFC site did not appear to be a significant source of any water quality constituent measured in this study.

When comparing the pollutant export loading between the two Charlotte filter strip sites the OGFC Pavement filter strip site exported significantly more TDN (1.4x), NH_4-N (3.6x), and NO_3-N (1.9x) than the conventional pavement filter strip during the study period. Runoff loadings for Cl^- (2.7x), dissolved Cr (3.8x), dissolved Cu (2.6x) and dissolved Cd (1.9x) were all significantly higher in conventional pavement filter strip runoff in comparison to the Charlotte OGFC pavement site.

The vegetated shoulder at the Davidson County conventional pavement site appeared to retain significant (> 40%) amounts of the H^+ (59%), NH_4-N (89%), dissolved Cr (47%), and dissolved Cd (40%) from pavement stormwater loadings that flowed into it. Conversely, this same filter strip exported significantly more DOC (1.7x), TP (2.1x), PP (2.3x) TDP (1.9x), and Cl^- (2x) than what flowed into it from the upslope conventional pavement surface. The retention characteristics of the Davidson NovaChip™ filter strip were different from the conventional pavement filter strip with only NH_4-N (46%) retention being a common factor between the two sites. In addition to NH_4-N, the NovaChip™ associated filter strip retained a significant proportion of the TSS (48%) and NO_3-N (41%) loadings that flowed into it. The grassed shoulder at the NovaChip™ site appeared to be a significant source of DTP (1.8x), DOC (1.6x), Cl^- (1.7x) and dissolved Pb (1.6x) to road surface runoff it received at this site. When comparing the pollutant export loading between the two Davidson County filter strip sites the NovaChip™ pavement filter strip site exported significantly more H^+ (1.5x), TSS (1.7x), TDN (1.4), NH_4-N (5.5x), dissolved Cr (1.6x), dissolved Cu (1.4x), dissolved Zn (1.6x), dissolved Cd (2x), and dissolved Pb (1.3x) than the conventional pavement filter strip during the study period. No unit area loading exports for the Davidson County conventional pavement filter strip exceeded that of the NovaChip™ filter strip during the study period.

Extrapolating our data to an average annual export for the Charlotte conventional pavement sites results in an annual export loading of 450 lbs/acre/yr TSS, 1.43 lbs/acre/yr. TP and 7.9 lbs/acre/yr TDN. These values are remarkably similar to the pollutant loadings reported by Wu and Allan (2001) for a bridge deck site on W.T. Harris Blvd. in Charlotte N.C. (423 lbs/acre/yr TSS, 0.8 lbs/acre/yr. TP, and 9.08 lbs/acre/yr. TDN). That site had an average daily traffic count of 50,200 ADT, or approximately 57% (conventional pavement) to 65% (OGFC) of the ADT interstate traffic recorded at the Charlotte I-77 sites monitored during this study. Extrapolating the Charlotte OGFC data from this study equates to an annual export loading of 266 lbs/acre TSS, 1.5 lbs/acre TP, and 15.7 lbs/acre TDN. This equates to a ≈ 40% reduction in TSS loading, similar TP loading and a doubling of the nitrogen loading in comparison to conventional pavement runoff.

The TSS loading for the Davidson County conventional pavement and NovaChip™ sites was 83.9 lbs/acre/yr. and 248.9 lbs/acre/yr, respectively. Total phosphorus loadings were 0.47 lbs/acre/yr and 0.79 lbs/acre/yr and total nitrogen loadings were 3.2 lbs/acre/yr. and 4.3 lbs/acre/yr for the conventional pavement and NovaChip™ pavement sites, respectively. TSS loadings for the Davidson conventional pavement site were significantly lower than that recorded for the Charlotte conventional and OGFC edge-of-pavement sites. While the edge-of-pavement NovaChip™ TSS loading was similar to the Charlotte OGFC TSS runoff loading, TP loadings recorded for the two Davidson County pavement sites averaged 0.063 lbs/acre/yr or 43% of the average TP loadings measured for the two Charlotte edge-of-pavement sites. The TDN loadings recorded for the Davidson County conventional pavement site (3.2 lbs/acre/yr.) and the NovaChip™ pavement (4.3 lbs/acre/yr) were significantly lower than the Charlotte sites monitored in this study and also the Charlotte data reported by Wu and Allan (2001) for the 100% impervious CLT-1 bridge deck site. The Davidson County average TDN loading is also ≈ 40% lower than the TDN loading rate for a section of conventional pavement on I-40 near Wilmington, N.C with a similar ADT count to the two Davidson County I-85 sites (Wu and Allan, 2001).

7.0 TOTAL SUSPENDED SEDIMENT AND SETTLEABLE SOLIDS GRAIN SIZE

7.1 Methods for Determining Grain Size Distribution on Suspended and Settleable Solids

Sub samples were split from the flow-weighted composite sample collected by the automated ISCO stormwater samplers after each runoff event. The volume-weighted composite sample was agitated to ensure a representative sub sample was obtained. A further 10 mL subsample was extracted and analyzed on a Beckman Coulter LS 13 320 Laser Diffraction Particle Counter (LDPC) in the UNC Charlotte Sedimentology Laboratory (Figure 7.1). The LDPC can measure particles ranging from 1000 µm down to 0.04 µm. In order to detect the different particle sizes, the instrument uses a laser, which is diffracted off of the suspended particles and splits into multiple beams. The instrument uses two detector windows that sense refracted beams and the particle size is determined from the angle of refraction of the laser light. Both the Automated Liquid Module (ALM) and the Universal Liquid Module (ULM) of the LDPC were used for the samples analyzed during this study. There are three parts to the ALM module; the auto sampler, which holds 30 sample tubes and loads the sample into the reservoir, the reservoir where the sample is diluted and continuously circulated through the sample module, which fits into the LS13 320. The module is fully automated so samples can be prepared in advance and left to run unattended. The test tubes hold about 10 mL of sample suspended in water. In many instances, the measured TSS concentrations fell below the recommended obscuration (light blocking) range (8-12%) for delivering reliable analytical results. Sufficient Light obscuration allows for high resolution particle sizing and counting down to 1 micron. In those instances, the water sample was centrifuged using a CRU-5000 centrifuge. The sample was divided equally into 2 containers holding 50 mL each. Each sub sample was spun in the centrifuge for 30 minutes at 2000 rpm at a preset temperature of 25 ºC. Water was then decanted from sample until 5-10 mL remained. The two concentrated sediment samples were combined and DI water added to centrifuge a second time under the same conditions to increase the concentration. An equal volume ″dummy″ sample was run in order to maintain the weight distribution within the centrifuge. The overlying water was again decanted until 5-10 mL remained and the sample was then injected manually into the Beckman Coulter laser particle counter using the ULM. The mean, median, d_{10}, d_{50}, d_{90}, mode, standard deviation, skewness, kurtosis, and variance are automatically calculated by the instrument for each sample. Random duplicates were run throughout the project to access the accuracy of the analyses.

The trough and weir instrumentation used in this study resulted in some particulate material that settled and was retained in the troughs and weir boxes during each event. The particulates contained in the weir boxes and sampling troughs were collected as soon as the runoff troughs dried out after each runoff event and for this study are referred to as settleable solids. Unfortunately, in some instances one or more rain events occurred before the settleable solids sample could be retrieved. Samples may or may not have been collected during these intervening periods, making it difficult to attribute the collectable settleable solids samples to a specific runoff event.

Figure 7.1 Beckman Coulter LS 13 320 Laser Diffraction Particle Counter Settleable Solids

Samples were collected from the trough and weirs with a dustpan and brush. Once collected the sample was air-dried for at least 24 hours. The air-dried sample was then weighed along with its sample bag and the pre-weighed mass of the bag was subtracted. Once the sample was removed from the bag for sieve analysis, the bag was weighed again to determine the mass of sample that was lost by not being retrievable from the bag. Large pieces of organic material were hand removed and the sample was re-weighed again. Larger clumps of aggregated sediment were broken down into individual grains by lightly grinding the sample with a mortar and pestle. The sample was then weighed again before sieving, to determine if any mass was lost in previous processes. The samples were placed on the top of an analytical sieve stack, layered accordingly, using a -3.0 ϕ, -2.0 ϕ, -1.0 ϕ, 0.0 ϕ, 1.0 ϕ, 2.0 ϕ, 3.0 ϕ, and 4.0 ϕ sieve sequence. Grain sizes are expressed in either mm or μm by converting ϕ units to metric equivalents through the following conversion: mm = $2^{(-\phi)}$. The sieve stack was then placed in a RoTap sieve shaker for fifteen minutes. As the RoTap could only accommodate seven sieves at any one time two sieving runs were performed for each sample. The first run included sieve sizes -3.0 ϕ through 3.0 ϕ. Particulates finer than 3.0 ϕ were collected in a bottom tray and then were shaken a second time for fifteen minutes in order to obtain the sample finer than 4.0 ϕ. After being shaken, the sample remaining on each mesh size was weighed on a pan balance, to the nearest 0.01 gram and recorded on a data sheet. Following the sieving, 0.5 grams of the finer than 4.0 ϕ sample, was combined with 8 mL of water, and then run on the LDPC. Where these samples exceeded the recommended concentration the Autoprep station was used to autodilute the sample until it met the desirable obscuration (concentration). The grain size distribution obtained from the Laser Particle counter was combined with the data from the sieve analysis to determine the mean grain size, sorting, skewness, and kurtosis of each settleable solids sample. Note that for TSS samples the size distributions are determined from actual measures of particle size through light obscuration and diffraction so that a mean and a median grain size can be calculated. Settleable solids are determined from a mass weighted distribution of grain size particles and therefore only the calculation of a mean grain size is possible.

7.2 Results

Results from replicate sample runs for TSS and settleable solids grain size analyses are presented in Table 7.1 and 7.2. Summary data for the TSS grain size analyses are presented for the four Charlotte sites in Tables 7.3-7.6 and Figure 7.2 and summaries for the Davidson County sites are presented in Tables 7.7-7.10 and Figure 7.3. Summary data for the settleable solids grain size analyses are presented for the four Charlotte sites in Table 7.11 and Figure 7.4 and summaries for the Davidson County sites are presented in Table 7.12 and Figure 7.5. The four moments of the grain size distribution are presented for each sample: sorting is equivalent to the standard deviation of the grain size distribution; skewness is a measure of the deviation of the distribution as compared to a normal grain size distribution, with a positively skewed deviation indicating the bulk of the grain size values (possibly including the median) falls to the left of the mean and the tail on the right side of the grain size distribution is longer than the left side; kurtosis is a measure of how heavy the tails of the sample probability distribution are in comparison to a normal distribution, higher kurtosis means that more of the variance of the grain size distribution is the result of extreme deviations, as opposed to more frequent modestly sized deviations. A sample with zero excess kurtosis is called a mesokurtic distribution. Most TSS and settleable solids samples analyzed during this study exhibited a leptokurtic distribution characterized by a more acute peak around the mean and faster tails as compared to a normal grain size distribution. On occasion, a few TSS and settleable solid samples exhibited negative kurtosis or a platykurtic grain size distribution. For these samples, their grain size distributions exhibited a lower, wider peak and thinner tails, or a more uniform distribution of grain sizes in comparison to a normal distribution. All of the TSS samples and most of the settleable solids samples analyzed for this study demonstrated a positive skewness (Tables 7.3-7.12)

7.3 Discussion

Mean TSS grain size values were significantly smaller for runoff samples from the Charlotte OGFC pavement and OGFC filter strip sites (very fine sand 62.5-125 μm) when compared to the

Charlotte conventional edge-of-road and the Charlotte conventional pavement filter strip sites (fine sand 125-250 µm, Figure 7.2). Total suspended sediment grain size became more uniform after runoff passed through the vegetated shoulders at both Charlotte sites, with skewness and kurtosis not changing significantly (Figure 7.2). Total suspended solids grain sizes for the Davidson County conventional and NovaChip™ edge-of-pavement and filter strip sites tended to be smaller than the Charlotte sites with mean grain size TSS values for all sites falling within the silt-sized class (3.9 µm-62.5 µm). No significant changes in sorting, skewness or kurtosis were evident between the Davidson County edge-of-pavement and filter strip sites (Figure 7.3).

Table 7.1 Summary of Total Suspended Solids Replicate Analyses

Parameters	N	Average Difference	Average % Difference	Standard Deviation
Mean	11	6.71 µm	14.3	10.2 µm
Median	11	2.37 µm	8.9	3.2 µm
Mode	11	2.84 µm	12.9	4.7 µm
Sorting	11	9.82 µm	21.6	10.3 µm
Skewness	11	0.71	27.5	0.8
Kurtosis	11	6.12	84.2	8.4

Table 7.2 Summary of Settleable Solids* Replicate Analyses

Parameters	N	Average Difference	Average % Difference	Standard Deviation
Mean	11	54.7 µm	24.2	33.4 µm

*Settleable Solids replicates were run on the sieve portion of each sample only and as such only statistics related to mean grain size are reported.

Table 7.3 Summary of TSS Grain Size Distribution for Charlotte Conventional Road Surface

Site	Event	Date Collected	Mean (μm)	Median (μm)	Mode (μm)	S.D. (μm) (Sorting)	Skewness	Kurtosis
CCR_EOP	11	1/12/2012	64.37	25.19	23.82	114.2	3.491	13
CCR_EOP	12	1/18/2012	68.77	30.86	31.51	110.5	3.219	11.03
CCR_EOP	13	1/22/2012	298.5	71.08	993.6	377.7	1.132	-0.080
CCR_EOP	15	3/3/2012	66.19	26.26	21.7	106.1	3.104	10.44
CCR_EOP	16	3/9/2012	45.89	32.32	50.23	46.09	2.091	5.03
CCR_EOP	20	5/23/2012	240.7	98.55	153.8	314.7	1.693	2.042
CCR_EOP	24	7/11/2012	361.9	122.2	1091	418.3	0.883	-0.637
CCR_EOP	25	7/21/2012	89.53	45.95	60.53	116.9	2.358	5.946
CCR_EOP	26	8/8/2012	60.07	24.36	19.76	96.58	3.517	15.25
CCR_EOP	29	9/9/2012	53.4	28.03	41.68	64.77	2.36	8.905
CCR_EOP	30	10/7/2012	107.7	35	18	170.5	2.565	6.688
Mean			132.4	49.07	227.78	176.03	2.40	8.70
S.D.			112.45	33.53	405.10	130.65	0.90	4.17

Table 7.4 Summary of TSS Grain Size Distribution for Charlotte OGFC Road Surface

Site	Event	Date Collected	Mean (μm)	Median (μm)	Mode (μm)	S.D. (μm) (Sorting)	Skewness	Kurtosis
COR_EOP	12	1/18/2012	80.89	31.47	31.51	134.9	2.744	6.803
COR_EOP	13	1/22/2012	36.04	26.62	31.51	32.3	1.587	1.611
COR_EOP	15	3/3/2012	96.5	33.5	23.82	153	2.669	7.301
COR_EOP	16	3/9/2012	51.72	25.81	26.15	73.1	3.203	13.09
COR_EOP	20	5/23/2012	55.7	38.07	50.23	69.37	4.312	26.77
COR_EOP	23	7/10/2012	131	48.4	45.76	188.5	2.084	3.763
COR_EOP	24	7/11/2012	216.5	70.48	55.14	311.9	1.892	2.704
COR_EOP	25	7/21/2012	178.8	71.69	87.9	266	2.444	5.849
COR_EOP	29	9/9/2012	35.37	15.62	12.4	47.26	2.21	4.571
COR_EOP	30	10/7/2012	113.7	42.02	28.7	168.6	2.337	5.324
Mean			99.62	40.37	39.31	144.49	2.55	7.78
S.D.			61.34	18.56	21.46	93.25	0.77	7.38

Table 7.5 Summary of TSS Grain Size Distribution for Charlotte Conventional Road Surface Filter Strip

Site	Event	Date Collected	Mean (µm)	Median (µm)	Mode (µm)	S.D. (µm) (Sorting)	Skewness	Kurtosis
CCR_FS	11	1/12/2012	46.75	20.87	45.76	75.26	3.59	16.02
CCR_FS	12	1/18/2012	869.40	894.80	1584.00	628.60	0.05	-1.327
CCR_FS	15	3/3/2012	34.28	18.30	18.00	46.86	3.00	10.04
CCR_FS	16	3/9/2012	29.35	19.93	60.53	27.65	2.23	9.40
CCR_FS	20	5/23/2012	31.24	17.98	21.70	37.36	2.35	6.45
CCR_FS	25	7/21/2012	20.50	11.84	12.40	23.29	1.96	3.45
CCR_FS	26	8/8/2012	79.07	21.74	23.82	136.60	2.39	4.92
CCR_FS	29	9/9/2012	30.74	12.78	11.29	44.81	2.40	5.28
CCR_FS	30	10/7/2012	58.24	22.23	19.76	102.30	3.55	14.03
Mean			133.29	115.61	199.70	124.75	2.39	8.70
S.D.			276.63	292.22	519.37	192.61	1.05	4.52

Table 7.6 Summary of TSS Grain Size Distribution for Charlotte Open Graded Friction Surface Filter Strip

Site	Event	Date Collected	Mean (µm)	Median (µm)	Mode (µm)	S.D. (µm) (Sorting)	Skewness	Kurtosis
COR_FS	11	1/12/2012	44.23	28.61	55.14	45.79	1.54	2.33
COR_FS	15	3/3/2012	40.43	16.66	14.94	56.69	2.30	5.20
COR_FS	16	3/9/2012	59.75	23.07	18.00	95.65	3.22	11.96
COR_FS	23	7/10/2012	69.92	28.93	26.15	109.80	3.14	11.25
COR_FS	24	7/11/2012	54.81	31.44	37.97	65.08	2.53	9.42
COR_FS	25	7/21/2012	81.75	31.53	26.15	122.60	2.51	6.29
COR_FS	26	8/8/2012	80.19	29.60	31.51	145.90	3.37	12.02
COR_FS	29	9/9/2012	84.76	25.00	12.40	129.70	2.16	4.12
Mean			64.48	26.86	27.78	96.40	2.60	7.82
S.D.			17.28	5.06	13.98	36.93	0.62	3.82

Table 7.7 Summary of TSS Grain Size Distribution for Davidson County Conventional Road Surface

Site	Event	Date Collected	Mean (µm)	Median (µm)	Mode (µm)	S.D. (µm) (Sorting)	Skewness	Kurtosis
DCR_EOP	2	10/20/2011	35.86	23.77	26.15	38.50	2.24	5.71
DCR_EOP	10	1/10/2012	21.36	13.18	14.94	28.27	3.57	15.62
DCR_EOP	12	1/18/2012	257.60	60.72	824.50	317.70	0.75	-1.040
DCR_EOP	13	1/22/2012	60.34	41.90	60.53	60.84	2.01	6.82
DCR_EOP	14	2/20/2012	39.68	28.27	28.70	36.75	1.60	2.53
DCR_EOP	15	3/3/2012	11.77	8.16	9.37	12.58	2.64	8.50
DCR_EOP	20	5/23/2012	32.70	17.02	16.40	45.10	2.84	8.67
DCR_EOP	21	6/6/2012	32.58	17.82	18.00	42.48	2.60	7.17
DCR_EOP	24	7/11/2012	37.23	21.88	18.00	41.92	1.96	3.73
DCR_EOP	25	7/21/2012	41.35	20.91	18.00	52.37	2.17	4.74
DCR_EOP	26	8/8/2012	25.87	13.90	16.40	34.84	2.73	8.12
DCR_EOP	27	8/23/2012	49.87	28.32	37.97	63.12	2.53	7.59
DCR_EOP	28	9/5/2012	36.85	21.83	26.15	42.01	1.88	3.11
DCR_EOP	30	10/7/2012	47.33	22.38	23.82	59.81	1.94	3.42
DCR_EOP	31	10/16/2012	43.24	23.28	26.15	51.87	1.95	3.39
Mean			51.58	24.22	77.67	61.88	2.23	6.36
S.D.			58.19	12.77	206.96	71.99	0.64	3.44

Table 7.8 Summary of TSS Grain Size Distribution for Davidson County NovaChip™ Road Surface

Site	Event	Date Collected	Mean (µm)	Median (µm)	Mode (µm)	S.D. (µm) (Sorting)	Skewness	Kurtosis
DNR_EOP	2	10/20/2011	34.15	24.53	26.15	33.54	2.13	5.13
DNR_EOP	10	1/10/2012	31.32	20.17	23.82	36.01	2.53	7.18
DNR_EOP	12	1/18/2012	57.26	24.75	26.15	97.83	3.52	13.42
DNR_EOP	14	2/20/2012	43.77	28.79	28.70	45.59	2.06	4.65
DNR_EOP	15	3/3/2012	34.50	17.20	18.00	48.71	2.78	8.32
DNR_EOP	20	5/23/2012	43.71	23.46	23.83	57.76	3.11	14.08
DNR_EOP	22	6/13/2012	41.30	22.19	26.15	50.09	2.07	4.20
DNR_EOP	24	7/11/2012	41.24	20.40	18.00	52.46	2.14	4.57
DNR_EOP	25	7/21/2012	47.92	22.48	19.76	62.05	2.34	7.11
DNR_EOP	26	8/8/2012	64.16	29.53	26.15	89.20	2.71	8.81
DNR_EOP	27	8/23/2012	50.57	28.88	45.76	57.42	1.77	2.77
DNR_EOP	28	9/5/2012	59.26	31.04	55.14	74.13	2.39	7.48
DNR_EOP	30	10/7/2012	97.34	26.58	21.70	153.20	2.08	3.35
DNR_EOP	31	10/16/2012	37.23	18.57	19.76	50.33	2.68	8.90
Mean			48.84	24.18	27.08	64.88	2.45	7.14
S.D.			17.10	4.32	10.61	31.27	0.48	3.44

Table 7.9 Summary of TSS Grain Size Distribution for Davidson County NovaChip™ Road Surface Filter Strip

Site	Event	Date Collected	Mean (µm)	Median (µm)	Mode (µm)	S.D. (µm) (Sorting)	Skewness	Kurtosis
DNR_FS	2	10/20/2011	27.98	19.54	21.70	27.62	2.25	6.45
DNR_FS	12	1/18/2012	135.60	17.17	9.37	215.90	1.74	1.95
DNR_FS	13	1/22/2012	58.93	44.55	80.07	50.87	1.11	0.75
DNR_FS	14	2/20/2012	154.10	47.98	517.20	216.40	1.67	1.73
DNR_FS	15	3/3/2012	8.85	6.47	7.08	13.10	9.17	112.60
DNR_FS	20	5/23/2012	37.88	13.87	12.40	59.18	2.49	5.75
DNR_FS	21	6/6/2012	9.04	7.36	8.54	8.46	3.88	21.97
DNR_FS	22	6/13/2012	29.79	12.14	12.40	48.73	2.79	7.17
DNR_FS	24	7/11/2012	35.22	12.69	11.29	56.06	2.54	6.15
DNR_FS	25	7/21/2012	213.30	86.46	751.10	251.00	1.18	0.25
DNR_FS	27	8/23/2012	66.96	25.02	55.14	85.26	1.58	1.63
DNR_FS	28	9/5/2012	21.89	10.24	9.37	34.08	3.57	15.37
DNR_FS	30	10/7/2012	27.49	14.75	16.40	38.64	3.24	12.54
Mean			63.62	24.48	116.31	85.02	2.86	14.95
S.D.			63.71	22.72	235.71	84.16	2.09	30.03

Table 7.10 Summary of TSS Grain Size Distribution for Davidson County Conventional Road Surface Filter Strip

Site	Event	Date Collected	Mean (µm)	Median (µm)	Mode (µm)	S.D. (µm) (Sorting)	Skewness	Kurtosis
DCR_FS	2	10/20/2011	27.38	20.97	21.70	23.52	1.94	5.65
DCR_FS	10	1/10/2012	104.40	13.86	10.29	191.40	2.31	4.75
DCR_FS	12	1/18/2012	30.07	12.57	12.40	52.63	3.41	12.05
DCR_FS	13	1/22/2012	200.60	36.38	751.10	294.80	1.60	1.61
DCR_FS	15	3/3/2012	12.73	8.95	10.29	14.39	4.22	27.90
DCR_FS	20	5/23/2012	46.68	21.42	19.76	64.29	2.32	5.22
DCR_FS	22	6/13/2012	49.36	19.69	153.80	56.92	1.22	0.31
DCR_FS	24	7/11/2012	30.24	15.96	19.76	41.17	2.60	6.84
DCR_FS	25	7/21/2012	68.41	21.48	14.94	93.81	1.73	2.03
DCR_FS	27	8/23/2012	34.72	17.87	16.40	42.60	2.00	3.56
DCR_FS	28	9/5/2012	29.00	11.60	6.44	41.80	2.37	5.30
DCR_FS	30	10/7/2012	26.06	14.74	18.00	38.25	3.85	18.16
DCR_FS	31	10/16/2012	32.73	10.62	8.54	49.74	2.04	2.93
Mean			53.26	17.39	81.80	77.33	2.43	7.41
S.D.			50.07	7.11	204.81	78.90	0.89	7.77

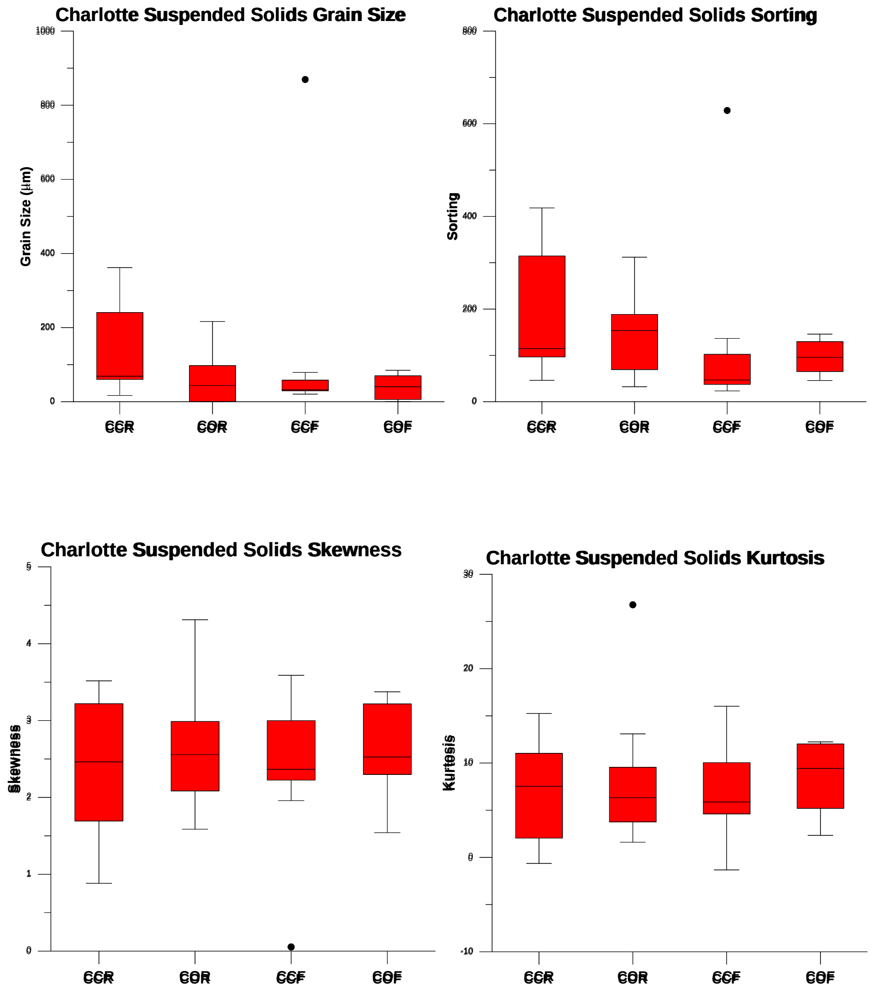


Figure 7.2 Total Suspended Solids Grain Size Moments (Mean, Sorting, Skewness and Kurtosis) for Charlotte I-77 Highway Sites

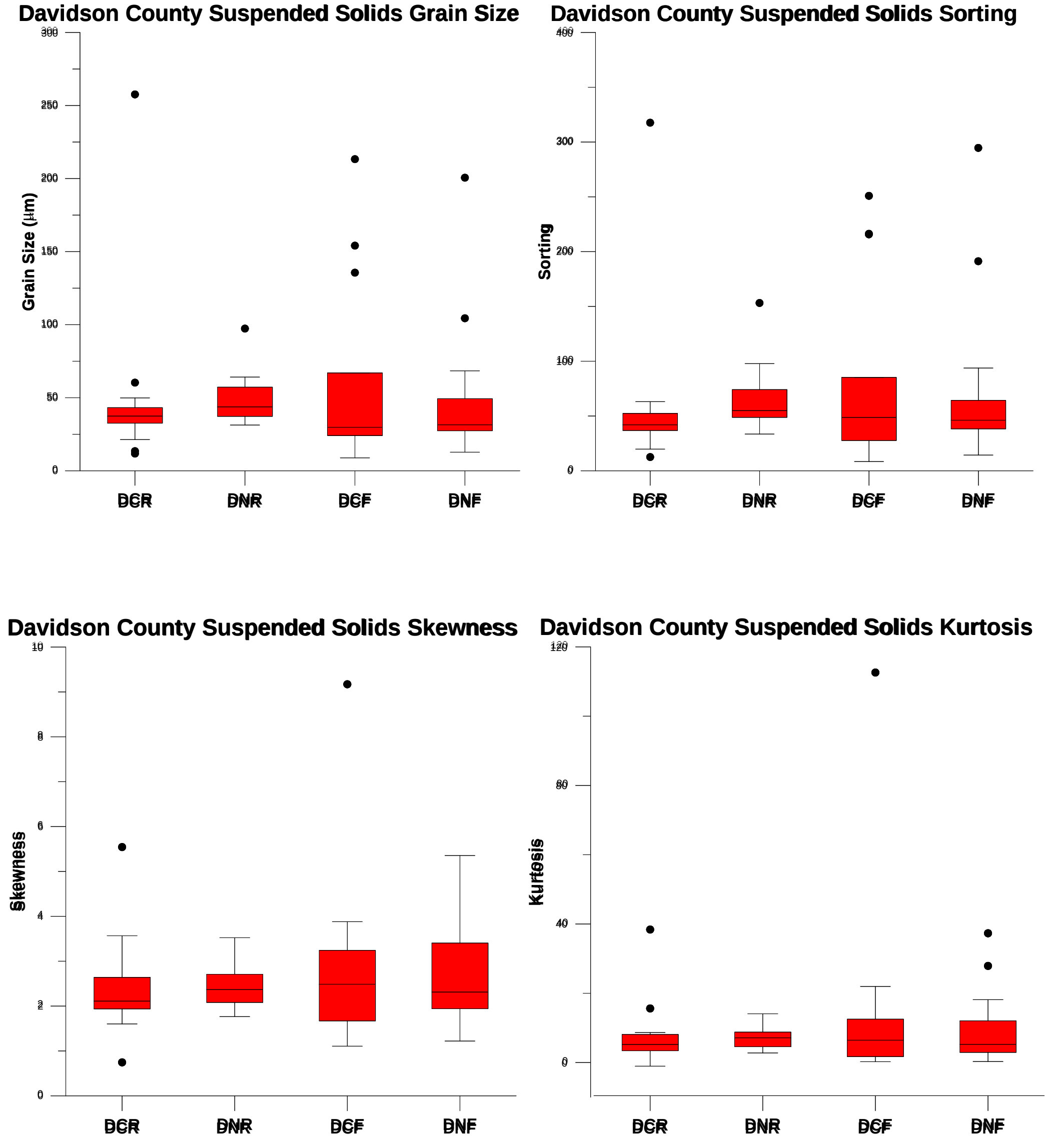


Figure 7.3 Total Suspended Solids Grain Size Moments (Mean, Sorting, Skewness and Kurtosis) for Davidson County I-85 Highway Sites

Settleable solids from the Charlotte edge-of-pavement sites were significantly coarser than the mean TSS grain sizes from these same sites, with both being classified as medium sand (1/4 to 1/2 mm) as compared to fine sand for the Charlotte conventional edge of road and filter strip surfaces and very fine sand for the Charlotte OGFC edge-of-road and filter strip surfaces (Table 7.11). Sorting was not significantly different between the Charlotte sites, but the Charlotte conventional filter strip and the OGFC edge-of-road and filter strip sites were significantly more positively skewed and had higher kurtosis values than the Charlotte conventional edge-of-pavement site (Figure 7.4). Settleable solids were also significantly coarser than TSS mean grain sizes for the Davidson County sites with the NovaChip™ filter strip and the conventional edge-of-pavement and filter strip sites mean grain sizes all classified as fine sands and the Davidson NovaChip™ edge-of-road site exhibiting mean settleable solid grain sizes in the medium sand classification (Table 7.12). Similar to the Charlotte sites skewness became more positive and kurtosis values increased in comparison to the edge-of-pavement sites (Figure 7.5).

Clearly the grain size distributions for the Settleable Solids fraction is significantly different than the TSS fraction for all runoff sites examined in this study (Figure 7.4 and 7.5). This difference in grain size distribution is likely a function of selective sampling attributable to the auto samplers used in this study (e.g. Gettel et al 2011) and/or the selective settling of larger of coarser particle sizes within the sample collection troughs and v-notch weir boxes. An examination of the amounts of settleable particulate material retained by the sampling infrastructure at the various sampling sites indicates that in general significantly more material (but not always) was present in the Charlotte Conventional Edge of Pavement and the Davidson County NovaChip™ Edge of Pavement Sites (Figure 7.6 A, B). A quantification of the proportion of the total solids flux represented by the settleable solids total is presented in Figures 7.7 (A, B). It is apparent that the settleable solids can comprise an appreciable quantity of the Total Solids flux for the Edge-of-Road Sites while generally representing ≤ 30% of the various filter strip runoff totals.

The grain size results for this study fall within the range of other studies that have examined particle size distributions in highway runoff (e.g. Brown et al. 2013, El-Mufleh et al. 2013, Kayhanian et al. 2012a,b, Li et al. 2005, Sutherland 2003). These studies and others have found that there is often a strong particle size association between nutrients, metals, bacteria. With smaller particle sizes exhibiting higher concentrations of pollutants owing to a greater surface area to weight ratio in comparison to larger particle sizes. Although, Ellis and Revitt (1982) report that Cd, Fe and Zn were more strongly associated with the coarser grain size fractions in a study examining gutter sediment from side roads in N.W. London. Of particular importance is the proportion of the size fraction $< 4\ \phi$ or $< 62\ \mu m$ as this silt and smaller sized fraction is difficult to settle or capture in many traditional BMPs. An examination of the median TSS particle size distributions reveals that only 7 of 93 samples (≈ 7.5%) collected during this study exceeded a median particle size of 62 μm (Table 7.11).

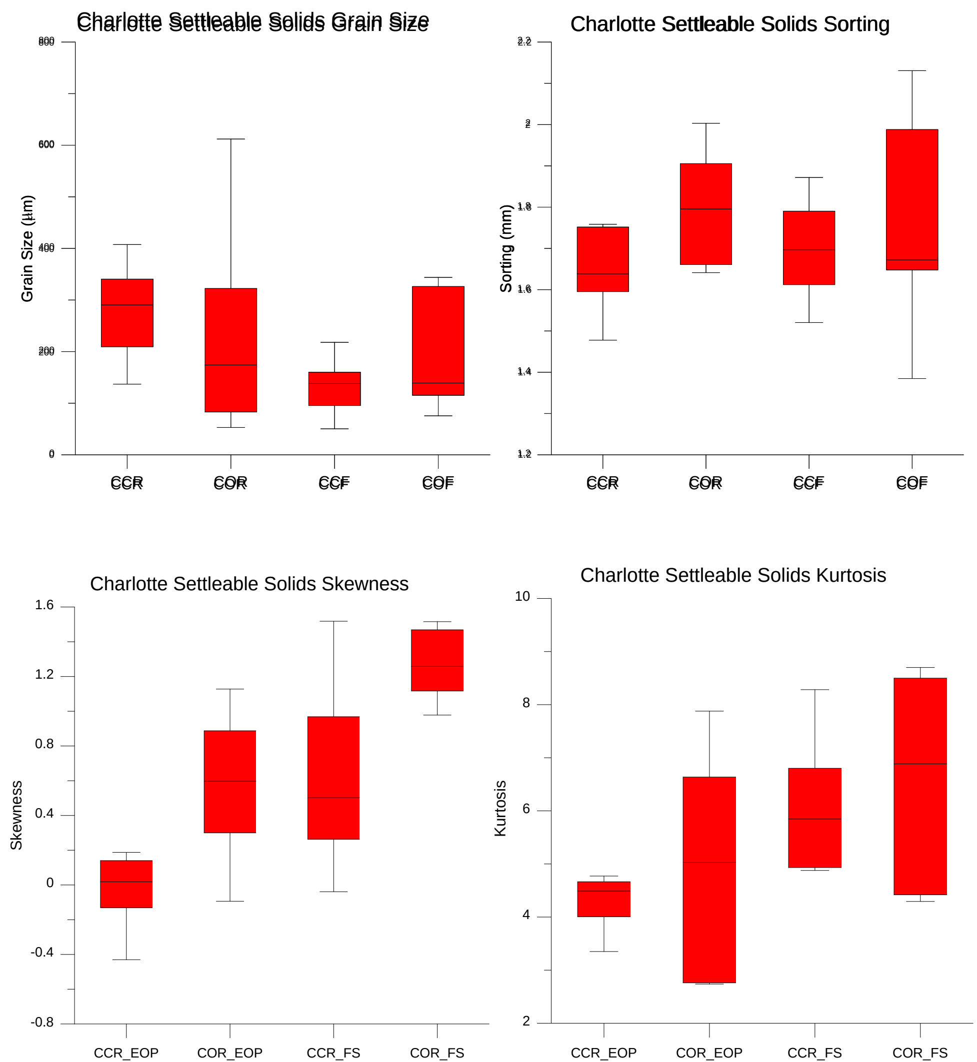


Figure 7.4 Settleable Solids Grain Size Moments (Mean, Sorting, Skewness and Kurtosis) for Charlotte I-77 Highway Sites

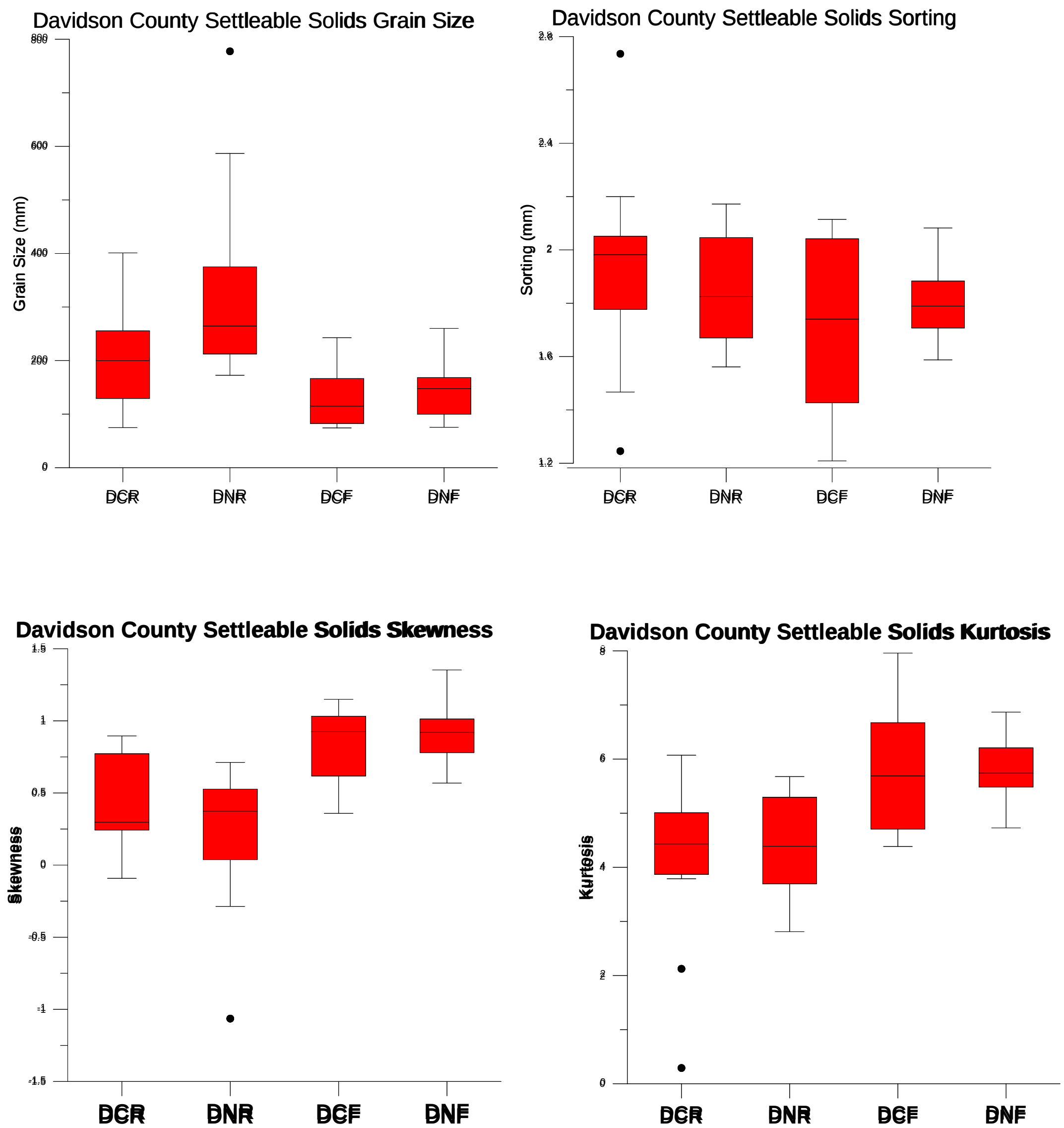
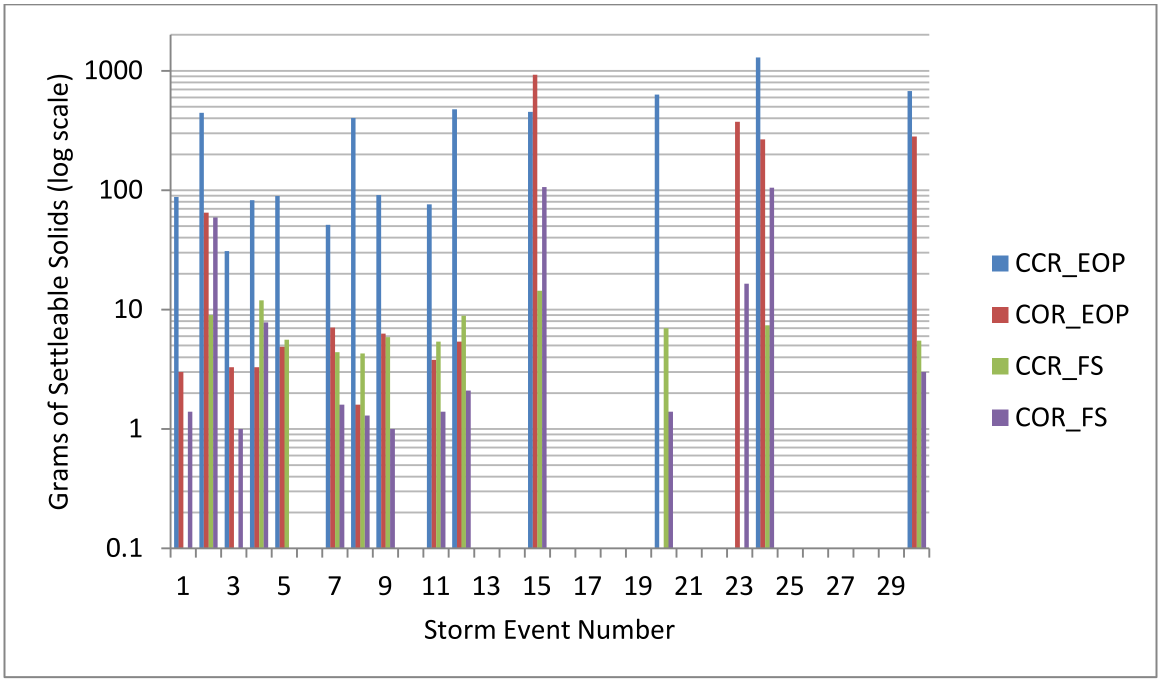
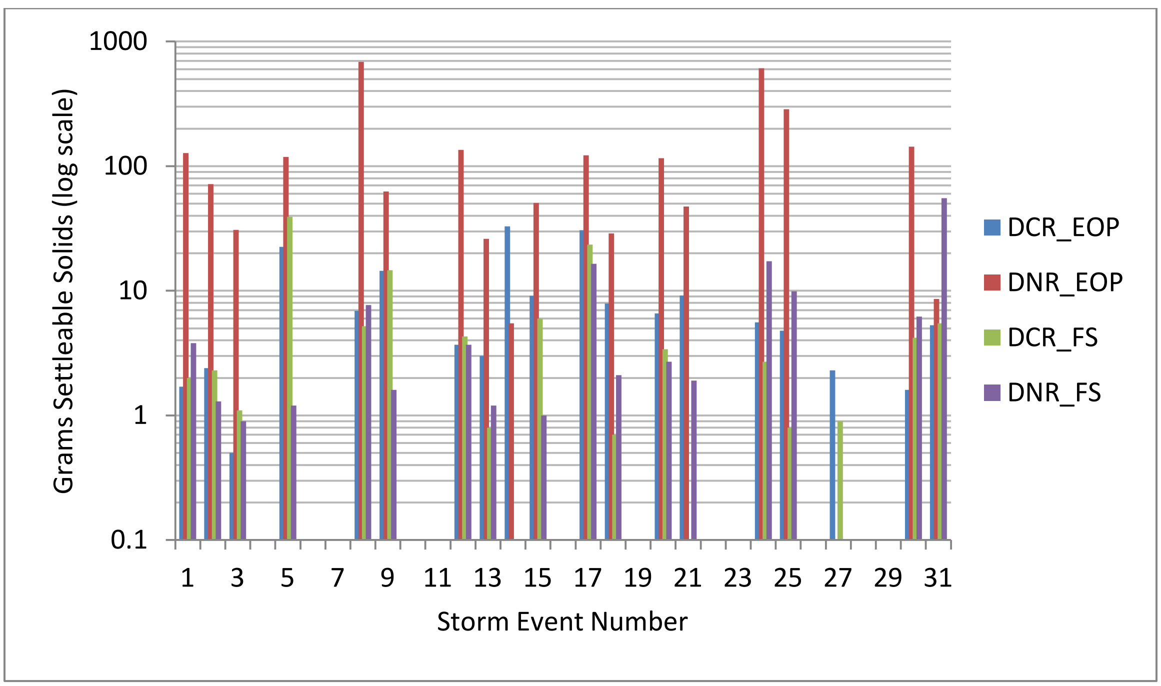


Figure 7.5 Settleable Solids Grain Size Moments (Mean, Sorting, Skewness and Kurtosis) for Davidson County I-85 Highway Sites

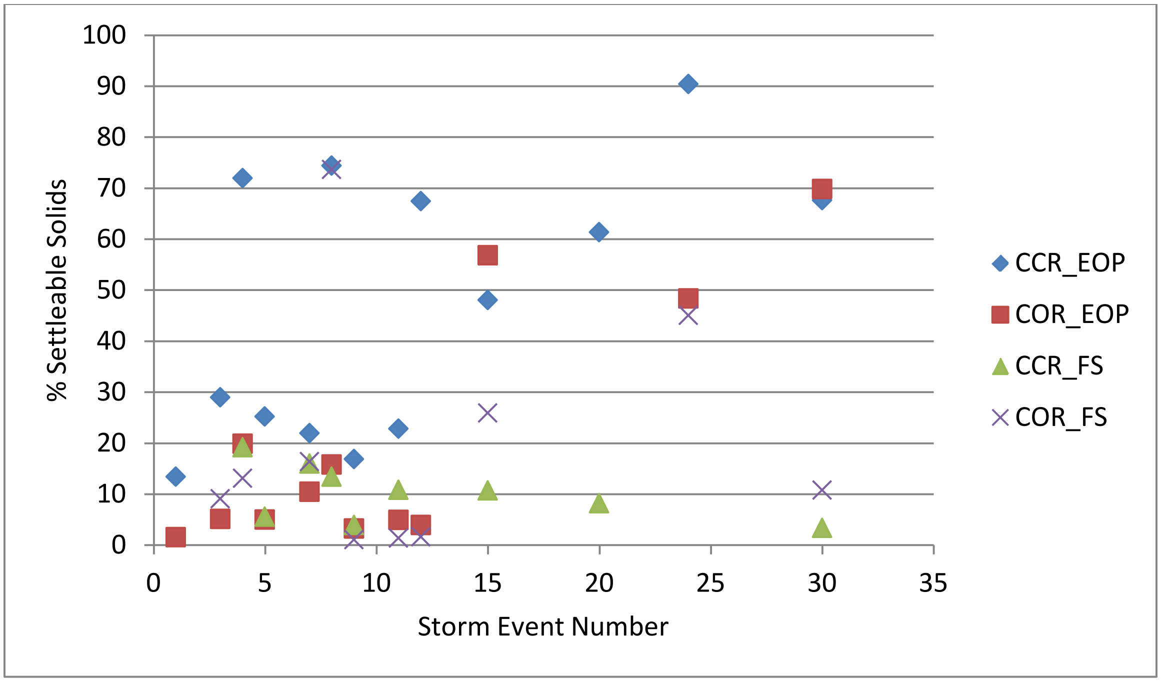


A. Charlotte Sites

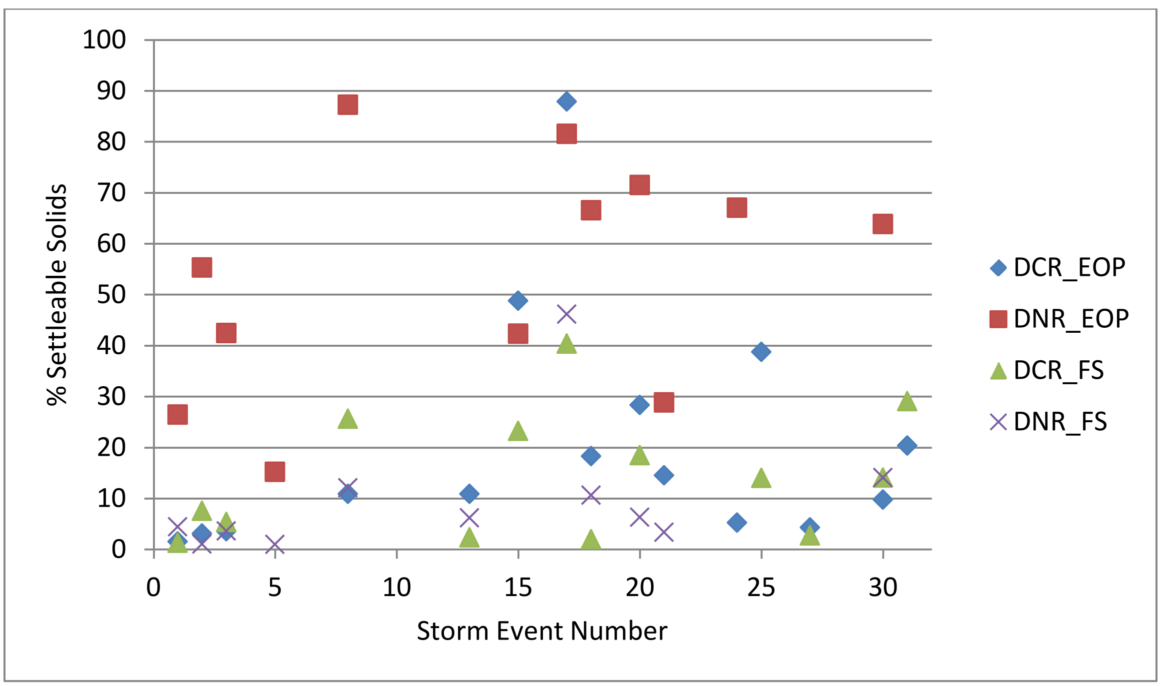


B. Davidson County Sites

Figure 7.6 Settleable Material Retained on Sampling Infrastructure after each Runoff Event



A. Charlotte Sites



B. Davidson County Sites

Figure 7.7 Percentage of Total Sediment Flux Represented by Settleable Solids Fraction for each Runoff Event

Table 7.11 Summary of Settleable Solids Grain Size Distribution for Charlotte I-77 Sites

Site	Event	Date Collected	Dry Weight (g)	Mean Size (mm)	Sorting (mm)	Skewness	Kurtosis
CCR_EOP	11	1/17/2012	76.20	0.14	0.30	-0.13	4.77
CCR_EOP	12	1/19/2012	475.70	0.21	0.33	0.14	4.67
CCR_EOP	15	3/8/2012	453.60	0.28	0.30	-0.03	3.35
CCR_EOP	20	5/31/2012	631.10	0.41	0.33	0.19	4.01
CCR_EOP	24	7/17/2012	1296.50	0.34	0.31	-0.43	4.37
CCR_EOP	30	10/14/2012	676.40	0.30	0.36	0.07	4.61
Mean				0.28	0.32	-0.03	4.30
S.D.				0.10	0.02	0.23	0.54
COR_EOP	11	1/17/2012	3.80	0.08	0.27	0.30	5.28
COR_EOP	12	1/19/2012	5.40	0.05	0.32	1.13	7.88
COR_EOP	15	3/8/2012	929.40	0.61	0.32	0.89	4.77
COR_EOP	20	5/31/2012	2.70	0.08	0.31	0.87	6.64
COR_EOP	23	7/10/2012	114.90	0.43	0.21	0.39	2.63
COR_EOP	24	7/17/2012	124.70	0.26	0.25	-0.09	2.76
COR_EOP	30	10/14/2012	62.50	0.32	0.27	0.32	2.74
Mean				0.26	0.28	0.54	4.67
S.D.				0.21	0.04	0.43	2.09
CCR_FS	11	1/17/2012	5.40	0.05	0.33	1.52	8.28
CCR_FS	12	1/19/2012	8.90	0.12	0.29	-0.04	5.53
CCR_FS	15	3/8/2012	14.40	0.16	0.27	0.48	4.88
CCR_FS	20	5/31/2012	7.00	0.10	0.31	0.53	6.80
CCR_FS	24	7/17/2012	7.40	0.15	0.30	0.26	4.93
CCR_FS	30	10/14/2012	5.50	0.22	0.35	0.97	6.16
Mean				0.13	0.31	0.62	6.10
S.D.				0.06	0.03	0.55	1.30
COR_FS	11	1/17/2012	1.40	0.08	0.25	1.12	4.42
COR_FS	12	1/19/2012	2.10	0.12	0.23	0.98	4.29
COR_FS	15	3/8/2012	106.50	0.33	0.32	1.52	8.70
COR_FS	20	5/31/2012	1.40	0.14	0.38	1.47	8.50
COR_FS	23	7/10/2012	16.50	0.10	0.26	0.63	5.45
COR_FS	24	7/17/2012	105.00	0.34	0.32	1.33	7.15
COR_FS	30	10/14/2012	3.00	0.14	0.31	1.18	6.62
Mean				0.18	0.30	1.18	6.45
S.D.				0.11	0.05	0.31	1.81

Table 7.12 Summary of Settleable Solids Grain Size Distribution for Davidson County I-85 Conventional Road Surface and NovaChip™ Sites

Site	Event	Date Collected	Dry Weight (g)	Mean Size (mm)	Sorting (mm)	Skewness	Kurtosis
DCR_EOP	2	10/20/2011	2.40	0.07	0.15	0.32	0.29
DCR_EOP	12	1/20/2012	3.70	0.21	0.24	0.28	4.23
DCR_EOP	13	1/26/2012	3.00	0.26	0.24	-0.09	3.79
DCR_EOP	14	2/28/2012	32.90	0.39	0.25	0.90	4.89
DCR_EOP	15	3/8/2012	9.10	0.19	0.22	0.22	3.87
DCR_EOP	17	3/27/2012	30.60	0.40	0.25	0.78	4.24
DCR_EOP	18	4/17/2012	7.90	0.22	0.25	0.58	4.14
DCR_EOP	20	5/29/2012	6.60	0.17	0.24	0.46	4.62
DCR_EOP	21	6/11/2012	9.20	0.13	0.29	0.77	5.65
DCR_EOP	24	7/18/2012	5.60	0.12	0.27	0.25	5.01
DCR_EOP	25	7/24/2012	4.80	0.16	0.29	0.24	5.33
DCR_EOP	27	8/28/2012	2.30	0.22	0.36	0.10	4.79
DCR_EOP	30	10/14/2012	1.60	0.28	0.42	0.27	2.12
DCR_EOP	31	10/31/2012	5.30	0.10	0.30	0.84	6.07
Mean				0.21	0.27	0.42	4.22
S.D.				0.10	0.06	0.30	1.48
DNR_EOP	2	10/20/2011	71.90	0.18	0.32	0.71	5.56
DNR_EOP	12	1/20/2012	26.20	0.21	0.25	0.44	4.56
DNR_EOP	13	1/26/2012	5.50	0.30	0.22	-0.29	2.81
DNR_EOP	15	3/8/2012	50.80	0.25	0.24	0.10	3.98
DNR_EOP	17	3/27/2012	122.30	0.78	0.26	0.44	3.18
DNR_EOP	18	4/17/2012	28.90	0.21	0.24	0.19	3.70
DNR_EOP	20	5/29/2012	115.70	0.59	0.28	0.53	4.31
DNR_EOP	21	6/11/2012	47.40	0.17	0.34	0.31	5.29
DNR_EOP	24	7/18/2012	611.30	0.38	0.31	-1.06	4.49
DNR_EOP	25	7/24/2012	285.70	0.28	0.31	0.44	5.68
DNR_EOP	30	10/14/2012	143.30	0.37	0.28	0.04	3.78
DNR_EOP	31	10/31/2012	8.60	0.22	0.31	0.64	4.46
Mean				0.33	0.28	0.21	4.32
S.D.				0.18	0.04	0.49	0.89

Table 7.12 Continued Summary of Settleable Solids Grain Size Distribution for Davidson County I-85 Conventional Road Surface and NovaChip™ Filter Strip Sites.

Site	Event	Date Collected	Dry Weight (g)	Mean Size (mm)	Sorting (mm)	Skewness	Kurtosis
DCR_FS	2	10/20/2011	2.30	0.09	0.23	0.90	4.71
DCR_FS	12	1/20/2012	4.30	0.07	0.23	0.92	4.63
DCR_FS	13	1/26/2012	0.80	0.10	0.37	1.03	7.96
DCR_FS	15	3/8/2012	6.00	0.10	0.25	0.95	5.11
DCR_FS	17	3/27/2012	23.50	0.19	0.25	0.93	5.27
DCR_FS	18	4/17/2012	0.70	0.16	0.32	1.12	6.67
DCR_FS	20	5/29/2012	3.40	0.13	0.31	1.15	6.43
DCR_FS	24	7/18/2012	2.70	0.15	0.32	0.62	6.48
DCR_FS	25	7/24/2012	0.80	0.08	0.29	1.02	6.11
DCR_FS	27	8/28/2012	0.90	0.08	0.24	0.73	4.94
DCR_FS	30	10/14/2012	4.20	0.24	0.43	0.36	4.39
DCR_FS	31	10/31/2012	5.50	0.17	0.43	0.48	6.75
Mean				0.13	0.31	0.85	5.79
S.D.				0.05	0.07	0.25	1.10
DNR_FS	2	10/20/2011	1.30	0.10	0.28	0.67	5.74
DNR_FS	12	1/20/2012	1.20	0.13	0.29	0.79	5.66
DNR_FS	13	1/26/2012	1.00	0.20	0.33	1.01	6.21
DNR_FS	17	3/27/2012	16.50	0.17	0.27	0.99	5.48
DNR_FS	18	4/17/2012	2.10	0.08	0.24	0.78	4.73
DNR_FS	20	5/29/2012	2.70	0.11	0.29	1.05	6.09
DNR_FS	21	6/11/2012	1.90	0.10	0.27	0.92	5.63
DNR_FS	24	7/18/2012	17.30	0.15	0.29	1.35	6.87
DNR_FS	25	7/24/2012	9.90	0.15	0.30	0.92	6.23
DNR_FS	30	10/14/2012	6.20	0.26	0.31	0.89	4.92
DNR_FS	31	10/31/2012	55.40	0.15	0.31	0.57	5.74
Mean				0.14	0.27	0.85	5.37
S.D.				0.06	0.07	0.27	1.46

8.0 CONCLUSIONS AND RECONMANDATIONS

The North Carolina Department of Transportation started to resurface roadway sections with OGFC and NovaChip™ overlays since the early 2000's for pavement rehabilitation and preservation. Pavement performance surveys conducted after resurfacing has shown improvements on all pavement characteristic indexes. As of today, about 1.59% and 0.36% of the North Carolina route miles have been paved with OGFC and NovaChip™, respectively.

The service life provided by hot-mixed asphalt overlays such as OGFC and NovaChip™ is in the order of 8-10 or more years depending on traffic loads and existing pavement conditions at time of application. According to resurfacing projects completed by other states, the average complete project cost for OGFC is about $2.00-$3.00 per square yard, which is close to the cost of conventional asphalt pavement. The project cost for NovaChip™ is about twice of OGFC's or $4.00-$5.00 per square yard. Although the economic return for resurfacing with OGFC and NovaChip™ is promising due to the extension of the service life of existing conventional pavements; little information is available on the environmental benefits due to application of OGFC or NovaChip™ treatment.

This research investigated the water quality benefits of OGFC and NovaChip™ overlays as a potential stormwater control measure. In addition, the research also investigated the effectiveness of roadside grassed filter-strips in series with permeable friction courses as runoff flows through the filter strips. A stormwater monitoring program was implemented during the period of October 2011 through November 2012 on sections of Interstate 77 in Charlotte, Mecklenburg, and along Interstate 85 in Davidson County. Traffic counts for the Charlotte OGFC site on I-77 and its paired control site of conventional pavement were 75,000 and 85,000 vehicles per day, respectively; whereas the Davidson County NovaChip™ and its paired conventional sites had much lower traffic counts of 25,000 vehicles per day. The roadside grassed filter-strips were 5-ft (1.5 m) in length for most monitoring sites, except at the Charlotte conventional site where it was 7 ft (2.1 m). Runoff from the roadway edge-of-pavement was intercepted and collected by a 40-ft (12.2-m) long concrete trough laid adjacent and parallel to the pavement edge. Runoff from filter strips receiving inflow from roadway EOP was collected at the downslope of the strip using similar trough configurations. Major findings derived from this research and recommendations are provided as follows.

- Runoff coefficients for OGFC, NovaChip™ and conventional asphalt pavement segments are found to be 0.85, 0.87 and 0.70-0.82, respectively. Vehicle-induced splashing loss on conventional asphalt appears to result in lowering the runoff coefficients at the conventional sites. The porous structure of OGFC overlay may detain the initial runoff volume, which lowers its runoff coefficient as compared to the NovaChip™ pavement. All of these factors can interact to result in differing water yields for a given pavement type. Regional climatic conditions may also play a significant role in influencing site-specific water yields that could deviate from our findings. In addition, results of this research primarily reflects the climatic conditions in the Piedmont region of North Carolina and may not be applicable to other geographic locations.

- The rate at which runoff water moves through a pavement surface can be affected by surface roughness and slope factors. Hydrologic lag time defined as the time lag between the centroid of precipitation and the centroid of runoff hydrograph was used to compare the flow through on different pavement types. The lag time calculated for OGFC overlay is 0.84 hrs, followed by 0.35 hrs for both conventional asphalt pavement sites, and 0.25 hrs for NovaChip™. When compared to conventional pavements, the OGFC overlay increases the lag time by a factor of 2.4 whereas the NovaChip™ overlay reduces the lag time by a factor of 0.71.
- Site-averaged TSS EMCs were 59 mg/L for Charlotte-conventional, 35 mg/L for OGFC, 29 mg/L for NovaChip™, and 13 mg/L for Davidson County-conventional. Apparently, the OGFC overlay results in a runoff TSS EMC that is approximately 41% lower than its paired conventional pavement site. Other research has reported higher percentages of TSS reduction by PFC installations; but their conventional pavement TSS EMCs (121-166 mg/L) were significantly higher than our TSS data (59 mg/L). Runoff TSS EMC's at the Davidson County conventional pavement site is consistent with other research findings obtained for low ADTs. Runoff TSS EMC for NovaChip™ was higher than its paired conventional site possibly because the smaller hydrographic lag time at the Novachip™ site allows a stronger flushing effect of sediments from its overlay surface.
- TSS EMCs discharged from the two Charlotte filter strips receiving runoff inflow from the OGFC and the conventional sites were 26 mg/L and 16 mg/L, respectively. The roadside filter strips resulted in 26% and 73% reductions in TSS EMCs, respectively, for incoming runoff from the OGFC and its paired conventional sites. The fact that particle sizes in runoff samples from OGFC were finer than its paired conventional site potentially explains the lower trapping efficiency of finer particles by the OGFC-filter strip. At the Davidson County filter strip sites, effluent TSS EMCs were in the range of 13-15 mg/L and the NovaChip™-filter strip had achieved a 48% TSS EMC removal efficiency. Runoff TSS EMC's from the Davidson County conventional pavement site (13 mg/L) was likely close to the irreducible concentration

of the filter strip. Hence, no further TSS removal by the filter strip was realized for the Davidson- conventional site runoff.

- Site-averaged runoff TP EMCs were 0.28 mg/L for OGFC, 0.19 mg/L for Charlotte-conventional pavement, 0.13mg/L for NovaChip™, and 0.09 mg/L for Davidson County-conventional. The difference in TP EMC's between the Charlotte-conventional and OGFC sites was not statistically significant, particularly since their median TP EMCs of 0.17 mg/L (Charlotte-conventional) and 0.16 mg/L (OGFC) were effectively equal to each other. These median TP EMCs are similar to the Texas median TP EMCs (0.12 to 0.19 mg/L) but are higher than the Eastern NC sites (0.05 to 0.10 mg/L). TP levels between Davidson County-conventional (0.09 mg/L) and NovaChip™ (0.13 mg/L) were statistically different from each other.
- Runoff TP EMCs exiting from filter strips receiving inflow runoff from respective roadway pavements are 0.28 mg/L (Charlotte OGFC filter), 0.15 mg /L (Charlotte-conventional filter), 0.18 mg/L (Davidson County NovaChip™ filter), and 0.16 mg/L (Davidson County-conventional filter). There was practically no change in TP EMC as runoff originating from edge-of-pavements flowing through the Charlotte filter strips. As indicated earlier, particle sizes in runoff samples from OGFC were finer than its paired conventional site, which could have caused higher TP EMC than the paired conventional site due to absorption of P onto fine particles that could not be effectively removed by sedimentation. The particulate phosphorous concentrations in pavement runoff accounted for 68% and 33-45% of the runoff TP EMC, respectively, at the Charlotte and Davidson County sites.
- Effluent TP EMCs from filter strips were generally within the range of 0.15 to 0.18 mg/L for our study, with the exception of the OGFC filter site. TP EMCs from edge-of-pavement runoff at the Davidson County sites were consistently below this concentration range. TP EMCs increased, significantly, from 0.09 mg/L to 0.16 mg/L, as runoff from conventional pavement passed through the adjacent filter strip. TP concentrations in runoff from the NovaChip™ pavement surface was slightly increased from 0.13 mg/L to 0.18 mg/L but this increase was not statistically significant.
- Site-averaged TDN EMCs were 2.13 mg/L for OGFC, 1.05 mg/L for Charlotte-conventional, 0.70 mg/L for NovaChip™, and 0.62 mg/L for Davidson County conventional pavement site. TDN EMC at OGFC was statistically higher than the Charlotte paired conventional site. In general significantly higher concentrations of other nitrogen species including NO_3-N and NH_4-N in OGFC runoff as compared to conventional pavement runoff concentrations were observed at this Charlotte monitoring location. It is also interesting to note that the OGFC

runoff concentrations for all nitrogen components are higher than that measured for bulk precipitation at this site. A possible source of this “extra” nitrogen may come from particulates, gasses and aerosols stored within the porous OGFC surface that were mobilized during runoff events. A similar storage pool of N on the conventional pavement was not likely to accumulate owing to a significantly smaller storage volume and deflation from wind and vehicular traffic that limits pollutant buildup. Significantly higher TDN concentrations were measured in NovaChip™ pavement runoff as compared to conventional pavement. No significant difference in NO_3-N, NH_4-N and DON runoff concentrations were measured between the Davidson County conventional and NovaChip™ pavement surfaces.

- As the pavement runoff flows through the adjacent filter strip, TDN EMC was reduced by about 45% at the OGFC site. There was a 25% reduction in TDN EMC at the Charlotte-conventional strip site; however, this reduction could not be proven statistically significant. There was essentially no reduction in TDN EMC at the Davidson-conventional filter site. Surprisingly, TDN EMC at the NovaChip™ filter site was increased by a factor of 5.6. This phenomenon was primarily due to the increase of DON as the pavement runoff ran over the filter strip. The source of dissolved organic nitrogen could not be identified from our study.
- Dissolved metal EMCs at the Charlotte OGFC site were 1.19 mg/L (Cr), 0.11 mg/L (Cd), 11.50 mg/L (Cu), 1.99 mg/L (Ni), 0.02 mg/L (Pt), 0.20 mg/L (Pb), and 76.8 mg/L (Zn). Dissolved metal EMCs at the Charlotte-conventional site were 2.54 mg/L (Cr), 0.19 mg/L (Cd), 11.32 mg/L (Cu), 1.37 mg/L (Ni), 0.02 mg/L (Pt), 0.27 mg/L (Pb), and 42.1 mg/L (Zn). The OGFC pavement did not exhibit any level of reduction in dissolved metal concentrations except for Cr. Dissolved Zn EMCs are markedly higher in Charlotte OGFC runoff as compared to all other sites.
- Dissolve metal EMCs at the Davidson County NovaChip™ site are 0.90 mg/L (Cr), 0.20 mg/L (Cd), 6.31 mg/L (Cu), 0.83 mg/L (Ni), 0.01 mg/L (Pt), 0.12 mg/L (Pb), and 23.6 mg/L (Zn). These dissolved metal concentrations at the Davidson County conventional pavement sites were 1.70 mg/L (Cr), 0.05 mg/L (Cd), 8.21 mg/L (Cu), 0.91 mg/L (Ni), 0.02 mg/L (Pt), 0.13 mg/L (Pb), and 17.06 mg/L (Zn).
- Our data indicate significant reductions in dissolved Cr (54%) and increase in dissolved Zn (75%) in OGFC runoff when compared to conventional pavement at the Charlotte sites. No other metals exhibited significant differences in EMC concentration between OGFC and conventional pavement runoff. Significant differences in dissolved Pt and Zn concentrations existed between the Davidson County NovaChip™ and the paired conventional sites. All other metal species exhibited similar EMCs between these two Davidson County sites.

- In most instances, the grassed filter strips at both Charlotte and Davidson County sites were not effective in reducing dissolved metal concentration for conventional, OGFC or NovaChip™ pavement runoff. The only dissolved metal species that consistently displayed a significant reduction in median EMCs after passing through the filter strip was Zn for the two Charlotte and Davidson County NovaChip™ locations.
- Our data does not indicate that OGFC pavement reduces dissolved metal concentrations. Although total metal concentrations were not measured in this study, it is reasonable to expect proportional reductions in total metal concentrations given that TSS concentrations declined in OGFC runoff in comparison to conventional runoff.
- Mean TSS grain size was significantly smaller for runoff samples from the Charlotte OGFC pavement and OGFC filter strip sites (62.5-125 µm, very fine sand) when compared to the Charlotte-conventional and filter strip sites (125-250 µm, fine sand). TSS grain size for the Davidson County-conventional and NovaChip™ sites tend to be smaller than the Charlotte data (3.9 µm-62.5 µm). Settleable solids for Charlotte sites were significantly coarser than the mean TSS grain size, both being classified as medium sand (1/4-1/2 mm) as compared to fine sand for the charlotte conventional EOP site and filter strip surfaces, and very find sand for the Charlotte OGFC EOP and filter strip surfaces.
- The use of OGFC provide delayed runoff flow rate, which helps reduce the transport of TSS, and particulate related pollutants from its pavement surface. A treatment train consisting of OGFC and roadside-grassed filter strip could provide 56% TSS reduction performance (i.e. 1 – (1 – 0.41)(1 – 0.26) where 41% is from OGFC and 26% is from the adjacent filter strip). This is equivalent to lowering the influent OGFC TSS from 26 mg/L to 11 mg/L. The grassed filter strip alone adjacent to the conventional pavement site demonstrated 73% removal efficiency. This is because TSS reduction performance is better with higher incoming TSS concentrations such as the case at the Charlotte conventional site (59 mg/L).
- A treatment train consists of NovaChip™ and filter strip may offer no net TSS reduction. The increase in TSS concentration in NovaChip™ surface runoff as compared to conventional pavement runoff is largely offset by retention within the adjacent filter strip, which results in similar TSS concentration as if runoff was originating from the conventional pavement surface and flowing over the filter strip.
- The water quality benefits of the OGFC overlay include minimizing the washout of vehicular pollutants, particularly TSS onto roadway surface during precipitation events, reducing pollutant loadings associated with particulates discharged to receiving streams, and serving as a stormwater control measure.

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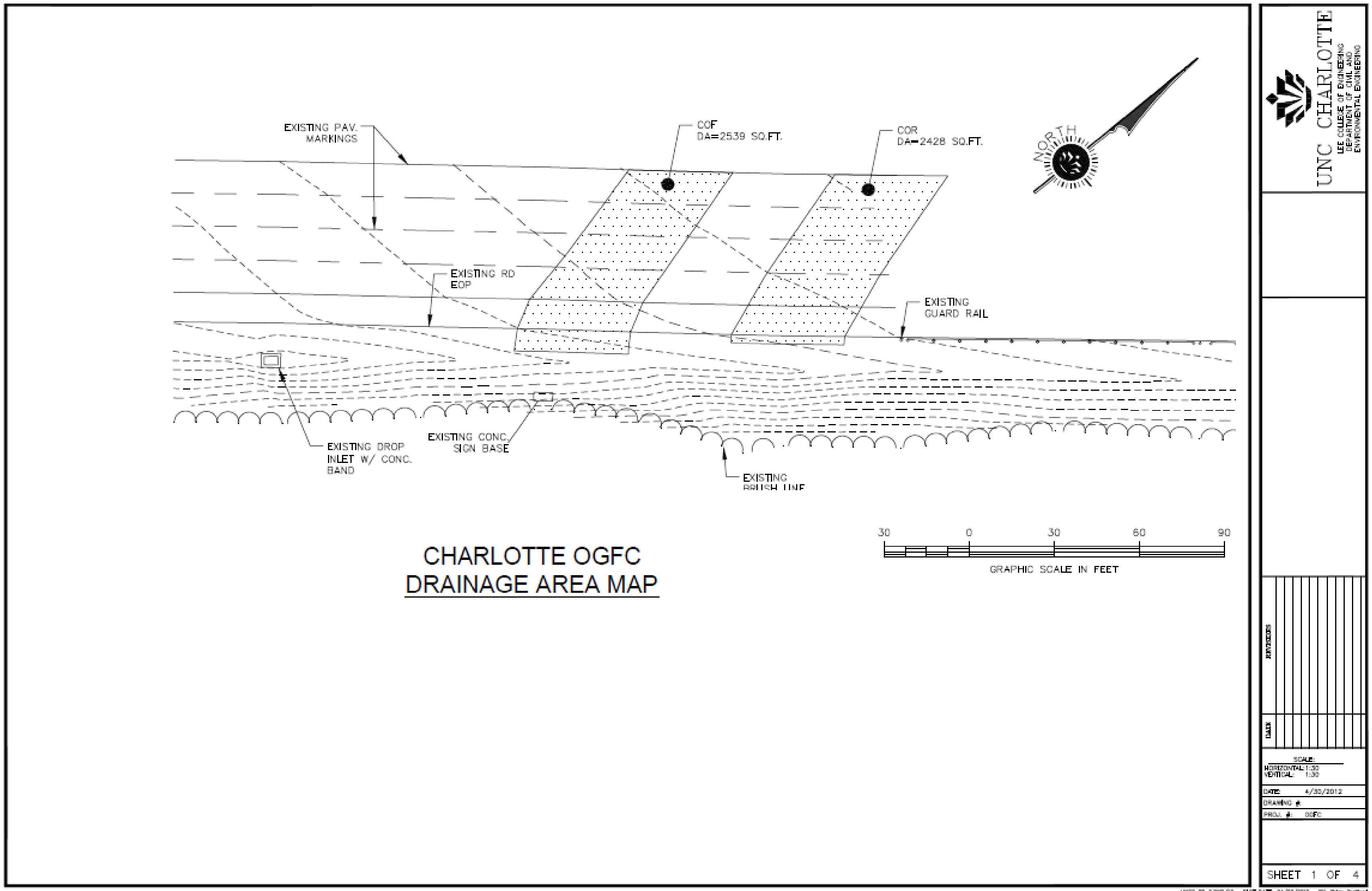
APPENDIX A: SUMMARY OF OGFC AND NOVACHIP LENGTHS

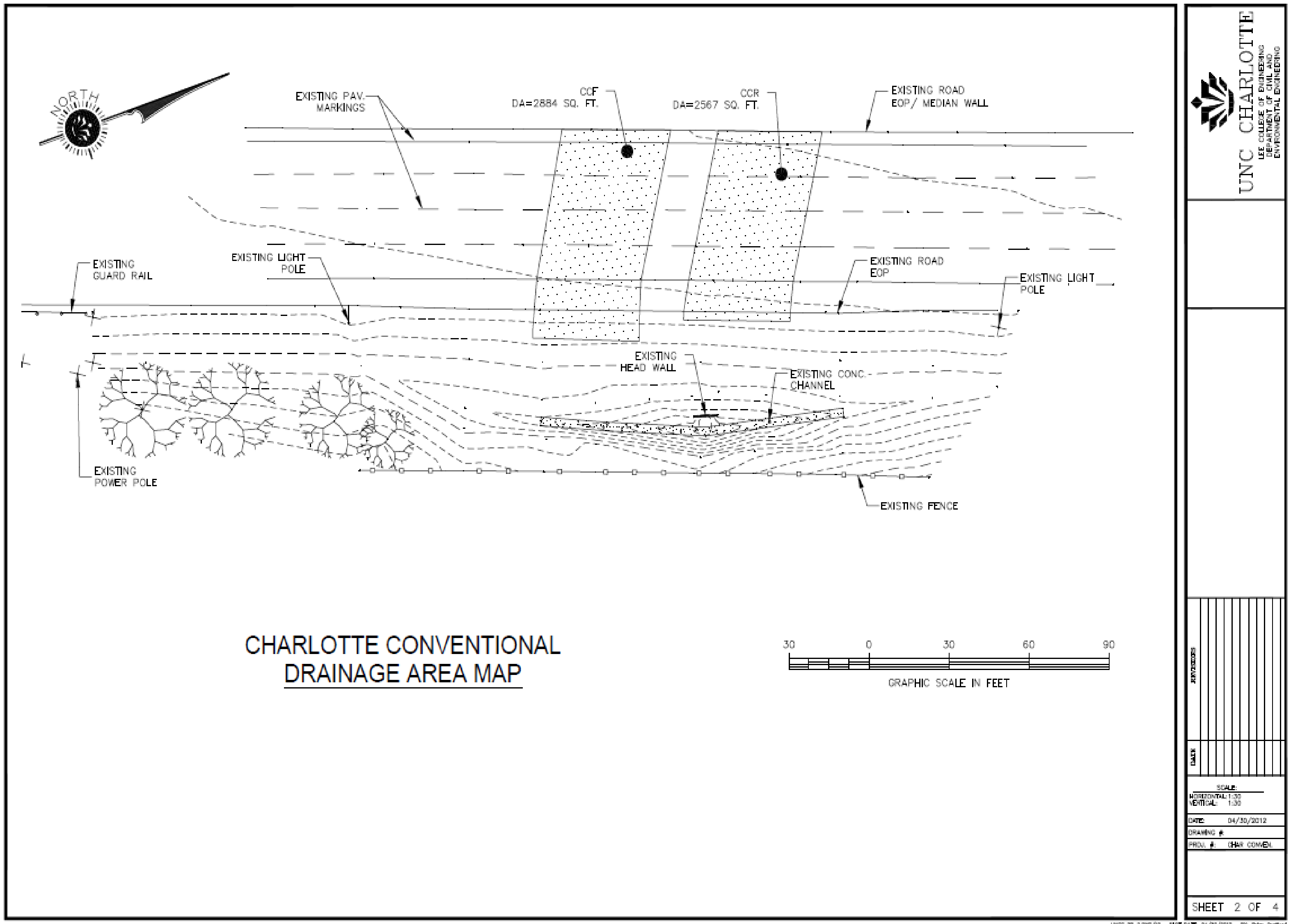
NCDOT Division	Roadways Paved with OGFC, % Route Miles as of 2010	Roadways Paved with NovaChip™, % Route Miles as of 2010
1	1.01	0.00
2	0.00	0.00
3	8.04	0.00
4	3.42	0.61
5	1.14	0.00
6	0.00	1.60
7	0.00	0.00
8	0.00	0.00
9	1.16	0.69
10	1.08	0.00
11	0.00	0.00
12	0.87	1.96
13	0.51	0.00
14	3.14	0.00

APPENDIX B: MAPS OF MONITORING SITES

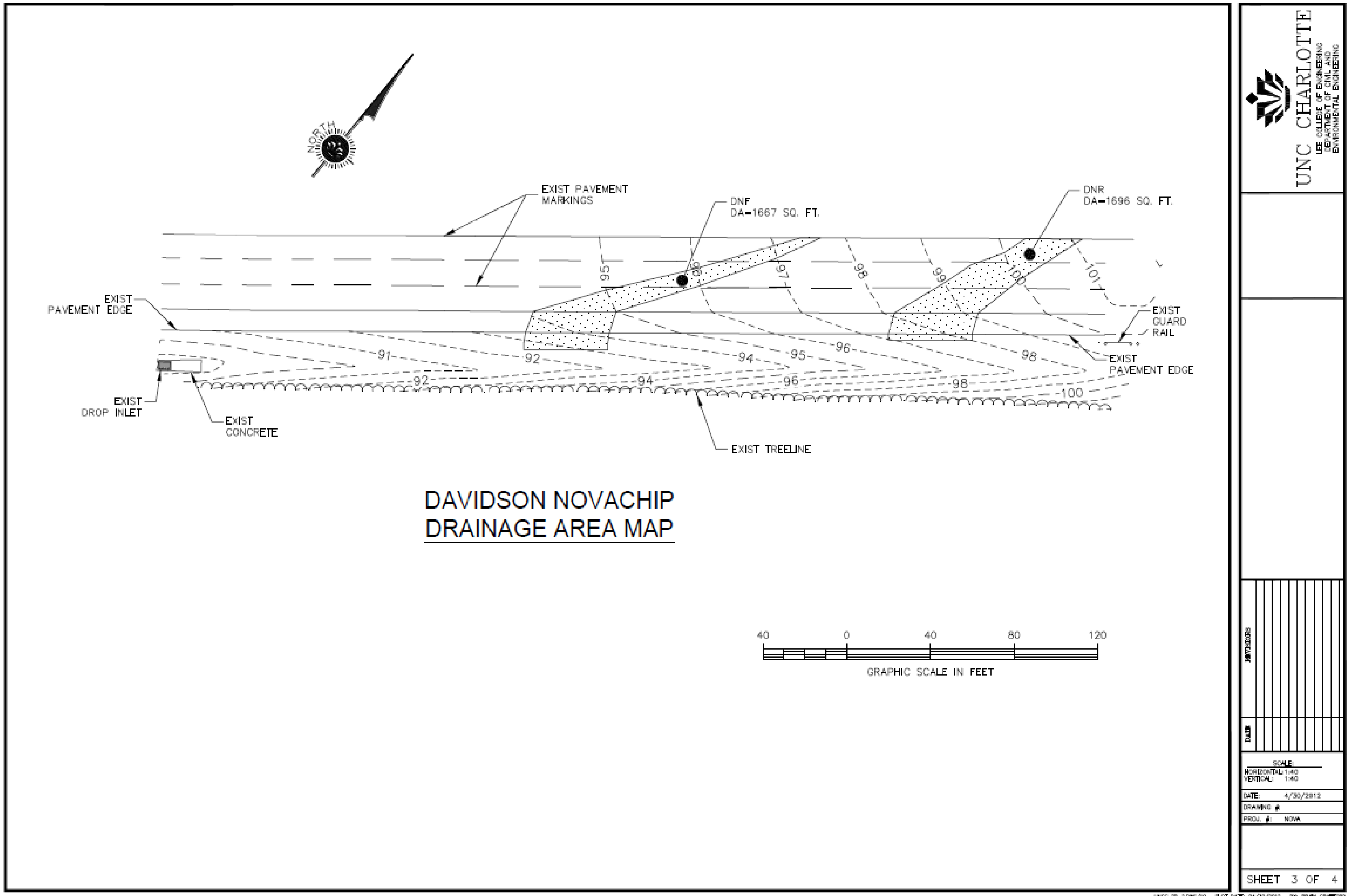
Appendix B-1: Charlotte OGFC Drainage Area Map



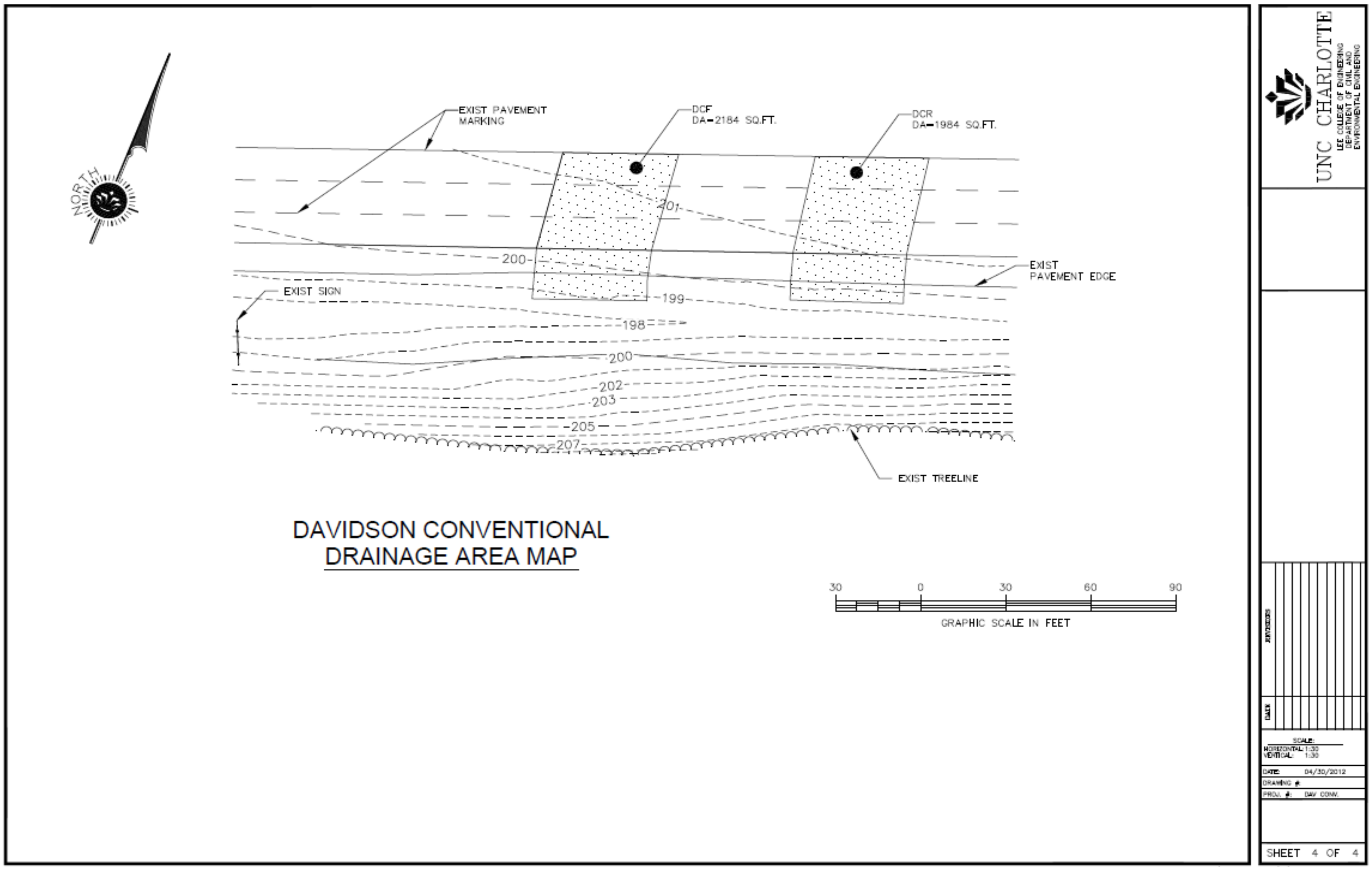
Appendix B-2: Charlotte Conventional Drainage Area Map



Appendix B-3: Davidson County NovaChip® Drainage Area Map

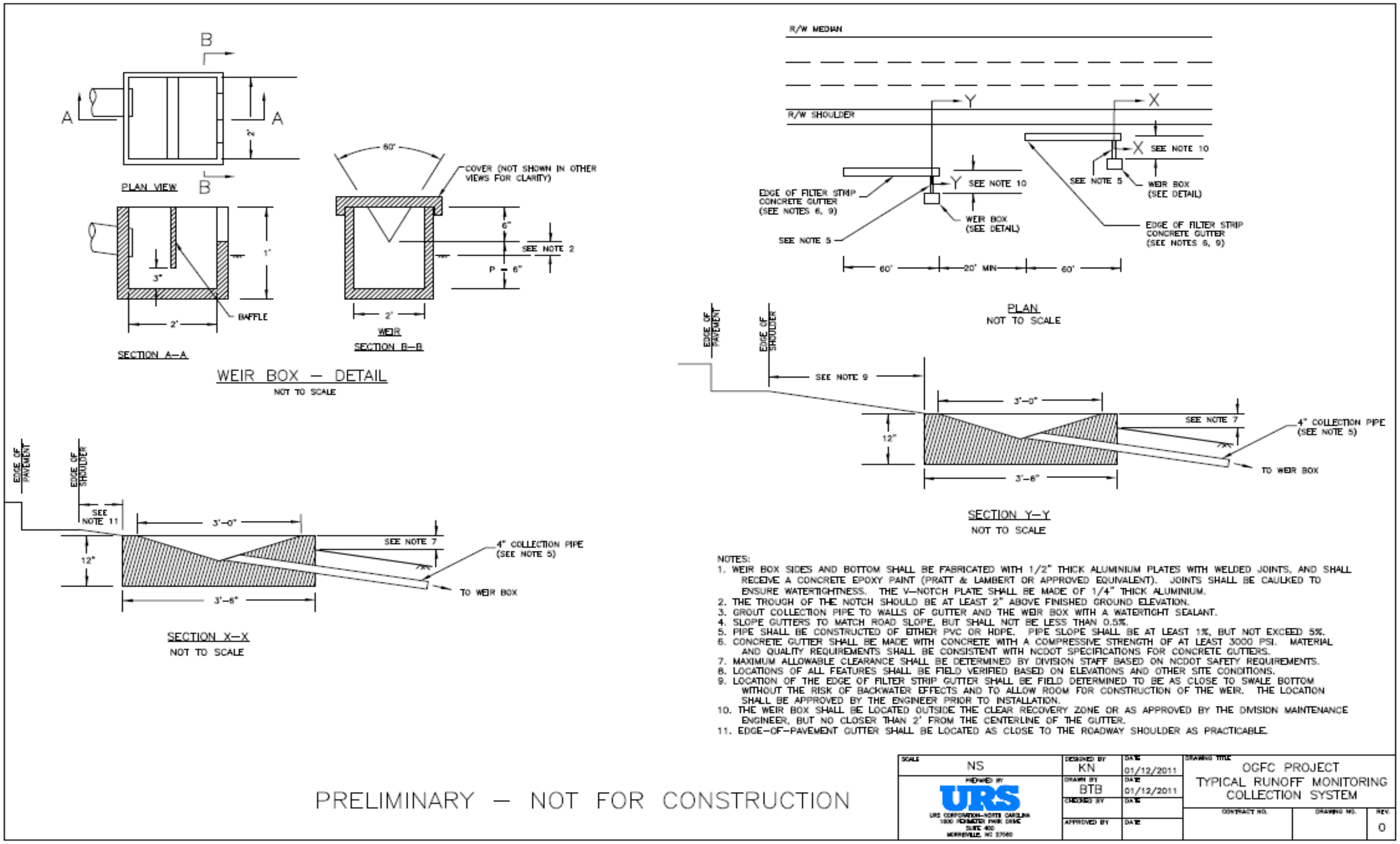


Appendix B-4: Davidson County Conventional Drainage Area Map



APPENDIX C: TYPICAL PROJECT MONITORING COLLECTION SYSTEMS

FIGURE C1-1: OGFC PROJECT TYPICAL RUNOFF MONITORING COLLECTION SYSTEM



APPENDIX D: STANDARD OPERATION PROTOCOLS FOR SAMPLE COLLECTION, PROCESSING, AND ANALYSIS

1. **<u>Rain Criteria</u>**
   - 1.1 Event Size 0.25" to 2.0″.
   - 1.2 Maximum time gap during rain event is six (6) hours.
   - 1.3 48 hours between events or 72 hours from a previously measureable (greater than 0.1 inch of rainfall) storm event.
   - 1.4 Use MPE for rainfall alerts

2. **<u>Sampling Criteria</u>**
   - 2.1 Samples will be collected and undergone initial processing within 24 hours of the cessation of runoff following a precipitation event. Initial processing includes filtration, sample preservation and performing pH, turbidity and conductivity measurements.
   - 2.2 Sample bottles are placed on ice and shipped back in a cooler to UNC Charlotte for processing. (Use freezer bags and insulated blanket draped over cooler to transport 5-gallon containers).
   - 2.3 Use a standardized numbering and labeling protocol (Section 5) before first sampler deployment and inform laboratory personnel.

3. **<u>Field Cleanup</u>**
   - 3.1 Replace sample bottle with cleaned bottle from UNC Charlotte. Check pH with pH paper or field meter.
   - 3.2 Replace sample line with cleaned line from UNC Charlotte.
   - 3.3 Drain weir and collect settleable solids from bottom of Weir Box. Settleable solids will be collected and placed in bags, which will then transport to laboratory for (air) drying and weighting. Field personnel will use a hand pump or similar tool to dewater the weir box; taking care to ensure that the settleable solids are not being emptied out.
   - 3.4 Wipe weir box and clean with distilled water and paper towels.
   - 3.5 Wipe and rinse strainers (attached to the suction line of the ISCO sampler) with DI water in the field
   - 3.6 Download data. Use ISCO DTUs for data transfer and perform field confirmation of data retrieval with a laptop computer.

4. **<u>Lab Processing</u>**
   - 4.1 Suspend sample with (polypropylene) churn splitter and filter 125 mL of sample with disposable filter pack. Filter pack is flushed with 500 mL of Super Q water before filtering and 100mL of sample to condition filter. Sample is filtered into pre-cleaned 125 mL Boston Round Bottle. (Clean Hands Protocol)
   - 4.2 Using the churn splitter collect an additional 125 mL of sample and add to a second pre-cleaned 125 mL Boston Round Bottle. (Clean Hands Protocol)
   - 4.3 The total and filtered metal subsamples are then acidified with two drops of trace metal grade HNO_3. (Clean Hands Protocol)
   - 4.4 Using the churn splitter collect an additional 100 mL of water and perform pH and conductivity and turbidity measurements.
   - 4.5 Using the churn splitter to collect another 500 mL of sample and filter through a pre-weighed and dried Whatman GFC filter. Record the sample volume and dry the filter paper for subsequent weighing after 24 hours.
   - 4.6 Pour off the filtrate into a 125 mL bottle and acidify with HNO_3 for IC cation analysis.
   - 4.7 Pour off second filtrate subsample into 125 mL bottle for IC anion analysis, DOC, TDP, and TDN analysis. Sample is preserved by freezing until final analysis.

4.8 Using the churn splitter collect final 125 mL unfiltered sample for analysis of TOC, TN and TP. Sample is preserved by freezing until final analysis.
4.9 Empty rest of carboy and soak it with the retrieved sample line in detergent for 24 hours. Rinse bottle and sample line with tap water and then soak in acid bath (2% HCl) for 24 hours. Double rinse bottle and sample line with Super Q water and dry and store in sealed plastic bag for transport to the field.

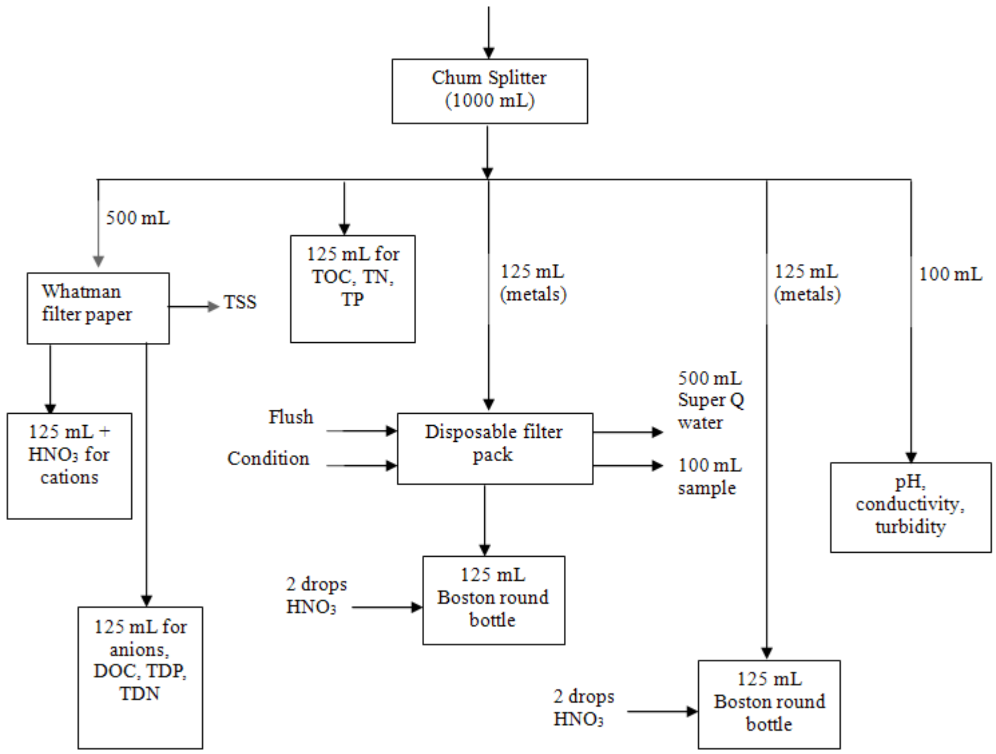


Figure D-1: Sampling Processing Flow Chart

5. Labeling

The composite sample container must be clearly identified and all sample bottles are to be property labeled as follows:

Sample container: Location: Charlotte (OGFC or Control); Davidson (NovaChip or Control)
Runoff type: Roadside or Vegetative Strip
Cleaned: 09/02/2011 Ready to use

Sample bottles: LPT-YYMMDD-HHmm ……………………………… (Field Samples)
LPT-YYMMDD-H'H'mm-SP …………………………… (Lab Samples)

Where: L = location (C = Charlotte, D = Davidson)
P = pavement type (O = OGFC, N = NovaChip)
T = runoff type (R = roadside, F = filter strip)
YYMMDD = YY (last two digits of year, 01-12), MM (month, two digits, 01-12), and DD (last two digits of day, 01-31)
HHmm = HH (military time, two digits, 01-24), mm (minutes, two digits, 00-59); time of sample collection from the field

H'H'mm = H'H' (military time, two digits, 01-24), mm (minutes, two digits, 00-59); time for sample preparation in the lab.
S = U for unfiltered sample, or F for filtered sample
P = A with acid preservation, or ″0″ without preservation

For example: COR_EOP-110902-1340-U0
Charlotte OGFC Roadside sample collected on Sept 02, 2011, unfiltered and no acid preservation

6. <u>Lab Procedures</u>

There will be a total of 10 samples taken from both Charlotte and Davidson locations.

- One bulk precipitation sample from each location (samples are collected for each event, no metals analysis for bulk precipitation samples)
- Two composite runoff samples from each of the two sampling sites at a sampling location, totaling 4 samples per location
- One sample is randomly selected from either site to perform quintuplet replicates from each rain event

6.1 Gloves should be worn all the time during lab testing
6.2 Use phosphate free soap to wash the bottles
6.3 Running DI water to rinse the bottles
6.4 Use a pre-cleaned beaker (or Boston round bottle) as container to drop one to two drops of HNO_3 to preserve cation and metal samples for storage.
6.5 No DI rinsing during pH conductivity measurements. Use sample to rinse between tests
6.6 Metal samples are to be analyzed for platinum, zinc, copper, cadmium, nickel, and lead
6.7 Use the following bottles for sample storage:
60-mL plastic for cations (NH_4, K^+, Na^+, Mg^{2+}, Ca^{2+}), (filtered acidified)
125-mL for anions (NO_3^-, ortho-P, SO_4^{2-}, Cl^-), TDP, TDN, TOC (filtered)
60-ml plastic for TN/TOC, TP (unfiltered)
125- ml glass beaker pH, conductivity (unfiltered)
500-mL beaker TSS (filtered)
6.8 QA/QC (including blanks, replicates)

7. **<u>USGS Protocol</u>**: Refer to USGS Field Manual for details.

APPENDIX E: WEIR BOX LABORATORY TESTING AND CALIBRATION

This appendix describes the re-testing and calibration of a 70 x 120 degree compound V-notch weir for use as the discharge measurement device in NCDOT's ″Stormwater Characterization from Roadways with Open Graded Friction Course Surfaces″ stormwater monitoring project. A testing apparatus was constructed to produce and measure flow rates in excess of 0.200 cubic ft per second; which was the low end maximum precipitation event to be sampled in the project.

Results of the test indicated the maximum flow measuring capacity of the 70 x 120 compound weir is approximately 0.223 cubic feet per second (100.25 gpm). The stage-discharge data and rating curve linear regression equations were found and are indicated in the results section of the report. In addition, it was determined that the installation of a 2″ x 3″ vinyl stilling well and 4 inch trench drain T-connection reduced the water level fluctuation within the weir box and increased the accuracy of the water level readings.

The resulting rating curve and linear regression equation found during testing gives the ability to directly estimate the stormwater discharge rate based on measured water level readings. In addition, the rating curve can be programmed into sampling equipment, such as the ISCO 6712 Portable Sampler, to automatically calculate discharge volumes for flow pacing and composite sampling.

Description of weir

The weir box was constructed out of 1/4-inch stainless steel. The inside dimensions of the box were measured to be 24 inches long x 24 inches wide x 12 inches deep. The front weir plate was constructed out of 2 millimeter aluminum and consisted of a lower 70 degree V-notch cutout and an upper 120 degree V-notch cutout. The crest of the 70 degree notch was centered horizontally and vertically, and was 2-1/8 inches in height. The rear plate of the box measured 11-1/2 inches in height and contained a 4-1/8 inch diameter cutout with its center located 2-9/16 inches from the top and 12 inches from the sides. In addition, a vertical interior wall located 12 inches from the front of the box extended down 9 inches from the top of the box. A detailed drawing of the 70 x 120 degree compound weir is indicated in Figure E-1.

In addition, preliminary testing has indicated that turbulence within the weir box affected the precision of the bubbler water level indicator; therefore, prior to final testing a 2″ x 3″ vinyl stilling well was installed approximately 9 inches from the front of the weir box. The stilling well was constructed out of a 2″ x 3″ white vinyl gutter. A 4-inch trench drain T-connection was also installed at the inlet of the weir box to dissipate the energy of the high velocity inflow. The installation of these two features greatly reduced the turbulence which was causing the fluctuation in the water level readings. Images of the installed stilling well and flow dissipater are indicated in Figure E-2.

Description of testing apparatus

A 7,680 gallon per hour sludge pump was used to generate the water discharge for laboratory testing. The sludge pump was placed in a large trough filled with water and a pipe network was constructed to carry the flow from the pump to the weir box inlet pipe. The pipe network consisted of a 1-1/2 inch diameter vertical PVC section that extended to an elevation above the weir box. A 90-degree bend was then used and a horizontal section carried the flow into a 1-1/2 inch Y-bend. At the downstream end of both outlets of the Y-bend a 1-1/2 inch ball valve was attached to allow for flow adjustment. Downstream of the ball valve attached to the inline outlet of the Y-bend was transitioned from the 1-1/2 inch diameter pipe to a 3 inch diameter pipe, which was used to carry the flow to the weir box inlet pipe. The pipe was transitioned to a 3 inch section to reduce the velocity of the flow entering the weir box inlet pipe. Downstream of the other ball valve the flow was diverted back into the trough. The Y-bend and ball valve configuration was used to give the ability to adjust the flow entering the weir box without backing up pressure on the pump. A detailed photo of the pump and pipe network is indicated in Figure E-3.

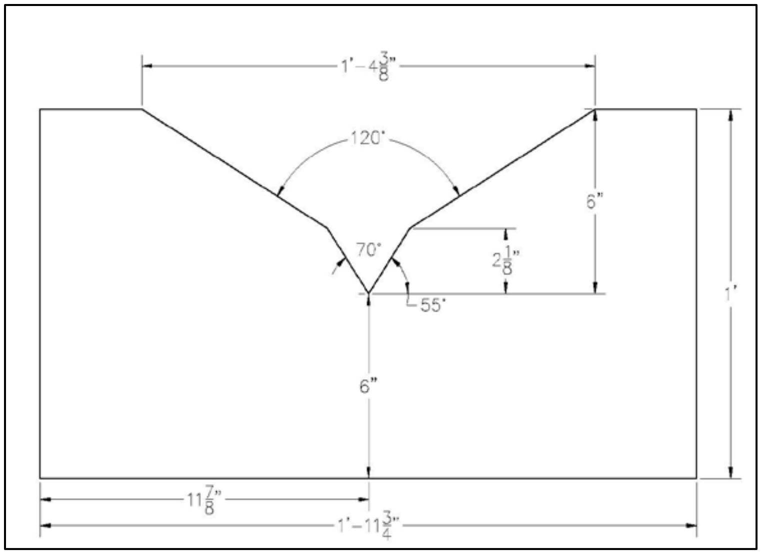


Figure E-1: 70 x 120 degree Compound Weir Plate

Figure E-2: Stilling well and Flow Dissipater

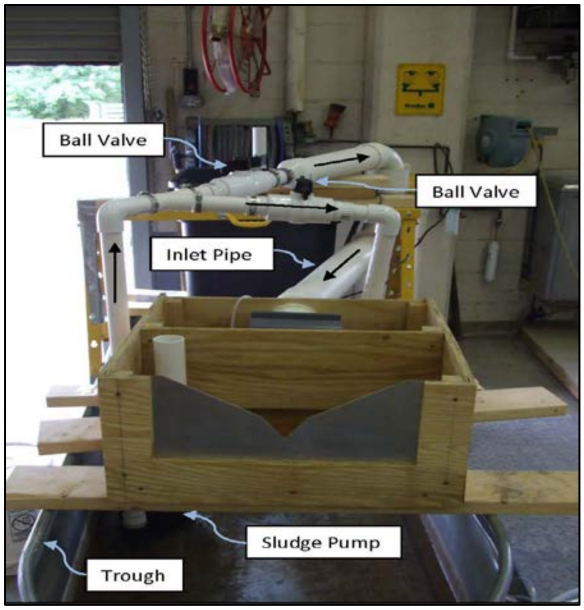


Figure E-3: Pump and Pipe Network

A 32 gallon container was used to measure the flow rate generated from the pump. The container was positioned next to the outlet of the pump and pipe network in order for the pipe network to be easily moved over the container for flow measurement. Due to turbulence under high flow conditions, a 1-1/2 inch diameter stilling well with a 1/4 inch diameter indicator hole was attached to the rear of the container. The indicator hole was placed at an elevation in the container with a known calibrated volume (see flow measurement apparatus calibration section). A 1-1/2 inch ball valve was attached to the front of the container 3 inches from the bottom and was used to quickly drain the container after each flow measurement. A photo of the flow measurement container is indicated in Figure E-4 and a detailed photo of the fully assembled testing apparatus is indicated in Figure E-5.

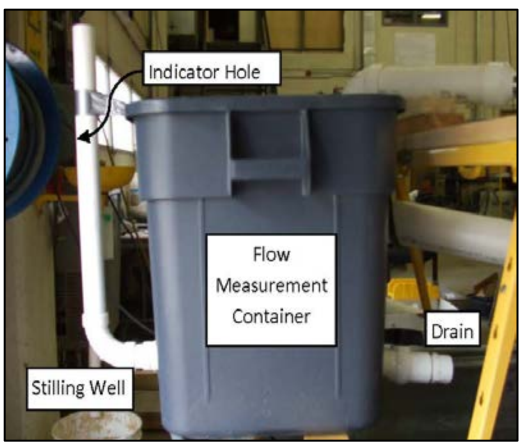


Figure E-4: Flow measurement container

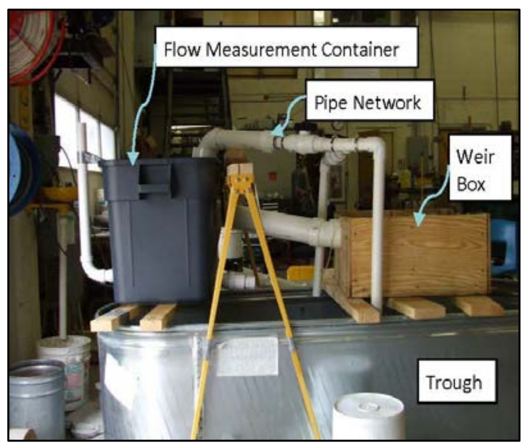


Figure E-5: Fully assembled testing apparatus

Flow measurement container calibration

The flow measurement container's calibrated volume for use in calculating each flow rate during testing was determined to be 94.22 liters or approximately 3.33 cubic feet. The following procedures were used in calibrating the container.

A 2,250 milliliter graduated container was used to calibrate a bucket whose calibrated volume was found to be 13.5 liters. The calibrated bucket was then used to fill the flow measurement container to a level approximately 4 inches below the top of the container. This volume was found to be 91.97 liters. An indicator hole was then cut into the stilling well just above the water level. Water was then added to the container until it began to spill out of the indicator hole. The total volume required to displace water from the indicator hole was found to be 94.22 liters. This volume was used in the flow rate calculations.

Testing procedure

The pipe network was setup with the ball valve upstream of the weir inlet pipe completely closed and the ball valve upstream of the diverter pipe completely opened. The level sensor was inserted in the level sensor bracket inside of the stilling well and the auto sampler was turned on. The weir box was filled with water until the water level was at the crest of the front weir plate and the water level was recorded. The pump was then turned on and the ball valve upstream of the weir inlet pipe was opened enough to establish a free falling sheet of water (nappe) over the weir crest. The water level sensor was allowed to stabilize and the water level was recorded. The pipe network was then moved over top of the flow measurement container and the time required to displace water out of the level indicator hole was recorded. The ball valve upstream of the weir inlet pipe was then adjusted so that the water level within the box was increased approximately 0.1 – 0.3 inches; and the water level and flow was measured and recorded. This process was repeated until the ball valve upstream of the weir inlet pipe was completely opened and the ball valve upstream of the diverter pipe was completely closed.

With the pump at maximum capacity, a fire hose was inserted into the weir box and turned on to a rate that would increase the water level within the box approximately 0.1 – 0.3 inches; and the water level was recorded. The fire hose was then moved over top of the flow measurement container and the time required to displace water out of the level indicator hole was recorded. The calculated fire hose flow rate was added to the maximum pump flow rate to yield the flow rate corresponding to the water level increase. This process was repeated until the maximum flow rate of the weir box was determined.

Data

The flow rate and water level data recorded during testing are included in Table E-1 below.

RESULTS

The results of the 70 x 120 degree compound weir box testing indicated a maximum flow measuring capacity of approximately 0.2234 cubic feet per second (100.25 GPM) with a corresponding water level reading in the stilling well of 4.608 inches. Flow rates in excess of 100.25 gpm produced unstable water level readings and would not allow for additional reliable readings to be taken. At these high flow rates, although the water levels became unstable, the overall trend was for the water level to decrease as the flow rate was increased. A possible explanation for this trend is that short circuiting of the flow over the interior wall increased the velocity upstream of the front weir plate to a point to where the water level within the stilling well was not affected. The rating curve for the 70 x 120 degree compound weir box is indicated in Figure E-6 and the stage-discharge relationship to be programed in to each auto sampler is indicated in Table E-2.

Table E-1: Flow Rate and Water Level Data

Time	Volume	Flow	Flow Module			
			water level	water level	Δ Height	
sec	ft3	cfs	ft	in	in	
39.0	0.06752	0.00173	0.164	1.968	0.684	
899.0	3.40398	0.00379	0.183	2.196	0.912	
421.8	3.40398	0.00807	0.213	2.556	1.272	
318.5	3.40398	0.01069	0.227	2.724	1.440	
231.9	3.40398	0.01468	0.245	2.940	1.656	
186.1	3.40398	0.01829	0.258	3.096	1.812	
154.1	3.40398	0.02209	0.271	3.252	1.968	
128.0	3.40398	0.02659	0.285	3.420	2.136	
105.4	3.40398	0.03230	0.300	3.600	2.316	
88.4	3.40398	0.03851	0.315	3.780	2.496	*1
71.4	3.40398	0.04767	0.330	3.960	2.676	
63.6	3.40398	0.05352	0.340	4.080	2.796	
53.9	3.40398	0.06315	0.353	4.236	2.952	
48.2	3.40398	0.07062	0.365	4.380	3.096	
41.9	3.40398	0.08124	0.377	4.524	3.240	
37.5	3.40398	0.09077	0.390	4.680	3.396	
31.8	3.40398	0.10704	0.404	4.848	3.564	
27.9	3.40398	0.12223	0.419	5.028	3.744	
23.8	3.40398	0.14284	0.434	5.208	3.924	
21.7	3.40398	0.15687	0.445	5.340	4.056	
19.9	3.40398	0.17080	0.457	5.484	4.200	
18.6	3.40398	0.18331	0.466	5.592	4.308	
17.5	3.40398	0.19407	0.471	5.652	4.368	*2
48.5	0.47675	0.20391	0.477	5.724	4.440	*3
221.0	3.40398	0.20947	0.484	5.808	4.524	*4
116.2	3.40398	0.22336	0.491	5.892	4.608	

*1 - Approx location where lower notch is at full capacity w/o using the top notch.
*2 - Max pump flow rate.
*3 - Used water hose to increase flow. Added flow rate of hose to pump max flow rate
*4 - Used water fire hose to increase flow. Added flow rate of fire hose to pump max flow rate

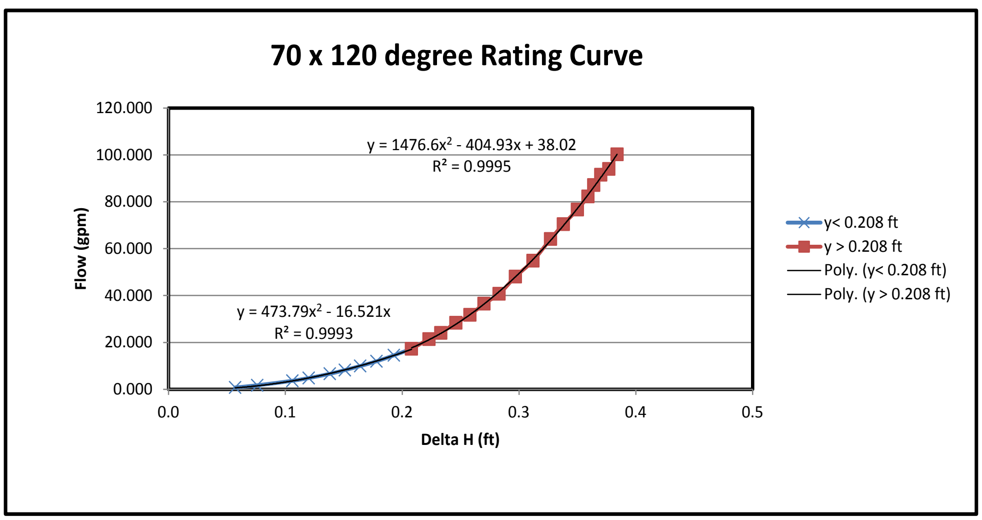


Figure E-6: 70 x 120 Degree Compound V-notch Rating Curve

Table E-2: Sampler Input stage-discharge relationship

Rating Curve (Gallon/Minute)		
	Level (ft)	Flow (gal/min)
1	0	0.000
2	0.107	0.000
3	0.164	0.777
4	0.183	1.699
5	0.213	3.623
6	0.227	4.797
7	0.245	6.588
8	0.258	8.210
9	0.271	9.914
10	0.285	11.936
11	0.300	14.495
12	0.315	17.283
13	0.330	21.398
14	0.340	24.022
15	0.353	28.345
16	0.365	31.697
17	0.377	36.463
18	0.390	40.742
19	0.404	48.044
20	0.419	54.859
21	0.434	64.113
22	0.445	70.406
23	0.457	76.659
24	0.466	82.273
25	0.471	87.104
26	0.477	91.521
27	0.484	94.018
28	0.491	100.253

APPENDIX F: METHODOLOGIES FOR DATA CORRECTION AND FIELD SURVEYING

1. Rainfall excess calibration methods

The rainfall excess was calculated using two methods. The first method assumes that the initial rainfall that doesn't produce runoff is completely lost and is intended to show the effect of depression storage. The second method assumes that the rainfall portion that doesn't initially produce runoff eventually does runoff; this method could potentially show the effect of runoff flowing through the porous pavement. Detailed descriptions of each method are indicated below:

Method 1:

1. Subtract the total runoff (in) from the total rainfall (in) to determine the total losses.
2. Examine the corrected water level date and determine when the water level sensor responds to runoff; also note when the sampler begins to calculate runoff.
3. Calculate the rainfall required to fill the weir box to the weir plate crest by dividing the volume below the crest (2 cu. ft) by the site's drainage area (sq. ft); and convert to inches.
4. Calculate the incremental runoff in inches using the corrected water level data.
5. Evenly distribute the rainfall volume previously calculated between the time that the water level response and time that the sampler begins to calculate runoff. This step is needed because sampler does not calculate this volume and it needs to be included as a check to make sure the right amount of rainfall is removed from the beginning of the storm.
6. Calculate the incremental rainfall and subtract the incremental runoff from the incremental rainfall. This value is a check because the incremental runoff should never be greater than the incremental rainfall.
7. Begin removing the initial rainfall that didn't trigger water level response. Remove until one of the following occurs:
    a. The total losses are exceeded. If the total losses are exceeded then the runoff exceeds the rainfall excess.
    b. The initial incremental runoff in the period following the subtracted rainfall exceeds the initial incremental rainfall. This indicated that too much rainfall has been removed. What was subtracted needs to be added back.
    c. The water level shows response. Water level response indicates that runoff has begun and it is assumed that the depression storage has been filled; therefore, no more rainfall should be removed at the beginning of the event.
8. Remove the remaining losses evenly throughout the remainder of the rainfall event. This is accomplished by dividing the remaining losses buy the remaining rainfall and multiplying the ratio times each rainfall increment.
9. This should result in the incremental runoff equaling the effective rainfall.

Method 2:

1. Use the same process outlined above except distribute the total losses evenly throughout the rainfall event. This is accomplished by dividing the total loss buy the total rainfall and multiplying the ratio times each rainfall increment.

2. Flow data correction method

The imported FlowLink hydrological data was thoroughly analyzed to ensure that practical data was used in the hydrological calculations. The first step in determining data practicality was to analyze the runoff to rainfall ratio. The total runoff volume was divided by the total rainfall volume to obtain the sites runoff coefficient. Total runoff volumes (gal) were calculated by summing the products of the incremental runoff rates (gpm) times the time increment between each measurement (1-minute). The runoff volume (converted to cubic ft) was then converted to inches by dividing by the drainage area. The rainfall volume (inches) was calculated by summing the incremental rainfall data. A calculated runoff coefficient exceeding 1.0-in/in, extremely low, or extremely different than the site's corresponding filter strip or roadside runoff coefficient was the initial indication that the data needed to be corrected.

The response of the runoff compared to the temporal rainfall distribution was also used as a check to see if the runoff coefficient was in a reasonable range. Water level response within the weir box at the beginning of the rainfall event gives a close indication of when runoff began. When water level response was not observed after portions of the overall rainfall event had occurred (especially those with extended periods of time between) then it was assumed that maximum runoff coefficient could potentially be much less than 1.0-in/in. Additionally, a portion of the total rainfall is required to fill the weir box before the sampler begins to measure runoff; therefore, it is logical to assume in all cases that the runoff coefficient is less than 1.0-in/in. The runoff required to fill the weir box (0.0083 – 0.0144-in) was found by dividing the volume below the weir box crest by each sites drainage area. An example of the above data check for hydrological data practicality is indicated below.

<u>Example:</u>

0.50-in of total rainfall was recorded; half (0.25-in) fell 3-hours before the water level responded to runoff entering the weir box. The following conclusions were considered:

1. Assuming all of the rainfall prior to water level response eventually made it to the weir box the maximum runoff coefficient the sampler data could possibly indicate is 0.98 in/in. It takes approximately 0.01-inchs to fill the weir box and runoff is not measured while the weir box is filling.

   C= (0.5-in - 0.01-in)/0.5-in = 0.98-in/in

2. Assuming a large portion of the rainfall that occurred 3-hours prior to water level response didn't produce runoff, an indicated runoff coefficient in the range of 0.48-in/in could be practical.

$$C = \frac{0.5in - (0.25in + 0.01in)}{0.5in} = 0.48\text{-}in/in$$

The above process was used to obtain an indication if the downloaded data was reasonable or if the data need to be corrected. Data comparison along with engineering judgment was then used determine the practicality of the dataset.

Additionally, the water level trend at the end of the dataset was analyzed for obvious water level errors. During the laboratory calibration process the weir plate crest elevation was found to be at a sampler water level reading of 0.107-ft; and prior to each rainfall event each sampler was calibrated at this water level. End of the dataset water levels found to be below 0.107-ft or above 0.125-ft were assumed to be an indication that a potential water level offset that was affecting the runoff volumes. The runoff hydrograph recession following the rainfall event and between sub-events was analyzed to get another indication of water level errors. Hydrograph recessions extending extremely longer than one hour following rainfall and short hydrograph recessions following significant rainfall were both considered as a water level offset that could potentially influence runoff volumes.

When a water level offset was suspected, the site's roadside and filter strip datasets were compared to get an indication of what was actually occurring at the monitoring location. In most cases it can be assumed that both monitoring sites at the same location should produce total runoff volumes and peak runoff rates in the same general range. An exception would be in storms of low magnitude and intensity where filter strip monitoring sites have the potential for much less runoff volumes.

When the initial runoff coefficient practicality checks indicated reasonable data and offsets were observed, the additional hydrograph recession flow volumes were zeroed out similarly to the corresponding site (filter strip or roadside) at the same location. If the data was found to be initially impractical with a suspicion of a water level offset, and the two sites at the same location indicated opposing runoff coefficients, total volumes, or peak runoff rates, a water level offset was assumed to have occurred throughout the duration of runoff. The offset was corrected using the following procedure:

1. Each water level reading was minimally adjusted down to 0.125-ft, up to 0.107-ft, or somewhere between 0.107 – 0.125-ft
2. The corrected water level data was imported into Flowlink for subsequent flow rate calculation based on the programed rating curve.
3. The re-processed Flowlink data was re-imported into a copy of the initial Microsoft Excel spreadsheet
4. The Runoff to rainfall ratio was re-analyzed according to the above outlined process.
5. The corrected dataset was compared with its corresponding roadside or filter strip monitoring site's dataset
6. The process was repeated until practical datasets were obtained

3: Survey method

The Charlotte and Davidson County sampling location surveys were produced using both a traditional total station and Lidar laser scanner. The following procedure was used to produce the surveys.

1. A traditional survey was completed at both locations. Survey shots were taken along the edge of pavement, top and bottom of ditches, tree/ brush lines, abrupt grade changes, and features located near sampling location (drop inlets, concrete structures, power poles, guardrails, etc.).
2. Lidar scanning was completed at both locations to obtain pavement data. Edge of pavement, pavement makings (intermediate pavement points), and reference points were the only data used from the Lidar data set.
3. The Lidar data was tied to the traditional survey using common reference points found within the Lidar data and traditional survey. Because the elevations along the edge of pavement from each set of data (Lidar and traditional surveyed data) were not exact, the Lidar data set was corrected vertically to match the traditionally surveyed edge of pavement data. This was accomplished by calculating the elevations difference of each point along the edge of pavement, taking the average, and moving the entire Lidar data set up or down at the calculated average difference. Contours were then produced using the complete data set.

APPENDIX G: THE MONITORING EVENTS AT CHARLOTTE AND DAVIDSON COUNTY

Table G-1 Runoff Hydrology for Charlotte OGFC Monitoring Sites

# Event	Date	COR_EOP Rain, inches	COR_EOP Runoff Coefficient	COR_FS Rain, inches	COR_FS Runoff Coefficient
1	10/11/2011	1.33	0.93	1.33	0.58
2	10/18/2011	2.38	0.89	2.38	0.89
3	10/28/2011	0.98	0.78	0.98	0.57
4	11/03/2011	1.08	0.92	1.08	0.92
5	11/16/2011	0.76	0.96	0.76	0.48
6	11/23/2011	0.51	0.82	0.51	0.78
7	12/07/2011	0.29	0.86	0.29	0.41
8	12/16/2011	0.31	0.64	0.31	0.25
9	12/20/2011	1.07	0.91	1.07	0.91
10	01/08/2012				
11	01/11/2012	0.51	0.86	0.51	0.69
12	01/17/2012	0.95	0.99	0.95	0.93
13	01/20/2012	0.82	0.81	0.82	0.71
14	02/19/2012				
15	03/03/2012	2.14	0.91	2.14	0.87
16	03/09/2012	0.36	0.62	0.36	0.42
17	03/23/2012	0.43	0.61	0.68	0.25
18	04/05/2012				
19	04/17/2012				
20	05/22/2012	0.38	0.68	0.38	0.30
21	06/06/2012				
22	06/12/2012				
23	07/09/2012	0.81	0.94		
24	07/10/2012	0.81	0.83	0.81	0.65
25	07/20/2012				
26	08/06/2012				
27	08/22/2012				
28	09/04/2012				
29	09/08/2012	0.93	0.99	0.93	0.69
30	10/06/2012	0.60	0.95	0.60	0.45
31	10/15/2012				
Average		0.87	0.85	0.89	0.62
S.D.		0.56	0.12	0.56	0.23

Table G-2 Runoff Hydrology for Charlotte Conventional Monitoring Sites

# Event	Date	CCR_EOP Rain, inches	CCR_EOP Runoff Coefficient	CCR_FS Rain, inches	CCR_FS Runoff Coefficient
1	10/11/2011	1.27	0.86		
2	10/18/2011	1.73	0.82	1.73	0.84
3	10/28/2011	0.69	0.53	0.69	0.48
4	11/03/2011	1.24	0.99	1.24	0.96
5	11/16/2011	0.75	0.88	0.75	0.87
6	11/23/2011	0.25	0.87	0.25	0.82
7	12/07/2011	0.29	0.93	0.29	0.68
8	12/16/2011	0.48	0.89	0.48	0.82
9	12/20/2011	1.26	0.93	1.26	0.90
10	01/08/2012				
11	01/11/2012	0.61	0.82	0.61	0.68
12	01/17/2012	0.86	0.99		
13	01/20/2012	0.66	0.74	0.66	0.72
14	02/19/2012				
15	03/03/2012	1.42	0.93	1.42	0.86
16	03/09/2012			0.29	0.62
17	03/23/2012	0.46	0.80	0.46	0.79
18	04/05/2012				
19	04/17/2012				
20	05/22/2012	1.32	0.76	1.32	0.78
21	06/06/2012				
22	06/12/2012				
23	07/09/2012				
24	07/10/2012	0.53	0.54		
25	07/20/2012	1.52	0.98	1.52	0.92
26	08/06/2012				
27	08/22/2012				
28	09/04/2012				
29	09/08/2012	0.35	0.64	0.35	0.63
30	10/06/2012	0.62	0.67	0.62	0.69
31	10/15/2012				
Average		0.86	0.82	0.82	0.77
S.D.		0.46	0.14	0.49	0.13

Table G-3 Runoff Hydrology for Davidson County NovaChip™ Monitoring Sites

# Event	Date	DNR_EOP Rain, inches	DNR_EOP Runoff Coefficient	DNR_FS Rain, inches	DNR_FS Runoff Coefficient
1	10/11/2011	1.98	0.95	1.98	0.99
2	10/18/2011	1.04	0.93	1.04	0.82
3	10/28/2011	0.82	0.83	0.82	0.69
4	11/03/2011	1.64	0.98		
5	11/16/2011	2.85	0.99	2.85	0.99
6	11/23/2011			0.25	0.74
7	12/07/2011				
8	12/16/2011	0.73	0.95	0.73	0.95
9	12/20/2011				
10	01/08/2012				
11	01/11/2012				
12	01/17/2012				
13	01/20/2012	0.34	0.74	0.34	0.55
14	02/19/2012	0.68	0.76	0.68	
15	03/03/2012	0.54	0.89	0.54	
16	03/09/2012				
17	03/23/2012	0.55	0.74	0.55	0.89
18	04/05/2012	0.62	0.65	0.62	0.48
19	04/17/2012	0.30	0.68		
20	05/22/2012	0.55	0.98	0.55	0.77
21	06/06/2012	1.34	0.99	1.34	0.94
22	06/12/2012	0.55	0.91	0.55	0.88
23	07/09/2012				
24	07/10/2012	2.19	0.87		
25	07/20/2012			0.56	0.63
26	08/06/2012				
27	08/22/2012				
28	09/04/2012	0.84	0.97	0.84	0.91
29	09/08/2012				
30	10/06/2012	1.14	0.92	1.14	0.70
31	10/15/2012			0.27	0.68
Average		1.04	0.87	0.90	0.79
S.D.		0.70	0.11	0.68	0.16

Table G-4 Runoff Hydrology for Davidson County Conventional Monitoring Sites

# Event	Date	DCR_EOP Rain, inches	DCR_EOP Runoff Coefficient	DCR_FS Rain, inches	DCR_FS Runoff Coefficient
1	10/11/2011	1.98	0.87	1.98	0.91
2	10/18/2011	1.04	0.77	1.04	0.70
3	10/28/2011	0.82	0.59	0.82	0.57
4	11/03/2011	1.64	0.98	1.64	0.96
5	11/16/2011			2.85	0.97
6	11/23/2011				
7	12/07/2011				
8	12/16/2011	0.73	0.97	0.73	0.89
9	12/20/2011			1.10	0.85
10	01/08/2012				
11	01/11/2012				
12	01/17/2012			0.25	0.84
13	01/20/2012	0.34	0.77	0.34	0.67
14	02/19/2012	0.68	0.82	0.68	0.79
15	03/03/2012	0.54	0.81	0.54	0.89
16	03/09/2012				
17	03/23/2012	0.55	0.82	0.55	0.72
18	04/05/2012	0.62	0.64	0.62	0.56
19	04/17/2012				
20	05/22/2012	0.55	0.81	0.55	0.61
21	06/06/2012	1.34	0.86		
22	06/12/2012	0.55	0.69	0.55	0.62
23	07/09/2012				
24	07/10/2012	2.19	0.82		
25	07/20/2012	0.56	0.62	0.56	0.51
26	08/06/2012	0.26	0.69		
27	08/22/2012	1.42	0.88	1.42	0.93
28	09/04/2012	0.84	0.65	0.84	0.50
29	09/08/2012				
30	10/06/2012	0.94	0.84	1.14	0.66
31	10/15/2012	0.27	0.78	0.27	0.74
Average		0.89	0.78	0.92	0.74
S.D.		0.55	0.11	0.64	0.15

APPENDIX H: STORM EMCS FOR THE CHARLOTTE AND DAVIDSON COUNTY SITES

Table H-1 Event Precipitation Chemistry for the Sites in Charlotte

Event #	Date	pH	Conductivity	Turbidity	TSS	DTP	TP	PP	PO_4-P	DOP	NPOC	TN	NH_4-N	NO_3-N	DON	Cl
			mS	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	10/11/11	5.37	7.66	0.46	2.33	0.06	0.06	0.00	0.00	0.06	1.13	0.46	0.23	0.02	0.21	0.24
2	10/18/11	5.57	4.96	0.33	0.33	0.04	0.05	0.01	0.00	0.04	0.84	0.22	0.26	0.03	0.00	0.10
3	10/28/11	5.62	12.49	0.85	3.67	0.06	0.06	0.00	0.05	0.01	1.87	0.54	0.44	0.21	0.00	0.33
4	11/3/11	5.69	8.14	0.37	3.00	0.05	0.06	0.01	0.00	0.05	1.22	0.26	0.20	0.15	0.00	1.22
5	11/16/11	5.62	9.26	0.39	1.33	0.05	0.07	0.02	0.00	0.05	1.82	0.56	0.27	0.19	0.10	0.47
6	11/23/11	5.74	6.29	0.82	0.50	0.07	0.10	0.03	0.00	0.07	1.13	0.36	0.11	0.19	0.06	2.04
8	12/16/11	5.82	10.20	0.94	1.00	0.06	NS	NS	0.00	0.06	NS	NS	0.62	0.39	NS	1.14
9	12/20/11	5.75	9.74	0.44	3.50	0.06	0.06	0.00	0.00	0.06	2.49	1.17	0.19	0.14	0.84	0.87
11	1/11/12	5.59	19.81	0.96	0.00	0.05	0.06	0.01	0.00	0.05	1.70	0.83	0.37	0.02	0.43	1.15
12	1/17/12	6.09	7.58	0.50	2.50	0.04	0.04	0.00	0.00	0.04	1.06	0.33	0.12	0.13	0.08	0.60
13	1/20/12	5.61	14.05	0.87	2.50	0.05	0.05	0.00	0.00	0.05	1.53	0.62	0.33	0.17	0.12	0.79
15	3/3/12	6.50	5.54	1.90	0.00	0.06	0.06	0.00	0.00	0.06	0.33	0.08	0.10	0.02	0.00	0.75
16	3/9/12	5.94	10.66	3.20	2.67	0.03	0.03	0.00	0.00	0.03	1.47	0.41	0.18	0.03	0.20	1.50
17	3/23/12	5.64	10.90	4.75	0.00	0.06	0.06	0.00	0.00	0.06	1.80	0.68	0.18	0.06	0.43	0.90
20	5/22/12	5.95	46.80	13.00	39.33	0.06	0.06	0.00	0.27	0.00	16.62	9.23	2.64	0.05	6.54	0.51
23	7/9/12	4.65	43.80	2.55	14.67	0.57	0.74	0.17	0.01	0.56	14.00	6.52	0.66	0.20	5.66	1.35
24	7/10/12	4.35	19.47	1.10	0.00	0.05	0.05	0.00	0.00	0.05	2.64	0.70	0.30	0.08	0.32	0.41
25	7/20/12	4.63	11.22	0.89	2.67	0.07	0.11	0.04	0.01	0.06	1.05	0.29	0.29	0.03	0.00	0.42
26	8/6/12	6.60	26.90	2.70	14.00	0.22	0.37	0.15	0.18	0.04	7.96	2.17	0.80	0.07	1.30	0.90
29	9/8/12	5.80	7.46	0.85	0.00	0.07	0.08	0.01	0.00	0.07	5.25	0.37	0.17	0.04	0.16	0.17
30	10/6/12	4.67	28.40	3.30	25.00	0.25	0.33	0.08	0.03	0.22	9.40	1.46	0.36	0.25	0.84	0.41
Number of Events		**21**	**21**	**21**	**21**	**21**	**20**	**20**	**21**	**21**	**20**	**20**	**21**	**21**	**20**	**21**
Mean		**5.58**	**15.30**	**1.96**	**5.67**	**0.10**	**0.13**	**0.03**	**0.03**	**0.08**	**3.76**	**1.36**	**0.42**	**0.12**	**0.87**	**0.78**
Standard Deviation		**0.58**	**11.88**	**2.80**	**9.95**	**0.12**	**0.17**	**0.05**	**0.07**	**0.12**	**4.62**	**2.32**	**0.54**	**0.10**	**1.83**	**0.49**
Coefficient of Variation		**10.41**	**77.64**	**142.99**	**175.54**	**125.86**	**136.49**	**187.79**	**262.11**	**145.40**	**122.75**	**170.40**	**128.82**	**83.21**	**211.56**	**63.57**

Table H-2 Event Runoff Chemistry Charlotte Conventional Road Surface Site

Event #	Date	pH	Conductivity	Turbidity	TSS	DTP	TP	PP	PO_4-P	DOP	NPOC	TN	NH_4-N	NO_3-N	DON	Cl	Cr	Ni	Cu	Zn	Cd	Pt	Pb
			mS	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	10/11/11	6.54	61.10	19.00	85.67	0.06	0.14	0.08	0.00	0.06	7.45	0.88	0.29	0.04	0.55	1.55	NS	NS	NS	NS	NS	NS	NS
2	10/18/11	6.30	26.20	11.00	69.00	0.11	0.18	0.07	0.00	0.11	4.15	0.53	0.32	0.08	0.14	0.65	NS	NS	NS	NS	NS	NS	NS
3	10/28/11	6.77	45.40	14.00	34.33	0.08	0.10	0.02	0.00	0.08	5.70	1.32	0.56	0.27	0.49	1.63	NS	NS	NS	NS	NS	NS	NS
4	11/3/11	6.40	26.20	1.20	4.33	0.07	0.09	0.02	0.00	0.07	3.16	0.64	0.44	0.23	0.00	2.22	NS	NS	NS	NS	NS	NS	NS
5	11/16/11	6.28	66.50	19.00	66.43	0.06	0.14	0.08	0.00	0.06	8.56	1.28	0.61	0.30	0.36	3.56	3.31	2.90	16.08	66.22	0.15	0.03	1.48
6	11/23/11	6.05	44.80	14.00	57.00	0.06	0.23	0.17	0.00	0.06	5.43	0.94	0.27	0.31	0.36	2.34	2.01	0.87	8.29	39.34	0.17	0.01	0.30
7	12/7/11	6.58	120.30	39.00	112.00	0.08	0.14	0.06	0.00	0.08	24.34	2.37	0.58	0.28	1.50	12.80	2.75	2.50	17.10	56.83	0.30	0.01	0.59
8	12/16/11	6.14	71.20	13.00	53.50	0.06	0.47	0.41	0.00	0.06	5.99	1.68	0.67	0.70	0.31	3.56	4.23	1.95	16.47	70.38	1.03	0.01	0.61
9	12/20/11	6.41	52.30	20.00	63.50	0.05	0.15	0.10	0.00	0.05	7.07	1.78	0.43	0.22	1.13	2.71	1.79	0.48	4.46	19.85	0.04	0.01	0.18
11	1/11/12	6.41	90.40	20.00	85.00	0.08	0.23	0.15	0.00	0.08	6.61	1.35	0.69	0.02	0.64	5.12	1.38	1.59	13.70	61.14	0.17	0.01	0.10
12	1/17/12	6.30	51.50	20.00	44.50	0.06	0.21	0.15	0.00	0.06	4.86	0.91	0.40	0.21	0.29	6.24	1.11	1.27	8.18	38.69	0.05	0.01	0.05
13	1/20/12	6.39	97.90	20.00	50.67	0.06	0.33	0.27	0.02	0.04	6.07	1.33	0.78	0.26	0.29	13.15	1.38	1.74	12.03	18.08	0.08	0.01	0.06
15	3/3/12	6.58	19.40	20.00	61.33	0.08	0.19	0.11	0.00	0.08	3.38	0.57	0.28	0.04	0.26	2.92	2.43	0.98	9.10	39.46	0.06	0.01	0.04
17	3/23/12	6.06	40.80	20.00	15.00	0.08	0.13	0.05	0.00	0.08	3.20	0.69	0.28	0.06	0.35	2.47	2.96	1.12	11.52	34.83	0.06	0.02	0.03
20	5/22/12	5.44	20.20	20.00	65.33	0.08	0.13	0.05	0.00	0.08	2.72	0.53	0.10	0.04	0.40	0.28	1.97	0.93	5.81	34.41	0.43	0.03	0.02
24	7/10/12	6.20	20.60	20.00	79.50	0.03	0.21	0.18	0.00	0.03	5.81	0.82	0.18	0.07	0.56	1.21	1.04	1.03	12.49	30.21	0.03	0.07	0.09
25	7/20/12	6.16	14.12	20.00	18.00	0.04	0.09	0.05	0.00	0.04	1.93	0.23	0.07	0.02	0.14	0.78	3.94	0.53	5.63	20.77	0.04	0.01	0.14
29	9/8/12	5.81	35.20	20.00	31.33	0.03	0.13	0.10	0.00	0.03	9.23	0.98	0.15	0.15	0.67	0.56	3.87	1.15	14.07	52.01	0.11	0.01	0.16
30	10/6/12	5.84	39.6	20.00	128.67	0.05	0.35	0.30	0.00	0.05	7.97	1.18	0.21	0.15	0.82	0.56	3.93	1.47	14.94	49.74	0.08	0.01	0.20
Number of Events		**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**15**	**15**	**15**	**15**	**15**	**15**	**15**
Mean		**6.25**	**49.67**	**18.43**	**59.22**	**0.06**	**0.19**	**0.13**	**0.00**	**0.06**	**6.51**	**1.05**	**0.38**	**0.18**	**0.49**	**3.39**	**2.54**	**1.37**	**11.32**	**42.13**	**0.19**	**0.02**	**0.27**
Standard Deviation		**0.32**	**29.14**	**6.96**	**31.61**	**0.02**	**0.10**	**0.10**	**0.00**	**0.02**	**4.78**	**0.52**	**0.21**	**0.16**	**0.36**	**3.73**	**1.12**	**0.68**	**4.18**	**16.74**	**0.26**	**0.02**	**0.38**
Coefficient of Variation		**5.05**	**58.67**	**37.76**	**53.38**	**30.85**	**51.56**	**80.83**	**435.89**	**32.47**	**73.47**	**49.21**	**55.56**	**89.16**	**73.70**	**110.13**	**44.01**	**49.67**	**36.92**	**39.74**	**137.82**	**97.18**	**142.10**

Table H-3 Event Runoff Chemistry Charlotte Open Grade Friction Surface Site

Event #	Date	pH	Conductivity	Turbidity	TSS	DTP	TP	PP	PO_4-P	DOP	NPOC	TN	NH_4-N	NO_3-N	DON	Cl	Cr	Ni	Cu	Zn	Cd	Pt	Pb
			mS	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	10/11/11	6.48	52.80	20.00	26.67	0.11	0.16	0.05	0.01	0.10	13.05	1.19	0.58	0.07	0.53	1.50	NS	NS	NS	NS	NS	NS	NS
3	10/28/11	6.92	38.50	6.20	14.00	0.08	0.10	0.02	0.03	0.05	5.70	1.32	0.83	0.41	0.08	1.17	NS	NS	NS	NS	NS	NS	NS
4	11/3/11	6.42	32.80	2.10	2.33	0.08	0.09	0.01	0.03	0.05	4.71	1.19	0.85	0.42	0.00	1.47	NS	NS	NS	NS	NS	NS	NS
5	11/16/11	6.42	72.50	8.70	22.33	0.08	0.17	0.09	0.00	0.08	10.91	1.84	0.43	1.02	0.38	2.87	2.22	2.10	10.37	55.40	0.15	0.02	0.26
6	11/23/11	6.23	43.50	6.50	22.50	0.09	0.11	0.02	0.00	0.09	6.47	1.40	0.35	0.82	0.24	1.77	0.42	0.62	3.95	21.13	0.16	0.01	0.10
7	12/7/11	6.56	102.50	18.00	42.50	0.09	0.21	0.12	0.00	0.09	13.80	3.20	0.81	0.79	1.60	4.87	2.21	1.91	9.16	71.74	0.20	0.02	0.24
8	12/16/11	6.18	97.50	5.00	7.50	0.08	0.12	0.04	0.00	0.08	9.05	3.32	1.22	1.76	0.34	3.70	1.62	2.80	12.32	90.04	0.11	0.03	1.26
9	12/20/11	6.66	51.40	11.00	33.50	0.09	0.11	0.02	0.00	0.09	9.42	3.14	0.63	0.48	2.03	2.58	1.49	1.33	8.33	53.49	0.10	0.01	0.23
11	1/11/12	6.66	105.50	17.00	29.00	0.08	0.16	0.08	0.00	0.08	7.32	2.74	1.02	0.02	1.69	5.12	0.96	2.14	10.55	84.46	0.14	0.01	0.11
12	1/17/12	6.40	54.20	8.20	24.50	0.06	0.15	0.09	0.02	0.04	5.69	1.49	0.66	0.60	0.23	5.79	1.11	1.27	8.18	38.69	0.05	0.01	0.05
13	1/20/12	6.57	71.30	15.00	26.67	0.07	0.10	0.03	0.00	0.07	6.41	1.54	0.65	0.54	0.35	6.82	0.81	1.56	9.51	31.14	0.37	0.01	0.05
15	3/3/12	6.44	30.70	8.40	63.33	0.10	0.29	0.19	0.00	0.10	5.56	1.86	0.65	0.09	1.12	2.08	0.37	0.97	5.67	46.75	0.04	0.01	0.05
16	3/9/12	6.16	69.50	6.30	13.33	0.08	0.11	0.03	0.00	0.08	13.86	3.54	0.82	0.24	2.48	5.45	0.74	2.29	13.61	73.64	0.06	0.02	0.03
17	3/23/12	6.61	60.00	9.00	67.00	0.09	0.45	0.36	0.00	0.09	10.43	2.54	0.64	0.14	1.76	2.88	0.49	2.92	10.71	80.83	0.04	0.06	0.11
20	5/22/12	5.56	73.80	7.00	36.00	0.09	0.45	0.36	0.02	0.07	16.80	3.26	0.88	0.35	2.03	0.81	0.63	2.09	10.87	84.52	0.07	0.04	0.03
23	7/9/12	6.14	59.60	4.00	111.00	0.09	1.96	1.87	0.02	0.07	16.92	2.43	0.65	0.20	1.58	1.34	2.19	3.66	19.02	161.40	0.08	0.02	0.27
24	7/10/12	6.18	36.90	7.80	74.00	0.05	0.23	0.18	0.00	0.05	10.82	1.33	0.33	0.14	0.86	1.15	1.56	2.60	21.58	147.70	0.13	0.02	0.11
29	9/8/12	6.15	31.70	5.10	12.67	0.07	0.10	0.03	0.02	0.05	10.88	1.08	0.36	0.20	0.53	0.36	1.33	1.37	14.14	66.36	0.05	0.01	0.12
30	10/6/12	5.73	56.6	5.9	37.33	0.06	0.17	0.11	0.00	0.06	11.97	2.12	0.69	0.47	0.97	0.69	0.88	2.31	16.08	122.30	0.08	0.01	0.10
Number of Events		**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**16**	**16**	**16**	**16**	**16**	**16**	**16**
Mean		**6.34**	**60.07**	**9.01**	**35.06**	**0.08**	**0.28**	**0.19**	**0.01**	**0.07**	**9.99**	**2.13**	**0.69**	**0.46**	**0.99**	**2.76**	**1.19**	**1.99**	**11.50**	**76.85**	**0.11**	**0.02**	**0.20**
Standard Deviation		**0.33**	**23.20**	**4.99**	**26.90**	**0.01**	**0.42**	**0.42**	**0.01**	**0.02**	**3.78**	**0.85**	**0.23**	**0.42**	**0.77**	**1.97**	**0.64**	**0.79**	**4.59**	**39.37**	**0.08**	**0.01**	**0.30**
Coefficient of Variation		**5.14**	**38.62**	**55.33**	**76.72**	**17.88**	**152.95**	**215.20**	**147.24**	**25.19**	**37.88**	**39.97**	**33.45**	**90.76**	**78.21**	**71.23**	**53.80**	**39.69**	**39.89**	**51.23**	**74.46**	**68.61**	**151.88**

Table H-4 Event Runoff Chemistry Charlotte Conventional Road Surface Filter Strip Site

Event #	Date	pH	Conductivity	Turbidity	TSS	DTP	TP	PP	PO_4-P	DOP	NPOC	TN	NH_4-N	NO_3-N	DON	Cl	Cr	Ni	Cu	Zn	Cd	Pt	Pb
			mS	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
3	10/28/11	6.66	122.90	12.00	13.00	0.10	0.13	0.03	0.04	0.06	7.39	0.80	0.30	0.23	0.27	25.63	NS	NS	NS	NS	NS	NS	NS
4	11/3/11	6.23	68.60	4.60	6.33	0.07	0.11	0.04	0.04	0.03	4.18	0.46	0.32	0.17	0.00	7.57	NS	NS	NS	NS	NS	NS	NS
5	11/16/11	6.31	169.10	12.00	21.67	0.08	0.18	0.10	0.02	0.06	13.66	1.07	0.00	0.22	0.85	17.11	2.17	1.46	15.48	27.03	0.16	0.03	0.50
6	11/23/11	6.12	96.40	10.00	16.50	0.10	0.18	0.08	0.00	0.10	9.62	0.76	0.00	0.24	0.52	8.52	1.60	0.89	10.10	16.56	0.22	0.01	0.29
7	12/7/11	6.46	157.90	22.00	17.50	0.09	0.11	0.02	0.00	0.09	13.85	1.03	0.00	0.07	0.96	5.44	1.78	1.64	13.70	29.69	0.71	0.01	0.71
8	12/16/11	6.20	124.90	9.50	10.50	0.07	0.11	0.04	0.00	0.07	7.34	0.96	0.00	0.38	0.57	7.88	3.64	2.06	18.41	34.20	1.86	0.01	0.63
9	12/20/11	6.60	78.80	12.00	19.00	0.06	0.12	0.06	0.00	0.06	8.41	1.02	0.00	0.00	1.02	4.77	2.29	0.88	11.77	26.43	0.08	0.01	1.11
11	1/11/12	6.54	135.20	22.00	16.00	0.07	0.19	0.12	0.00	0.07	8.65	0.80	0.00	0.01	0.79	7.88	1.63	1.44	19.29	32.64	0.07	0.01	0.29
13	1/20/12	6.30	131.90	17.00	16.00	0.07	0.10	0.03	0.02	0.05	7.69	0.70	0.00	0.13	0.57	19.77	1.23	1.37	13.94	12.33	0.14	0.01	0.13
15	3/3/12	6.46	57.20	5.70	14.67	0.08	0.14	0.06	0.00	0.08	6.91	0.43	0.19	0.02	0.23	4.57	2.51	0.77	9.70	19.62	0.05	0.01	0.10
16	3/9/12	6.15	94.40	6.50	10.00	0.07	0.12	0.05	0.00	0.07	9.51	0.73	0.00	0.02	0.71	9.64	1.82	1.33	14.57	20.28	0.05	0.01	0.11
17	3/23/12	6.31	109.80	5.20	1.00	0.11	0.14	0.03	0.00	0.11	5.72	0.52	0.00	0.03	0.49	9.03	5.24	3.12	34.59	54.49	0.12	0.02	0.35
20	5/22/12	5.60	29.10	4.50	11.33	0.11	0.14	0.03	0.00	0.11	4.10	0.42	0.00	0.03	0.39	0.65	2.02	0.59	6.92	9.72	0.03	0.04	0.06
25	7/20/12	6.53	33.60	4.40	9.33	0.13	0.16	0.03	0.03	0.10	5.55	0.63	0.20	0.04	0.39	1.22	5.36	1.19	14.36	18.86	0.04	0.02	0.27
29	9/8/12	6.16	72.80	5.40	13.33	0.17	0.24	0.07	0.04	0.13	19.59	1.48	0.29	0.18	1.01	1.11	3.27	1.85	32.80	29.74	0.07	0.02	0.36
30	10/6/12	5.77	38.7	13	55.00	0.1	0.17	0.07	0.00	0.10	7.74	0.83	0.18	0.15	0.51	0.93	3.05	1.10	13.58	31.03	0.03	0.02	0.20
Number of Events		**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**14**	**14**	**14**	**14**	**14**	**14**	**14**
Mean		**6.28**	**95.08**	**10.36**	**15.70**	**0.09**	**0.15**	**0.05**	**0.01**	**0.08**	**8.74**	**0.79**	**0.09**	**0.12**	**0.58**	**8.23**	**2.69**	**1.41**	**16.37**	**25.90**	**0.26**	**0.01**	**0.36**
Standard Deviation		**0.29**	**43.58**	**5.90**	**11.64**	**0.03**	**0.04**	**0.03**	**0.02**	**0.03**	**4.00**	**0.28**	**0.13**	**0.11**	**0.29**	**7.13**	**1.30**	**0.64**	**8.03**	**11.24**	**0.49**	**0.01**	**0.29**
Coefficient of Variation		**4.57**	**45.83**	**56.92**	**74.14**	**30.70**	**25.93**	**53.00**	**144.34**	**32.24**	**45.80**	**35.46**	**139.20**	**93.58**	**50.68**	**86.56**	**48.44**	**45.73**	**49.03**	**43.40**	**190.64**	**60.83**	**79.77**

Table H-5 Event Runoff Chemistry Charlotte Open Grade Friction Surface Filter Strip Site

Event #	Date	pH	Conductivity	Turbidity	TSS	DTP	TP	PP	PO_4-P	DOP	NPOC	TN	NH_4-N	NO_3-N	DON	Cl	Cr	Ni	Cu	Zn	Cd	Pt	Pb
			mS	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	10/11/11	6.67	50.80	11.00	38.00	0.14	0.28	0.14	0.02	0.12	8.59	1.17	0.34	0.04	0.79	1.91	NS	NS	NS	NS	NS	NS	NS
2	10/18/11	6.06	25.40	7.80	12.33	0.10	0.13	0.03	0.04	0.06	4.55	0.68	0.35	0.09	0.23	0.58	NS	NS	NS	NS	NS	NS	NS
3	10/28/11	6.95	29.40	5.40	3.00	0.08	0.10	0.02	0.02	0.06	3.85	0.69	0.41	0.18	0.10	1.13	NS	NS	NS	NS	NS	NS	NS
4	11/3/11	6.43	35.60	2.60	8.67	0.10	0.11	0.01	0.05	0.05	1.75	0.83	0.62	0.34	0.00	1.81	NS	NS	NS	NS	NS	NS	NS
5	11/16/11	6.42	65.00	9.40	30.90	0.08	0.17	0.09	0.00	0.08	8.85	0.90	0.22	0.31	0.37	2.07	2.55	0.80	5.88	14.75	0.11	0.02	0.25
6	11/23/11	6.20	51.60	8.00	14.50	0.10	0.16	0.06	0.00	0.10	7.86	1.07	0.20	0.06	0.82	0.82	0.59	0.78	6.42	14.64	0.47	0.01	0.17
7	12/7/11	6.66	160.10	15.00	11.50	0.11	0.14	0.03	0.00	0.11	15.47	1.69	0.21	0.22	1.27	12.83	1.48	1.12	7.74	24.43	0.11	0.02	0.25
8	12/16/11	6.40	101.70	5.90	1.00	0.09	NS	NS	0.00	0.09	NS	NS	0.38	0.90	NS	4.34	1.66	1.44	8.77	26.68	0.12	0.03	2.13
9	12/20/11	6.62	53.10	10.00	16.00	0.11	0.13	0.02	0.00	0.11	11.78	1.96	0.23	0.27	1.46	2.44	0.52	0.44	3.08	10.08	0.11	0.01	0.13
11	1/11/12	6.61	105.70	21.00	49.00	0.12	0.15	0.03	0.00	0.12	7.84	1.36	0.25	0.04	1.07	5.74	1.29	1.27	7.44	20.94	0.04	0.01	0.25
12	1/17/12	6.36	58.10	13.00	24.00	0.10	0.15	0.05	0.04	0.06	6.33	0.97	0.31	0.39	0.27	5.58	0.88	0.80	6.28	13.98	0.03	0.01	0.06
13	1/20/12	6.56	61.60	16.00	20.67	0.07	0.11	0.04	0.00	0.07	5.08	0.62	0.00	0.19	0.42	5.04	0.84	0.73	5.58	10.58	0.10	0.01	0.06
15	3/3/12	6.43	30.80	12.00	27.33	0.09	0.16	0.07	0.00	0.09	5.03	0.79	0.74	0.07	0.00	1.85	0.50	0.65	5.34	21.66	0.04	0.01	0.08
16	3/9/12	6.27	119.10	20.00	61.43	0.55	1.10	0.55	0.13	0.42	13.30	9.00	1.69	0.07	7.24	8.26	0.82	2.22	13.32	31.62	0.26	0.02	0.22
17	3/23/12	6.25	80.10	16.00	57.00	0.26	0.50	0.24	0.06	0.20	13.46	3.64	1.70	0.11	1.83	4.14	0.63	1.87	14.22	25.04	0.04	0.04	0.13
20	5/22/12	5.88	94.30	15.00	24.67	0.26	0.50	0.24	0.05	0.21	17.51	2.58	0.61	0.23	1.74	2.83	0.91	2.12	13.85	20.07	0.06	0.06	0.07
23	7/9/12	6.41	72.50	12.00	45.33	0.30	0.52	0.22	0.08	0.22	17.17	2.46	0.64	0.24	1.58	2.55	2.02	2.66	20.44	54.33	0.06	0.05	0.26
24	7/10/12	6.39	66.80	9.50	40.67	0.23	0.44	0.21	0.05	0.18	16.21	1.82	0.37	0.16	1.28	2.28	1.28	3.12	20.81	76.34	0.73	0.11	0.14
29	9/8/12	6.07	42.20	6.40	10.67	0.18	0.23	0.05	0.05	0.13	13.84	1.07	0.13	0.17	0.77	0.53	0.91	1.23	11.30	22.99	0.02	0.01	0.16
30	10/6/12	5.70	56.9	6.5	15.33	0.13	0.21	0.08	0.00	0.13	12.26	1.56	0.13	0.33	1.10	1.02	0.79	1.82	13.76	34.23	0.24	0.07	0.15
Number of Events		**20**	**20**	**20**	**20**	**20**	**19**	**19**	**20**	**20**	**19**	**19**	**20**	**20**	**19**	**20**	**16**	**16**	**16**	**16**	**16**	**16**	**16**
Mean		**6.37**	**68.04**	**11.13**	**25.60**	**0.16**	**0.28**	**0.11**	**0.03**	**0.13**	**10.04**	**1.83**	**0.48**	**0.22**	**1.18**	**3.39**	**1.10**	**1.44**	**10.26**	**26.40**	**0.16**	**0.03**	**0.28**
Standard Deviation		**0.29**	**34.01**	**4.94**	**17.72**	**0.11**	**0.25**	**0.13**	**0.04**	**0.08**	**4.90**	**1.90**	**0.46**	**0.19**	**1.58**	**3.01**	**0.58**	**0.78**	**5.36**	**17.16**	**0.19**	**0.03**	**0.50**
Coefficient of Variation		**4.57**	**49.98**	**44.38**	**69.23**	**71.69**	**88.35**	**114.91**	**119.09**	**65.19**	**48.84**	**103.86**	**96.03**	**87.38**	**134.67**	**88.99**	**52.27**	**54.39**	**52.19**	**65.01**	**121.27**	**100.25**	**176.43**

Table H-6 Event Precipitation Chemistry for the Sites in Davidson County

Event #	Date	pH	Conductivity	Turbidity	TSS	DTP	TP	PP	PO_4-P	DOP	NPOC	TN	NH_4-N	NO_3-N	DON	Cl
			mS	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	10/11/11	5.30	6.16	0.36	0.67	0.05	0.05	0.00	0.00	0.05	1.83	0.32	0.25	0.02	0.06	0.37
2	10/18/11	5.85	4.74	0.64	3.33	0.04	0.07	0.03	0.00	0.04	1.30	0.27	0.21	0.08	0.00	0.12
3	10/28/11	5.42	12.60	0.47	3.00	0.08	0.10	0.02	0.00	0.08	1.37	0.60	0.46	0.26	0.00	0.37
4	11/3/11	5.46	5.93	0.65	0.67	0.05	0.05	0.00	0.00	0.05	0.87	0.23	0.18	0.11	0.00	0.78
5	11/16/11	5.89	6.63	0.28	1.00	0.06	0.06	0.00	0.00	0.06	0.97	0.31	0.24	0.10	0.00	0.38
6	11/23/11	6.02	5.17	0.55	0.00	0.06	0.10	0.04	0.00	0.06	1.34	0.26	0.20	0.24	0.00	2.33
8	12/16/11	5.79	7.80	0.39	0.50	0.06	0.06	0.00	0.00	0.06	1.31	0.66	0.51	0.32	0.00	0.88
9	12/20/11	5.05	5.90	0.35	3.50	0.06	0.06	0.00	0.00	0.06	1.50	0.65	0.50	0.00	0.14	0.37
10	1/8/12	4.99	28.20	0.64	0.00	0.07	0.07	0.00	0.00	0.07	4.60	1.89	1.46	0.04	0.38	1.57
12	1/17/12	6.06	8.02	0.67	1.00	0.04	0.04	0.00	0.05	0.00	1.35	0.38	0.30	0.16	0.00	1.24
13	1/20/12	4.74	23.40	0.68	2.50	0.05	0.05	0.00	0.02	0.03	2.73	1.12	0.87	0.39	0.00	0.90
15	3/3/12	5.99	5.79	1.80	2.67	0.06	0.06	0.00	0.00	0.06	1.76	0.70	0.54	0.03	0.12	0.83
17	3/23/12	5.52	11.45	2.30	1.00	0.05	0.05	0.00	0.00	0.05	1.65	0.75	0.58	0.07	0.10	0.64
18	4/5/12	5.32	13.42	12.00	9.00	0.03	0.10	0.07	0.00	0.03	1.73	0.99	0.77	0.09	0.13	0.45
19	4/17/12	4.47	20.30	2.30	11.33	0.04	0.06	0.02	0.00	0.04	2.87	1.64	1.27	0.09	0.28	0.89
20	5/22/12	5.10	10.45	1.20	0.67	0.05	0.05	0.00	0.00	0.05	2.63	0.45	0.35	0.03	0.07	0.11
21	6/6/12	5.99	4.77	0.50	0.00	0.03	0.03	0.00	0.00	0.03	0.94	0.13	0.10	0.01	0.02	0.09
22	6/12/12	4.68	10.94	0.80	0.00	0.02	0.02	0.00	0.00	0.02	2.14	0.50	0.39	0.05	0.06	0.48
24	7/10/12	4.60	12.07	0.84	3.33	0.03	0.03	0.00	0.00	0.03	2.38	0.42	0.32	0.03	0.06	0.61
25	7/20/12	4.93	13.55	0.92	2.00	0.02	0.03	0.01	0.00	0.02	2.39	0.36	0.28	0.05	0.03	0.46
26	8/6/10	4.97	13.51	1.00	4.67	0.03	0.04	0.01	0.00	0.03	2.95	0.59	0.46	0.34	0.00	0.62
27	8/22/12	4.63	10.55	0.61	0.00	0.06	0.06	0.00	0.00	0.06	1.80	0.40	0.31	0.05	0.04	0.33
28	9/4/12	4.78	8.53	0.52	0.00	0.02	0.02	0.00	0.00	0.02	1.57	0.22	0.17	0.03	0.02	0.23
30	10/6/12	4.38	17.70	0.49	0.00	0.03	0.03	0.00	0.00	0.03	2.46	0.54	0.42	0.07	0.05	0.22
31	10/15/12	5.09	13.80	0.64	0.00	0.03	0.03	0.00	0.00	0.03	1.65	0.43	0.33	0.07	0.02	0.93
Number of Events		**25**	**25**	**25**	**25**	**25**	**25**	**25**	**25**	**25**	**25**	**25**	**25**	**25**	**25**	**25**
Mean		**5.24**	**11.26**	**1.26**	**2.03**	**0.04**	**0.05**	**0.01**	**0.00**	**0.04**	**1.92**	**0.59**	**0.46**	**0.11**	**0.06**	**0.65**
Standard Deviation		**0.54**	**6.02**	**2.30**	**2.84**	**0.02**	**0.02**	**0.02**	**0.01**	**0.02**	**0.82**	**0.42**	**0.33**	**0.11**	**0.09**	**0.50**
Coefficient of Variation		**10.21**	**53.46**	**182.14**	**139.57**	**37.08**	**43.57**	**210.41**	**366.21**	**45.35**	**42.80**	**71.79**	**71.79**	**100.97**	**148.00**	**77.70**

Table H-7 Event Runoff Chemistry Davidson County Conventional Road Surface Site

Event #	Date	pH	Conductivity	Turbidity	TSS	DTP	TP	PP	PO_4-P	DOP	NPOC	TN	NH_4-N	NO_3-N	DON	Cl	Cr	Ni	Cu	Zn	Cd	Pt	Pb
			mS	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	10/11/11	6.33	25.80	10.00	13.33	0.05	0.07	0.02	0.00	0.05	3.03	0.38	0.11	0.02	0.26	1.34	NS	NS	NS	NS	NS	NS	NS
2	10/18/11	6.64	24.10	8.60	20.00	0.05	0.10	0.05	0.00	0.05	5.14	0.40	0.18	0.09	0.13	1.15	NS	NS	NS	NS	NS	NS	NS
3	10/28/11	6.27	30.70	9.20	6.00	0.06	0.06	0.00	0.00	0.06	2.67	0.43	0.28	0.14	0.01	1.68	NS	NS	NS	NS	NS	NS	NS
4	11/3/11	6.82	36.30	15.00	54.00	0.08	0.14	0.06	0.00	0.08	3.13	0.48	0.30	0.19	0.00	1.80	NS	NS	NS	NS	NS	NS	NS
8	12/16/11	6.44	55.90	31.00	17.00	0.07	NS	NS	0.00	0.07	NS	NS	0.44	0.39	NS	3.23	2.03	0.95	4.99	27.30	0.16	0.01	0.49
13	1/20/12	6.54	95.70	27.00	20.00	0.07	0.09	0.02	0.00	0.07	6.41	1.11	0.48	0.41	0.22	10.87	3.03	1.25	10.53	9.88	0.08	0.01	0.04
15	3/3/12	6.54	99.40	9.00	4.67	0.08	0.09	0.01	0.00	0.08	2.29	0.33	0.00	0.04	0.29	30.66	1.75	0.58	5.73	7.79	0.02	0.00	0.05
17	3/23/12	6.39	82.70	4.20	2.00	0.08	0.09	0.01	0.00	0.08	5.81	0.91	0.42	0.09	0.40	9.68	2.49	1.35	11.10	18.51	0.03	0.01	0.04
18	4/5/12	6.02	110.50	22.00	19.00	0.08	0.19	0.11	0.00	0.08	11.23	1.46	0.59	0.16	0.72	8.92	3.50	1.40	11.47	20.18	0.06	0.01	0.19
20	5/22/12	5.83	14.95	4.00	8.00	0.08	0.09	0.01	0.00	0.08	2.94	0.40	0.15	0.02	0.22	0.33	0.86	0.54	4.72	11.66	0.05	0.04	0.03
21	6/6/12	6.34	21.90	4.60	10.00	0.03	0.06	0.03	0.00	0.03	2.91	0.28	0.11	0.02	0.15	0.63	0.76	0.28	3.50	7.09	0.03	0.01	0.09
22	6/12/12	6.67	27.80	4.40	10.67	0.03	0.04	0.01	0.00	0.03	4.49	0.63	0.21	0.06	0.35	1.47	1.01	0.53	5.50	9.32	0.03	0.02	0.09
24	7/10/12	6.17	13.91	4.00	12.00	0.03	0.05	0.02	0.00	0.03	2.29	0.32	0.12	0.04	0.16	0.81	0.68	0.53	6.25	17.30	0.01	0.01	0.12
25	7/20/12	6.08	21.60	4.10	4.67	0.03	0.07	0.04	0.00	0.03	5.15	0.66	0.23	0.06	0.37	0.92	1.74	0.85	8.43	21.71	0.06	0.02	0.12
26	8/6/12	6.64	5.71	11.00	12.67	0.07	0.13	0.06	0.00	0.07	14.50	1.06	0.32	0.27	0.47	2.40	3.40	3.11	26.84	42.70	0.11	0.05	0.27
27	8/22/12	5.65	13.75	4.25	8.67	0.07	0.13	0.06	0.00	0.07	2.86	0.62	0.16	0.08	0.38	0.33	0.73	0.24	2.73	12.22	0.01	0.01	0.10
28	9/4/12	5.96	15.61	4.00	6.67	0.02	0.06	0.04	0.00	0.02	2.92	0.38	0.12	0.05	0.21	0.40	1.04	0.57	6.43	10.48	0.02	0.01	0.10
30	10/6/12	5.27	16.51	2.1	4.00	0.03	0.04	0.01	0.00	0.03	2.25	0.39	0.09	0.06	0.24	0.32	0.74	0.38	3.50	11.74	0.01	0.01	0.08
31	10/15/12	5.40	45.10	8.80	21.00	0.06	0.09	0.03	0.00	0.06	6.60	0.97	0.39	0.12	0.46	1.48	1.80	1.11	11.48	28.08	0.05	0.02	0.14
Number of Events		**19**	**19**	**19**	**19**	**19**	**18**	**18**	**19**	**19**	**18**	**18**	**19**	**19**	**18**	**19**	**15**	**15**	**15**	**15**	**15**	**15**	**15**
Mean		**6.21**	**39.89**	**9.86**	**13.39**	**0.06**	**0.09**	**0.03**	**0.00**	**0.06**	**4.81**	**0.62**	**0.25**	**0.12**	**0.28**	**4.13**	**1.70**	**0.91**	**8.21**	**17.06**	**0.05**	**0.02**	**0.13**
Standard Deviation		**0.44**	**32.82**	**8.29**	**11.50**	**0.02**	**0.04**	**0.03**	**0.00**	**0.02**	**3.31**	**0.34**	**0.16**	**0.12**	**0.17**	**7.23**	**1.00**	**0.72**	**5.97**	**9.78**	**0.04**	**0.01**	**0.12**
Coefficient of Variation		**7.00**	**82.28**	**84.12**	**85.93**	**38.46**	**44.14**	**83.59**		**38.46**	**68.87**	**54.63**	**63.66**	**97.38**	**62.48**	**175.08**	**58.80**	**78.84**	**72.74**	**57.30**	**87.48**	**77.01**	**90.82**

Table H-8 Event Runoff Chemistry Davidson County NovaChip™ Road Surface Site

Event #	Date	pH	Conductivity	Turbidity	TSS	DTP	TP	PP	PO_4-P	DOP	NPOC	TN	NH_4-N	NO_3-N	DON	Cl	Cr	Ni	Cu	Zn	Cd	Pt	Pb
			mS	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	10/11/11	6.64	25.00	11.00	47.00	0.06	0.10	0.04	0.00	0.06	3.70	0.42	0.18	0.02	0.23	0.85	NS	NS	NS	NS	NS	NS	NS
2	10/18/11	6.49	28.70	11.00	15.00	0.06	0.11	0.05	0.00	0.06	3.62	0.52	0.21	0.11	0.20	1.29	NS	NS	NS	NS	NS	NS	NS
3	10/28/11	6.42	30.80	6.60	15.33	0.09	0.10	0.01	0.00	0.09	2.79	0.57	0.28	0.14	0.15	1.68	NS	NS	NS	NS	NS	NS	NS
4	11/3/11	6.69	21.80	1.70	3.33	0.07	0.09	0.02	0.00	0.07	2.30	0.45	0.27	0.18	0.00	1.34	NS	NS	NS	NS	NS	NS	NS
5	11/16/11	6.53	26.10	17.00	58.50	0.06	0.14	0.08	0.00	0.06	2.66	0.39	0.00	0.26	0.13	1.63	1.13	0.50	3.54	14.29	0.14	0.01	0.12
8	12/16/11	6.46	37.00	13.00	36.00	0.06	0.11	0.05	0.00	0.06	2.53	0.87	0.37	0.42	0.08	2.55	0.91	0.84	3.22	35.72	0.21	0.01	0.38
15	3/3/12	6.67	106.90	12.00	36.00	0.08	0.34	0.26	0.00	0.08	6.03	0.59	0.00	0.07	0.53	19.05	0.58	0.75	7.41	23.32	0.03	0.00	0.06
17	3/23/12	6.47	68.90	4.50	17.00	0.08	0.14	0.06	0.00	0.08	6.34	1.02	0.37	0.09	0.56	7.95	1.23	1.40	11.25	35.22	0.05	0.01	0.06
18	4/5/12	5.95	60.40	6.90	9.00	0.03	0.08	0.05	0.00	0.03	5.99	1.04	0.00	0.12	0.92	5.02	NS	NS	NS	NS	NS	NS	NS
19	4/17/12	6.01	75.00	4.40	78.00	0.04	0.23	0.19	0.00	0.04	12.41	2.04	0.74	0.09	1.21	5.84	NS	NS	NS	NS	NS	NS	NS
20	5/22/12	5.79	19.32	7.30	21.33	0.08	0.14	0.06	0.00	0.08	3.61	0.48	0.13	0.04	0.31	1.05	0.63	0.59	5.13	18.76	0.04	0.01	0.02
21	6/6/12	6.54	18.40	26.00	22.00	0.13	0.21	0.08	0.04	0.09	13.66	0.79	0.11	0.06	0.62	2.81	0.89	1.86	9.64	55.13	1.40	0.02	0.19
22	6/12/12	6.58	28.60	10.50	34.67	0.02	0.11	0.09	0.00	0.02	6.58	0.57	0.00	0.06	0.51	1.84	0.56	0.56	5.68	10.31	0.02	0.01	0.10
24	7/10/12	6.06	16.66	13.00	39.33	0.03	0.08	0.05	0.00	0.03	3.60	0.39	0.09	0.04	0.26	0.83	0.78	0.38	4.53	5.17	0.02	0.01	0.08
28	9/4/12	5.96	21.10	8.30	18.00	0.03	0.08	0.05	0.00	0.03	4.92	0.44	0.15	0.07	0.22	0.50	1.76	0.80	7.93	25.78	0.06	0.01	0.11
30	10/6/12	5.40	22.5	8.4	19.33	0.03	0.06	0.03	0.00	0.03	3.83	0.56	0.08	0.09	0.40	0.42	0.54	0.66	4.79	12.26	0.01	0.00	0.08
Number of Events		**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**10**	**10**	**10**	**10**	**10**	**10**	**10**
Mean		**6.29**	**37.95**	**10.10**	**29.36**	**0.06**	**0.13**	**0.07**	**0.00**	**0.06**	**5.28**	**0.70**	**0.19**	**0.11**	**0.40**	**3.41**	**0.90**	**0.83**	**6.31**	**23.60**	**0.20**	**0.01**	**0.12**
Standard Deviation		**0.38**	**25.93**	**5.74**	**19.56**	**0.03**	**0.07**	**0.06**	**0.01**	**0.02**	**3.34**	**0.42**	**0.19**	**0.10**	**0.32**	**4.68**	**0.39**	**0.45**	**2.66**	**15.04**	**0.43**	**0.01**	**0.10**
Coefficient of Variation		**6.01**	**68.34**	**56.79**	**66.60**	**48.99**	**54.32**	**87.74**	**400.00**	**41.53**	**63.27**	**59.80**	**104.09**	**87.93**	**81.01**	**137.01**	**42.74**	**54.45**	**42.20**	**63.74**	**216.13**	**56.10**	**85.85**

Table H-9 Event Runoff Chemistry Davidson County Conventional Road Surface Filter Strip Site

Event #	Date	pH	Conductivity	Turbidity	TSS	DTP	TP	PP	PO_4-P	DOP	NPOC	TN	NH_4-N	NO_3-N	DON	Cl	Cr	Ni	Cu	Zn	Cd	Pt	Pb
			mS	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	10/11/11	6.71	48.10	14.00	16.00	0.10	0.13	0.03	0.01	0.09	5.64	0.48	0.06	0.02	0.41	3.04	NS	NS	NS	NS	NS	NS	NS
2	10/18/11	6.53	44.90	12.50	7.50	0.09	0.30	0.21	0.04	0.05	5.76	0.38	0.00	0.05	0.33	3.77	NS	NS	NS	NS	NS	NS	NS
3	10/28/11	6.38	48.80	14.00	8.00	0.10	0.10	0.00	0.04	0.06	4.50	0.49	0.07	0.21	0.21	4.83	NS	NS	NS	NS	NS	NS	NS
4	11/3/11	6.66	28.60	8.70	14.67	0.09	0.11	0.02	0.02	0.07	2.41	0.26	0.00	0.12	0.15	1.73	NS	NS	NS	NS	NS	NS	NS
5	11/16/11	6.62	30.30	12.00	7.00	0.09	0.06	0.00	0.00	0.09	3.30	0.31	0.00	0.21	0.10	2.00	0.64	0.44	3.29	7.74	0.10	0.01	0.09
8	12/16/11	6.47	45.30	13.00	4.50	0.06	0.09	0.03	0.00	0.06	3.64	0.61	0.00	0.35	0.27	3.08	0.73	0.37	2.98	12.39	0.06	0.01	0.41
9	12/20/11	6.89	26.70	13.00	18.50	0.06	0.08	0.02	0.00	0.06	3.62	0.61	0.32	0.08	0.22	4.13	1.05	0.65	4.06	10.57	0.18	0.01	0.23
12	1/17/12	6.50	78.70	65.00	50.67	0.08	0.16	0.08	0.00	0.08	6.17	0.56	0.00	0.18	0.38	13.84	0.89	0.73	6.16	8.05	0.02	0.01	0.05
13	1/20/12	6.30	114.50	54.00	28.00	0.07	0.13	0.06	0.00	0.07	10.09	0.88	0.00	0.27	0.61	19.46	0.81	0.73	5.63	4.71	0.03	0.00	0.07
15	3/3/12	6.59	250.00	14.00	8.00	0.10	0.11	0.01	0.00	0.10	3.95	0.40	0.00	0.03	0.37	37.21	1.06	0.85	7.30	47.49	0.06	0.00	0.19
17	3/24/12	6.57	158.90	18.00	17.00	0.12	0.15	0.03	0.00	0.12	12.92	1.01	0.00	0.06	0.95	21.52	2.18	2.22	14.38	23.40	0.07	0.01	0.24
18	4/5/12	6.18	103.30	28.00	19.00	0.09	0.18	0.09	0.00	0.09	7.71	0.69	0.00	0.03	0.65	9.95	1.60	2.10	10.28	14.07	0.19	0.04	0.30
20	5/22/12	5.81	27.00	7.50	8.67	0.12	0.15	0.03	0.00	0.12	3.98	0.40	0.00	0.02	0.38	1.05	0.57	1.42	4.96	5.67	0.03	0.05	0.04
22	6/12/12	6.60	46.50	12.50	12.67	0.07	0.12	0.05	0.00	0.07	11.21	0.79	0.00	0.05	0.75	3.34	0.73	1.39	9.88	14.11	0.02	0.02	0.13
25	7/20/12	6.32	39.50	5.20	3.33	0.21	0.26	0.05	0.05	0.16	7.50	0.78	0.17	0.04	0.56	2.46	1.16	1.13	6.72	10.48	0.02	0.02	0.13
27	8/22/12	6.01	18.72	6.60	4.67	0.14	0.24	0.10	0.00	0.14	3.52	0.46	0.08	0.07	0.32	0.39	0.93	0.72	8.35	9.36	0.03	0.01	0.20
28	9/4/12	6.10	26.80	7.30	6.00	0.10	0.15	0.05	0.02	0.08	6.28	0.53	0.00	0.03	0.50	0.73	0.91	0.90	6.97	11.25	0.04	0.02	0.12
30	10/6/12	5.67	34.20	8.60	8.00	0.11	0.16	0.05	0.00	0.11	5.56	0.48	0.00	0.10	0.38	0.91	0.43	0.79	5.68	9.83	0.02	0.01	0.11
31	10/15/12	5.51	80.50	13.00	13.00	0.24	0.29	0.05	0.13	0.11	10.47	1.20	0.00	0.21	0.99	3.19	1.10	1.84	14.86	22.21	0.05	0.01	0.19
Number of Events		**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**15**	**15**	**15**	**15**	**15**	**15**	**15**
Mean		**6.34**	**65.86**	**17.21**	**13.43**	**0.11**	**0.16**	**0.05**	**0.02**	**0.09**	**6.22**	**0.60**	**0.04**	**0.11**	**0.45**	**7.19**	**0.99**	**1.09**	**7.43**	**14.09**	**0.06**	**0.01**	**0.17**
Standard Deviation		**0.37**	**57.59**	**15.82**	**11.00**	**0.05**	**0.07**	**0.05**	**0.03**	**0.03**	**3.02**	**0.24**	**0.08**	**0.10**	**0.25**	**9.56**	**0.43**	**0.58**	**3.60**	**10.63**	**0.05**	**0.01**	**0.10**
Coefficient of Variation		**5.88**	**87.44**	**91.96**	**81.92**	**43.34**	**44.38**	**94.11**	**198.62**	**32.00**	**48.59**	**41.03**	**221.84**	**87.57**	**55.91**	**132.91**	**43.99**	**53.88**	**48.45**	**75.43**	**91.46**	**93.51**	**60.46**

Table H-10 Event Runoff Chemistry Davidson County NovaChip^{TM} Road Surface Filter Strip Site

Event #	Date	pH	Conductivity	Turbidity	TSS	DTP	TP	PP	PO_4-P	DOP	NPOC	TN	NH_4-N	NO_3-N	DON	Cl	Cr	Ni	Cu	Zn	Cd	Pt	Pb
			mS	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	10/11/11	6.62	47.20	16.00	10.67	0.10	0.12	0.02	0.00	0.10	5.04	0.44	0.14	0.01	0.29	1.36	NS	NS	NS	NS	NS	NS	NS
2	10/18/11	6.22	50.70	36.00	36.00	0.09	0.16	0.07	0.02	0.07	5.89	0.55	0.28	0.03	0.24	1.78	NS	NS	NS	NS	NS	NS	NS
3	10/28/11	6.59	58.90	21.00	10.67	0.10	0.12	0.02	0.03	0.07	4.31	0.38	0.09	0.12	0.16	1.91	NS	NS	NS	NS	NS	NS	NS
5	11/16/11	6.47	40.50	22.00	11.00	0.07	0.07	0.00	0.00	0.07	3.85	0.30	0.00	0.06	0.24	1.55	1.54	0.42	3.49	7.59	0.07	0.01	0.13
6	11/23/11	6.26	62.30	29.00	14.50	0.10	0.13	0.03	0.00	0.10	8.35	0.70	0.00	0.10	0.60	1.29	0.67	0.72	5.26	10.84	0.15	0.01	0.19
8	12/16/11	6.39	50.20	26.00	20.50	0.08	0.10	0.02	0.00	0.08	3.74	0.53	0.00	0.25	0.28	2.42	0.98	0.62	2.73	13.80	0.12	0.01	0.39
13	1/20/12	6.91	271.00	42.00	24.67	> 1.3	>1.3	NS	2.04	NS	112.40	54.27	1.47	0.11	52.70	42.19	1.11	1.94	7.78	25.20	0.05	0.01	0.21
15	3/3/12	6.46	334.00	20.00	11.33	0.10	0.14	0.04	0.00	0.10	9.77	0.88	0.00	0.02	0.86	42.72	1.86	0.91	9.13	14.48	0.11	0.00	0.20
17	3/23/12	6.63	134.90	17.00	10.00	0.11	0.16	0.05	0.00	0.11	12.04	0.98	0.00	0.04	0.94	16.88	0.91	1.71	11.97	18.84	0.06	0.02	0.48
18	4/5/12	6.30	115.10	47.00	15.00	0.09	0.18	0.09	0.00	0.09	8.82	0.72	0.00	0.01	0.70	7.24	1.82	1.90	9.99	16.90	0.11	0.03	0.73
20	5/22/12	5.79	59.20	9.10	24.00	0.11	0.16	0.05	0.04	0.07	6.36	1.03	0.00	0.02	1.00	3.04	1.04	1.00	8.76	25.93	0.02	0.02	0.08
21	6/6/12	6.25	44.20	7.50	11.00	0.08	0.12	0.04	0.00	0.08	5.24	0.44	0.00	0.02	0.42	1.56	1.67	0.75	7.45	9.83	0.04	0.01	0.18
22	6/12/12	6.55	66.40	18.00	17.33	0.06	0.15	0.09	0.00	0.06	17.63	1.19	0.00	0.03	1.17	3.71	1.31	1.48	10.37	17.53	0.10	0.02	0.16
25	7/20/12	6.28	87.20	9.10	12.67	0.38	0.60	0.22	0.11	0.27	11.55	1.45	0.51	0.03	0.91	5.62	1.47	1.14	8.28	25.14	0.07	0.01	0.18
28	9/4/12	6.27	35.90	8.40	6.00	0.12	0.17	0.05	0.02	0.10	7.93	0.58	0.12	0.07	0.39	0.74	1.71	0.82	7.74	12.70	0.01	0.01	0.14
30	10/6/12	5.48	40.50	9.60	12.00	0.12	0.17	0.05	0.02	0.10	6.11	0.66	0.15	0.09	0.43	0.89	0.52	0.74	7.11	11.29	0.04	0.01	0.13
31	10/15/12	5.76	83.40	7.10	5.00	0.23	0.27	0.04	0.14	0.09	13.5	1.53	0.22	0.24	1.07	3.05	0.71	1.49	12.68	23.12	0.05	0.02	0.22
Number of Events		**17**	**17**	**17**	**17**	**16**	**16**	**16**	**17**	**16**	**17**	**17**	**17**	**17**	**17**	**17**	**14**	**14**	**14**	**14**	**14**	**14**	**14**
Mean		**6.31**	**93.04**	**20.28**	**14.84**	**0.12**	**0.18**	**0.06**	**0.14**	**0.10**	**14.27**	**3.92**	**0.18**	**0.07**	**3.67**	**8.11**	**1.24**	**1.12**	**8.05**	**16.66**	**0.07**	**0.01**	**0.24**
Standard Deviation		**0.36**	**84.03**	**12.30**	**7.72**	**0.08**	**0.12**	**0.05**	**0.49**	**0.05**	**25.57**	**12.98**	**0.36**	**0.07**	**12.64**	**13.48**	**0.45**	**0.50**	**2.86**	**6.19**	**0.04**	**0.01**	**0.17**
Coefficient of Variation		**5.64**	**90.32**	**60.66**	**52.03**	**64.79**	**68.71**	**91.51**	**342.60**	**48.90**	**179.26**	**331.22**	**205.81**	**100.48**	**344.28**	**166.17**	**36.48**	**44.60**	**35.46**	**37.17**	**56.13**	**55.90**	**71.73**

APPENDIX I: CONSTITUTE/POLLUTANT LOADS BY EVENT

Table I-1 October 11, 2011 Charlotte Sites Precipitation 1.27″ Conventional Pavement Sites, 1.33″ OGFC Sites

10/11/2011	BPC	CCR EOP	CCR FS	CCR EOP-BPC	% Retention	CCR FS-CCR EOP	% Retention	COR EOP-CCR EOP	% Retention
H+ Eq/acre	556.87	32.53	NS	-524.34	94	NS	NS	9.71	-30
TSS lbs./acre	0.67	21.30	NS	20.63	-3072	NS	NS	-13.80	65
DTP lbs./acre	0.02	0.01	NS	0.00	14	NS	NS	0.02	-107
TP lbs./acre	0.02	0.03	NS	0.02	-102	NS	NS	0.01	-29
Part. P lbs/acre	0.00	0.02	NS	0.02	*	NS	NS	-0.01	29
NPOC lbs./acre	0.32	1.85	NS	1.53	-471	NS	NS	1.82	-98
TN lbs./acre	0.13	0.22	NS	0.09	-67	NS	NS	0.11	-53
NH_4 lbs./acre	0.09	0.09	NS	0.01	-8	NS	NS	0.12	-129
Cl lbs./acre	0.07	0.39	NS	0.32	-460	NS	NS	0.04	-9
NO_3 lbs/acre	0.03	0.06	NS	0.03	-87	NS	NS	0.06	-101
PO_4 lbs/acre	0.00	0.00	NS	0.00	*	NS	NS	0.01	*
DON lbs/acre	0.06	0.13	NS	0.08	-132	NS	NS	0.01	-7
Cr g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Ni g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cu g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Zn g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cd g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pt g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pb g/acre		NS	NS	NA	NS	NS	NS	NS	NS

10/11/2011	BPO	COR EOP	COR FS	COR EOP-BPO	% Retention	COR FS-COR EOP	% Retention	COR FS-CCR FS	% Retention
H+ Eq/acre	583.18	42.24	17.01	-540.94	93	-25.23	60	NS	NS
TSS lbs./acre	0.70	7.50	6.67	6.80	-966	-0.83	11	NS	NS
DTP lbs./acre	0.02	0.03	0.02	0.01	-71	-0.01	21	NS	NS
TP lbs./acre	0.02	0.04	0.05	0.03	-149	0.00	-9	NS	NS
Part. P lbs/acre	0.00	0.01	0.02	0.01	*	0.01	-75	NS	NS
NPOC lbs./acre	0.34	3.67	1.51	3.33	-980	-2.16	59	NS	NS
TN lbs./acre	0.14	0.33	0.21	0.20	-143	-0.13	38	NS	NS
NH_4 lbs./acre	0.09	0.21	0.08	0.12	-136	-0.13	64	NS	NS
Cl lbs./acre	0.07	0.42	0.33	0.35	-485	-0.09	21	NS	NS
NO_3 lbs/acre	0.03	0.11	0.04	0.08	-259	-0.07	63	NS	NS
PO_4 lbs/acre	0.00	0.01	0.01	0.01	*	0.00	-56	NS	NS
DON lbs/acre	0.06	0.14	0.14	0.08	-138	-0.01	5	NS	NS
Cr g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Ni g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cu g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Zn g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cd g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pt g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pb g/acre		NS	NS	NA	NS	NS	NS	NS	NS

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-2 October 28, 2011 Charlotte Sites Precipitation 0.69″ Conventional Pavement Sites, 0.98″ OGFC Sites

10/29/2011	BPC	CCR EOP	CCR FS	CCR EOP-BPC	% Retention	CCR FS-CCR EOP	% Retention	COR EOP-CCR EOP	% Retention
H+ Eq/acre	170.14	6.40	7.45	-163.74	96	1.05	-16	3.06	-48
TSS lbs./acre	0.57	2.85	1.17	2.28	-397	-1.68	59	-0.42	15
DTP lbs./acre	0.01	0.01	0.01	0.00	29	0.00	-35	0.01	-109
TP lbs./acre	0.01	0.01	0.01	0.00	12	0.00	-41	0.01	-109
Part. P lbs/acre	0.00	0.00	0.00	0.00	*	0.00	-62	0.00	-109
NPOC lbs./acre	0.29	0.47	0.66	0.18	-62	0.19	-40	0.52	-109
TN lbs./acre	0.09	0.11	0.07	0.02	-28	-0.04	35	0.12	-109
NH_4 lbs./acre	0.09	0.06	0.03	-0.03	33	-0.03	42	0.12	-207
Cl lbs./acre	0.05	0.14	2.30	0.08	-159	2.17	-1602	0.07	-51
NO_3 lbs/acre	0.18	0.12	0.11	-0.06	31	-0.01	8	0.27	-221
PO_4 lbs/acre	0.02	0.00	0.01	-0.02	100	0.01	*	0.01	*
DON lbs/acre	0.00	0.03	0.02	0.03	*	-0.02	45	-0.03	100
Cr g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Ni g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cu g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Zn g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cd g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pt g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pb g/acre		NS	NS	NA	NS	NS	NS	NS	NS

10/29/2011	BPO	COR EOP	COR FS	COR EOP-BPO	% Retention	COR FS-COR EOP	% Retention	COR FS-CCR FS	% Retention
H+ Eq/acre	241.65	9.46	6.49	-232.19	96	-2.97	31	-0.96	13
TSS lbs./acre	0.81	2.43	0.38	1.61	-198	-2.05	84	-0.78	67
DTP lbs./acre	0.01	0.01	0.01	0.00	-4	0.00	27	0.00	-14
TP lbs./acre	0.01	0.02	0.01	0.00	-30	0.00	27	0.00	-9
Part. P lbs/acre	0.00	0.00	0.00	0.00	*	0.00	27	0.00	5
NPOC lbs./acre	0.42	0.99	0.49	0.57	-138	-0.50	50	-0.17	26
TN lbs./acre	0.12	0.23	0.09	0.11	-89	-0.14	62	0.02	-22
NH_4 lbs./acre	0.13	0.18	0.07	0.06	-46	-0.12	64	0.03	-92
Cl lbs./acre	0.07	0.20	0.14	0.13	-175	-0.06	29	-2.16	94
NO_3 lbs/acre	0.25	0.40	0.13	0.14	-56	-0.27	67	0.02	-15
PO_4 lbs/acre	0.03	0.01	0.01	-0.02	54	-0.01	37	0.00	21
DON lbs/acre	0.00	0.00	0.01	0.00	*	0.01	*	-0.01	67
Cr g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Ni g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cu g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Zn g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cd g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pt g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pb g/acre		NS	NS	NA	NS	NS	NS	NS	NS

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

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Table I-3 November 3, 2011 Charlotte Sites Precipitation 1.24″ Conventional Pavement Sites, 1.08″ OGFC Sites

11/4/2011	BPC	CCR EOP	CCR FS	CCR EOP-BPC	% Retention	CCR FS-CCR EOP	% Retention	COR EOP-CCR EOP	% Retention
H+ Eq/acre	260.24	50.24	71.90	-210.00	81	21.67	-43.13	-11.57	23
TSS lbs./acre	0.84	1.21	1.70	0.36	-43	0.50	-41.43	-0.68	57
DTP lbs./acre	0.01	0.02	0.02	0.01	-39	0.00	3.23	0.00	8
TP lbs./acre	0.02	0.03	0.03	0.01	-49	0.00	-18.27	0.00	19
Part. P lbs/acre	0.00	0.01	0.01	0.00	-98	0.01	-93.54	0.00	60
NPOC lbs./acre	0.34	0.88	1.12	0.54	-157	0.25	-27.93	0.18	-20
TN lbs./acre	0.07	0.18	0.12	0.10	-141	-0.05	30.79	0.09	-49
NH_4 lbs./acre	0.07	0.16	0.11	0.09	-116	-0.05	30.13	0.09	-54
Cl lbs./acre	0.34	0.62	2.04	0.27	-80	1.42	-229.95	-0.29	47
NO_3 lbs/acre	0.19	0.29	0.20	0.10	-53	-0.09	29.93	0.13	-44
PO_4 lbs/acre	0.00	0.00	0.03	0.00	*	0.03	*	0.02	*
DON lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	0.00	*
Cr g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Ni g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cu g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Zn g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cd g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pt g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pb g/acre		NS	NS	NA	NS	NS	NS	NS	NS

11/4/2011	BPO	COR EOP	COR FS	COR EOP-BPO	% Retention	COR FS-COR EOP	% Retention	COR FS-CCR FS	% Retention
H+ Eq/acre	226.66	38.66	37.99	-188.00	83	-0.67	2	-33.91	47
TSS lbs./acre	0.73	0.52	1.95	-0.21	29	1.43	-273	0.25	-15
DTP lbs./acre	0.01	0.02	0.02	0.01	-47	0.00	-26	0.00	-20
TP lbs./acre	0.01	0.02	0.02	0.01	-37	0.00	-23	0.00	16
Part. P lbs/acre	0.00	0.00	0.00	0.00	*	0.00	-1	-0.01	79
NPOC lbs./acre	0.30	1.06	0.39	0.76	-254	-0.66	63	-0.73	65
TN lbs./acre	0.06	0.27	0.19	0.20	-313	-0.08	30	0.06	-52
NH_4 lbs./acre	0.06	0.24	0.18	0.18	-281	-0.06	26	0.07	-63
Cl lbs./acre	0.30	0.33	0.41	0.03	-10	0.08	-24	-1.63	80
NO_3 lbs/acre	0.17	0.42	0.34	0.25	-152	-0.08	19	0.13	-66
PO_4 lbs/acre	0.00	0.02	0.03	0.02	*	0.01	-65	0.00	-10
DON lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	0.00	*
Cr g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Ni g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cu g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Zn g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cd g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pt g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pb g/acre		NS	NS	NA	NS	NS	NS	NS	NS

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-4 November 16, 2011 Charlotte Sites Precipitation 0.75″ Conventional Pavement Sites, 0.76″ OGFC Sites

11/17/2011	BPC	CCR EOP	CCR FS	CCR EOP-BPC	% Retention	CCR FS-CCR EOP	% Retention	COR EOP-CCR EOP	% Retention
H+ Eq/acre	184.93	35.64	32.74	-149.29	81	-2.91	8	-7.19	20
TSS lbs./acre	0.23	9.95	3.19	9.72	-4289	-6.75	68	-6.26	63
DTP lbs./acre	0.01	0.01	0.01	0.00	-6	0.00	-31	0.00	-47
TP lbs./acre	0.01	0.02	0.03	0.01	-76	0.01	-27	0.01	-34
Part. P lbs/acre	0.00	0.01	0.01	0.01	-252	0.00	-23	0.00	-24
NPOC lbs./acre	0.31	1.28	2.01	0.97	-314	0.73	-57	0.52	-40
TN lbs./acre	0.09	0.19	0.16	0.10	-102	-0.03	18	0.11	-59
NH_4 lbs./acre	0.06	0.12	0.00	0.06	-98	-0.12	100	-0.03	22
Cl lbs./acre	0.08	0.53	2.52	0.45	-565	1.99	-374	-0.06	11
NO_3 lbs/acre	0.10	0.25	0.14	0.15	-141	-0.11	44	0.31	-122
PO_4 lbs/acre	0.03	0.00	0.01	-0.03	100	0.01	*	0.01	*
DON lbs/acre	0.02	0.04	0.13	0.02	-71	0.08	-193	0.06	-147
Cr g/acre		0.22	0.14	NA	NS	-0.08	35	-0.06	26
Ni g/acre		0.20	0.10	NA	NS	-0.10	50	-0.04	20
Cu g/acre		1.09	1.03	NA	NS	-0.06	5	-0.32	29
Zn g/acre		4.50	1.81	NA	NS	-2.69	60	-0.35	8
Cd g/acre		0.01	0.01	NA	NS	0.00	-5	0.00	-12
Pt g/acre		0.00	0.00	NA	NS	0.00	-2	0.00	7
Pb g/acre		0.10	0.03	NA	NS	-0.07	67	-0.08	81

11/17/2011	BPO	COR EOP	COR FS	COR EOP-BPO	% Retention	COR FS-COR EOP	% Retention	COR FS-CCR FS	% Retention
H+ Eq/acre	187.40	28.45	14.14	-158.95	85	-14.32	50	-18.60	57
TSS lbs./acre	0.23	3.68	2.53	3.46	-1505	-1.15	31	-0.66	21
DTP lbs./acre	0.01	0.01	0.01	0.00	-53	-0.01	50	-0.01	44
TP lbs./acre	0.01	0.03	0.01	0.02	-133	-0.01	50	-0.01	47
Part. P lbs/acre	0.00	0.01	0.01	0.01	*	-0.01	50	-0.01	50
NPOC lbs./acre	0.31	1.80	0.73	1.49	-475	-1.07	60	-1.29	64
TN lbs./acre	0.10	0.30	0.07	0.21	-216	-0.23	76	-0.08	53
NH_4 lbs./acre	0.06	0.09	0.02	0.03	-52	-0.07	75	0.02	*
Cl lbs./acre	0.08	0.47	0.17	0.39	-484	-0.30	64	-2.35	93
NO_3 lbs/acre	0.11	0.56	0.11	0.46	-428	-0.46	81	-0.03	25
PO_4 lbs/acre	0.03	0.01	0.01	-0.02	68	0.00	46	0.00	32
DON lbs/acre	0.03	0.11	0.03	0.08	-318	-0.07	70	-0.09	75
Cr g/acre		0.17	0.09	NA	NS	-0.07	43	-0.05	35
Ni g/acre		0.16	0.03	NA	NS	-0.13	81	-0.07	70
Cu g/acre		0.78	0.22	NA	NS	-0.56	72	-0.82	79
Zn g/acre		4.15	0.55	NA	NS	-3.60	87	-1.26	70
Cd g/acre		0.01	0.00	NA	NS	-0.01	64	-0.01	62
Pt g/acre		0.00	0.00	NA	NS	0.00	60	0.00	64
Pb g/acre		0.02	0.01	NA	NS	-0.01	52	-0.02	72

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-5 November 23, 2011 Charlotte Sites Precipitation 0.25″ Conventional Pavement Sites, 0.51″ OGFC Sites

11/23/2011	BPC	CCR EOP	CCR FS	CCR EOP-BPC	% Retention	CCR FS-CCR EOP	% Retention	COR EOP-CCR EOP	% Retention
H+ Eq/acre	46.76	19.93	15.89	-26.84	57	-4.04	20	5.39	-27
TSS lbs./acre	0.03	2.81	0.76	2.78	-9818	-2.05	73	-0.68	24
DTP lbs./acre	0.00	0.00	0.00	0.00	25	0.00	-56	0.01	-188
TP lbs./acre	0.01	0.01	0.01	0.01	-100	0.00	27	0.00	8
Part. P lbs/acre	0.00	0.01	0.00	0.01	-393	0.00	56	-0.01	77
NPOC lbs./acre	0.06	0.27	0.44	0.20	-319	0.18	-66	0.35	-129
TN lbs./acre	0.02	0.05	0.04	0.03	-129	-0.01	23	0.09	-188
NH_4 lbs./acre	0.01	0.02	0.00	0.01	-120	-0.02	100	0.03	-148
Cl lbs./acre	0.12	0.12	0.39	0.00	0	0.28	-241	0.05	-45
NO_3 lbs/acre	0.02	0.04	0.03	0.02	-85	-0.02	38	0.28	-635
PO_4 lbs/acre	0.01	0.00	0.00	-0.01	100	0.00	*	0.01	*
DON lbs/acre	0.01	0.02	0.03	0.01	-162	0.01	-27	0.00	-19
Cr g/acre		0.04	0.03	NA	NS	-0.01	26	-0.03	60
Ni g/acre		0.02	0.02	NA	NS	0.00	5	0.01	-36
Cu g/acre		0.19	0.21	NA	NS	0.03	-14	-0.02	8
Zn g/acre		0.88	0.35	NA	NS	-0.53	61	0.03	-3
Cd g/acre		0.00	0.00	NA	NS	0.00	-22	0.00	-87
Pt g/acre		0.00	0.00	NA	NS	0.00	6	0.00	-15
Pb g/acre		0.01	0.01	NA	NS	0.00	10	0.00	39

11/23/2011	BPO	COR EOP	COR FS	COR EOP-BPO	% Retention	COR FS-COR EOP	% Retention	COR FS-CCR FS	% Retention
H+ Eq/acre	95.39	25.31	25.77	-70.08	73	0.45	-2	9.88	-62
TSS lbs./acre	0.06	2.13	1.31	2.07	-3590	-0.83	39	0.54	-71
DTP lbs./acre	0.01	0.01	0.01	0.00	-5	0.00	-6	0.00	-95
TP lbs./acre	0.01	0.01	0.01	0.00	10	0.00	-38	0.01	-73
Part. P lbs/acre	0.00	0.00	0.01	0.00	45	0.00	-185	0.00	-46
NPOC lbs./acre	0.13	0.61	0.71	0.48	-371	0.09	-15	0.26	-59
TN lbs./acre	0.04	0.13	0.10	0.09	-224	-0.04	27	0.06	-173
NH_4 lbs./acre	0.02	0.04	0.02	0.03	-167	-0.02	47	0.02	*
Cl lbs./acre	0.24	0.17	0.07	-0.07	29	-0.09	56	-0.32	81
NO_3 lbs/acre	0.05	0.32	0.19	0.27	-565	-0.13	41	0.16	-601
PO_4 lbs/acre	0.02	0.01	0.01	-0.01	73	0.00	-35	0.00	-157
DON lbs/acre	0.02	0.03	0.04	0.01	-53	0.01	-31	0.01	-22
Cr g/acre		0.02	0.02	NA	NS	0.01	-32	-0.01	28
Ni g/acre		0.03	0.03	NA	NS	0.01	-21	0.01	-73
Cu g/acre		0.17	0.26	NA	NS	0.09	-54	0.05	-24
Zn g/acre		0.91	0.60	NA	NS	-0.31	34	0.25	-72
Cd g/acre		0.01	0.02	NA	NS	0.01	-175	0.01	-321
Pt g/acre		0.00	0.00	NA	NS	0.00	-11	0.00	-36
Pb g/acre		0.00	0.01	NA	NS	0.00	-71	0.00	-17

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-6 December 7, 2011 Charlotte Sites Precipitation 0.29″ Conventional Pavement Sites, 0.29″ OGFC Sites

12/8/2011	BPC	CCR EOP	CCR FS	CCR EOP-BPC	% Retention	CCR FS-CCR EOP	% Retention	COR EOP-CCR EOP	% Retention
H+ Eq/acre	NS	7.32	7.03	NS	NS	-0.29	4	-0.25	3
TSS lbs./acre	NS	6.87	0.78	NS	NS	-6.09	89	-4.47	65
DTP lbs./acre	NS	0.00	0.00	NS	NS	0.00	18	0.00	-4
TP lbs./acre	NS	0.01	0.00	NS	NS	0.00	43	0.00	-38
Part. P lbs/acre	NS	0.00	0.00	NS	NS	0.00	76	0.00	-84
NPOC lbs./acre	NS	1.49	0.62	NS	NS	-0.88	59	-0.71	48
TN lbs./acre	NS	0.15	0.05	NS	NS	-0.10	68	0.04	-24
NH_4 lbs./acre	NS	0.05	0.00	NS	NS	-0.05	100	0.01	-28
Cl lbs./acre	NS	0.79	0.24	NS	NS	-0.54	69	-0.51	65
NO_3 lbs/acre	NS	0.14	0.02	NS	NS	-0.12	88	0.18	-125
PO_4 lbs/acre	NS	0.00	0.00	NS	NS	0.00	3	0.00	-42
DON lbs/acre	NS	0.08	0.04	NS	NS	-0.04	46	-0.01	18
Cr g/acre		0.08	0.04	NA	NS	-0.04	53	-0.02	26
Ni g/acre		0.07	0.03	NA	NS	-0.04	52	-0.02	30
Cu g/acre		0.48	0.28	NA	NS	-0.20	42	-0.24	51
Zn g/acre		1.58	0.60	NA	NS	-0.98	62	0.26	-16
Cd g/acre		0.01	0.01	NA	NS	0.01	-70	0.00	39
Pt g/acre		0.00	0.00	NA	NS	0.00	34	0.00	-75
Pb g/acre		0.02	0.01	NA	NS	0.00	12	-0.01	62

12/8/2011	BPO	COR EOP	COR FS	COR EOP-BPO	% Retention	COR FS-COR EOP	% Retention	COR FS-CCR FS	% Retention
H+ Eq/acre	NS	7.07	2.67	NS	NS	-4.40	62	-4.35	62
TSS lbs./acre	NS	2.40	0.31	NS	NS	-2.09	87	-0.47	60
DTP lbs./acre	NS	0.01	0.00	NS	NS	0.00	42	0.00	26
TP lbs./acre	NS	0.01	0.00	NS	NS	-0.01	68	0.00	23
Part. P lbs/acre	NS	0.01	0.00	NS	NS	-0.01	88	0.00	10
NPOC lbs./acre	NS	0.78	0.42	NS	NS	-0.36	47	-0.20	33
TN lbs./acre	NS	0.18	0.05	NS	NS	-0.14	75	0.00	1
NH_4 lbs./acre	NS	0.06	0.01	NS	NS	-0.05	88	0.01	*
Cl lbs./acre	NS	0.28	0.35	NS	NS	0.07	-25	0.10	-42
NO_3 lbs/acre	NS	0.32	0.06	NS	NS	-0.25	80	0.05	-275
PO_4 lbs/acre	NS	0.00	0.00	NS	NS	0.00	31	0.00	-1
DON lbs/acre	NS	0.06	0.03	NS	NS	-0.04	59	-0.02	38
Cr g/acre		0.06	0.02	NA	NS	-0.04	68	-0.02	50
Ni g/acre		0.05	0.01	NA	NS	-0.04	72	-0.02	59
Cu g/acre		0.24	0.09	NA	NS	-0.14	60	-0.18	66
Zn g/acre		1.84	0.30	NA	NS	-1.54	84	-0.30	50
Cd g/acre		0.01	0.00	NA	NS	0.00	73	-0.01	90
Pt g/acre		0.00	0.00	NA	NS	0.00	45	0.00	-47
Pb g/acre		0.01	0.00	NA	NS	0.00	51	-0.01	79

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-7 December 16, 2011 Charlotte Sites Precipitation 0.48″ Conventional Pavement Sites, 0.31″ OGFC Sites

12/12/2011	BPC	CCR EOP	CCR FS	CCR EOP-BPC	% Retention	CCR FS-CCR EOP	% Retention	COR EOP-CCR EOP	% Retention
H+ Eq/acre	74.68	31.78	25.59	-42.90	57	-6.19	19	-18.34	58
TSS lbs./acre	0.11	5.17	0.94	5.06	-4656	-4.23	82	-4.84	94
DTP lbs./acre	0.01	0.01	0.01	0.00	11	0.00	-8	0.00	38
TP lbs./acre	NS	0.05	0.01	NS	NS	-0.04	78	-0.04	88
Part. P lbs/acre	NS	0.04	0.00	NS	NS	-0.04	91	-0.04	95
NPOC lbs./acre	NS	0.37	0.33	NS	NS	-0.04	11	0.14	-39
TN lbs./acre	NS	0.10	0.04	NS	NS	-0.06	58	0.08	-82
NH_4 lbs./acre	0.05	0.05	0.00	0.01	-17	-0.05	100	0.04	-69
Cl lbs./acre	0.06	0.22	0.35	0.15	-240	0.13	-61	-0.01	4
NO_3 lbs/acre	0.10	0.19	0.08	0.09	-95	-0.11	60	0.25	-132
PO_4 lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	0.00	*
DON lbs/acre	NS	0.02	0.03	NS	NS	0.01	-35	0.00	-1
Cr g/acre		0.19	0.15	NA	NS	-0.04	20	-0.15	82
Ni g/acre		0.09	0.08	NA	NS	0.00	2	-0.03	33
Cu g/acre		0.72	0.75	NA	NS	0.02	-3	-0.47	65
Zn g/acre		3.09	1.39	NA	NS	-1.70	55	-1.26	41
Cd g/acre		0.05	0.08	NA	NS	0.03	-68	-0.04	95
Pt g/acre		0.00	0.00	NA	NS	0.00	21	0.00	1
Pb g/acre		0.03	0.03	NA	NS	0.00	4	0.00	4

12/12/2011	BPO	COR EOP	COR FS	COR EOP-BPO	% Retention	COR FS-COR EOP	% Retention	COR FS-CCR FS	% Retention
H+ Eq/acre	48.23	13.43	3.12	-34.80	72	-10.31	77	-22.47	88
TSS lbs./acre	0.07	0.34	0.02	0.27	-379	-0.32	95	-0.92	98
DTP lbs./acre	0.00	0.00	0.00	0.00	15	0.00	57	0.00	75
TP lbs./acre	NS	0.01	NS	NS	NS	NS	NS	NS	NS
Part. P lbs/acre	NS	0.00	NS	NS	NS	NS	NS	NS	NS
NPOC lbs./acre	NS	0.51	NS	NS	NS	NS	NS	NS	NS
TN lbs./acre	NS	0.19	NS	NS	NS	NS	NS	NS	NS
NH_4 lbs./acre	0.09	0.09	0.01	0.00	3	-0.08	85	0.01	*
Cl lbs./acre	0.13	0.21	0.12	0.08	-59	-0.09	44	-0.24	67
NO_3 lbs/acre	0.20	0.44	0.11	0.24	-122	-0.33	76	0.03	-42
PO_4 lbs/acre	0.00	0.00	0.00	0.00	*	0.00	69	0.00	*
DON lbs/acre	NS	0.02	NS	NS	NS	NS	NS	NS	NS
Cr g/acre		0.03	0.01	NA	NS	-0.02	60	-0.13	91
Ni g/acre		0.06	0.01	NA	NS	-0.05	80	-0.07	86
Cu g/acre		0.25	0.07	NA	NS	-0.18	73	-0.68	91
Zn g/acre		1.83	0.21	NA	NS	-1.62	89	-1.18	85
Cd g/acre		0.00	0.00	NA	NS	0.00	57	-0.07	99
Pt g/acre		0.00	0.00	NA	NS	0.00	68	0.00	60
Pb g/acre		0.03	0.02	NA	NS	-0.01	35	-0.01	35

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

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Table I-8 December 20, 2011 Charlotte Sites Precipitation 1.26″ Conventional Pavement Sites, 1.07″ OGFC Sites

12/22/2011	BPC	CCR EOP	CCR FS	CCR EOP-BPC	% Retention	CCR FS-CCR EOP	% Retention	COR EOP-CCR EOP	% Retention
H+ Eq/acre	230.32	46.86	29.28	-183.45	80	-17.58	38	-24.96	53
TSS lbs./acre	1.00	16.86	4.88	15.86	-1587	-11.98	71	-9.47	56
DTP lbs./acre	0.02	0.01	0.02	0.00	23	0.00	-16	0.01	-50
TP lbs./acre	0.02	0.04	0.03	0.02	-133	-0.01	23	-0.02	39
Part. P lbs/acre	0.00	0.03	0.02	0.03	*	-0.01	42	-0.02	83
NPOC lbs./acre	0.71	1.88	2.16	1.17	-164	0.28	-15	0.20	-11
TN lbs./acre	0.33	0.47	0.26	0.14	-42	-0.21	45	0.22	-47
NH_4 lbs./acre	0.07	0.15	0.00	0.08	-108	-0.15	100	0.03	-22
Cl lbs./acre	0.25	0.72	1.23	0.47	-191	0.51	-71	-0.15	21
NO_3 lbs/acre	0.18	0.26	0.10	0.09	-50	-0.16	61	0.21	-79
PO_4 lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	0.01	*
DON lbs/acre	0.24	0.30	0.24	0.06	-26	-0.06	21	0.15	-49
Cr g/acre		0.22	0.27	NA	NS	0.05	-24	-0.07	31
Ni g/acre		0.06	0.10	NA	NS	0.04	-76	0.07	-129
Cu g/acre		0.54	1.37	NA	NS	0.84	-156	0.30	-55
Zn g/acre		2.39	3.08	NA	NS	0.69	-29	2.96	-124
Cd g/acre		0.00	0.01	NA	NS	0.01	-114	0.00	-108
Pt g/acre		0.00	0.00	NA	NS	0.00	3	0.00	-52
Pb g/acre		0.02	0.13	NA	NS	0.11	-488	0.00	-3

12/22/2011	BPO	COR EOP	COR FS	COR EOP-BPO	% Retention	COR FS-COR EOP	% Retention	COR FS-CCR FS	% Retention
H+ Eq/acre	195.59	21.90	23.98	-173.69	89	2.09	-10	-5.30	18
TSS lbs./acre	0.85	7.39	3.53	6.54	-771	-3.87	52	-1.36	28
DTP lbs./acre	0.01	0.02	0.02	0.01	-37	0.00	-22	0.01	-57
TP lbs./acre	0.01	0.02	0.03	0.01	-67	0.00	-18	0.00	7
Part. P lbs/acre	0.00	0.00	0.00	0.00	*	0.00	0	-0.01	71
NPOC lbs./acre	0.60	2.08	2.60	1.47	-244	0.52	-25	0.44	-20
TN lbs./acre	0.28	0.69	0.43	0.41	-145	-0.26	38	0.17	-65
NH_4 lbs./acre	0.06	0.18	0.06	0.12	-199	-0.11	64	0.06	*
Cl lbs./acre	0.21	0.57	0.54	0.36	-172	-0.03	6	-0.69	56
NO_3 lbs/acre	0.15	0.47	0.26	0.32	-218	-0.21	44	0.16	-156
PO_4 lbs/acre	0.00	0.01	0.01	0.01	*	0.00	-30	0.01	*
DON lbs/acre	0.20	0.45	0.32	0.25	-121	-0.13	28	0.08	-35
Cr g/acre		0.15	0.05	NA	NS	-0.10	65	-0.22	81
Ni g/acre		0.13	0.04	NA	NS	-0.09	67	-0.06	57
Cu g/acre		0.83	0.31	NA	NS	-0.53	63	-1.06	78
Zn g/acre		5.35	1.01	NA	NS	-4.35	81	-2.07	67
Cd g/acre		0.01	0.01	NA	NS	0.00	-10	0.00	-7
Pt g/acre		0.00	0.00	NA	NS	0.00	36	0.00	0
Pb g/acre		0.02	0.01	NA	NS	-0.01	44	-0.12	90

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-9 January 11, 2012 Charlotte Sites Precipitation 0.61″ Conventional Pavement Sites, 0.51″ OGFC Sites

1/12/2012	BPC	CCR EOP	CCR FS	CCR EOP-BPC	% Retention	CCR FS-CCR EOP	% Retention	COR EOP-CCR EOP	% Retention
H+ Eq/acre	161.17	19.93	12.35	-141.24	88	-7.58	38	-9.97	50
TSS lbs./acre	0.00	9.60	1.51	9.60	*	-8.09	84	-6.69	70
DTP lbs./acre	0.01	0.01	0.01	0.00	-31	0.00	27	0.00	11
TP lbs./acre	0.01	0.03	0.02	0.02	-213	-0.01	31	-0.01	38
Part. P lbs/acre	0.00	0.02	0.01	0.02	*	-0.01	33	-0.01	53
NPOC lbs./acre	0.23	0.75	0.82	0.51	-218	0.07	-9	-0.01	2
TN lbs./acre	0.11	0.15	0.08	0.04	-34	-0.08	51	0.12	-80
NH_4 lbs./acre	0.07	0.10	0.00	0.03	-51	-0.10	100	0.03	-32
Cl lbs./acre	0.16	0.58	0.74	0.42	-264	0.17	-29	-0.06	11
NO_3 lbs/acre	0.01	0.01	0.01	0.00	-2	-0.01	58	0.00	11
PO_4 lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	0.00	*
DON lbs/acre	0.06	0.07	0.07	0.01	-21	0.00	-3	0.10	-135
Cr g/acre		0.07	0.07	NA	NS	0.00	2	-0.03	39
Ni g/acre		0.08	0.06	NA	NS	-0.02	24	0.02	-19
Cu g/acre		0.70	0.83	NA	NS	0.12	-18	-0.22	32
Zn g/acre		3.13	1.40	NA	NS	-1.73	55	0.71	-23
Cd g/acre		0.01	0.00	NA	NS	-0.01	66	0.00	24
Pt g/acre		0.00	0.00	NA	NS	0.00	27	0.00	-55
Pb g/acre		0.01	0.01	NA	NS	0.01	-147	0.00	-3

1/12/2012	BPO	COR EOP	COR FS	COR EOP-BPO	% Retention	COR FS-COR EOP	% Retention	COR FS-CCR FS	% Retention
H+ Eq/acre	134.75	9.96	8.90	-124.79	93	-1.05	11	-3.45	28
TSS lbs./acre	0.00	2.91	3.92	2.91	*	1.01	-35	2.41	-159
DTP lbs./acre	0.01	0.01	0.01	0.00	-39	0.00	-20	0.00	-45
TP lbs./acre	0.01	0.02	0.01	0.01	-131	0.00	25	-0.01	33
Part. P lbs/acre	0.00	0.01	0.00	0.01	*	-0.01	70	-0.01	79
NPOC lbs./acre	0.20	0.73	0.63	0.54	-274	-0.11	15	-0.19	23
TN lbs./acre	0.10	0.27	0.11	0.18	-188	-0.17	60	0.03	-44
NH_4 lbs./acre	0.06	0.13	0.03	0.08	-138	-0.11	80	0.03	*
Cl lbs./acre	0.13	0.51	0.46	0.38	-287	-0.05	11	-0.29	38
NO_3 lbs/acre	0.01	0.01	0.01	0.00	-8	0.00	-17	0.01	-151
PO_4 lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	0.00	*
DON lbs/acre	0.05	0.17	0.09	0.12	-239	-0.08	50	0.01	-15
Cr g/acre		0.04	0.05	NA	NS	0.00	-8	-0.02	33
Ni g/acre		0.10	0.05	NA	NS	-0.05	53	-0.02	25
Cu g/acre		0.48	0.27	NA	NS	-0.21	44	-0.56	67
Zn g/acre		3.84	0.76	NA	NS	-3.08	80	-0.64	46
Cd g/acre		0.01	0.00	NA	NS	-0.01	79	0.00	53
Pt g/acre		0.00	0.00	NA	NS	0.00	32	0.00	-45
Pb g/acre		0.01	0.01	NA	NS	0.00	-77	0.00	26

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-10 January 17, 2012 Charlotte Sites Precipitation 0.86″ Conventional Pavement Sites, 0.95″ OGFC Sites

1/18/2012	BPC	CCR EOP	CCR FS	CCR EOP-BPC	% Retention	CCR FS-CCR EOP	% Retention	COR EOP-CCR EOP	% Retention
H+ Eq/acre	71.85	46.70	NS	-25.16	35	NS	NS	-7.94	17
TSS lbs./acre	0.49	9.14	NS	8.65	-1776	NS	NS	-3.88	42
DTP lbs./acre	0.01	0.01	NS	0.00	-58	NS	NS	0.00	-4
TP lbs./acre	0.01	0.04	NS	0.04	-453	NS	NS	-0.01	25
Part. P lbs/acre	0.00	0.03	NS	0.03	*	NS	NS	-0.01	37
NPOC lbs./acre	0.21	1.00	NS	0.79	-384	NS	NS	0.22	-22
TN lbs./acre	0.06	0.19	NS	0.12	-194	NS	NS	0.13	-72
NH_4 lbs./acre	0.03	0.11	NS	0.08	-253	NS	NS	0.08	-72
Cl lbs./acre	0.12	1.28	NS	1.17	-1003	NS	NS	-0.04	3
NO_3 lbs/acre	0.11	0.19	NS	0.08	-77	NS	NS	0.38	-195
PO_4 lbs/acre	0.00	0.00	NS	0.00	*	NS	NS	0.02	*
DON lbs/acre	0.02	0.06	NS	0.04	-293	NS	NS	-0.01	18
Cr g/acre		0.10	NS	NA	NS	NS	NS	0.00	-4
Ni g/acre		0.12	NS	NA	NS	NS	NS	0.01	-4
Cu g/acre		0.76	NS	NA	NS	NS	NS	0.03	-4
Zn g/acre		3.60	NS	NA	NS	NS	NS	0.16	-4
Cd g/acre		0.00	NS	NA	NS	NS	NS	0.00	-4
Pt g/acre		0.00	NS	NA	NS	NS	NS	0.00	-4
Pb g/acre		0.00	NS	NA	NS	NS	NS	0.00	-4

1/18/2012	BPO	COR EOP	COR FS	COR EOP-BPO	% Retention	COR FS-COR EOP	% Retention	COR FS-CCR FS	% Retention
H+ Eq/acre	79.37	38.76	39.47	-40.61	51	0.71	-2	NS	NS
TSS lbs./acre	0.54	5.26	4.78	4.72	-877	-0.47	9	NS	NS
DTP lbs./acre	0.01	0.01	0.02	0.00	-50	0.01	-55	NS	NS
TP lbs./acre	0.01	0.03	0.03	0.02	-274	0.00	7	NS	NS
Part. P lbs/acre	0.00	0.02	0.01	0.02	*	-0.01	48	NS	NS
NPOC lbs./acre	0.23	1.22	1.26	0.99	-435	0.04	-3	NS	NS
TN lbs./acre	0.07	0.32	0.19	0.25	-357	-0.13	39	NS	NS
NH_4 lbs./acre	0.03	0.18	0.08	0.15	-449	-0.10	56	NS	NS
Cl lbs./acre	0.13	1.24	1.11	1.12	-869	-0.13	11	NS	NS
NO_3 lbs/acre	0.12	0.57	0.35	0.45	-372	-0.23	40	NS	NS
PO_4 lbs/acre	0.00	0.02	0.02	0.02	*	0.01	-49	NS	NS
DON lbs/acre	0.02	0.05	0.05	0.03	-193	0.00	-9	NS	NS
Cr g/acre		0.11	0.08	NA	NS	-0.03	26	NS	NS
Ni g/acre		0.12	0.07	NA	NS	-0.05	41	NS	NS
Cu g/acre		0.80	0.57	NA	NS	-0.23	29	NS	NS
Zn g/acre		3.77	1.26	NA	NS	-2.50	66	NS	NS
Cd g/acre		0.00	0.00	NA	NS	0.00	53	NS	NS
Pt g/acre		0.00	0.00	NA	NS	0.00	28	NS	NS
Pb g/acre		0.01	0.01	NA	NS	0.00	0	NS	NS

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-11 January 20, 2012 Charlotte Sites Precipitation 0.66″ Conventional Pavement Sites, 0.82″ OGFC Sites

1/22/2012	BPC	CCR EOP	CCR FS	CCR EOP-BPC	% Retention	CCR FS-CCR EOP	% Retention	COR EOP-CCR EOP	% Retention
H+ Eq/acre	166.53	20.56	24.41	-145.97	88	3.85	-19	-2.16	11
TSS lbs./acre	0.37	5.64	1.72	5.26	-1408	-3.92	70	-1.62	29
DTP lbs./acre	0.01	0.01	0.01	0.00	11	0.00	-13	0.00	-58
TP lbs./acre	0.01	0.04	0.01	0.03	-391	-0.03	71	-0.02	59
Part. P lbs/acre	0.00	0.03	0.00	0.03	*	-0.03	89	-0.03	85
NPOC lbs./acre	0.23	0.68	0.83	0.45	-196	0.15	-22	0.29	-43
TN lbs./acre	0.09	0.15	0.07	0.05	-59	-0.07	49	0.08	-57
NH_4 lbs./acre	0.06	0.11	0.00	0.05	-76	-0.11	100	0.01	-12
Cl lbs./acre	0.12	1.46	2.12	1.34	-1135	0.66	-45	-0.44	30
NO_3 lbs/acre	0.14	0.16	0.07	0.02	-15	-0.09	53	0.30	-184
PO_4 lbs/acre	0.00	0.01	0.01	0.01	*	0.00	14	-0.01	100
DON lbs/acre	0.01	0.02	0.06	0.01	-105	0.03	-133	0.01	-28
Cr g/acre		0.07	0.06	NA	NS	-0.01	14	-0.01	21
Ni g/acre		0.09	0.07	NA	NS	-0.02	24	0.02	-22
Cu g/acre		0.61	0.68	NA	NS	0.07	-12	0.04	-7
Zn g/acre		0.91	0.60	NA	NS	-0.31	34	1.22	-133
Cd g/acre		0.00	0.01	NA	NS	0.00	-67	0.02	-529
Pt g/acre		0.00	0.00	NA	NS	0.00	17	0.00	-35
Pb g/acre		0.00	0.01	NA	NS	0.00	-123	0.00	-24

1/22/2012	BPO	COR EOP	COR FS	COR EOP-BPO	% Retention	COR FS-COR EOP	% Retention	COR FS-CCR FS	% Retention
H+ Eq/acre	206.90	18.40	16.46	-188.50	91	-1.94	11	-7.95	33
TSS lbs./acre	0.46	4.02	2.72	3.55	-765	-1.30	32	1.00	-58
DTP lbs./acre	0.01	0.01	0.01	0.00	-14	0.00	13	0.00	-23
TP lbs./acre	0.01	0.02	0.01	0.01	-62	0.00	4	0.00	-35
Part. P lbs/acre	0.00	0.00	0.01	0.00	*	0.00	-17	0.00	-64
NPOC lbs./acre	0.28	0.97	0.67	0.68	-240	-0.30	31	-0.16	19
TN lbs./acre	0.12	0.23	0.08	0.12	-101	-0.15	65	0.01	-9
NH_4 lbs./acre	0.08	0.13	0.00	0.05	-59	-0.13	100	0.00	*
Cl lbs./acre	0.15	1.03	0.66	0.88	-599	-0.36	35	-1.46	69
NO_3 lbs/acre	0.17	0.46	0.14	0.28	-162	-0.31	69	0.07	-89
PO_4 lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	-0.01	100
DON lbs/acre	0.02	0.03	0.05	0.02	-110	0.02	-55	-0.01	15
Cr g/acre		0.06	0.05	NA	NS	0.00	8	-0.01	16
Ni g/acre		0.11	0.04	NA	NS	-0.06	59	-0.02	34
Cu g/acre		0.65	0.33	NA	NS	-0.32	49	-0.35	51
Zn g/acre		2.13	0.63	NA	NS	-1.50	70	0.03	-5
Cd g/acre		0.03	0.01	NA	NS	-0.02	75	0.00	7
Pt g/acre		0.00	0.00	NA	NS	0.00	25	0.00	-23
Pb g/acre		0.00	0.00	NA	NS	0.00	-3	0.00	43

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-12 March 3, 2012 Charlotte Sites Precipitation 1.42″ Conventional Pavement Sites, 2.14″ OGFC Sites

3/3/2012	BPC	CCR EOP	CCR FS	CCR EOP-BPC	% Retention	CCR FS-CCR EOP	% Retention	COR EOP-CCR EOP	% Retention
H+ Eq/acre	46.16	36.09	43.42	-10.07	22	7.34	-20	36.11	-100
TSS lbs./acre	0.00	18.55	4.05	18.55	*	-14.50	78	9.21	-50
DTP lbs./acre	0.02	0.02	0.02	0.00	-25	0.00	9	0.02	-81
TP lbs./acre	0.02	0.06	0.04	0.04	-198	-0.02	33	0.07	-121
Part. P lbs/acre	0.00	0.03	0.02	0.03	*	-0.02	50	0.05	-150
NPOC lbs./acre	0.11	1.02	1.91	0.92	-868	0.89	-87	1.42	-139
TN lbs./acre	0.03	0.17	0.12	0.14	-538	-0.05	30	0.64	-373
NH_4 lbs./acre	0.04	0.11	0.07	0.07	-168	-0.04	37	0.26	-238
Cl lbs./acre	0.24	0.88	1.26	0.64	-268	0.38	-43	0.03	-3
NO_3 lbs/acre	0.03	0.05	0.02	0.02	-69	-0.03	59	0.13	-280
PO_4 lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	0.00	*
DON lbs/acre	0.00	0.08	0.06	0.08	*	-0.01	19	0.41	-533
Cr g/acre		0.33	0.31	NA	NS	-0.02	6	-0.26	78
Ni g/acre		0.13	0.10	NA	NS	-0.04	28	0.06	-43
Cu g/acre		1.25	1.21	NA	NS	-0.03	3	-0.12	10
Zn g/acre		5.41	2.46	NA	NS	-2.96	55	3.88	-72
Cd g/acre		0.01	0.01	NA	NS	0.00	28	0.00	19
Pt g/acre		0.00	0.00	NA	NS	0.00	9	0.00	-86
Pb g/acre		0.01	0.01	NA	NS	0.01	-99	0.00	-48

3/3/2012	BPO	COR EOP	COR FS	COR EOP-BPO	% Retention	COR FS-COR EOP	% Retention	COR FS-CCR FS	% Retention
H+ Eq/acre	69.56	72.20	71.18	2.64	-4	-1.02	1	27.76	-64
TSS lbs./acre	0.00	27.77	11.55	27.77	*	-16.22	58	7.50	-185
DTP lbs./acre	0.03	0.04	0.04	0.01	-51	-0.01	13	0.02	-72
TP lbs./acre	0.03	0.13	0.07	0.10	-337	-0.06	47	0.03	-75
Part. P lbs/acre	0.00	0.08	0.03	0.08	*	-0.05	65	0.01	-78
NPOC lbs./acre	0.16	2.44	2.13	2.28	-1433	-0.31	13	0.22	-12
TN lbs./acre	0.04	0.81	0.33	0.77	-1904	-0.48	59	0.21	-179
NH_4 lbs./acre	0.06	0.36	0.40	0.30	-501	0.04	-11	0.34	-496
Cl lbs./acre	0.36	0.91	0.78	0.55	-152	-0.13	14	-0.48	38
NO_3 lbs/acre	0.04	0.18	0.13	0.14	-325	-0.05	27	0.11	-572
PO_4 lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	0.00	*
DON lbs/acre	0.00	0.49	0.00	0.49	#DIV/0!	-0.49	100	-0.06	100
Cr g/acre		0.07	0.10	NA	NS	0.02	-31	-0.22	69
Ni g/acre		0.19	0.13	NA	NS	-0.07	35	0.03	-30
Cu g/acre		1.13	1.02	NA	NS	-0.11	9	-0.19	16
Zn g/acre		9.30	4.15	NA	NS	-5.15	55	1.69	-69
Cd g/acre		0.01	0.01	NA	NS	0.00	-16	0.00	-29
Pt g/acre		0.00	0.00	NA	NS	0.00	36	0.00	-31
Pb g/acre		0.01	0.02	NA	NS	0.01	-73	0.00	-29

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-13 March 9, 2012 Charlotte Sites Precipitation 0.29″ Conventional Pavement Sites, 0.36″ OGFC Sites

3/9/3012	BPC	CCR EOP	CCR FS	CCR EOP-BPC	% Retention	CCR FS-CCR EOP	% Retention	COR EOP-CCR EOP	% Retention
H+ Eq/acre	34.23	NS	13.08	NS	NS	NS	NS	NS	NS
TSS lbs./acre	0.18	NS	0.41	NS	NS	NS	NS	NS	NS
DTP lbs./acre	0.00	NS	0.00	NS	NS	NS	NS	NS	NS
TP lbs./acre	0.00	NS	0.00	NS	NS	NS	NS	NS	NS
Part. P lbs/acre	0.00	NS	0.00	NS	NS	NS	NS	NS	NS
NPOC lbs./acre	0.10	NS	0.39	NS	NS	NS	NS	NS	NS
TN lbs./acre	0.03	NS	0.03	NS	NS	NS	NS	NS	NS
NH_4 lbs./acre	0.02	NS	0.00	NS	NS	NS	NS	NS	NS
Cl lbs./acre	0.10	NS	0.39	NS	NS	NS	NS	NS	NS
NO_3 lbs/acre	0.01	NS	0.00	NS	NS	NS	NS	NS	NS
PO_4 lbs/acre	0.00	NS	0.00	NS	NS	NS	NS	NS	NS
DON lbs/acre	0.01	NS	0.03	NS	NS	NS	NS	NS	NS
Cr g/acre		NS	0.03	NA	NS	NS	NS	NS	NS
Ni g/acre		NS	0.02	NA	NS	NS	NS	NS	NS
Cu g/acre		NS	0.27	NA	NS	NS	NS	NS	NS
Zn g/acre		NS	0.37	NA	NS	NS	NS	NS	NS
Cd g/acre		NS	0.00	NA	NS	NS	NS	NS	NS
Pt g/acre		NS	0.00	NA	NS	NS	NS	NS	NS
Pb g/acre		NS	0.00	NA	NS	NS	NS	NS	NS

3/9/2012	BPO	COR EOP	COR FS	COR EOP-BPO	% Retention	COR FS-COR EOP	% Retention	COR FS-CCR FS	% Retention
H+ Eq/acre	42.49	15.77	8.35	-26.72	63	-7.42	47	-4.74	36
TSS lbs./acre	0.22	0.67	2.10	0.45	-208	1.43	-214	1.70	-417
DTP lbs./acre	0.00	0.00	0.02	0.00	-64	0.01	-369	0.02	-561
TP lbs./acre	0.00	0.01	0.04	0.00	-126	0.03	-582	0.03	-671
Part. P lbs/acre	0.00	0.00	0.02	0.00	*	0.02	-1150	0.02	-825
NPOC lbs./acre	0.12	0.70	0.46	0.58	-482	-0.24	35	0.07	-18
TN lbs./acre	0.03	0.18	0.31	0.14	-435	0.13	-73	0.28	-939
NH_4 lbs./acre	0.02	0.05	0.07	0.03	-183	0.02	-40	0.07	*
Cl lbs./acre	0.12	0.27	0.28	0.15	-123	0.01	-3	-0.11	28
NO_3 lbs/acre	0.01	0.05	0.01	0.04	-406	-0.04	81	0.01	-158
PO_4 lbs/acre	0.00	0.00	0.01	0.00	*	0.01	*	0.01	*
DON lbs/acre	0.02	0.12	0.25	0.11	-666	0.12	-99	0.22	-763
Cr g/acre		0.02	0.01	NA	NS	0.00	24	-0.02	62
Ni g/acre		0.05	0.03	NA	NS	-0.02	34	0.01	-40
Cu g/acre		0.31	0.21	NA	NS	-0.10	33	-0.06	23
Zn g/acre		1.68	0.49	NA	NS	-1.19	71	0.12	-31
Cd g/acre		0.00	0.00	NA	NS	0.00	-226	0.00	-317
Pt g/acre		0.00	0.00	NA	NS	0.00	39	0.00	-35
Pb g/acre		0.00	0.00	NA	NS	0.00	-341	0.00	-73

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-14 March 23, 2012 Charlotte Sites Precipitation 0.46″ Conventional Pavement Sites, 0.68″ OGFC Sites

3/24/2012	BPC	CCR EOP	CCR FS	CCR EOP-BPC	% Retention	CCR FS-CCR EOP	% Retention	COR EOP-CCR EOP	% Retention
H+ Eq/acre	108.32	33.11	18.18	-75.21	69	-14.93	45	-22.64	68
TSS lbs./acre	0.00	1.26	0.08	1.26	*	-1.18	93	5.04	-401
DTP lbs./acre	0.01	0.01	0.01	0.00	-7	0.00	-34	0.00	-26
TP lbs./acre	0.01	0.01	0.01	0.00	-74	0.00	-5	0.03	-288
Part. P lbs/acre	0.00	0.00	0.00	0.00	*	0.00	41	0.03	-708
NPOC lbs./acre	0.19	0.27	0.47	0.08	-43	0.20	-74	0.71	-265
TN lbs./acre	0.07	0.06	0.04	-0.01	18	-0.02	27	0.18	-312
NH_4 lbs./acre	0.02	0.03	0.00	0.01	-23	-0.03	100	0.05	-155
Cl lbs./acre	0.09	0.21	0.74	0.11	-121	0.53	-257	0.06	-31
NO_3 lbs/acre	0.03	0.02	0.01	-0.01	21	-0.01	56	0.02	-68
PO_4 lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	0.00	*
DON lbs/acre	0.05	0.03	0.04	-0.02	35	0.01	-37	0.14	-481
Cr g/acre		0.11	0.19	NA	NS	0.08	-73	-0.09	82
Ni g/acre		0.04	0.12	NA	NS	0.07	-172	0.08	-193
Cu g/acre		0.44	1.28	NA	NS	0.85	-193	0.02	-4
Zn g/acre		1.32	2.02	NA	NS	0.70	-53	2.12	-160
Cd g/acre		0.00	0.00	NA	NS	0.00	-75	0.00	39
Pt g/acre		0.00	0.00	NA	NS	0.00	-16	0.00	-293
Pb g/acre		0.00	0.01	NA	NS	0.01	-999	0.00	-280

3/24/2012	BPO	COR EOP	COR FS	COR EOP-BPO	% Retention	COR FS-COR EOP	% Retention	COR FS-CCR FS	% Retention
H+ Eq/acre	160.13	10.47	9.83	-149.66	93	-0.64	6	-8.35	46
TSS lbs./acre	0.00	6.30	2.20	6.30	*	-4.10	65	2.11	-2583
DTP lbs./acre	0.01	0.01	0.01	0.00	9	0.00	-18	0.00	-11
TP lbs./acre	0.01	0.04	0.02	0.03	-358	-0.02	54	0.01	-68
Part. P lbs/acre	0.00	0.03	0.01	0.03	*	-0.02	73	0.01	-277
NPOC lbs./acre	0.28	0.98	0.52	0.70	-254	-0.46	47	0.05	-11
TN lbs./acre	0.10	0.24	0.14	0.13	-128	-0.10	41	0.10	-231
NH_4 lbs./acre	0.04	0.08	0.08	0.04	-112	0.01	-8	0.08	*
Cl lbs./acre	0.14	0.27	0.16	0.13	-95	-0.11	41	-0.58	78
NO_3 lbs/acre	0.04	0.04	0.02	0.00	10	-0.02	49	0.01	-94
PO_4 lbs/acre	0.00	0.00	0.01	0.00	*	0.01	*	0.01	*
DON lbs/acre	0.07	0.17	0.07	0.10	-155	-0.10	58	0.03	-75
Cr g/acre		0.02	0.01	NA	NS	-0.01	47	-0.18	94
Ni g/acre		0.12	0.03	NA	NS	-0.09	74	-0.08	72
Cu g/acre		0.46	0.25	NA	NS	-0.21	46	-1.04	81
Zn g/acre		3.45	0.44	NA	NS	-3.01	87	-1.58	78
Cd g/acre		0.00	0.00	NA	NS	0.00	56	0.00	84
Pt g/acre		0.00	0.00	NA	NS	0.00	69	0.00	-4
Pb g/acre		0.00	0.00	NA	NS	0.00	49	-0.01	82

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-15 May 22, 2012 Charlotte Sites Precipitation 1.32″ Conventional Pavement Sites, 0.38″ OGFC Sites

5/23/2012	BPC	CCR EOP	CCR FS	CCR EOP-BPC	% Retention	CCR FS-CCR EOP	% Retention	COR EOP-CCR EOP	% Retention
H+ Eq/acre	152.24	374.40	265.84	222.16	-146	-108.56	29	-301.25	80
TSS lbs./acre	11.77	14.85	2.64	3.09	-26	-12.21	82	-12.74	86
DTP lbs./acre	0.02	0.02	0.03	0.00	-1	0.01	-41	-0.01	71
TP lbs./acre	0.02	0.03	0.03	0.01	-65	0.00	-11	0.00	11
Part. P lbs/acre	0.00	0.01	0.01	0.01	*	0.00	38	0.01	-85
NPOC lbs./acre	4.97	0.62	0.96	-4.35	88	0.34	-55	0.37	-59
TN lbs./acre	2.76	0.12	0.10	-2.64	96	-0.02	20	0.07	-57
NH_4 lbs./acre	1.02	0.03	0.00	-0.99	97	-0.03	100	0.04	-138
Cl lbs./acre	0.15	0.06	0.15	-0.09	58	0.09	-140	-0.02	26
NO_3 lbs/acre	0.08	0.05	0.03	-0.03	39	-0.01	28	0.07	-145
PO_4 lbs/acre	0.25	0.00	0.00	-0.25	100	0.00	*	0.00	*
DON lbs/acre	1.95	0.09	0.09	-1.86	95	0.00	-1	0.02	-28
Cr g/acre		0.20	0.21	NA	NS	0.01	-5	-0.19	92
Ni g/acre		0.10	0.06	NA	NS	-0.03	35	-0.04	42
Cu g/acre		0.60	0.73	NA	NS	0.13	-22	-0.31	52
Zn g/acre		3.55	1.03	NA	NS	-2.52	71	-1.30	37
Cd g/acre		0.04	0.00	NA	NS	-0.04	92	-0.04	96
Pt g/acre		0.00	0.00	NA	NS	0.00	-19	0.00	69
Pb g/acre		0.00	0.01	NA	NS	0.00	-304	0.00	52

5/23/2012	BPO	COR EOP	COR FS	COR EOP-BPO	% Retention	COR FS-COR EOP	% Retention	COR FS-CCR FS	% Retention
H+ Eq/acre	43.83	73.16	15.45	29.33	-67	-57.71	79	-250.39	94
TSS lbs./acre	3.39	2.11	0.64	-1.28	38	-1.47	70	-2.01	76
DTP lbs./acre	0.01	0.01	0.01	0.00	-2	0.00	-27	-0.02	74
TP lbs./acre	0.01	0.03	0.01	0.02	-410	-0.01	51	-0.02	60
Part. P lbs/acre	0.00	0.02	0.01	0.02	*	-0.01	71	0.00	11
NPOC lbs./acre	1.43	0.98	0.45	-0.45	31	-0.53	54	-0.50	53
TN lbs./acre	0.79	0.19	0.07	-0.60	76	-0.12	65	-0.03	32
NH_4 lbs./acre	0.29	0.07	0.02	-0.23	77	-0.05	69	0.02	*
Cl lbs./acre	0.04	0.05	0.07	0.00	-8	0.03	-54	-0.08	52
NO_3 lbs/acre	0.02	0.11	0.03	0.09	-422	-0.08	71	0.00	0
PO_4 lbs/acre	0.07	0.00	0.00	-0.07	96	0.00	-22	0.00	*
DON lbs/acre	0.56	0.11	0.04	-0.45	80	-0.07	62	-0.05	52
Cr g/acre		0.02	0.01	NA	NS	-0.01	36	-0.20	95
Ni g/acre		0.06	0.02	NA	NS	-0.03	55	-0.04	60
Cu g/acre		0.29	0.16	NA	NS	-0.13	44	-0.57	78
Zn g/acre		2.24	0.24	NA	NS	-2.01	90	-0.79	77
Cd g/acre		0.00	0.00	NA	NS	0.00	58	0.00	79
Pt g/acre		0.00	0.00	NA	NS	0.00	27	0.00	81
Pb g/acre		0.00	0.00	NA	NS	0.00	-17	-0.01	86

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-16 July 10, 2012 Charlotte Sites Precipitation 0.53″ Conventional Pavement Sites, 0.81″ OGFC Sites

7/11/2012	BPC	CCR EOP	CCR FS	CCR EOP-BPC	% Retention	CCR FS-CCR EOP	% Retention	COR EOP-CCR EOP	% Retention
H+ Eq/acre	2433.48	18.56	NS	-2414.92	99	NS	NS	27.10	-146
TSS lbs./acre	0.00	5.16	NS	5.16	*	NS	NS	6.12	-119
DTP lbs./acre	0.01	0.00	NS	0.00	68	NS	NS	0.01	-292
TP lbs./acre	0.01	0.01	NS	0.01	-127	NS	NS	0.02	-157
Part. P lbs/acre	0.00	0.01	NS	0.01	*	NS	NS	0.02	-135
NPOC lbs./acre	0.32	0.38	NS	0.06	-19	NS	NS	1.27	-337
TN lbs./acre	0.08	0.05	NS	-0.03	36	NS	NS	0.15	-282
NH_4 lbs./acre	0.05	0.02	NS	-0.03	67	NS	NS	0.05	-326
Cl lbs./acre	0.05	0.08	NS	0.03	-58	NS	NS	0.10	-123
NO_3 lbs/acre	0.04	0.02	NS	-0.02	47	NS	NS	0.07	-331
PO_4 lbs/acre	0.00	0.00	NS	0.00	*	NS	NS	0.00	*
DON lbs/acre	0.04	0.04	NS	0.00	6	NS	NS	0.10	-261
Cr g/acre		0.03	NS	NA	NS	NS	NS	0.08	-252
Ni g/acre		0.03	NS	NA	NS	NS	NS	0.15	-491
Cu g/acre		0.37	NS	NA	NS	NS	NS	1.12	-306
Zn g/acre		0.89	NS	NA	NS	NS	NS	9.32	-1048
Cd g/acre		0.00	NS	NA	NS	NS	NS	0.01	-812
Pt g/acre		0.00	NS	NA	NS	NS	NS	0.00	40
Pb g/acre		0.00	NS	NA	NS	NS	NS	0.01	-196

7/11/2012	BPO	COR EOP	COR FS	COR EOP-BPO	% Retention	COR FS-COR EOP	% Retention	COR FS-CCR FS	% Retention
H+ Eq/acre	3719.09	45.66	22.05	-3673.43	99	-23.61	52	NS	NS
TSS lbs./acre	0.00	11.27	4.85	11.27	*	-6.42	57	NS	NS
DTP lbs./acre	0.01	0.01	0.03	0.00	17	0.02	-260	NS	NS
TP lbs./acre	0.01	0.04	0.05	0.03	-282	0.02	-50	NS	NS
Part. P lbs/acre	0.00	0.03	0.03	0.03	*	0.00	9	NS	NS
NPOC lbs./acre	0.84	1.65	1.93	0.80	-95	0.29	-17	NS	NS
TN lbs./acre	0.35	0.20	0.22	-0.14	41	0.01	-7	NS	NS
NH_4 lbs./acre	0.19	0.06	0.06	-0.13	66	-0.01	12	NS	NS
Cl lbs./acre	0.29	0.18	0.27	-0.11	39	0.10	-55	NS	NS
NO_3 lbs/acre	0.03	0.09	0.08	0.06	-206	-0.01	8	NS	NS
PO_4 lbs/acre	0.00	0.00	0.02	0.00	*	0.02	*	NS	NS
DON lbs/acre	0.19	0.13	0.15	-0.06	31	0.02	-16	NS	NS
Cr g/acre		0.11	0.07	NA	NS	-0.04	36	NS	NS
Ni g/acre		0.18	0.17	NA	NS	-0.01	6	NS	NS
Cu g/acre		1.49	1.13	NA	NS	-0.37	24	NS	NS
Zn g/acre		10.21	4.13	NA	NS	-6.08	60	NS	NS
Cd g/acre		0.01	0.04	NA	NS	0.03	-335	NS	NS
Pt g/acre		0.00	0.01	NA	NS	0.00	-357	NS	NS
Pb g/acre		0.01	0.01	NA	NS	0.00	3	NS	NS

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-17 September 4, 2012 Charlotte Sites Precipitation 0.93″ Conventional Pavement Sites, 0.35″ OGFC Sites

9/12/2012	BPC	CCR EOP	CCR FS	CCR EOP-BPC	% Retention	CCR FS-CCR EOP	% Retention	COR EOP-CCR EOP	% Retention
H+ Eq/acre	151.51	94.76	41.67	-56.75	37	-53.09	56	-27.76	29
TSS lbs./acre	0.00	4.23	1.77	4.23	*	-2.46	58	-1.58	37
DTP lbs./acre	0.01	0.00	0.02	-0.01	73	0.02	-458	0.01	-261
TP lbs./acre	0.02	0.02	0.03	0.00	-4	0.01	-82	0.00	-19
Part. P lbs/acre	0.00	0.01	0.01	0.01	*	0.00	31	-0.01	54
NPOC lbs./acre	1.11	1.24	2.60	0.14	-13	1.36	-109	1.03	-82
TN lbs./acre	0.08	0.13	0.20	0.05	-69	0.06	-49	0.09	-71
NH_4 lbs./acre	0.05	0.03	0.05	-0.02	44	0.02	-88	0.07	-267
Cl lbs./acre	0.04	0.08	0.15	0.04	-110	0.07	-95	0.00	-1
NO_3 lbs/acre	0.04	0.09	0.11	0.06	-155	0.01	-16	0.09	-103
PO_4 lbs/acre	0.00	0.00	0.02	0.00	*	0.02	*	0.01	*
DON lbs/acre	0.03	0.09	0.13	0.06	-168	0.04	-47	0.02	-21
Cr g/acre		0.24	0.20	NA	NS	-0.04	17	-0.11	47
Ni g/acre		0.07	0.11	NA	NS	0.04	-58	0.06	-84
Cu g/acre		0.86	1.98	NA	NS	1.11	-129	0.48	-55
Zn g/acre		3.18	1.79	NA	NS	-1.39	44	3.10	-97
Cd g/acre		0.01	0.00	NA	NS	0.00	43	0.00	31
Pt g/acre		0.00	0.00	NA	NS	0.00	-14	0.00	-55
Pb g/acre		0.01	0.02	NA	NS	0.01	-125	0.00	-21

9/12/2012	BPO	COR EOP	COR FS	COR EOP-BPO	% Retention	COR FS-COR EOP	% Retention	COR FS-CCR FS	% Retention
H+ Eq/acre	151.51	67.00	131.61	-84.51	56	64.61	-96	89.94	-216
TSS lbs./acre	0.00	2.64	2.23	2.64	*	-0.41	16	0.46	-26
DTP lbs./acre	0.01	0.01	0.02	0.00	1	0.00	-29	0.00	16
TP lbs./acre	0.02	0.02	0.03	0.00	-24	0.01	-46	0.00	4
Part. P lbs/acre	0.00	0.01	0.01	0.00	*	0.01	-86	0.00	-25
NPOC lbs./acre	1.11	2.27	1.78	1.16	-105	-0.49	21	-0.82	31
TN lbs./acre	0.08	0.23	0.23	0.15	-190	0.00	0	0.03	-16
NH_4 lbs./acre	0.05	0.10	0.02	0.05	-107	-0.07	74	-0.02	50
Cl lbs./acre	0.04	0.08	0.15	0.04	-112	0.07	-96	0.00	-1
NO_3 lbs/acre	0.04	0.19	0.21	0.15	-417	0.03	-15	0.11	-101
PO_4 lbs/acre	0.00	0.01	0.00	0.01	*	-0.01	100	-0.02	100
DON lbs/acre	0.03	0.11	0.16	0.08	-224	0.05	-45	0.03	-19
Cr g/acre		0.13	0.05	NA	NS	-0.07	58	-0.14	74
Ni g/acre		0.13	0.12	NA	NS	-0.01	7	0.01	-8
Cu g/acre		1.34	0.91	NA	NS	-0.43	32	-1.07	54
Zn g/acre		6.28	2.26	NA	NS	-4.02	64	0.47	-26
Cd g/acre		0.00	0.02	NA	NS	0.01	-230	0.01	-299
Pt g/acre		0.00	0.00	NA	NS	0.00	-275	0.00	-411
Pb g/acre		0.01	0.01	NA	NS	0.00	13	-0.01	53

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-18 October 6, 2012 Charlotte Sites Precipitation 0.62″ Conventional Pavement Sites, 0.60″ OGFC Sites

10/7/2012	BPC	CCR EOP	CCR FS	CCR EOP-BPC	% Retention	CCR FS-CCR EOP	% Retention	COR EOP-CCR EOP	% Retention
H+ Eq/acre	1362.52	61.72	74.68	-1300.80	95	12.96	-21	47.38	-77
TSS lbs./acre	3.51	11.72	5.33	8.21	-234	-6.39	55	-6.90	59
DTP lbs./acre	0.04	0.00	0.01	-0.03	87	0.01	-113	0.00	-70
TP lbs./acre	0.05	0.03	0.02	-0.01	31	-0.02	48	-0.01	31
Part. P lbs/acre	0.01	0.03	0.01	0.02	-143	-0.02	75	-0.01	48
NPOC lbs./acre	1.32	0.73	0.75	-0.59	45	0.02	-3	0.82	-113
TN lbs./acre	0.20	0.11	0.08	-0.10	48	-0.03	25	0.17	-155
NH_4 lbs./acre	0.07	0.02	0.02	-0.04	63	0.00	8	0.09	-372
Cl lbs./acre	0.06	0.05	0.09	-0.01	10	0.04	-76	0.04	-74
NO_3 lbs/acre	0.16	0.06	0.06	-0.10	61	0.00	-2	0.21	-338
PO_4 lbs/acre	0.01	0.00	0.00	-0.01	100	0.00	*	0.00	*
DON lbs/acre	0.12	0.08	0.05	-0.04	37	-0.03	35	0.05	-67
Cr g/acre		0.16	0.13	NA	NS	-0.03	17	-0.11	68
Ni g/acre		0.06	0.05	NA	NS	-0.01	20	0.07	-123
Cu g/acre		0.62	0.60	NA	NS	-0.02	3	0.32	-53
Zn g/acre		2.06	1.36	NA	NS	-0.69	34	5.11	-249
Cd g/acre		0.00	0.00	NA	NS	0.00	58	0.00	-49
Pt g/acre		0.00	0.00	NA	NS	0.00	-72	0.00	-31
Pb g/acre		0.01	0.01	NA	NS	0.00	-7	0.00	32

10/7/2012	BPO	COR EOP	COR FS	COR EOP-BPO	% Retention	COR FS-COR EOP	% Retention	COR FS-CCR FS	% Retention
H+ Eq/acre	1318.57	109.10	55.38	-1209.47	92	-53.73	49	-19.30	26
TSS lbs./acre	3.51	4.82	0.94	1.31	-37	-3.88	81	-4.39	82
DTP lbs./acre	0.04	0.01	0.01	-0.03	78	0.00	-3	0.00	18
TP lbs./acre	0.05	0.02	0.01	-0.02	53	-0.01	41	0.00	22
Part. P lbs/acre	0.01	0.01	0.00	0.00	-26	-0.01	66	0.00	28
NPOC lbs./acre	1.32	1.55	0.75	0.23	-17	-0.80	51	0.00	0
TN lbs./acre	0.20	0.27	0.10	0.07	-34	-0.18	65	0.01	-19
NH_4 lbs./acre	0.07	0.11	0.01	0.05	-73	-0.10	91	-0.01	53
Cl lbs./acre	0.06	0.09	0.06	0.03	-56	-0.03	30	-0.03	30
NO_3 lbs/acre	0.16	0.27	0.09	0.11	-71	-0.18	67	0.03	-43
PO_4 lbs/acre	0.01	0.00	0.00	-0.01	100	0.00	*	0.00	*
DON lbs/acre	0.12	0.13	0.07	0.01	-6	-0.06	46	0.02	-37
Cr g/acre		0.05	0.02	NA	NS	-0.03	57	-0.11	84
Ni g/acre		0.14	0.05	NA	NS	-0.08	63	0.00	-4
Cu g/acre		0.94	0.38	NA	NS	-0.56	59	-0.22	36
Zn g/acre		7.17	0.95	NA	NS	-6.22	87	-0.41	30
Cd g/acre		0.00	0.01	NA	NS	0.00	-40	0.01	-399
Pt g/acre		0.00	0.00	NA	NS	0.00	-176	0.00	-110
Pb g/acre		0.01	0.00	NA	NS	0.00	23	0.00	51

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-19 October 11, 2011 Davidson County Sites Precipitation 1.98″

10/12/2011	BP	DCR EOP	DCR FS	DCR EOP-BP	% Retention	DCR FS-DCR EOP	% Retention	NCR EOP-DCR EOP	% Retention
H+ Eq/acre	1020.04	82.73	35.99	-937.31	92	-46.73	56	-38.57	47
TSS lbs./acre	0.30	5.20	6.51	4.90	-1638	1.31	-25	14.77	-284
DTP lbs./acre	0.02	0.02	0.04	0.00	13	0.02	-109	0.01	-31
TP lbs./acre	0.02	0.03	0.05	0.00	-22	0.03	-94	0.02	-56
Part. P lbs/acre	0.00	0.01	0.01	0.01	*	0.00	-57	0.01	-118
NPOC lbs./acre	0.82	1.18	2.29	0.36	-44	1.11	-94	0.39	-33
TN lbs./acre	0.14	0.15	0.20	0.00	-3	0.05	-32	0.03	-19
NH_4 lbs./acre	0.07	0.05	0.03	-0.01	19	-0.02	40	0.04	-81
Cl lbs./acre	0.17	0.52	1.24	0.36	-212	0.71	-136	-0.16	31
NO_3 lbs/acre	0.04	0.05	0.04	0.00	-11	-0.01	23	-0.01	14
PO_4 lbs/acre	0.00	0.00	0.01	0.00	*	0.01	*	0.00	*
DON lbs/acre	0.08	0.10	0.16	0.01	-16	0.07	-68	0.00	3
Cr g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Ni g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cu g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Zn g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cd g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pt g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pb g/acre		NS	NS	NA	NS	NS	NS	NS	NS

10/12/2011	BP	NCR EOP	NCR FS	NCR EOP-BP	% Retention	NCR FS-NCR EOP	% Retention	NCR FS-DCR FS	% Retention
H+ Eq/acre	1020.04	44.15	44.43	-975.89	96	0.27	-1	8.43	-23
TSS lbs./acre	0.30	19.97	4.36	19.67	-6576	-15.62	78	-2.16	33
DTP lbs./acre	0.02	0.03	0.04	0.00	-14	0.02	-60	0.00	0
TP lbs./acre	0.02	0.04	0.05	0.02	-89	0.01	-15	0.00	7
Part. P lbs/acre	0.00	0.02	0.01	0.02	*	-0.01	52	0.00	33
NPOC lbs./acre	0.82	1.57	2.06	0.75	-92	0.48	-31	-0.24	10
TN lbs./acre	0.14	0.18	0.18	0.03	-23	0.00	-1	-0.02	8
NH_4 lbs./acre	0.07	0.10	0.07	0.03	-47	-0.02	23	0.04	-132
Cl lbs./acre	0.17	0.36	0.56	0.19	-115	0.20	-54	-0.68	55
NO_3 lbs/acre	0.04	0.04	0.02	0.00	4	-0.02	45	-0.01	38
PO_4 lbs/acre	0.00	0.00	0.01	0.00	*	0.01	*	0.00	44
DON lbs/acre	0.08	0.09	0.12	0.01	-12	0.02	-26	-0.05	28
Cr g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Ni g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cu g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Zn g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cd g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pt g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pb g/acre		NS	NS	NA	NS	NS	NS	NS	NS

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-20 October 18, 2011 Davidson County Sites Precipitation 1.04″

10/19/2011	BP	DCR EOP	DCR FS	DCR EOP-BP	% Retention	DCR FS-DCR EOP	% Retention	NCR EOP-DCR EOP	% Retention
H+ Eq/acre	151.00	18.96	22.08	-132.05	87	3.13	-17	13.18	-70
TSS lbs./acre	0.79	3.65	1.24	2.86	-364	-2.41	66	-0.36	10
DTP lbs./acre	0.01	0.01	0.01	0.00	3	0.01	-63	0.00	-44
TP lbs./acre	0.02	0.02	0.05	0.00	-11	0.03	-171	0.01	-32
Part. P lbs/acre	0.01	0.01	0.03	0.00	-29	0.03	-280	0.00	-20
NPOC lbs./acre	0.31	0.94	0.95	0.63	-206	0.01	-1	-0.15	16
TN lbs./acre	0.06	0.07	0.06	0.01	-15	-0.01	14	0.04	-59
NH_4 lbs./acre	0.05	0.04	0.00	-0.01	23	-0.04	100	0.02	-43
Cl lbs./acre	0.03	0.21	0.62	0.18	-622	0.41	-197	0.07	-35
NO_3 lbs/acre	0.10	0.09	0.05	-0.01	11	-0.04	48	0.04	-49
PO_4 lbs/acre	0.00	0.00	0.02	0.00	*	0.02	*	0.00	*
DON lbs/acre	0.00	0.02	0.05	0.02	1190	0.03	-161	0.02	-94
Cr g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Ni g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cu g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Zn g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cd g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pt g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pb g/acre		NS	NS	NA	NS	NS	NS	NS	NS

10/19/2011	BP	NCR EOP	NCR FS	NCR EOP-BP	% Retention	NCR FS-NCR EOP	% Retention	NCR FS-DCR FS	% Retention
H+ Eq/acre	151.00	32.14	52.82	-118.87	79	20.68	-64	30.74	-139
TSS lbs./acre	0.79	3.28	6.96	2.50	-318	3.67	-112	5.72	-462
DTP lbs./acre	0.01	0.01	0.02	0.00	-39	0.00	-32	0.00	-17
TP lbs./acre	0.02	0.02	0.03	0.01	-46	0.01	-28	-0.02	38
Part. P lbs/acre	0.01	0.01	0.01	0.00	-55	0.00	-24	-0.02	61
NPOC lbs./acre	0.31	0.79	1.14	0.48	-158	0.35	-44	0.19	-20
TN lbs./acre	0.06	0.11	0.11	0.05	-82	-0.01	7	0.04	-71
NH_4 lbs./acre	0.05	0.06	0.07	0.01	-10	0.01	-18	0.07	*
Cl lbs./acre	0.03	0.28	0.34	0.25	-877	0.06	-21	-0.28	45
NO_3 lbs/acre	0.10	0.13	0.03	0.03	-32	-0.10	77	-0.02	34
PO_4 lbs/acre	0.00	0.00	0.01	0.00	*	0.01	*	-0.01	26
DON lbs/acre	0.00	0.04	0.05	0.04	2210	0.01	-18	-0.01	12
Cr g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Ni g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cu g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Zn g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cd g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pt g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pb g/acre		NS	NS	NA	NS	NS	NS	NS	NS

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-21 October 28, 2011 Davidson County Sites Precipitation 0.82″

10/29/2011	BP	DCR EOP	DCR FS	DCR EOP-BP	% Retention	DCR FS-DCR EOP	% Retention	NCR EOP-DCR EOP	% Retention
H+ Eq/acre	320.45	26.57	20.03	-293.88	92	-6.54	25	-0.10	0
TSS lbs./acre	0.56	0.65	0.85	0.10	-17	0.19	-29	1.70	-260
DTP lbs./acre	0.01	0.01	0.01	-0.01	56	0.00	-62	0.01	-111
TP lbs./acre	0.02	0.01	0.01	-0.01	65	0.00	-62	0.01	-135
Part. P lbs/acre	0.00	0.00	0.00	0.00	100	0.00	*	0.00	*
NPOC lbs./acre	0.26	0.29	0.48	0.04	-14	0.18	-63	0.14	-47
TN lbs./acre	0.11	0.05	0.05	-0.06	58	0.00	-11	0.04	-88
NH_4 lbs./acre	0.11	0.04	0.01	-0.08	66	-0.03	75	0.02	-41
Cl lbs./acre	0.07	0.18	0.51	0.11	-169	0.33	-180	0.07	-41
NO_3 lbs/acre	0.27	0.08	0.12	-0.19	69	0.04	-47	0.03	-41
PO_4 lbs/acre	0.00	0.00	0.01	0.00	*	0.01	*	0.00	*
DON lbs/acre	0.00	0.00	0.02	0.00	*	0.02	*	0.02	*
Cr g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Ni g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cu g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Zn g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cd g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pt g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pb g/acre		NS	NS	NA	NS	NS	NS	NS	NS

10/29/2011	BP	NCR EOP	NCR FS	NCR EOP-BP	% Retention	NCR FS-NCR EOP	% Retention	NCR FS-DCR FS	% Retention
H+ Eq/acre	320.45	26.47	14.95	-293.98	92	-11.52	44	-5.08	25
TSS lbs./acre	0.56	2.35	1.37	1.80	-322	-0.99	42	0.52	-61
DTP lbs./acre	0.01	0.01	0.01	0.00	7	0.00	7	0.00	-21
TP lbs./acre	0.02	0.02	0.02	0.00	17	0.00	0	0.00	-45
Part. P lbs/acre	0.00	0.00	0.00	0.00	59	0.00	-67	0.00	*
NPOC lbs./acre	0.26	0.43	0.55	0.17	-68	0.13	-29	0.08	-16
TN lbs./acre	0.11	0.09	0.05	-0.02	21	-0.04	45	0.00	7
NH_4 lbs./acre	0.11	0.06	0.02	-0.06	52	-0.04	72	0.01	-58
Cl lbs./acre	0.07	0.26	0.25	0.19	-278	-0.01	5	-0.27	52
NO_3 lbs/acre	0.27	0.12	0.09	-0.16	57	-0.03	28	-0.04	31
PO_4 lbs/acre	0.00	0.00	0.01	0.00	*	0.01	*	0.00	22
DON lbs/acre	0.00	0.02	0.02	0.02	*	0.00	8	0.00	-4
Cr g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Ni g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cu g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Zn g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cd g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pt g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pb g/acre		NS	NS	NA	NS	NS	NS	NS	NS

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-22 November 3, 2011 Davidson County Sites Precipitation 1.64″

11/4/2011	BP	DCR EOP	DCR FS	DCR EOP-BP	% Retention	DCR FS-DCR EOP	% Retention	NCR EOP-DCR EOP	% Retention
H+ Eq/acre	640.91	25.06	35.48	-615.85	96	10.42	-42	8.67	-35
TSS lbs./acre	1.11	19.71	5.24	18.59	-1668	-14.46	73	-18.49	94
DTP lbs./acre	0.03	0.03	0.03	0.00	2	0.00	-10	0.00	13
TP lbs./acre	0.04	0.05	0.04	0.01	-37	-0.01	23	-0.02	36
Part. P lbs/acre	0.01	0.02	0.01	0.01	-195	-0.01	*	-0.01	*
NPOC lbs./acre	0.51	1.14	0.86	0.63	-124	-0.28	25	-0.31	27
TN lbs./acre	0.22	0.18	0.09	-0.05	21	-0.08	47	-0.01	7
NH_4 lbs./acre	0.23	0.14	0.00	-0.09	39	-0.14	100	-0.01	10
Cl lbs./acre	0.14	0.66	0.62	0.52	-382	-0.04	6	-0.17	26
NO_3 lbs/acre	0.55	0.30	0.19	-0.24	44	-0.12	39	-0.02	7
PO_4 lbs/acre	0.00	0.00	0.02	0.00	*	0.02	*	0.00	*
DON lbs/acre	0.00	0.00	0.05	0.00	*	0.05	*	0.00	*
Cr g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Ni g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cu g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Zn g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cd g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pt g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pb g/acre		NS	NS	NA	NS	NS	NS	NS	NS

11/4/2011	BP	NCR EOP	NCR FS	NCR EOP-BP	% Retention	NCR FS-NCR EOP	% Retention	NCR FS-DCR FS	% Retention
H+ Eq/acre	640.91	33.73	NS	-607.18	95	NS	NS	NS	NS
TSS lbs./acre	1.11	1.21	NS	0.10	-9	NS	NS	NS	NS
DTP lbs./acre	0.03	0.03	NS	0.00	14	NS	NS	NS	NS
TP lbs./acre	0.04	0.03	NS	0.00	12	NS	NS	NS	NS
Part. P lbs/acre	0.01	0.01	NS	0.00	2	NS	NS	NS	NS
NPOC lbs./acre	0.51	0.84	NS	0.33	-64	NS	NS	NS	NS
TN lbs./acre	0.22	0.16	NS	-0.06	26	NS	NS	NS	NS
NH_4 lbs./acre	0.23	0.13	NS	-0.10	45	NS	NS	NS	NS
Cl lbs./acre	0.14	0.49	NS	0.35	-258	NS	NS	NS	NS
NO_3 lbs/acre	0.55	0.28	NS	-0.26	48	NS	NS	NS	NS
PO_4 lbs/acre	0.00	0.00	NS	0.00	*	NS	NS	NS	NS
DON lbs/acre	0.00	0.00	NS	0.00	*	NS	NS	NS	NS
Cr g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Ni g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cu g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Zn g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cd g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pt g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pb g/acre		NS	NS	NA	NS	NS	NS	NS	NS

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-23 November 16, 2011 Davidson County Sites Precipitation 2.85″

11/17/2011	BP	DCR EOP	DCR FS	DCR EOP-BP	% Retention	DCR FS-DCR EOP	% Retention	NCR EOP-DCR EOP	% Retention
H+ Eq/acre	377.40	NS	67.89	NS	NS	NS	NS	NS	NS
TSS lbs./acre	0.65	NS	4.37	NS	NS	NS	NS	NS	NS
DTP lbs./acre	0.04	NS	0.06	NS	NS	NS	NS	NS	NS
TP lbs./acre	0.04	NS	0.04	NS	NS	NS	NS	NS	NS
Part. P lbs/acre	0.00	NS	-0.02	NS	NS	NS	NS	NS	NS
NPOC lbs./acre	0.63	NS	2.06	NS	NS	NS	NS	NS	NS
TN lbs./acre	0.20	NS	0.19	NS	NS	NS	NS	NS	NS
NH_4 lbs./acre	0.10	NS	0.00	NS	NS	NS	NS	NS	NS
Cl lbs./acre	0.25	NS	1.24	NS	NS	NS	NS	NS	NS
NO_3 lbs/acre	0.29	NS	0.12	NS	NS	NS	NS	NS	NS
PO_4 lbs/acre	0.15	NS	0.00	NS	NS	NS	NS	NS	NS
DON lbs/acre	0.06	NS	0.17	NS	NS	NS	NS	NS	NS
Cr g/acre		NS	0.18	NA	NS	NS	NS	NS	NS
Ni g/acre		NS	0.13	NA	NS	NS	NS	NS	NS
Cu g/acre		NS	0.93	NA	NS	NS	NS	NS	NS
Zn g/acre		NS	2.19	NA	NS	NS	NS	NS	NS
Cd g/acre		NS	0.03	NA	NS	NS	NS	NS	NS
Pt g/acre		NS	0.00	NA	NS	NS	NS	NS	NS
Pb g/acre		NS	0.02	NA	NS	NS	NS	NS	NS

11/17/2011	BP	NCR EOP	NCR FS	NCR EOP-BP	% Retention	NCR FS-NCR EOP	% Retention	NCR FS-DCR FS	% Retention
H+ Eq/acre	377.40	85.68	98.27	-291.72	77	12.59	-15	30.39	-45
TSS lbs./acre	0.65	37.44	7.03	36.80	-5697	-30.41	81	2.67	-61
DTP lbs./acre	0.04	0.04	0.04	0.00	1	0.01	-17	-0.01	20
TP lbs./acre	0.04	0.09	0.04	0.05	-131	-0.04	50	0.01	-20
Part. P lbs/acre	0.00	0.05	0.00	0.05	*	-0.05	100	0.02	*
NPOC lbs./acre	0.63	1.70	2.46	1.07	-172	0.76	-45	0.40	-19
TN lbs./acre	0.20	0.25	0.19	0.05	-25	-0.06	24	0.00	2
NH_4 lbs./acre	0.10	0.00	0.00	-0.10	100	0.00	*	0.00	*
Cl lbs./acre	0.25	1.05	0.99	0.80	-322	-0.06	5	-0.25	20
NO_3 lbs/acre	0.29	0.43	0.15	0.14	-49	-0.28	65	0.03	-26
PO_4 lbs/acre	0.15	0.00	0.00	-0.15	100	0.00	*	0.00	*
DON lbs/acre	0.06	0.15	0.16	0.10	-173	0.00	-2	-0.01	7
Cr g/acre		0.33	0.45	NA	NS	0.12	-36	0.27	-147
Ni g/acre		0.14	0.12	NA	NS	-0.02	14	0.00	2
Cu g/acre		1.03	1.01	NA	NS	-0.02	2	0.08	-9
Zn g/acre		4.15	2.20	NA	NS	-1.95	47	0.01	-1
Cd g/acre		0.04	0.02	NA	NS	-0.02	46	-0.01	24
Pt g/acre		0.00	0.00	NA	NS	0.00	0	0.00	-2
Pb g/acre		0.03	0.04	NA	NS	0.00	-8	0.01	-54

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-24 December 16, 2011 Davidson County Sites Precipitation 0.73″

12/12/2011	BP	DCR EOP	DCR FS	DCR EOP-BP	% Retention	DCR FS-DCR EOP	% Retention	NCR EOP-DCR EOP	% Retention
H+ Eq/acre	121.70	26.29	22.68	-95.40	78	-3.61	14	-1.57	6
TSS lbs./acre	0.08	2.71	0.66	2.63	-3181	-2.05	76	2.94	-108
DTP lbs./acre	0.01	0.01	0.01	0.00	-13	0.00	21	0.00	16
TP lbs./acre	0.01	NS	0.01	NS	NS	NS	NS	NS	NS
Part. P lbs/acre	0.00	NS	0.00	NS	NS	NS	NS	NS	NS
NPOC lbs./acre	0.22	NS	0.54	NS	NS	NS	NS	NS	NS
TN lbs./acre	0.11	NS	0.09	NS	NS	NS	NS	NS	NS
NH_4 lbs./acre	0.07	0.09	0.00	0.02	-32	-0.09	100	-0.02	17
Cl lbs./acre	0.15	0.51	0.46	0.37	-253	-0.06	12	-0.11	22
NO_3 lbs/acre	0.23	0.28	0.23	0.04	-19	-0.05	18	0.01	-5
PO_4 lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	0.00	*
DON lbs/acre	0.00	NS	0.04	NS	NS	NS	NS	NS	NS
Cr g/acre		0.15	0.05	NA	NS	-0.10	67	-0.08	56
Ni g/acre		0.07	0.02	NA	NS	-0.04	64	-0.01	13
Cu g/acre		0.36	0.20	NA	NS	-0.16	45	-0.13	37
Zn g/acre		1.98	0.83	NA	NS	-1.15	58	0.57	-29
Cd g/acre		0.01	0.00	NA	NS	-0.01	68	0.00	-29
Pt g/acre		0.00	0.00	NA	NS	0.00	35	0.00	31
Pb g/acre		0.04	0.03	NA	NS	-0.01	24	-0.01	24

12/12/2011	BP	NCR EOP	NCR FS	NCR EOP-BP	% Retention	NCR FS-NCR EOP	% Retention	NCR FS-DCR FS	% Retention
H+ Eq/acre	121.70	24.72	29.04	-96.98	80	4.32	-17	6.36	-28
TSS lbs./acre	0.08	5.66	3.22	5.57	-6740	-2.44	43	2.56	-385
DTP lbs./acre	0.01	0.01	0.01	0.00	5	0.00	-33	0.00	-42
TP lbs./acre	0.01	0.02	0.02	0.01	-74	0.00	9	0.00	-18
Part. P lbs/acre	0.00	0.01	0.00	0.01	*	0.00	60	0.00	29
NPOC lbs./acre	0.22	0.40	0.59	0.18	-83	0.19	-48	0.05	-9
TN lbs./acre	0.11	0.14	0.08	0.03	-27	-0.05	39	-0.01	8
NH_4 lbs./acre	0.07	0.08	0.00	0.01	-9	-0.08	100	0.00	*
Cl lbs./acre	0.15	0.40	0.38	0.25	-175	-0.02	5	-0.08	17
NO_3 lbs/acre	0.23	0.29	0.18	0.06	-24	-0.11	39	-0.05	23
PO_4 lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	0.00	*
DON lbs/acre	0.00	0.01	0.04	0.01	*	0.03	-237	0.00	-12
Cr g/acre		0.07	0.07	NA	NS	0.00	-8	0.02	-44
Ni g/acre		0.06	0.04	NA	NS	-0.02	26	0.02	-78
Cu g/acre		0.23	0.19	NA	NS	-0.03	15	0.00	2
Zn g/acre		2.55	0.98	NA	NS	-1.56	61	0.15	-19
Cd g/acre		0.02	0.01	NA	NS	-0.01	44	0.00	-126
Pt g/acre		0.00	0.00	NA	NS	0.00	29	0.00	24
Pb g/acre		0.03	0.03	NA	NS	0.00	-1	0.00	-1

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-25 January 20, 2012 Davidson County Sites Precipitation 0.34″

1/22/2012	BP	DCR EOP	DCR FS	DCR EOP-BP	% Retention	DCR FS-DCR EOP	% Retention	NCR EOP-DCR EOP	% Retention
H+ Eq/acre	635.96	7.76	11.74	-628.20	99	3.97	-51	NS	NS
TSS lbs./acre	0.19	1.19	1.45	0.99	-516	0.26	-22	NS	NS
DTP lbs./acre	0.00	0.00	0.00	0.00	-8	0.00	13	NS	NS
TP lbs./acre	0.00	0.01	0.01	0.00	NS	NS	NS	NS	NS
Part. P lbs/acre	0.00	0.00	0.00	0.00	NS	NS	NS	NS	NS
NPOC lbs./acre	0.21	0.38	0.52	0.17	NS	NS	NS	NS	NS
TN lbs./acre	0.09	0.07	0.05	-0.02	NS	NS	NS	NS	NS
NH_4 lbs./acre	0.04	0.04	0.00	-0.01	16	-0.04	100	NS	NS
Cl lbs./acre	0.07	0.64	1.00	0.58	-829	0.36	-56	NS	NS
NO_3 lbs/acre	0.13	0.14	0.08	0.00	-1	-0.06	41	NS	NS
PO_4 lbs/acre	0.01	0.00	0.00	-0.01	100	0.00	*	NS	NS
DON lbs/acre	0.02	0.01	0.03	-0.02	NS	NS	NS	NS	NS
Cr g/acre		0.08	0.02	NA	NS	-0.06	77	NS	NS
Ni g/acre		0.03	0.02	NA	NS	-0.02	49	NS	NS
Cu g/acre		0.28	0.13	NA	NS	-0.15	54	NS	NS
Zn g/acre		0.27	0.11	NA	NS	-0.16	59	NS	NS
Cd g/acre		0.00	0.00	NA	NS	0.00	68	NS	NS
Pt g/acre		0.00	0.00	NA	NS	0.00	30	NS	NS
Pb g/acre		0.00	0.00	NA	NS	0.00	-32	NS	NS

1/22/2012	BP	NCR EOP	NCR FS	NCR EOP-BP	% Retention	NCR FS-NCR EOP	% Retention	NCR FS-DCR FS	% Retention
H+ Eq/acre	635.96	NS	2.36	NS	NS	NS	NS	-9.37	80
TSS lbs./acre	0.19	NS	1.05	NS	NS	NS	NS	-0.40	28
DTP lbs./acre	0.00	NS	NS	NS	NS	NS	NS	NS	NS
TP lbs./acre	0.00	NS	NS	NS	NS	NS	NS	NS	NS
Part. P lbs/acre	0.00	NS	NS	NS	NS	NS	NS	NS	NS
NPOC lbs./acre	0.21	NS	4.76	NS	NS	NS	NS	4.24	-814
TN lbs./acre	0.09	NS	2.30	NS	NS	NS	NS	2.25	-4937
NH_4 lbs./acre	0.04	NS	0.08	NS	NS	NS	NS	0.08	*
Cl lbs./acre	0.07	NS	1.79	NS	NS	NS	NS	0.78	-78
NO_3 lbs/acre	0.13	NS	0.02	NS	NS	NS	NS	-0.06	75
PO_4 lbs/acre	0.01	NS	0.26	NS	NS	NS	NS	0.26	*
DON lbs/acre	0.02	NS	2.23	NS	NS	NS	NS	2.21	-7929
Cr g/acre		NS	0.02	NA	NS	NS	NS	0.00	-12
Ni g/acre		NS	0.04	NA	NS	NS	NS	0.02	-117
Cu g/acre		NS	0.15	NA	NS	NS	NS	0.02	-14
Zn g/acre		NS	0.48	NA	NS	NS	NS	0.37	-339
Cd g/acre		NS	0.00	NA	NS	NS	NS	0.00	-34
Pt g/acre		NS	0.00	NA	NS	NS	NS	0.00	-146
Pb g/acre		NS	0.00	NA	NS	NS	NS	0.00	-162

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-26 March 3, 2012 Davidson County Sites Precipitation 0.54″

3/3/2012	BP	DCR EOP	DCR FS	DCR EOP-BP	% Retention	DCR FS-DCR EOP	% Retention	NCR EOP-DCR EOP	% Retention
H+ Eq/acre	56.80	12.97	12.71	-43.83	77	-0.25	2	-2.42	19
TSS lbs./acre	0.33	0.46	0.87	0.14	-42	0.41	-89	3.45	-747
DTP lbs./acre	0.01	0.01	0.01	0.00	-8	0.00	-38	0.00	-10
TP lbs./acre	0.01	0.01	0.01	0.00	-22	0.00	-34	0.03	-315
Part. P lbs/acre	0.00	0.00	0.00	0.00	*	0.00	-10	0.03	-2754
NPOC lbs./acre	0.22	0.23	0.43	0.01	-5	0.20	-90	0.43	-190
TN lbs./acre	0.09	0.03	0.04	-0.05	62	0.01	-35	0.03	-100
NH_4 lbs./acre	0.00	0.00	0.00	0.00	*	0.00	*	0.00	*
Cl lbs./acre	0.10	3.04	4.06	2.94	-2879	1.02	-33	-0.97	32
NO_3 lbs/acre	0.02	0.02	0.01	0.00	2	0.00	14	0.02	-89
PO_4 lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	0.00	*
DON lbs/acre	0.08	0.03	0.04	-0.05	65	0.01	-42	0.03	-101
Cr g/acre		0.08	0.05	NA	NS	-0.03	34	-0.05	63
Ni g/acre		0.03	0.04	NA	NS	0.02	-62	0.01	-42
Cu g/acre		0.26	0.36	NA	NS	0.10	-40	0.11	-42
Zn g/acre		0.35	2.35	NA	NS	2.00	-571	0.80	-229
Cd g/acre		0.00	0.00	NA	NS	0.00	-225	0.00	-65
Pt g/acre		0.00	0.00	NA	NS	0.00	-10	0.00	-10
Pb g/acre		0.00	0.01	NA	NS	0.01	-325	0.00	-30

3/3/2012	BP	NCR EOP	NCR FS	NCR EOP-BP	% Retention	NCR FS-NCR EOP	% Retention	NCR FS-DCR FS	% Retention
H+ Eq/acre	56.80	10.55	NS	-46.25	81	NS	NS	NS	NS
TSS lbs./acre	0.33	3.92	NS	3.59	-1100	NS	NS	NS	NS
DTP lbs./acre	0.01	0.01	NS	0.00	-19	NS	NS	NS	NS
TP lbs./acre	0.01	0.04	NS	0.03	-404	NS	NS	NS	NS
Part. P lbs/acre	0.00	0.03	NS	0.03	*	NS	NS	NS	NS
NPOC lbs./acre	0.22	0.66	NS	0.44	-204	NS	NS	NS	NS
TN lbs./acre	0.09	0.06	NS	-0.02	24	NS	NS	NS	NS
NH_4 lbs./acre	0.00	0.00	NS	0.00	*	NS	NS	NS	NS
Cl lbs./acre	0.10	2.07	NS	1.97	-1931	NS	NS	NS	NS
NO_3 lbs/acre	0.02	0.03	NS	0.01	-85	NS	NS	NS	NS
PO_4 lbs/acre	0.00	0.00	NS	0.00	*	NS	NS	NS	NS
DON lbs/acre	0.08	0.06	NS	-0.02	30	NS	NS	NS	NS
Cr g/acre		0.03	NS	NA	NS	NS	NS	NS	NS
Ni g/acre		0.04	NS	NA	NS	NS	NS	NS	NS
Cu g/acre		0.37	NS	NA	NS	NS	NS	NS	NS
Zn g/acre		1.15	NS	NA	NS	NS	NS	NS	NS
Cd g/acre		0.00	NS	NA	NS	NS	NS	NS	NS
Pt g/acre		0.00	NS	NA	NS	NS	NS	NS	NS
Pb g/acre		0.00	NS	NA	NS	NS	NS	NS	NS

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-27 March 23, 2012 Davidson County Sites Precipitation 0.55″

3/24/2012	BP	DCR EOP	DCR FS	DCR EOP-BP	% Retention	DCR FS-DCR EOP	% Retention	NCR EOP-DCR EOP	% Retention
H+ Eq/acre	170.73	18.79	10.88	-151.94	89	-7.91	42	-4.58	24
TSS lbs./acre	0.12	0.20	1.51	0.08	-63	1.31	-645	1.37	-673
DTP lbs./acre	0.01	0.01	0.01	0.00	-31	0.00	-31	0.00	9
TP lbs./acre	0.01	0.01	0.01	0.00	-47	0.00	-46	0.00	-41
Part. P lbs/acre	0.00	0.00	0.00	0.00	*	0.00	-163	0.00	-446
NPOC lbs./acre	0.21	0.59	1.15	0.39	-188	0.56	-95	0.00	1
TN lbs./acre	0.09	0.09	0.09	0.00	2	0.00	3	0.00	-2
NH_4 lbs./acre	0.05	0.06	0.00	0.01	-21	-0.06	100	-0.01	20
Cl lbs./acre	0.08	0.98	1.92	0.91	-1133	0.93	-95	-0.25	25
NO_3 lbs/acre	0.04	0.04	0.02	0.00	-13	-0.02	43	0.00	7
PO_4 lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	0.00	*
DON lbs/acre	0.05	0.04	0.08	-0.01	20	0.04	-110	0.01	-29
Cr g/acre		0.11	0.09	NA	NS	-0.03	23	-0.06	55
Ni g/acre		0.06	0.09	NA	NS	0.03	-45	0.00	6
Cu g/acre		0.51	0.58	NA	NS	0.07	-14	-0.04	8
Zn g/acre		0.85	0.95	NA	NS	0.09	-11	0.62	-73
Cd g/acre		0.00	0.00	NA	NS	0.00	-88	0.00	-20
Pt g/acre		0.00	0.00	NA	NS	0.00	-61	0.00	-52
Pb g/acre		0.00	0.01	NA	NS	0.01	-430	0.00	-39

3/24/2012	BP	NCR EOP	NCR FS	NCR EOP-BP	% Retention	NCR FS-NCR EOP	% Retention	NCR FS-DCR FS	% Retention
H+ Eq/acre	170.73	14.21	11.80	-156.52	92	-2.42	17	0.92	-8
TSS lbs./acre	0.12	1.57	1.11	1.45	-1161	-0.46	29	-0.41	27
DTP lbs./acre	0.01	0.01	0.01	0.00	-19	0.00	-65	0.00	-14
TP lbs./acre	0.01	0.01	0.02	0.01	-108	0.00	-37	0.00	-33
Part. P lbs/acre	0.00	0.01	0.01	0.01	*	0.00	0	0.00	-107
NPOC lbs./acre	0.21	0.59	1.34	0.38	-185	0.75	-128	0.18	-16
TN lbs./acre	0.09	0.09	0.11	0.00	-1	0.01	-15	0.02	-21
NH_4 lbs./acre	0.05	0.04	0.00	0.00	3	-0.04	100	0.00	*
Cl lbs./acre	0.08	0.73	1.87	0.66	-820	1.14	-155	-0.05	2
NO_3 lbs/acre	0.04	0.04	0.02	0.00	-5	-0.02	52	0.00	21
PO_4 lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	0.00	*
DON lbs/acre	0.05	0.05	0.10	0.00	-3	0.05	-102	0.02	-24
Cr g/acre		0.05	0.05	NA	NS	-0.01	12	-0.04	48
Ni g/acre		0.06	0.09	NA	NS	0.03	-47	0.00	4
Cu g/acre		0.47	0.60	NA	NS	0.13	-28	0.02	-4
Zn g/acre		1.48	0.95	NA	NS	-0.53	36	0.00	0
Cd g/acre		0.00	0.00	NA	NS	0.00	-60	0.00	-2
Pt g/acre		0.00	0.00	NA	NS	0.00	-128	0.00	-115
Pb g/acre		0.00	0.02	NA	NS	0.02	-842	0.01	-146

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-28 April 5, 2012 Davidson County Sites Precipitation 0.62″

4/6/2012	BP	DCR EOP	DCR FS	DCR EOP-BP	% Retention	DCR FS-DCR EOP	% Retention	NCR EOP-DCR EOP	% Retention
H+ Eq/acre	305.03	38.95	23.58	-266.08	87	-15.37	39	7.53	-19
TSS lbs./acre	1.26	1.71	1.49	0.44	-35	-0.21	13	-0.89	52
DTP lbs./acre	0.00	0.01	0.01	0.00	-71	0.00	2	0.00	62
TP lbs./acre	0.01	0.02	0.01	0.00	-22	0.00	17	-0.01	57
Part. P lbs/acre	0.01	0.01	0.01	0.00	-1	0.00	28	-0.01	54
NPOC lbs./acre	0.24	1.01	0.61	0.77	-314	-0.40	40	-0.46	46
TN lbs./acre	0.14	0.13	0.05	-0.01	5	-0.08	59	-0.04	28
NH_4 lbs./acre	0.08	0.07	0.00	-0.01	10	-0.07	100	-0.07	100
Cl lbs./acre	0.06	0.80	0.78	0.74	-1160	-0.02	2	-0.34	43
NO_3 lbs/acre	0.06	0.06	0.01	0.01	-12	-0.05	82	-0.01	22
PO_4 lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	0.00	*
DON lbs/acre	0.07	0.06	0.05	0.00	4	-0.01	21	0.02	-30
Cr g/acre		0.14	0.06	NA	NS	-0.09	60	NS	NS
Ni g/acre		0.06	0.08	NA	NS	0.02	-32	NS	NS
Cu g/acre		0.47	0.37	NA	NS	-0.10	22	NS	NS
Zn g/acre		0.82	0.50	NA	NS	-0.32	39	NS	NS
Cd g/acre		0.00	0.01	NA	NS	0.00	-170	NS	NS
Pt g/acre		0.00	0.00	NA	NS	0.00	-260	NS	NS
Pb g/acre		0.01	0.01	NA	NS	0.00	-37	NS	NS

4/6/2012	BP	NCR EOP	NCR FS	NCR EOP-BP	% Retention	NCR FS-NCR EOP	% Retention	NCR FS-DCR FS	% Retention
H+ Eq/acre	305.03	46.48	NS	-258.55	85	NS	NS	NS	NS
TSS lbs./acre	1.26	0.82	NS	-0.44	35	NS	NS	NS	NS
DTP lbs./acre	0.00	0.00	NS	0.00	35	NS	NS	NS	NS
TP lbs./acre	0.01	0.01	NS	-0.01	48	NS	NS	NS	NS
Part. P lbs/acre	0.01	0.00	NS	-0.01	*	NS	NS	NS	NS
NPOC lbs./acre	0.24	0.55	NS	0.30	-125	NS	NS	NS	NS
TN lbs./acre	0.14	0.10	NS	-0.04	31	NS	NS	NS	NS
NH_4 lbs./acre	0.08	0.00	NS	-0.08	100	NS	NS	NS	NS
Cl lbs./acre	0.06	0.46	NS	0.39	-620	NS	NS	NS	NS
NO_3 lbs/acre	0.06	0.05	NS	-0.01	13	NS	NS	NS	NS
PO_4 lbs/acre	0.00	0.00	NS	0.00	*	NS	NS	NS	NS
DON lbs/acre	0.07	0.08	NS	0.02	-25	NS	NS	NS	NS
Cr g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Ni g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cu g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Zn g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Cd g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pt g/acre		NS	NS	NA	NS	NS	NS	NS	NS
Pb g/acre		NS	NS	NA	NS	NS	NS	NS	NS

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-29 May 22, 2012 Davidson County Sites Precipitation 0.55″

5/23/2012	BP	DCR EOP	DCR FS	DCR EOP-BP	% Retention	DCR FS-DCR EOP	% Retention	NCR EOP-DCR EOP	% Retention
H+ Eq/acre	449.07	67.40	53.41	-381.67	85	-13.99	21	22.46	-33
TSS lbs./acre	0.08	0.80	0.66	0.72	-867	-0.14	18	1.80	-224
DTP lbs./acre	0.01	0.01	0.01	0.00	-31	0.00	-12	0.00	-20
TP lbs./acre	0.01	0.01	0.01	0.00	-47	0.00	-25	0.01	-87
Part. P lbs/acre	0.00	0.00	0.00	0.00	*	0.00	-124	0.01	-621
NPOC lbs./acre	0.33	0.30	0.30	-0.03	9	0.00	-1	0.14	-48
TN lbs./acre	0.06	0.04	0.03	-0.02	28	-0.01	24	0.02	-45
NH_4 lbs./acre	0.03	0.02	0.00	-0.01	42	-0.02	100	0.00	-3
Cl lbs./acre	0.01	0.03	0.08	0.02	-137	0.05	-138	0.09	-283
NO_3 lbs/acre	0.02	0.01	0.01	-0.01	29	0.00	32	0.01	-73
PO_4 lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	0.00	*
DON lbs/acre	0.02	0.02	0.03	0.00	12	0.01	-32	0.02	-72
Cr g/acre		0.04	0.02	NA	NS	-0.02	51	0.00	12
Ni g/acre		0.03	0.05	NA	NS	0.02	-96	0.01	-30
Cu g/acre		0.22	0.17	NA	NS	-0.05	21	0.07	-31
Zn g/acre		0.54	0.20	NA	NS	-0.34	64	0.50	-93
Cd g/acre		0.00	0.00	NA	NS	0.00	59	0.00	-2
Pt g/acre		0.00	0.00	NA	NS	0.00	-1	0.00	58
Pb g/acre		0.00	0.00	NA	NS	0.00	-12	0.00	12

5/23/2012	BP	NCR EOP	NCR FS	NCR EOP-BP	% Retention	NCR FS-NCR EOP	% Retention	NCR FS-DCR FS	% Retention
H+ Eq/acre	449.07	89.85	70.60	-359.22	80	-19.25	21	17.19	-32
TSS lbs./acre	0.08	2.61	2.30	2.52	-3036	-0.30	12	1.64	-250
DTP lbs./acre	0.01	0.01	0.01	0.00	-57	0.00	-8	0.00	-16
TP lbs./acre	0.01	0.02	0.02	0.01	-174	0.00	10	0.00	-35
Part. P lbs/acre	0.00	0.01	0.00	0.01	*	0.00	35	0.00	-110
NPOC lbs./acre	0.33	0.44	0.61	0.11	-34	0.17	-39	0.31	-102
TN lbs./acre	0.06	0.06	0.10	0.00	-5	0.04	-68	0.07	-222
NH_4 lbs./acre	0.03	0.02	0.00	-0.01	40	-0.02	100	0.00	*
Cl lbs./acre	0.01	0.13	0.29	0.11	-806	0.16	-128	0.21	-267
NO_3 lbs/acre	0.02	0.02	0.01	0.00	-23	-0.01	48	0.00	-32
PO_4 lbs/acre	0.00	0.00	0.01	0.00	*	0.01	*	0.01	*
DON lbs/acre	0.02	0.04	0.10	0.01	-51	0.06	-159	0.07	-237
Cr g/acre		0.03	0.05	NA	NS	0.01	-29	0.03	-131
Ni g/acre		0.03	0.04	NA	NS	0.01	-33	-0.01	11
Cu g/acre		0.28	0.38	NA	NS	0.10	-34	0.21	-123
Zn g/acre		1.04	1.13	NA	NS	0.09	-9	0.93	-478
Cd g/acre		0.00	0.00	NA	NS	0.00	63	0.00	8
Pt g/acre		0.00	0.00	NA	NS	0.00	-7	0.00	56
Pb g/acre		0.00	0.00	NA	NS	0.00	-239	0.00	-165

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-30 June 6, 2012 Davidson County Sites Precipitation 1.34″

6/6/2012	BP	DCR EOP	DCR FS	DCR EOP-BP	% Retention	DCR FS-DCR EOP	% Retention	NCR EOP-DCR EOP	% Retention
H+ Eq/acre	140.95	54.21	NS	-86.74	62	NS	NS	-14.88	27
TSS lbs./acre	0.00	2.61	NS	2.61	#DIV/0!	NS	NS	4.00	-153
DTP lbs./acre	0.01	0.01	NS	0.00	14	NS	NS	0.03	-398
TP lbs./acre	0.01	0.02	NS	0.01	-72	NS	NS	0.05	-302
Part. P lbs/acre	0.00	0.01	NS	0.01	*	NS	NS	0.02	-207
NPOC lbs./acre	0.28	0.76	NS	0.48	-167	NS	NS	3.35	-440
TN lbs./acre	0.04	0.07	NS	0.03	-82	NS	NS	0.16	-223
NH_4 lbs./acre	0.03	0.04	NS	0.01	-53	NS	NS	0.01	-14
Cl lbs./acre	0.03	0.16	NS	0.14	-527	NS	NS	0.68	-412
NO_3 lbs/acre	0.02	0.02	NS	0.00	-7	NS	NS	0.06	-309
PO_4 lbs/acre	0.00	0.00	NS	0.00	*	NS	NS	0.04	*
DON lbs/acre	0.02	0.04	NS	0.02	-135	NS	NS	0.15	-373
Cr g/acre		0.09	NS	NA	NS	NS	NS	0.03	-33
Ni g/acre		0.03	NS	NA	NS	NS	NS	0.22	-667
Cu g/acre		0.41	NS	NA	NS	NS	NS	0.90	-217
Zn g/acre		0.84	NS	NA	NS	NS	NS	6.68	-794
Cd g/acre		0.00	NS	NA	NS	NS	NS	0.19	-6321
Pt g/acre		0.00	NS	NA	NS	NS	NS	0.00	-81
Pb g/acre		0.01	NS	NA	NS	NS	NS	0.02	-146

6/6/2012	BP	NCR EOP	NCR FS	NCR EOP-BP	% Retention	NCR FS-NCR EOP	% Retention	NCR FS-DCR FS	% Retention
H+ Eq/acre	140.95	39.33	72.81	-101.62	72	33.48	-85	NS	NS
TSS lbs./acre	0.00	6.61	3.14	6.61	#DIV/0!	-3.47	53	NS	NS
DTP lbs./acre	0.01	0.04	0.02	0.03	-329	-0.02	42	NS	NS
TP lbs./acre	0.01	0.06	0.03	0.05	-593	-0.03	46	NS	NS
Part. P lbs/acre	0.00	0.02	0.01	0.02	*	-0.01	53	NS	NS
NPOC lbs./acre	0.28	4.11	1.50	3.82	-1345	-2.61	64	NS	NS
TN lbs./acre	0.04	0.24	0.13	0.20	-489	-0.11	47	NS	NS
NH_4 lbs./acre	0.03	0.04	0.00	0.02	-75	-0.04	100	NS	NS
Cl lbs./acre	0.03	0.84	0.44	0.82	-3111	-0.40	47	NS	NS
NO_3 lbs/acre	0.02	0.08	0.02	0.06	-336	-0.05	68	NS	NS
PO_4 lbs/acre	0.00	0.04	0.00	0.04	*	-0.04	*	NS	NS
DON lbs/acre	0.02	0.19	0.12	0.17	-1011	-0.07	36	NS	NS
Cr g/acre		0.12	0.22	NA	NS	0.10	-79	NS	NS
Ni g/acre		0.25	0.10	NA	NS	-0.16	62	NS	NS
Cu g/acre		1.31	0.96	NA	NS	-0.35	27	NS	NS
Zn g/acre		7.52	1.27	NA	NS	-6.25	83	NS	NS
Cd g/acre		0.19	0.01	NA	NS	-0.19	97	NS	NS
Pt g/acre		0.00	0.00	NA	NS	0.00	70	NS	NS
Pb g/acre		0.03	0.02	NA	NS	0.00	9	NS	NS

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-31 June 12, 2012 Davidson County Sites Precipitation 0.55″

6/13/2012	BP	DCR EOP	DCR FS	DCR EOP-BP	% Retention	DCR FS-DCR EOP	% Retention	NCR EOP-DCR EOP	% Retention
H+ Eq/acre	1181.18	8.34	8.80	-1172.84	99	0.46	-6	5.19	-62
TSS lbs./acre	0.00	0.92	0.98	0.92	*	0.06	-7	3.01	-329
DTP lbs./acre	0.00	0.00	0.01	0.00	-4	0.00	-110	0.00	12
TP lbs./acre	0.00	0.00	0.01	0.00	-38	0.01	-170	0.01	-263
Part. P lbs/acre	0.00	0.00	0.00	0.00	*	0.00	-349	0.01	-1087
NPOC lbs./acre	0.27	0.39	0.87	0.12	-45	0.48	-124	0.36	-93
TN lbs./acre	0.06	0.05	0.06	-0.01	14	0.01	-14	0.01	-21
NH_4 lbs./acre	0.03	0.02	0.00	-0.01	30	-0.02	100	-0.02	100
Cl lbs./acre	0.06	0.13	0.26	0.07	-110	0.13	-103	0.08	-65
NO_3 lbs/acre	0.03	0.02	0.02	-0.01	23	-0.01	27	0.01	-31
PO_4 lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	0.00	*
DON lbs/acre	0.03	0.03	0.06	0.00	-2	0.03	-89	0.03	-91
Cr g/acre		0.04	0.03	NA	NS	-0.01	35	-0.01	28
Ni g/acre		0.02	0.05	NA	NS	0.03	-137	0.01	-42
Cu g/acre		0.21	0.35	NA	NS	0.13	-61	0.08	-36
Zn g/acre		0.36	0.49	NA	NS	0.13	-36	0.17	-46
Cd g/acre		0.00	0.00	NA	NS	0.00	35	0.00	-21
Pt g/acre		0.00	0.00	NA	NS	0.00	-14	0.00	-14
Pb g/acre		0.00	0.00	NA	NS	0.00	-22	0.00	-45

6/13/2012	BP	NCR EOP	NCR FS	NCR EOP-BP	% Retention	NCR FS-NCR EOP	% Retention	NCR FS-DCR FS	% Retention
H^+ Eq/acre	1181.18	13.53	14.02	-1167.64	99	0.49	-4	5.22	-59
TSS lbs./acre	0.00	3.93	1.90	3.93	*	-2.03	52	0.92	-94
DTP lbs./acre	0.00	0.00	0.01	0.00	9	0.00	-190	0.00	-22
TP lbs./acre	0.00	0.01	0.02	0.01	-401	0.00	-32	0.01	-77
Part. P lbs/acre	0.00	0.01	0.01	0.01	*	0.00	3	0.01	-155
NPOC lbs./acre	0.27	0.75	1.93	0.48	-181	1.19	-159	1.07	-123
TN lbs./acre	0.06	0.06	0.13	0.00	-4	0.07	-102	0.07	-114
NH_4 lbs./acre	0.03	0.00	0.00	-0.03	100	0.00	*	0.00	*
Cl lbs./acre	0.06	0.21	0.41	0.15	-246	0.20	-95	0.15	-58
NO_3 lbs/acre	0.03	0.03	0.01	0.00	0	-0.02	56	0.00	21
PO_4 lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	0.00	*
DON lbs/acre	0.03	0.06	0.13	0.03	-94	0.07	-120	0.07	-122
Cr g/acre		0.03	0.07	NA	NS	0.04	-128	0.04	-154
Ni g/acre		0.03	0.07	NA	NS	0.04	-154	0.03	-52
Cu g/acre		0.29	0.52	NA	NS	0.22	-77	0.17	-49
Zn g/acre		0.53	0.87	NA	NS	0.34	-64	0.38	-76
Cd g/acre		0.00	0.01	NA	NS	0.00	-337	0.00	-720
Pt g/acre		0.00	0.00	NA	NS	0.00	-19	0.00	-20
Pb g/acre		0.01	0.01	NA	NS	0.00	-50	0.00	-78

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-32 July 10, 2012 Davidson County Sites Precipitation 2.19″

7/11/2012	BP	DCR EOP	DCR FS	DCR EOP-BP	% Retention	DCR FS-DCR EOP	% Retention	NCR EOP-DCR EOP	% Retention
H+ Eq/acre	5654.52	124.19	NC	-5530.33	98	NS	NS	46.39	-37
TSS lbs./acre	1.65	4.86	NC	3.21	*	NS	NS	12.12	-249
DTP lbs./acre	0.01	0.01	NC	0.00	18	NS	NS	0.00	-7
TP lbs./acre	0.01	0.02	NC	0.01	-36	NS	NS	0.01	-71
Part. P lbs/acre	0.00	0.01	NC	0.01	*	NS	NS	0.01	-167
NPOC lbs./acre	1.18	0.93	NC	-0.26	22	NS	NS	0.63	-68
TN lbs./acre	0.21	0.13	NC	-0.08	37	NS	NS	0.04	-30
NH_4 lbs./acre	0.08	0.06	NC	-0.02	23	NS	NS	-0.01	20
Cl lbs./acre	0.30	0.33	NC	0.03	-9	NS	NS	0.03	-9
NO_3 lbs/acre	0.08	0.06	NC	-0.01	15	NS	NS	0.00	-6
PO_4 lbs/acre	0.00	0.00	NC	0.00	*	NS	NS	0.00	*
DON lbs/acre	0.12	0.06	NC	-0.06	47	NS	NS	0.05	-73
Cr g/acre		0.12	NC	NA	NS	NS	NS	0.03	-23
Ni g/acre		0.10	NC	NA	NS	NS	NS	-0.02	22
Cu g/acre		1.15	NC	NA	NS	NS	NS	-0.26	23
Zn g/acre		3.18	NC	NA	NS	NS	NS	-2.17	68
Cd g/acre		0.00	NC	NA	NS	NS	NS	0.00	-51
Pt g/acre		0.00	NC	NA	NS	NS	NS	0.00	-7
Pb g/acre		0.02	NC	NA	NS	NS	NS	-0.01	34

7/11/2012	BP	NCR EOP	NCR FS	NCR EOP-BP	% Retention	NCR FS-NCR EOP	% Retention	NCR FS-DCR FS	% Retention
H^+ Eq/acre	5654.52	170.57	NS	-5483.95	97	NS	NS	NS	NS
TSS lbs./acre	1.65	16.98	NS	15.33	*	NS	NS	NS	NS
DTP lbs./acre	0.01	0.01	NS	0.00	13	NS	NS	NS	NS
TP lbs./acre	0.01	0.03	NS	0.02	-132	NS	NS	NS	NS
Part. P lbs/acre	0.00	0.02	NS	0.02	*	NS	NS	NS	NS
NPOC lbs./acre	1.18	1.55	NS	0.37	-32	NS	NS	NS	NS
TN lbs./acre	0.21	0.17	NS	-0.04	19	NS	NS	NS	NS
NH_4 lbs./acre	0.08	0.05	NS	-0.03	39	NS	NS	NS	NS
Cl lbs./acre	0.30	0.36	NS	0.06	-19	NS	NS	NS	NS
NO_3 lbs/acre	0.08	0.07	NS	-0.01	10	NS	NS	NS	NS
PO_4 lbs/acre	0.00	0.00	NS	0.00	*	NS	NS	NS	NS
DON lbs/acre	0.12	0.11	NS	-0.01	9	NS	NS	NS	NS
Cr g/acre		0.15	NS	NA	NS	NS	NS	NS	NS
Ni g/acre		0.08	NS	NA	NS	NS	NS	NS	NS
Cu g/acre		0.89	NS	NA	NS	NS	NS	NS	NS
Zn g/acre		1.01	NS	NA	NS	NS	NS	NS	NS
Cd g/acre		0.00	NS	NA	NS	NS	NS	NS	NS
Pt g/acre		0.00	NS	NA	NS	NS	NS	NS	NS
Pb g/acre		0.01	NS	NA	NS	NS	NS	NS	NS

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-33 July 20, 2012 Davidson County Sites Precipitation 0.56″

7/20/2012	BP	DCR EOP	DCR FS	DCR EOP-BP	% Retention	DCR FS-DCR EOP	% Retention	NCR EOP-DCR EOP	% Retention
H+ Eq/acre	676.30	29.68	14.05	-646.62	96	-15.63	53	NS	NS
TSS lbs./acre	0.25	0.37	0.22	0.11	-45	-0.15	41	NS	NS
DTP lbs./acre	0.00	0.00	0.01	0.00	7	0.01	-476	NS	NS
TP lbs./acre	0.00	0.01	0.02	0.00	-45	0.01	-206	NS	NS
Part. P lbs/acre	0.00	0.00	0.00	0.00	*	0.00	-3	NS	NS
NPOC lbs./acre	0.30	0.40	0.49	0.10	-33	0.08	-20	NS	NS
TN lbs./acre	0.05	0.05	0.05	0.01	-14	0.00	3	NS	NS
NH_4 lbs./acre	0.00	0.02	0.01	0.02	*	-0.01	37	NS	NS
Cl lbs./acre	0.06	0.07	0.16	0.01	-23	0.09	-119	NS	NS
NO_3 lbs/acre	0.03	0.02	0.01	-0.01	32	-0.01	39	NS	NS
PO_4 lbs/acre	0.00	0.00	0.01	0.00	*	0.01	*	NS	NS
DON lbs/acre	0.04	0.03	0.04	-0.01	25	0.01	-24	NS	NS
Cr g/acre		0.06	0.03	NA	NS	-0.03	45	NS	NS
Ni g/acre		0.03	0.03	NA	NS	0.00	-9	NS	NS
Cu g/acre		0.30	0.20	NA	NS	-0.10	34	NS	NS
Zn g/acre		0.77	0.31	NA	NS	-0.47	60	NS	NS
Cd g/acre		0.00	0.00	NA	NS	0.00	75	NS	NS
Pt g/acre		0.00	0.00	NA	NS	0.00	44	NS	NS
Pb g/acre		0.00	0.00	NA	NS	0.00	13	NS	NS

7/20/2012	BP	NCR EOP	NCR FS	NCR EOP-BP	% Retention	NCR FS-NCR EOP	% Retention	NCR FS-DCR FS	% Retention
H^+ Eq/acre	676.30	NS	19.03	NS	NS	NS	NS	4.98	-35
TSS lbs./acre	0.25	NS	1.01	NS	NS	NS	NS	0.80	-369
DTP lbs./acre	0.00	NS	0.03	NS	NS	NS	NS	0.02	-124
TP lbs./acre	0.00	NS	0.05	NS	NS	NS	NS	0.03	-185
Part. P lbs/acre	0.00	NS	0.02	NS	NS	NS	NS	0.01	-444
NPOC lbs./acre	0.30	NS	0.92	NS	NS	NS	NS	0.44	-90
TN lbs./acre	0.05	NS	0.12	NS	NS	NS	NS	0.07	-130
NH_4 lbs./acre	0.00	NS	0.05	NS	NS	NS	NS	0.04	-258
Cl lbs./acre	0.06	NS	0.45	NS	NS	NS	NS	0.29	-182
NO_3 lbs/acre	0.03	NS	0.01	NS	NS	NS	NS	0.00	7
PO_4 lbs/acre	0.00	NS	0.03	NS	NS	NS	NS	0.02	-170
DON lbs/acre	0.04	NS	0.07	NS	NS	NS	NS	0.04	-101
Cr g/acre		NS	0.05	NA	NS	NS	NS	0.02	-56
Ni g/acre		NS	0.04	NA	NS	NS	NS	0.01	-25
Cu g/acre		NS	0.30	NA	NS	NS	NS	0.10	-52
Zn g/acre		NS	0.91	NA	NS	NS	NS	0.60	-196
Cd g/acre		NS	0.00	NA	NS	NS	NS	0.00	-394
Pt g/acre		NS	0.00	NA	NS	NS	NS	0.00	-15
Pb g/acre		NS	0.01	NA	NS	NS	NS	0.00	-72

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-34 August 22, 2012 Davidson County Sites Precipitation 1.42″

8/23/2012	BP	DCR EOP	DCR FS	DCR EOP-BP	% Retention	DCR FS-DCR EOP	% Retention	NCR EOP-DCR EOP	% Retention
H+ Eq/acre	3421.69	287.56	24.29	-3134.13	92	-263.27	92	NS	NS
TSS lbs./acre	0.00	2.45	1.40	2.45	*	-1.06	43	NS	NS
DTP lbs./acre	0.00	0.02	0.04	0.02	-3603	0.02	-111	NS	NS
TP lbs./acre	0.00	0.04	0.07	0.04	-6777	0.04	-95	NS	NS
Part. P lbs/acre	0.00	0.02	0.03	0.02	*	0.01	-76	NS	NS
NPOC lbs./acre	0.02	0.81	1.05	0.79	-4946	0.25	-30	NS	NS
TN lbs./acre	0.00	0.18	0.14	0.17	-4883	-0.04	22	NS	NS
NH_4 lbs./acre	0.00	0.06	0.03	0.06	-2155	-0.03	51	NS	NS
Cl lbs./acre	0.00	0.09	0.12	0.09	-3131	0.02	-25	NS	NS
NO_3 lbs/acre	0.00	0.10	0.09	0.10	-4772	-0.01	14	NS	NS
PO_4 lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	NS	NS
DON lbs/acre	0.00	0.00	0.00	0.00	-231	0.00	16	NS	NS
Cr g/acre		0.09	0.13	NA	NS	0.03	-35	NS	NS
Ni g/acre		0.03	0.10	NA	NS	0.07	-215	NS	NS
Cu g/acre		0.35	1.13	NA	NS	0.78	-224	NS	NS
Zn g/acre		1.57	1.27	NA	NS	-0.30	19	NS	NS
Cd g/acre		0.00	0.00	NA	NS	0.00	-206	NS	NS
Pt g/acre		0.00	0.00	NA	NS	0.00	12	NS	NS
Pb g/acre		0.01	0.03	NA	NS	0.01	-107	NS	NS

8/23/2012	BP	NCR EOP	NCR FS	NCR EOP-BP	% Retention	NCR FS-NCR EOP	% Retention	NCR FS-DCR FS	% Retention
H^+ Eq/acre	626.51	NS	NS	NS	NS	NS	NS	NS	NS
TSS lbs./acre	0.00	NS	NS	NS	NS	NS	NS	NS	NS
DTP lbs./acre	0.00	NS	NS	NS	NS	NS	NS	NS	NS
TP lbs./acre	0.00	NS	NS	NS	NS	NS	NS	NS	NS
Part. P lbs/acre	0.00	NS	NS	NS	NS	NS	NS	NS	NS
NPOC lbs./acre	0.02	NS	NS	NS	NS	NS	NS	NS	NS
TN lbs./acre	0.00	NS	NS	NS	NS	NS	NS	NS	NS
NH_4 lbs./acre	0.00	NS	NS	NS	NS	NS	NS	NS	NS
Cl lbs./acre	0.00	NS	NS	NS	NS	NS	NS	NS	NS
NO_3 lbs/acre	0.00	NS	NS	NS	NS	NS	NS	NS	NS
PO_4 lbs/acre	0.00	NS	NS	NS	NS	NS	NS	NS	NS
DON lbs/acre	0.00	NS	NS	NS	NS	NS	NS	NS	NS
Cr g/acre		NS	NS	NS	NS	NS	NS	NS	NS
Ni g/acre		NS	NS	NS	NS	NS	NS	NS	NS
Cu g/acre		NS	NS	NS	NS	NS	NS	NS	NS
Zn g/acre		NS	NS	NS	NS	NS	NS	NS	NS
Cd g/acre		NS	NS	NS	NS	NS	NS	NS	NS
Pt g/acre		NS	NS	NS	NS	NS	NS	NS	NS
Pb g/acre		NS	NS	NS	NS	NS	NS	NS	NS

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-35 September 4, 2012 Davidson County Sites Precipitation 0.84″

9/5/2012	BP	DCR EOP	DCR FS	DCR EOP-BP	% Retention	DCR FS-DCR EOP	% Retention	NCR EOP-DCR EOP	% Retention
H+ Eq/acre	1432.95	61.54	34.29	-1371.41	96	-27.25	44	30.30	-49
TSS lbs./acre	0.00	0.83	0.57	0.83	*	-0.25	31	2.50	-303
DTP lbs./acre	0.00	0.00	0.01	0.00	35	0.01	-285	0.00	-124
TP lbs./acre	0.00	0.01	0.01	0.00	-95	0.01	-92	0.01	-99
Part. P lbs/acre	0.00	0.00	0.00	0.00	*	0.00	4	0.00	-87
NPOC lbs./acre	0.30	0.36	0.60	0.06	-21	0.24	-65	0.55	-151
TN lbs./acre	0.04	0.05	0.05	0.01	-12	0.00	-7	0.03	-73
NH_4 lbs./acre	0.02	0.02	0.00	0.00	-8	-0.02	100	0.02	-89
Cl lbs./acre	0.04	0.05	0.07	0.01	-13	0.02	-40	0.04	-87
NO_3 lbs/acre	0.03	0.02	0.01	0.00	13	-0.01	50	0.03	-131
PO_4 lbs/acre	0.00	0.00	0.01	0.00	*	0.01	*	0.00	*
DON lbs/acre	0.02	0.03	0.05	0.00	-22	0.02	-76	0.01	-52
Cr g/acre		0.06	0.04	NA	NS	-0.02	32	0.09	-153
Ni g/acre		0.03	0.04	NA	NS	0.01	-21	0.04	-109
Cu g/acre		0.36	0.30	NA	NS	-0.06	17	0.30	-84
Zn g/acre		0.59	0.49	NA	NS	-0.10	17	1.57	-267
Cd g/acre		0.00	0.00	NA	NS	0.00	-36	0.00	-307
Pt g/acre		0.00	0.00	NA	NS	0.00	18	0.00	36
Pb g/acre		0.01	0.01	NA	NS	0.00	8	0.00	-61

9/5/2012	BP	NCR EOP	NCR FS	NCR EOP-BP	% Retention	NCR FS-NCR EOP	% Retention	NCR FS-DCR FS	% Retention
H^+ Eq/acre	1432.95	91.83	42.20	-1341.12	94	-49.64	54	7.90	-23
TSS lbs./acre	0.00	3.32	1.04	3.32	*	-2.28	69	0.47	-82
DTP lbs./acre	0.00	0.01	0.02	0.00	-46	0.02	-275	0.01	-118
TP lbs./acre	0.00	0.01	0.03	0.01	-288	0.01	-99	0.02	-106
Part. P lbs/acre	0.00	0.01	0.01	0.01	*	0.00	6	0.00	-82
NPOC lbs./acre	0.30	0.91	1.37	0.61	-204	0.47	-51	0.78	-130
TN lbs./acre	0.04	0.08	0.10	0.04	-94	0.02	-24	0.05	-99
NH_4 lbs./acre	0.02	0.04	0.03	0.02	-105	-0.01	21	0.03	*
Cl lbs./acre	0.04	0.09	0.13	0.05	-111	0.04	-39	0.06	-84
NO_3 lbs/acre	0.03	0.06	0.06	0.03	-100	0.00	3	0.04	-348
PO_4 lbs/acre	0.00	0.00	0.01	0.00	*	0.01	*	0.01	-143
DON lbs/acre	0.02	0.04	0.07	0.02	-86	0.03	-62	0.02	-39
Cr g/acre		0.15	0.13	NA	NS	-0.01	9	0.10	-241
Ni g/acre		0.07	0.06	NA	NS	0.00	4	0.03	-65
Cu g/acre		0.66	0.61	NA	NS	-0.06	8	0.31	-102
Zn g/acre		2.16	1.00	NA	NS	-1.16	54	0.51	-105
Cd g/acre		0.01	0.00	NA	NS	0.00	83	0.00	49
Pt g/acre		0.00	0.00	NA	NS	0.00	-56	0.00	-21
Pb g/acre		0.01	0.01	NA	NS	0.00	-18	0.01	-106

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-36 October 6, 2012 Davidson County Sites Precipitation 1.14″

10/7/2012	BP	DCR EOP	DCR FS	DCR EOP-BP	% Retention	DCR FS-DCR EOP	% Retention	NCR EOP-DCR EOP	% Retention
H+ Eq/acre	4884.91	591.54	165.35	-4293.37	88	-426.19	72	-162.36	27
TSS lbs./acre	0.00	0.97	1.36	0.97	*	0.39	-40	3.62	-373
DTP lbs./acre	0.01	0.01	0.02	0.00	6	0.01	-157	0.00	2
TP lbs./acre	0.01	0.01	0.03	0.00	-25	0.02	-181	0.00	-47
Part. P lbs/acre	0.00	0.00	0.01	0.00	*	0.01	-251	0.00	-194
NPOC lbs./acre	0.63	0.55	0.95	-0.09	14	0.40	-74	0.37	-67
TN lbs./acre	0.14	0.09	0.08	-0.04	32	-0.01	14	0.04	-41
NH_4 lbs./acre	0.08	0.03	0.00	-0.06	67	-0.03	100	0.00	14
Cl lbs./acre	0.06	0.08	0.16	0.02	-38	0.08	-101	0.02	-28
NO_3 lbs/acre	0.08	0.06	0.07	-0.02	23	0.01	-17	0.03	-41
PO_4 lbs/acre	0.00	0.00	0.00	0.00	*	0.00	*	0.00	*
DON lbs/acre	0.06	0.06	0.07	0.00	-6	0.01	-10	0.04	-61
Cr g/acre		0.08	0.03	NA	NS	-0.05	59	-0.02	28
Ni g/acre		0.04	0.06	NA	NS	0.02	-47	0.03	-71
Cu g/acre		0.39	0.44	NA	NS	0.05	-14	0.13	-34
Zn g/acre		1.29	0.76	NA	NS	-0.53	41	0.03	-2
Cd g/acre		0.00	0.00	NA	NS	0.00	-5	0.00	23
Pt g/acre		0.00	0.00	NA	NS	0.00	55	0.00	64
Pb g/acre		0.01	0.01	NA	NS	0.00	-1	0.00	-3

10/7/2012	BP	NCR EOP	NCR FS	NCR EOP-BP	% Retention	NCR FS-NCR EOP	% Retention	NCR FS-DCR FS	% Retention
H^+ Eq/acre	4884.91	429.19	271.62	-4455.73	91	-157.57	37	106.27	-64
TSS lbs./acre	0.00	4.59	2.17	4.59	*	-2.42	53	0.81	-59
DTP lbs./acre	0.01	0.01	0.02	0.00	8	0.01	-204	0.00	-16
TP lbs./acre	0.01	0.01	0.03	0.01	-84	0.02	-116	0.00	-13
Part. P lbs/acre	0.00	0.01	0.01	0.01	*	0.00	-27	0.00	-6
NPOC lbs./acre	0.63	0.91	1.10	0.28	-43	0.19	-21	0.16	-17
TN lbs./acre	0.14	0.13	0.12	0.00	3	-0.01	11	0.04	-45
NH_4 lbs./acre	0.08	0.02	0.03	-0.06	71	0.01	-45	0.03	*
Cl lbs./acre	0.06	0.10	0.16	0.04	-77	0.06	-63	0.00	-3
NO_3 lbs/acre	0.08	0.09	0.07	0.01	-9	-0.02	24	-0.01	8
PO_4 lbs/acre	0.00	0.00	0.01	0.00	*	0.01	*	0.01	*
DON lbs/acre	0.06	0.10	0.08	0.04	-71	-0.02	19	0.01	-18
Cr g/acre		0.06	0.04	NA	NS	-0.02	28	0.01	-26
Ni g/acre		0.07	0.06	NA	NS	-0.01	15	0.00	1
Cu g/acre		0.52	0.58	NA	NS	0.07	-13	0.14	-33
Zn g/acre		1.32	0.93	NA	NS	-0.40	30	0.17	-22
Cd g/acre		0.00	0.00	NA	NS	0.00	-191	0.00	-112
Pt g/acre		0.00	0.00	NA	NS	0.00	-128	0.00	-82
Pb g/acre		0.01	0.01	NA	NS	0.00	-26	0.00	-28

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC

Table I-37 October 15, 2012 Davidson County Sites Precipitation 0.27″

10/16/2012	BP	DCR EOP	DCR FS	DCR EOP-BP	% Retention	DCR FS-DCR EOP	% Retention	NCR EOP-DCR EOP	% Retention
H+ Eq/acre	225.59	86.18	63.47	-139.41	62	-22.71	26	NS	NS
TSS lbs./acre	0.00	1.00	0.59	1.00	*	-0.41	41	NS	NS
DTP lbs./acre	0.00	0.00	0.01	0.00	-56	0.01	-279	NS	NS
TP lbs./acre	0.00	0.00	0.01	0.00	-134	0.01	-206	NS	NS
Part. P lbs/acre	0.00	0.00	0.00	0.00	*	0.00	-58	NS	NS
NPOC lbs./acre	0.10	0.32	0.47	0.21	-212	0.16	-50	NS	NS
TN lbs./acre	0.03	0.05	0.05	0.02	-78	0.01	-18	NS	NS
NH_4 lbs./acre	0.01	0.02	0.00	0.02	-258	-0.02	100	NS	NS
Cl lbs./acre	0.06	0.07	0.14	0.01	-24	0.07	-105	NS	NS
NO_3 lbs/acre	0.02	0.02	0.04	0.00	-23	0.02	-73	NS	NS
PO_4 lbs/acre	0.00	0.00	0.02	0.00	*	0.02	*	NS	NS
DON lbs/acre	0.02	0.02	0.04	0.01	-36	0.02	-103	NS	NS
Cr g/acre		0.04	0.02	NA	NS	-0.02	42	NS	NS
Ni g/acre		0.02	0.04	NA	NS	0.01	-58	NS	NS
Cu g/acre		0.25	0.31	NA	NS	0.06	-23	NS	NS
Zn g/acre		0.61	0.46	NA	NS	-0.15	25	NS	NS
Cd g/acre		0.00	0.00	NA	NS	0.00	6	NS	NS
Pt g/acre		0.00	0.00	NA	NS	0.00	20	NS	NS
Pb g/acre		0.00	0.00	NA	NS	0.00	-32	NS	NS

10/16/2012	BP	NCR EOP	NCR FS	NCR EOP-BP	% Retention	NCR FS-NCR EOP	% Retention	NCR FS-DCR FS	% Retention
H^+ Eq/acre	225.59	NS	32.80	NS	NS	NS	NS	-30.67	48
TSS lbs./acre	0.00	NS	0.21	NS	NS	NS	NS	-0.38	65
DTP lbs./acre	0.00	NS	0.01	NS	NS	NS	NS	0.00	12
TP lbs./acre	0.00	NS	0.01	NS	NS	NS	NS	0.00	14
Part. P lbs/acre	0.00	NS	0.00	NS	NS	NS	NS	0.00	26
NPOC lbs./acre	0.10	NS	0.56	NS	NS	NS	NS	0.09	-18
TN lbs./acre	0.03	NS	0.06	NS	NS	NS	NS	0.01	-17
NH_4 lbs./acre	0.01	NS	0.01	NS	NS	NS	NS	0.01	*
Cl lbs./acre	0.06	NS	0.13	NS	NS	NS	NS	-0.02	12
NO_3 lbs/acre	0.02	NS	0.04	NS	NS	NS	NS	0.00	-2
PO_4 lbs/acre	0.00	NS	0.02	NS	NS	NS	NS	0.00	4
DON lbs/acre	0.02	NS	0.04	NS	NS	NS	NS	0.00	0
Cr g/acre		NS	0.01	NS	NS	NS	NS	-0.01	40
Ni g/acre		NS	0.03	NS	NS	NS	NS	-0.01	26
Cu g/acre		NS	0.24	NS	NS	NS	NS	-0.07	22
Zn g/acre		NS	0.44	NS	NS	NS	NS	-0.02	4
Cd g/acre		NS	0.00	NS	NS	NS	NS	0.00	-6
Pt g/acre		NS	0.00	NS	NS	NS	NS	0.00	-34
Pb g/acre		NS	0.00	NS	NS	NS	NS	0.00	-4

NS- No Sample, * Division by Zero, NA- not applicable trace metal analyses were not performed on Bulk Precipitation Samples. TN=TDN Loading/acre. NPOC = DOC