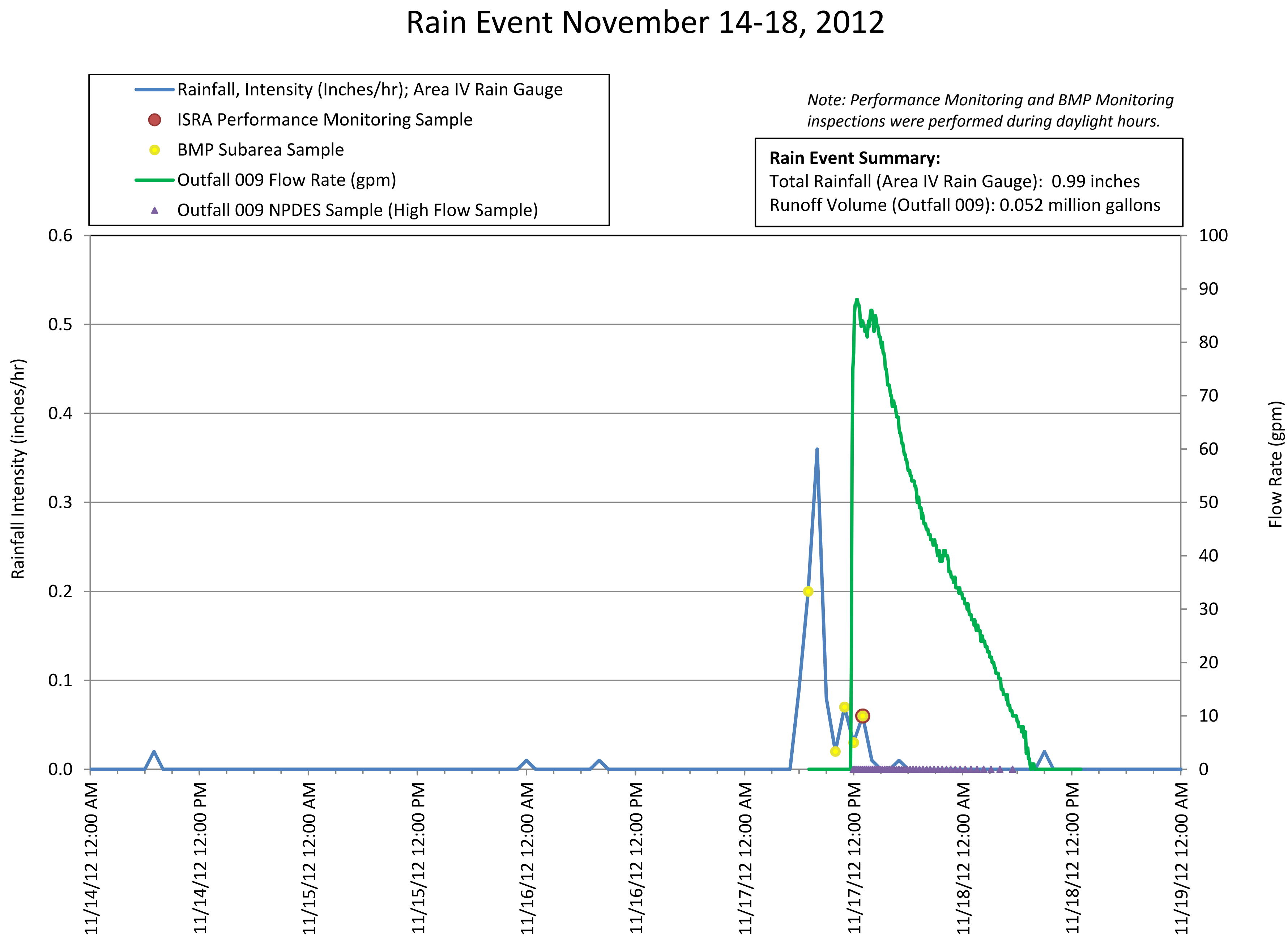
APPENDIX A

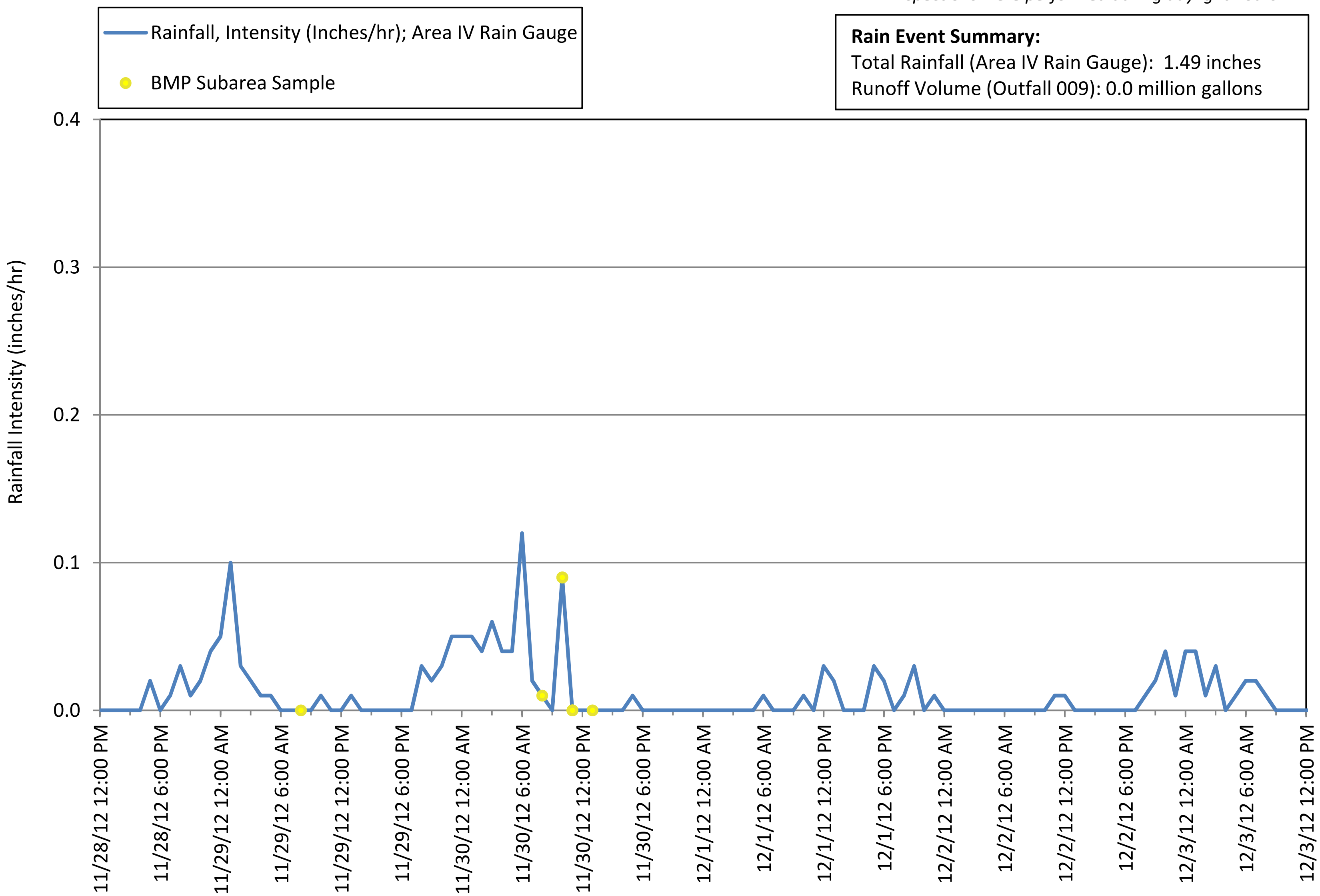
RAIN EVENT AND SAMPLING CHARTS
2012/2013 RAINY SEASON

2012/2013 Rainy Season Rain Event and Sampling Charts
(Page 1 of 7)



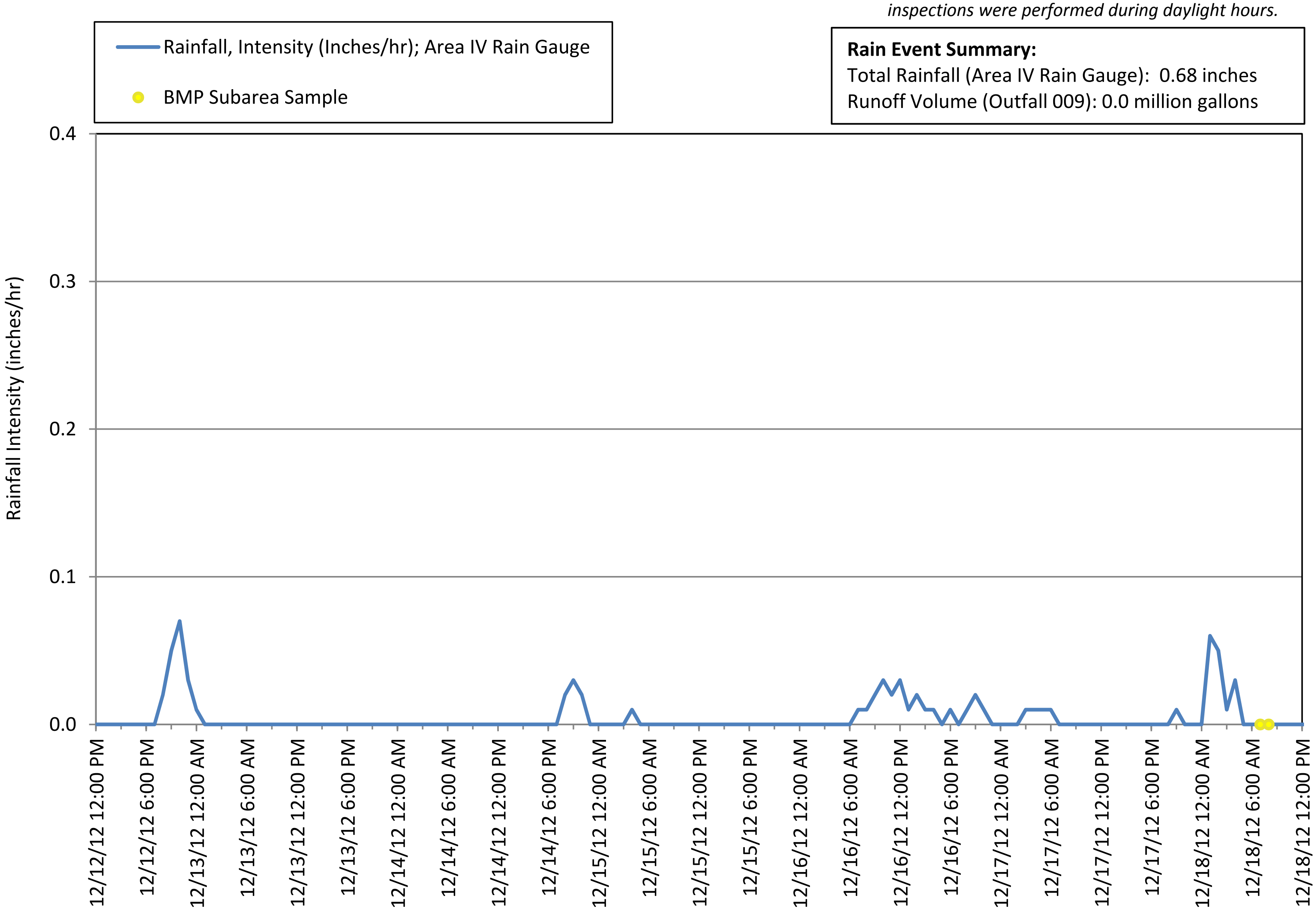
Rain Event November 28- December 4, 2012

Note: Performance Monitoring and BMP Monitoring inspections were performed during daylight hours.



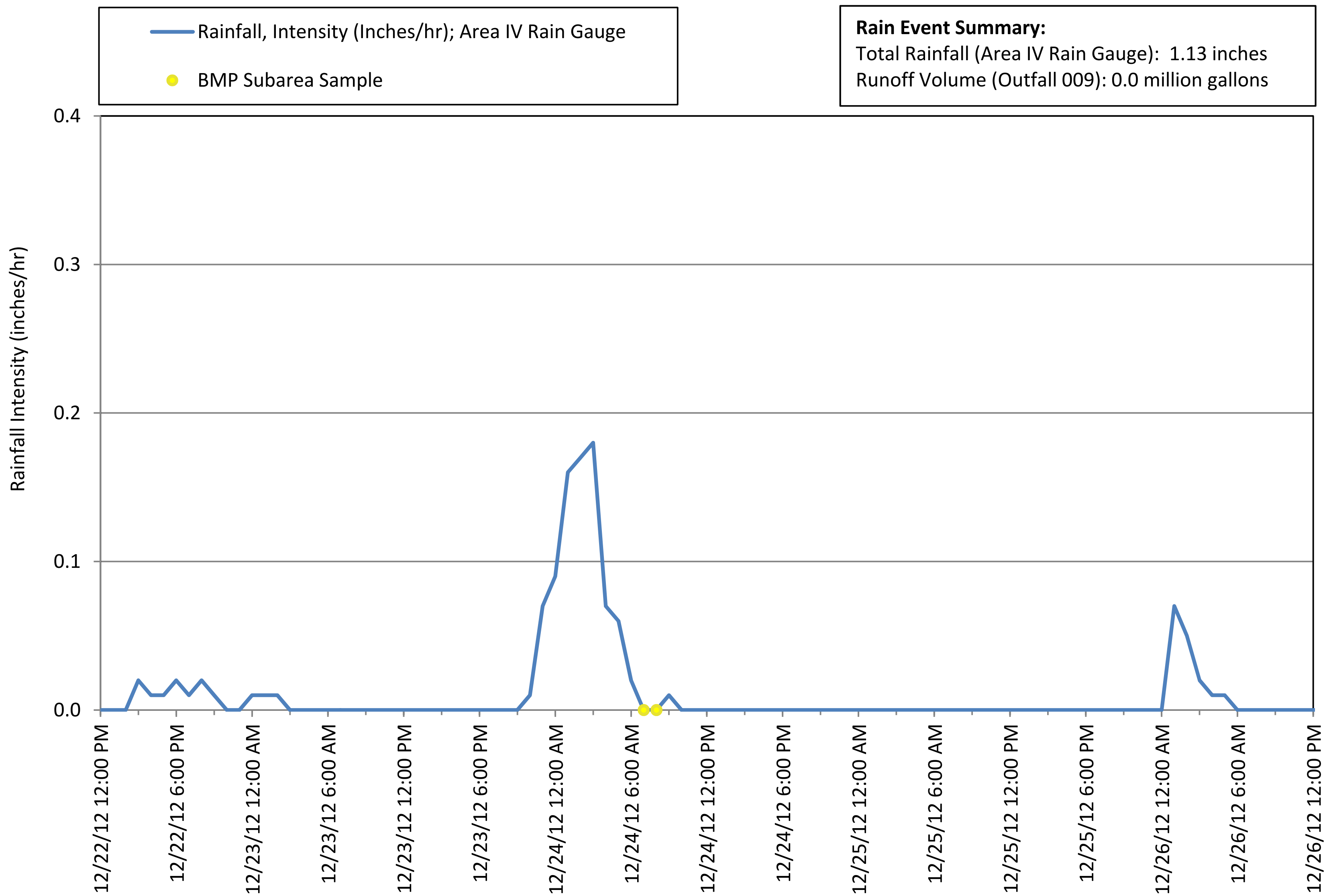
Rain Event December 12-18, 2012

Note: Performance Monitoring and BMP Monitoring inspections were performed during daylight hours.

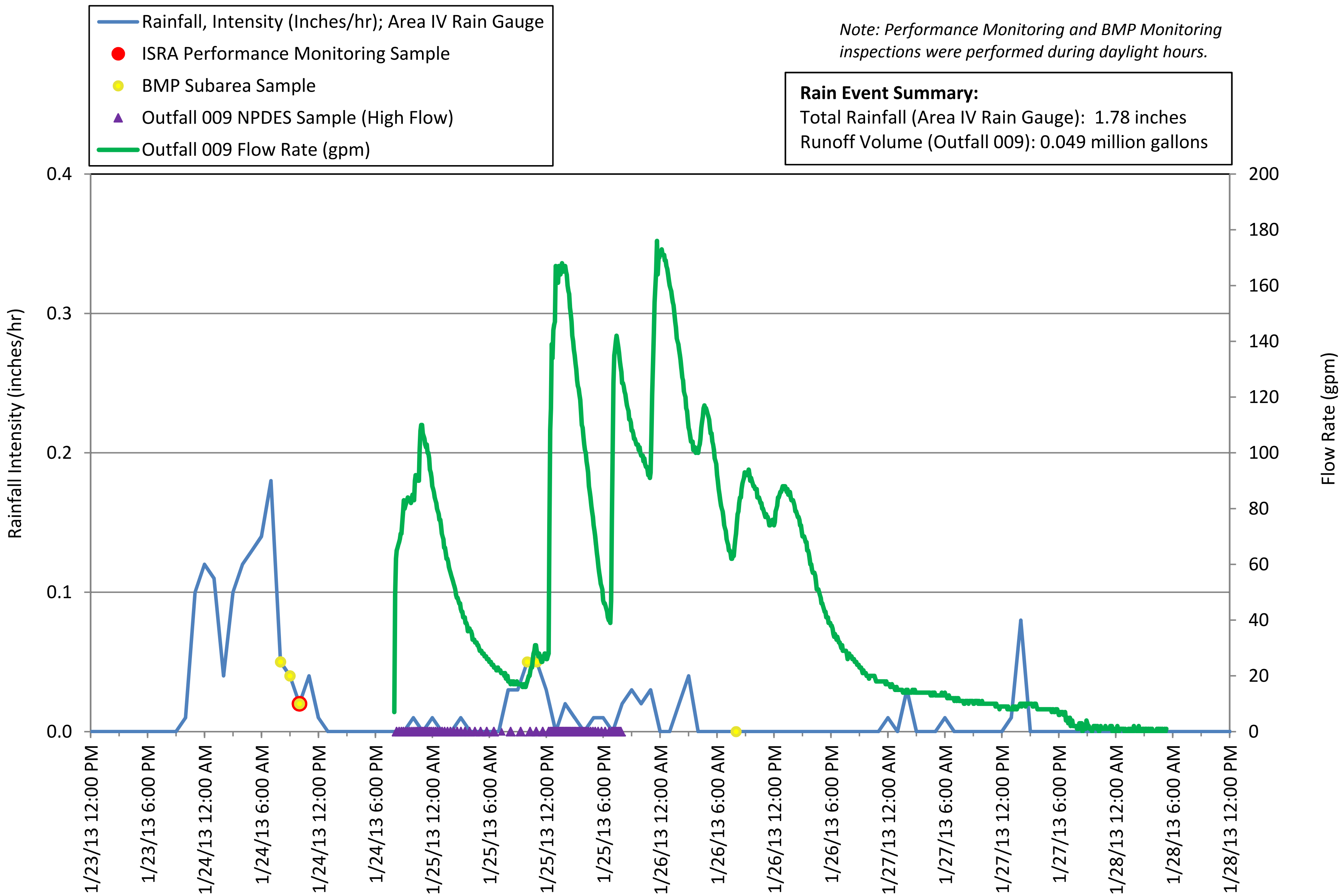


Rain Event December 22-26, 2012

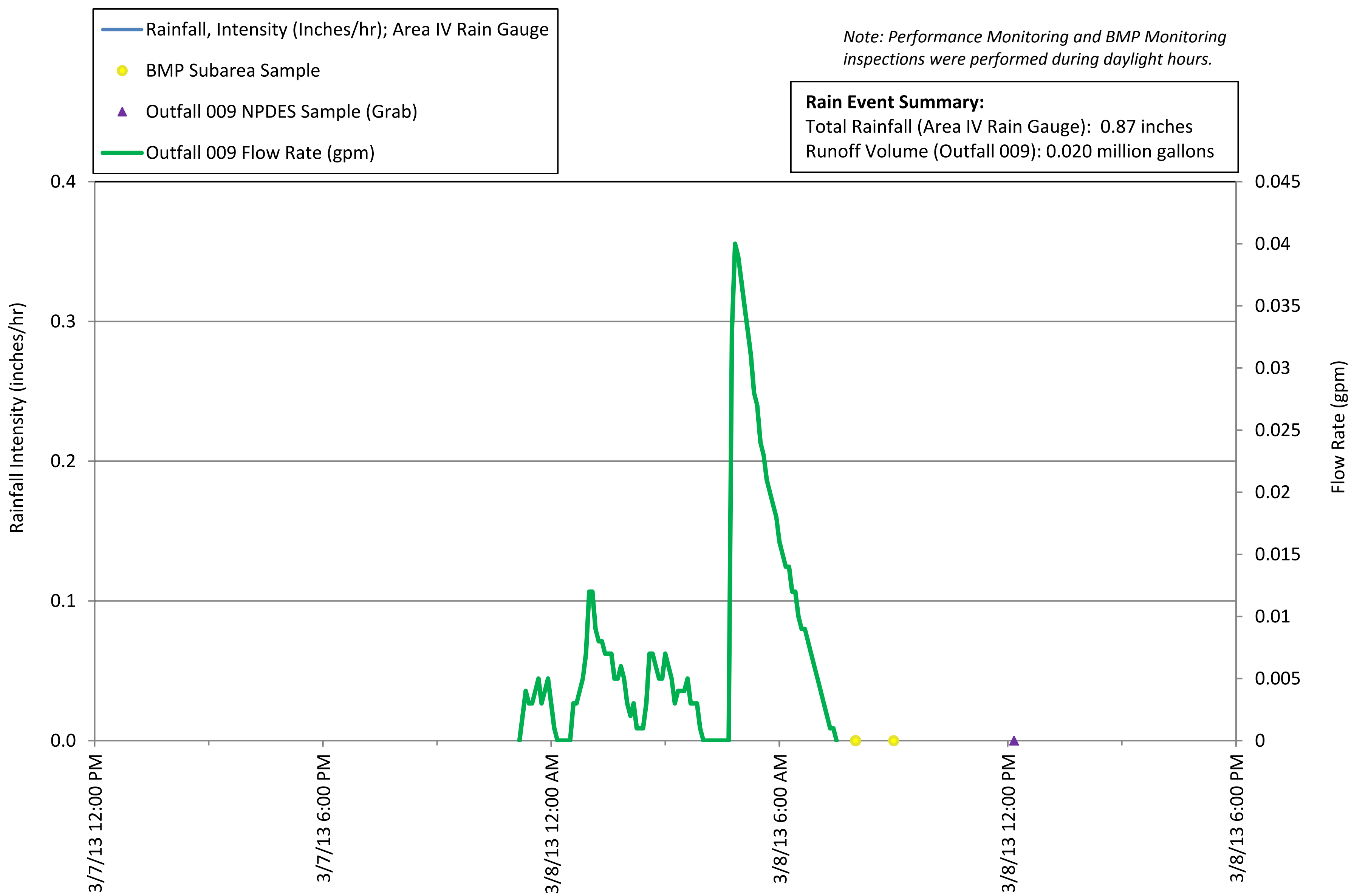
Note: Performance Monitoring and BMP Monitoring inspections were performed during daylight hours.



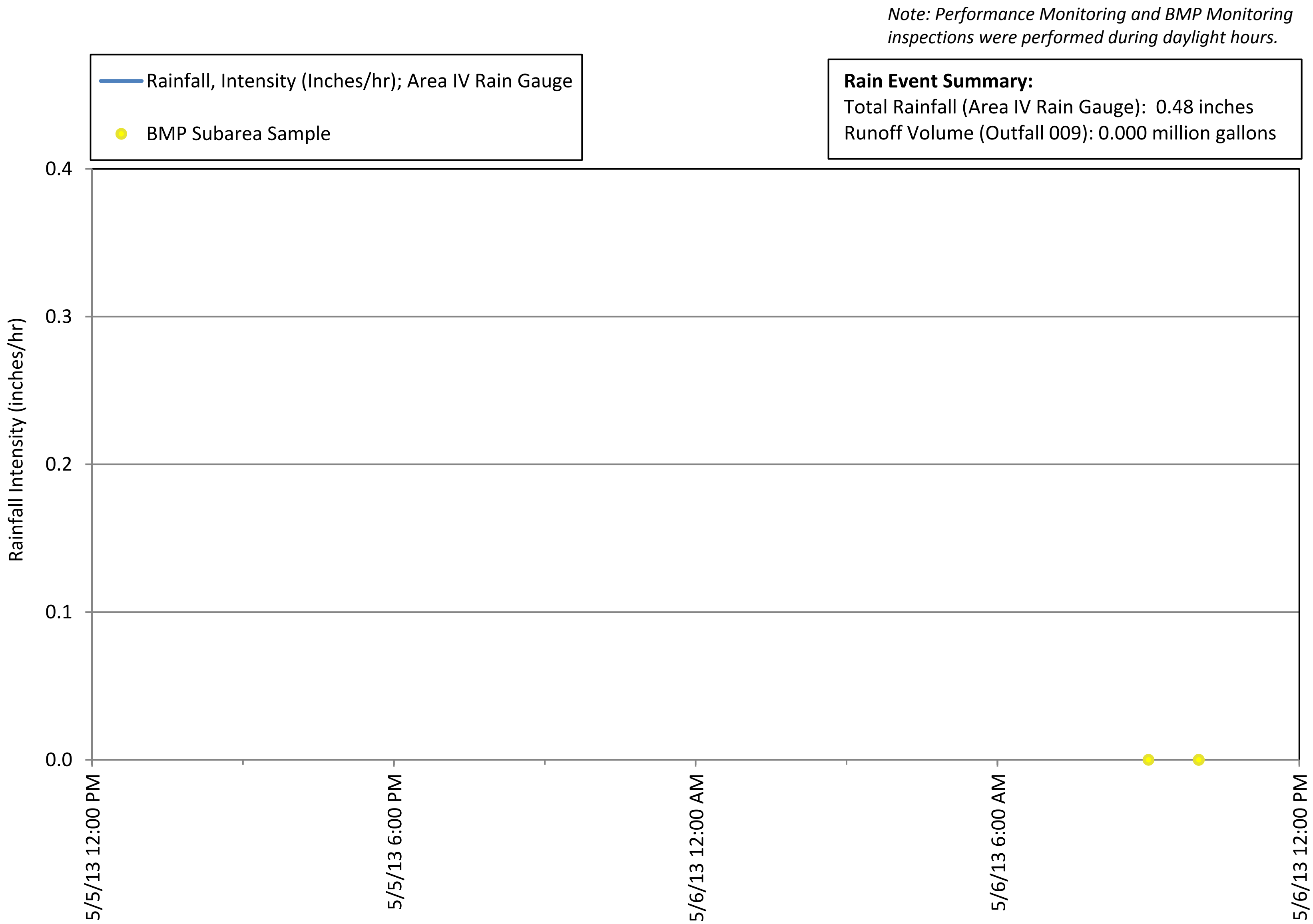
Rain Event January 23-27, 2013



Rain Event March 7-8, 2013



Rain Event May 6, 2013



APPENDIX B

LABORATORY AND DATA VALIDATION REPORTS
PERFORMANCE MONITORING AND BMP MONITORING SAMPLES
2012/2013 RAINY SEASON

Table B-1
Laboratory Reports and Data Validation Reports
2012/2013 Rainy Season
Page 1 of 1

Sample Delivery Group	Sample Collection Date	Sample Type	Laboratory Name	Laboratory Report	Validation Report
ISRA Performance Monitoring					
440-30119	11/17/2012	Primary	TA-Irvine	Y	N
440-35950	1/24/2013	Primary	TA-Irvine	Y	Y
J55398	11/17/2012	RWQCB Split	ASL/CAS/Weck	Y	N
J56215	1/24/2013	RWQCB Split	ASL/CAS/Weck	Y	Y
BMP Monitoring					
440-30121	11/17/2012	Primary	TA-Irvine/PTS	Y	Y
440-31032	11/29/2012	Primary	TA-Irvine/PTS	Y	Y
440-31175	11/30/2012	Primary	TA-Irvine/PTS	Y	Y
440-33012	12/18/2012	Primary	TA-Irvine/PTS	Y	Y
440-33481	12/24/2012	Primary	TA-Irvine/PTS	Y	Y
440-35908	1/24/2013	Primary	TA-Irvine/PTS	Y	Y
440-36074	1/25/2013	Primary	TA-Irvine/PTS	Y	Y
440-36153	1/26/2013	Primary	TA-Irvine/PTS	Y	Y
440-40343	3/8/2013	Primary	TA-Irvine/PTS	Y	Y
440-45546	5/6/2013	Primary	TA-Irvine/PTS	Y	Y

Notes

ASL - American Scientific Laboraties, LLC
CAS - Columbia Analytical Laboratory
PTS - PTS Laboratories, Inc., Santa Fe Springs, California
TA-Irvine - Test America Laboratories, Irvine, California
WECK - Weck Laboratories, Inc.

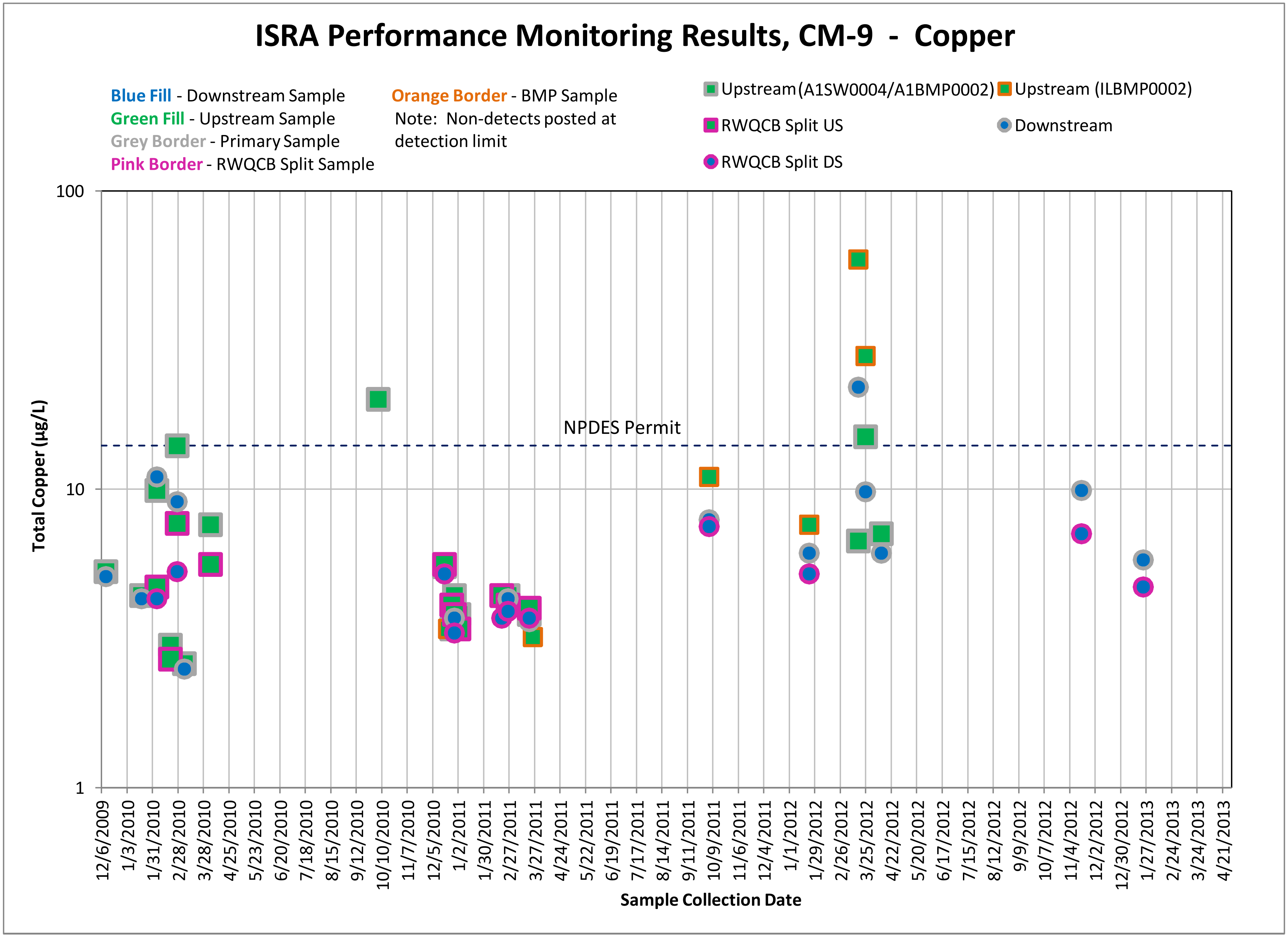
Please contact Debbie Taege at 818-466-8849 if you would like to receive a CD containing the Laboratory and Data Validation Reports listed in Table B-1. The reports are not posted to the Boeing External Website due to the large file size.

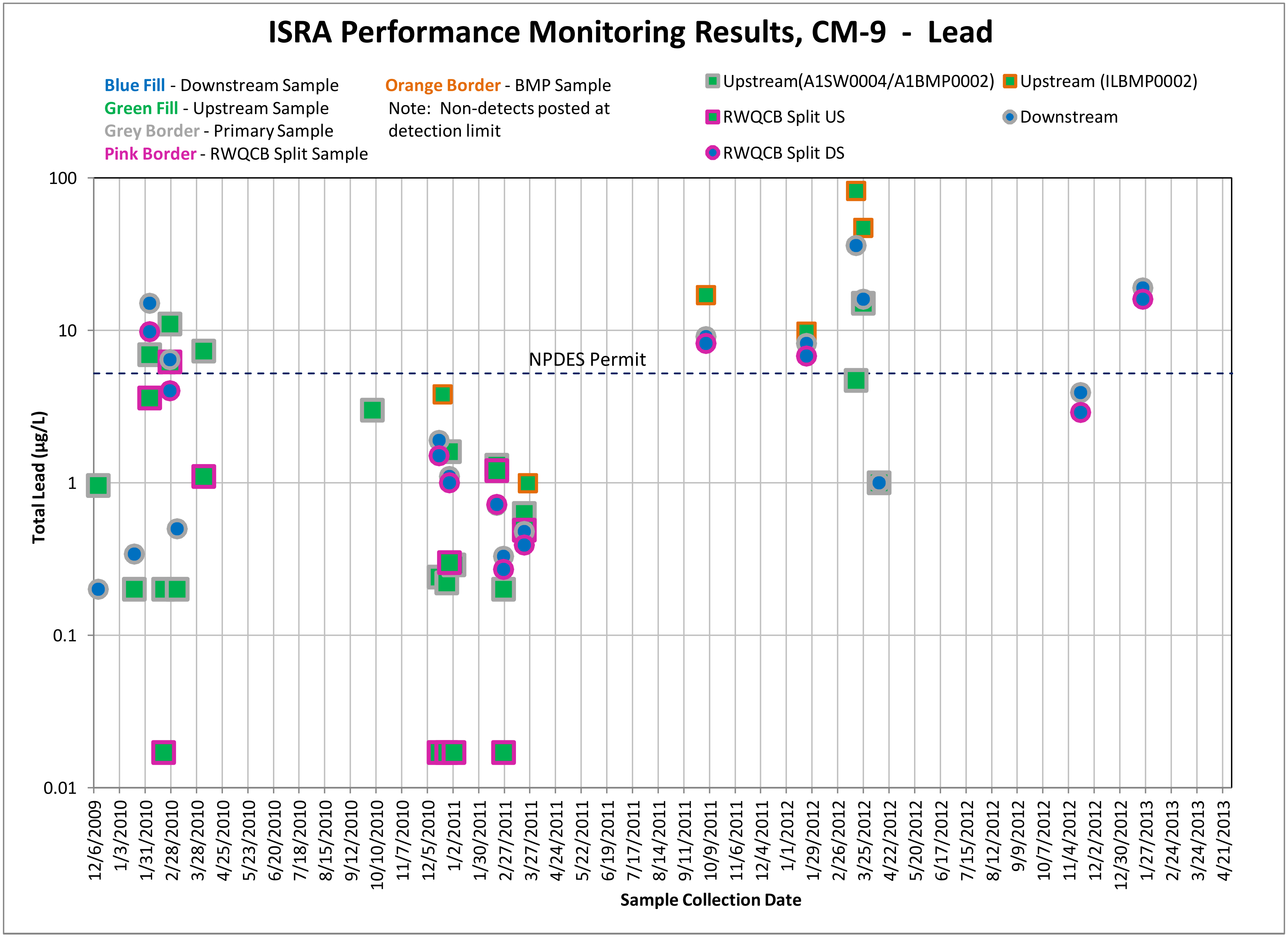
APPENDIX C

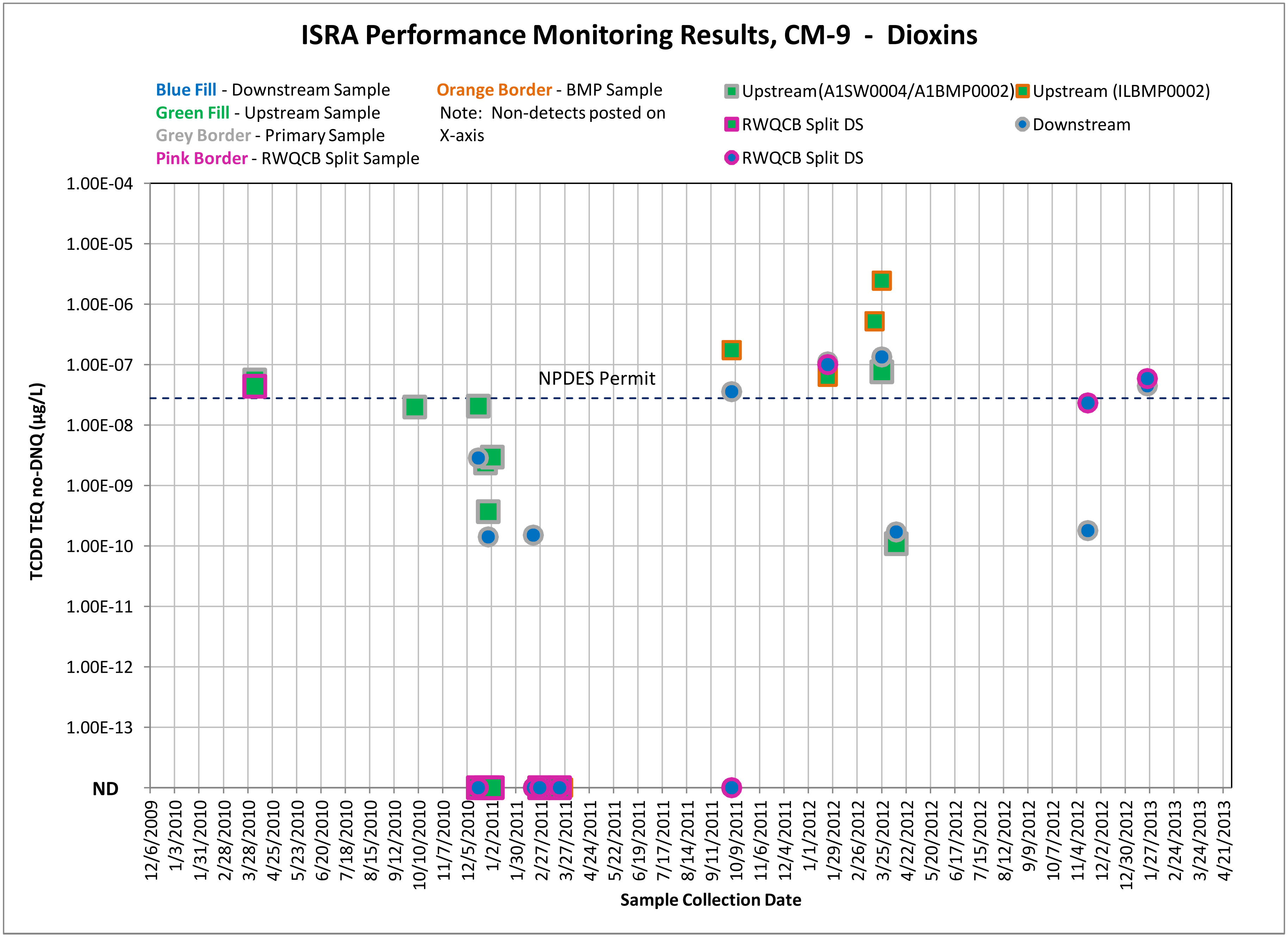
PERFORMANCE MONITORING CHARTS
2012/2013 RAINY SEASON

APPENDIX C-1

PERFORMANCE MONITORING DATA GRAPHS VS. TIME – DETECTIONS, BY DRAINAGE


ISRA Performance Monitoring Results, CM-9 - Copper
Blue Fill - Downstream Sample
Green Fill - Upstream Sample
Grey Border - Primary Sample
Pink Border - RWQCB Split Sample
Orange Border - BMP Sample
Note: Non-detects posted at detection limit
Upstream (A1SW0004/A1BMP0002)
Upstream (ILBMP0002)
RWQCB Split US
Downstream
RWQCB Split DS
NPDES Permit
Total Copper (µg/L)
100
10
1
12/6/2009
1/3/2010
1/31/2010
2/28/2010
3/28/2010
4/25/2010
5/23/2010
6/20/2010
7/18/2010
8/15/2010
9/12/2010
10/10/2010
11/7/2010
12/5/2010
1/2/2011
1/30/2011
2/27/2011
3/27/2011
4/24/2011
5/22/2011
6/19/2011
7/17/2011
8/14/2011
9/11/2011
10/9/2011
11/6/2011
12/4/2011
1/1/2012
1/29/2012
2/26/2012
3/25/2012
4/22/2012
5/20/2012
6/17/2012
7/15/2012
8/12/2012
9/9/2012
10/7/2012
11/4/2012
12/2/2012
12/30/2012
1/27/2013
2/24/2013
3/24/2013
4/21/2013
Sample Collection Date


ISRA Performance Monitoring Results, CM-9 - Lead
Blue Fill - Downstream Sample
Green Fill - Upstream Sample
Grey Border - Primary Sample
Pink Border - RWQCB Split Sample
Orange Border - BMP Sample
Note: Non-detects posted at detection limit
Upstream(A1SW0004/A1BMP0002)
Upstream (ILBMP0002)
RWQCB Split US
Downstream
RWQCB Split DS
NPDES Permit
Total Lead (µg/L)
100
10
1
0.1
0.01
12/6/2009
1/3/2010
1/31/2010
2/28/2010
3/28/2010
4/25/2010
5/23/2010
6/20/2010
7/18/2010
8/15/2010
9/12/2010
10/10/2010
11/7/2010
12/5/2010
1/2/2011
1/30/2011
2/27/2011
3/27/2011
4/24/2011
5/22/2011
6/19/2011
7/17/2011
8/14/2011
9/11/2011
10/9/2011
11/6/2011
12/4/2011
1/1/2012
1/29/2012
2/26/2012
3/25/2012
4/22/2012
5/20/2012
6/17/2012
7/15/2012
8/12/2012
9/9/2012
10/7/2012
11/4/2012
12/2/2012
12/30/2012
1/27/2013
2/24/2013
3/24/2013
4/21/2013
Sample Collection Date

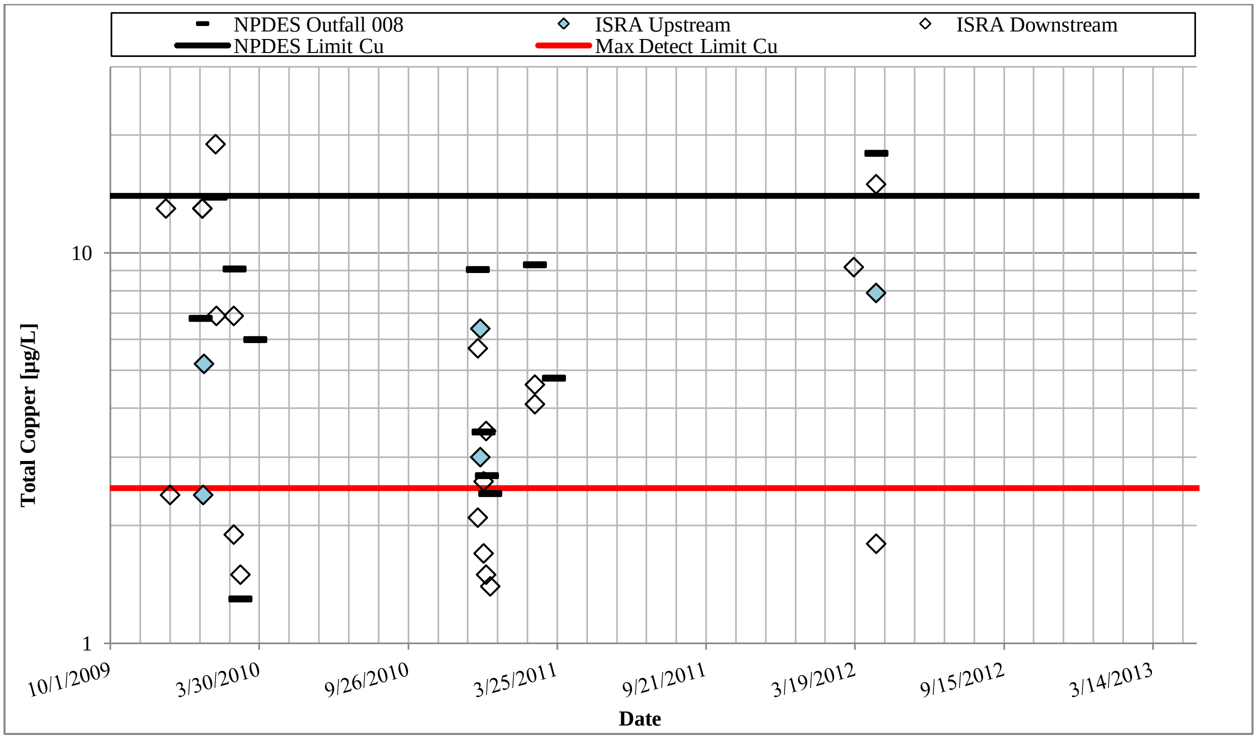

ISRA Performance Monitoring Results, CM-9 - Dioxins
Blue Fill - Downstream Sample
Green Fill - Upstream Sample
Grey Border - Primary Sample
Pink Border - RWQCB Split Sample
Orange Border - BMP Sample
Note: Non-detects posted on X-axis
Upstream(A1SW0004/A1BMP0002)
Upstream (ILBMP0002)
RWQCB Split DS
Downstream
RWQCB Split DS
NPDES Permit
TCDD TEQ no-DNQ (µg/L)
1.00E-04
1.00E-05
1.00E-06
1.00E-07
1.00E-08
1.00E-09
1.00E-10
1.00E-11
1.00E-12
1.00E-13
ND
12/6/2009
1/3/2010
1/31/2010
2/28/2010
3/28/2010
4/25/2010
5/23/2010
6/20/2010
7/18/2010
8/15/2010
9/12/2010
10/10/2010
11/7/2010
12/5/2010
1/2/2011
1/30/2011
2/27/2011
3/27/2011
4/24/2011
5/22/2011
6/19/2011
7/17/2011
8/14/2011
9/11/2011
10/9/2011
11/6/2011
12/4/2011
1/1/2012
1/29/2012
2/26/2012
3/25/2012
4/22/2012
5/20/2012
6/17/2012
7/15/2012
8/12/2012
9/9/2012
10/7/2012
11/4/2012
12/2/2012
12/30/2012
1/27/2013
2/24/2013
3/24/2013
4/21/2013
Sample Collection Date

APPENDIX C-2

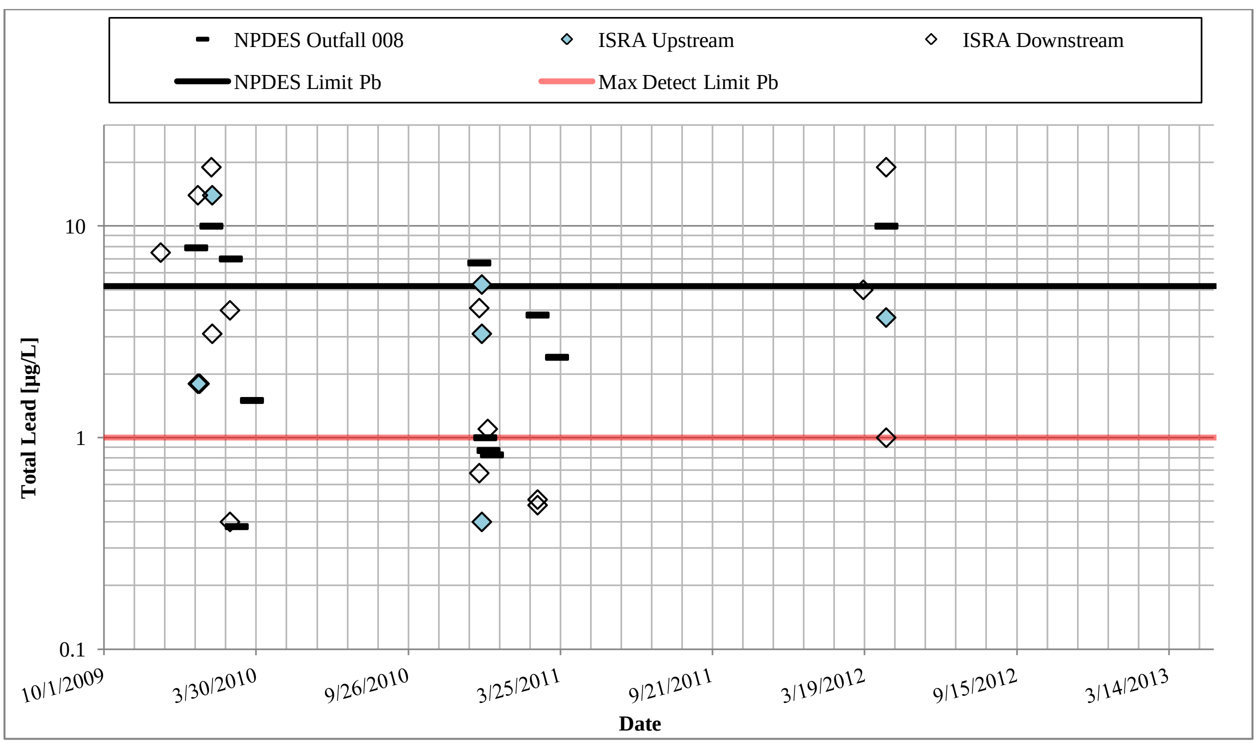
PERFORMANCE MONITORING DATA GRAPHS VS. TIME – BY OUTFALL

OUTFALL 008 TIMESERIES CHARTS
ISRA PERFORMANCE MONITORING PROGRAM

COPPER



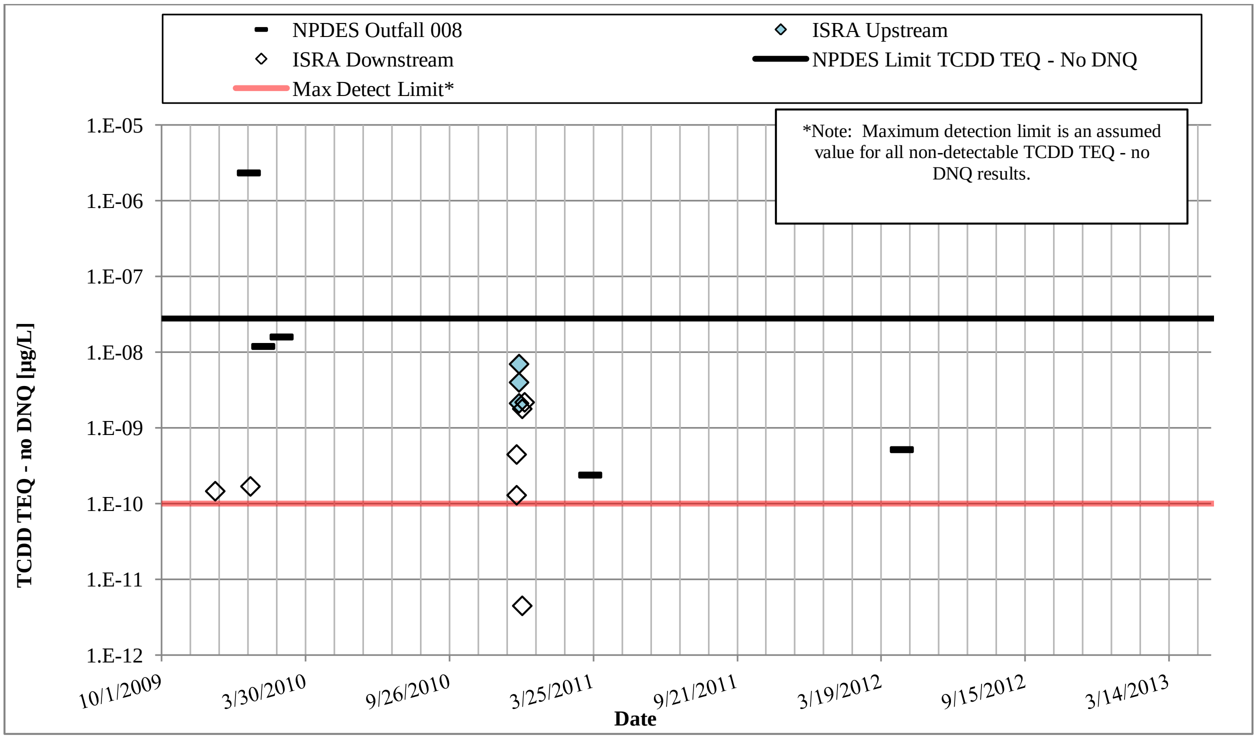
LEAD



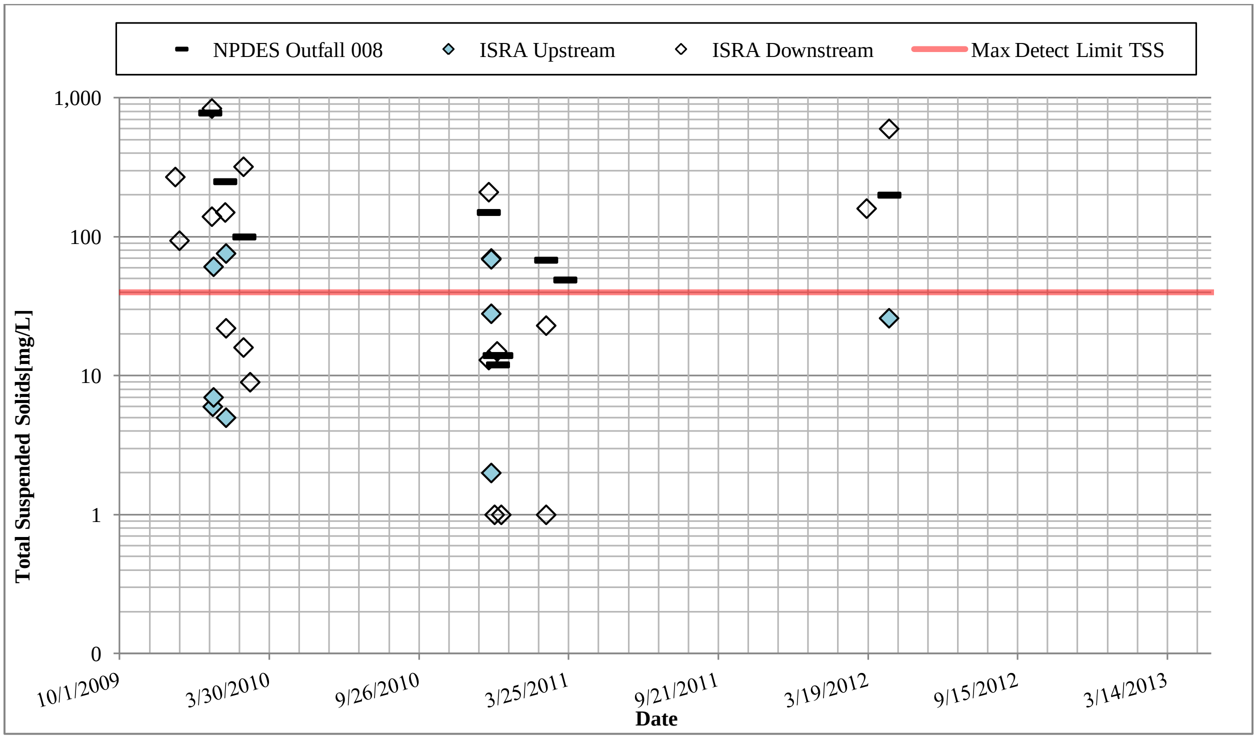
Sample results measured below the detection limit have been excluded. Results shown below the maximum detection limit line correspond to samples with a detection limit less than the maximum detection limit.

OUTFALL 008 TIMESERIES CHARTS
ISRA PERFORMANCE MONITORING PROGRAM

DIOXINS (TCDD-TEQ - no DNQ)



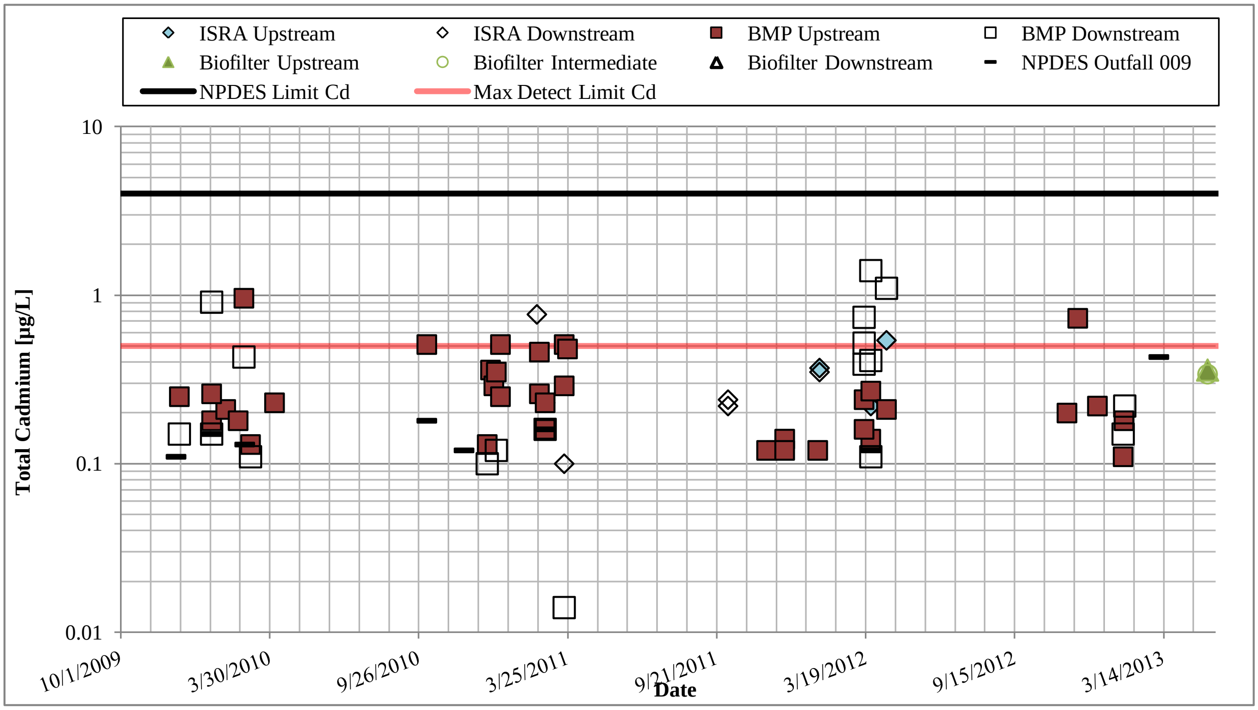
TSS



Sample results measured below the detection limit have been excluded. Results shown below the maximum detection limit line correspond to samples with a detection limit less than the maximum detection limit.

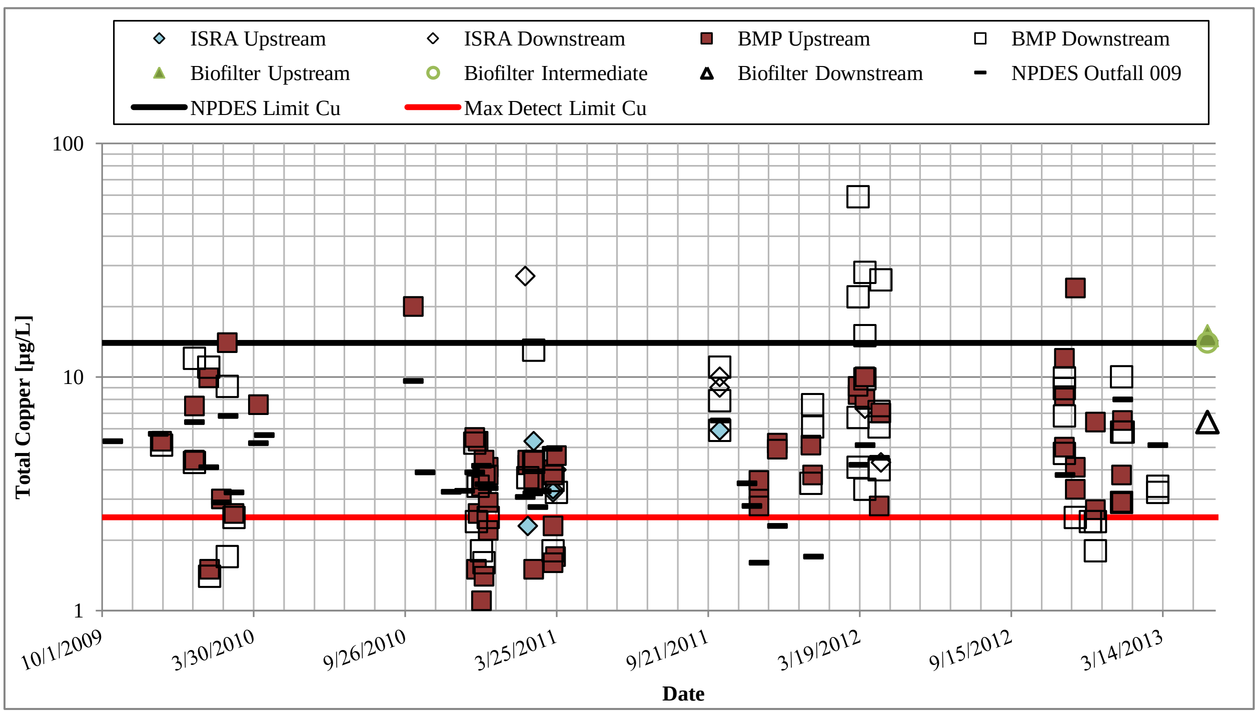
OUTFALL 009 TIMESERIES CHARTS
ISRA PERFORMANCE MONITORING PROGRAM

CADMIUM



Background CM Upstream monitoring locations 8 and 11 were discontinued for the 2011-2012 monitoring season

COPPER

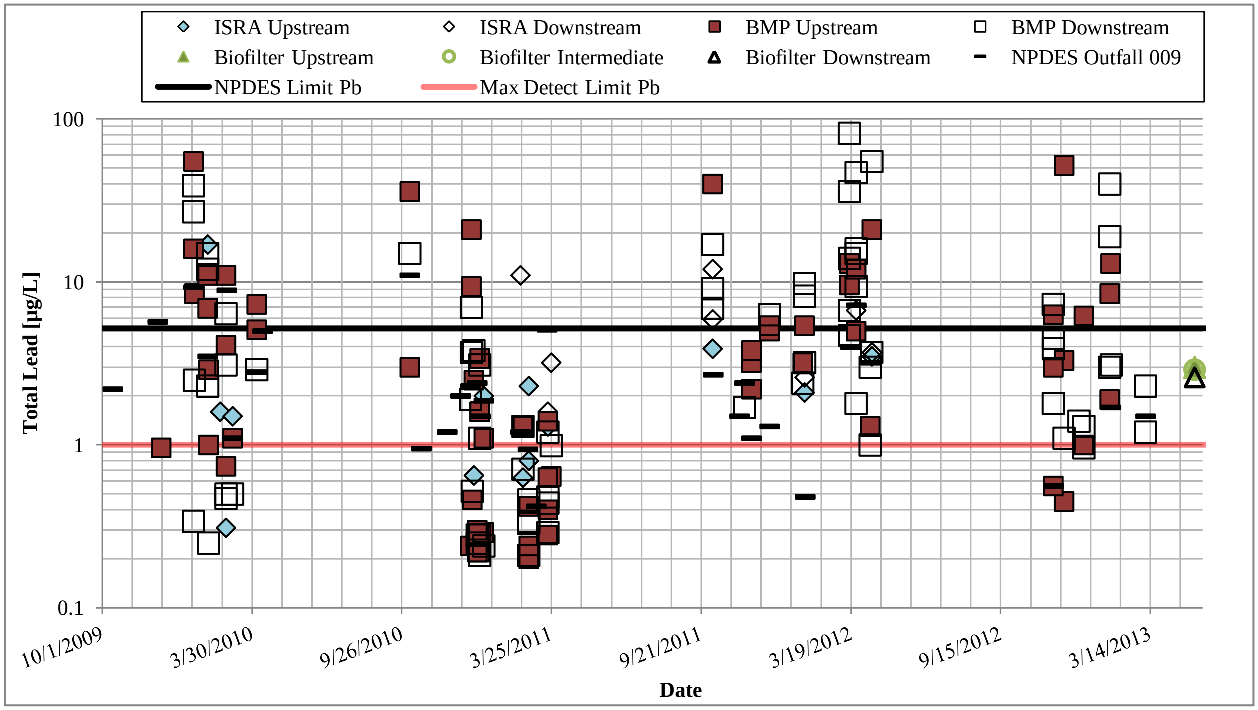


Background CM Upstream monitoring locations 8 and 11 were discontinued for the 2011-2012 monitoring season

Sample results measured below the detection limit have been excluded. Results shown below the maximum detection limit line correspond to samples with a detection limit less than the maximum detection limit.

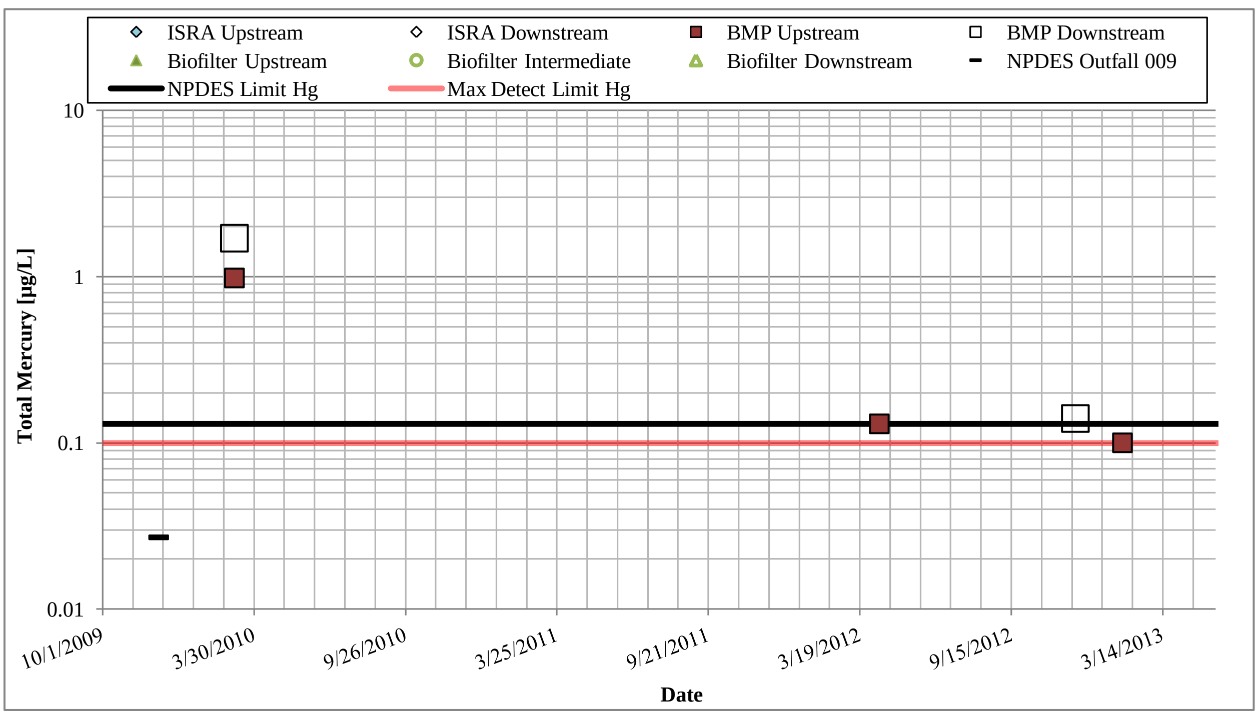
OUTFALL 009 TIMESERIES CHARTS
ISRA PERFORMANCE MONITORING PROGRAM

LEAD



Background CM Upstream monitoring locations 8 and 11 were discontinued for the 2011-2012 monitoring season

MERCURY

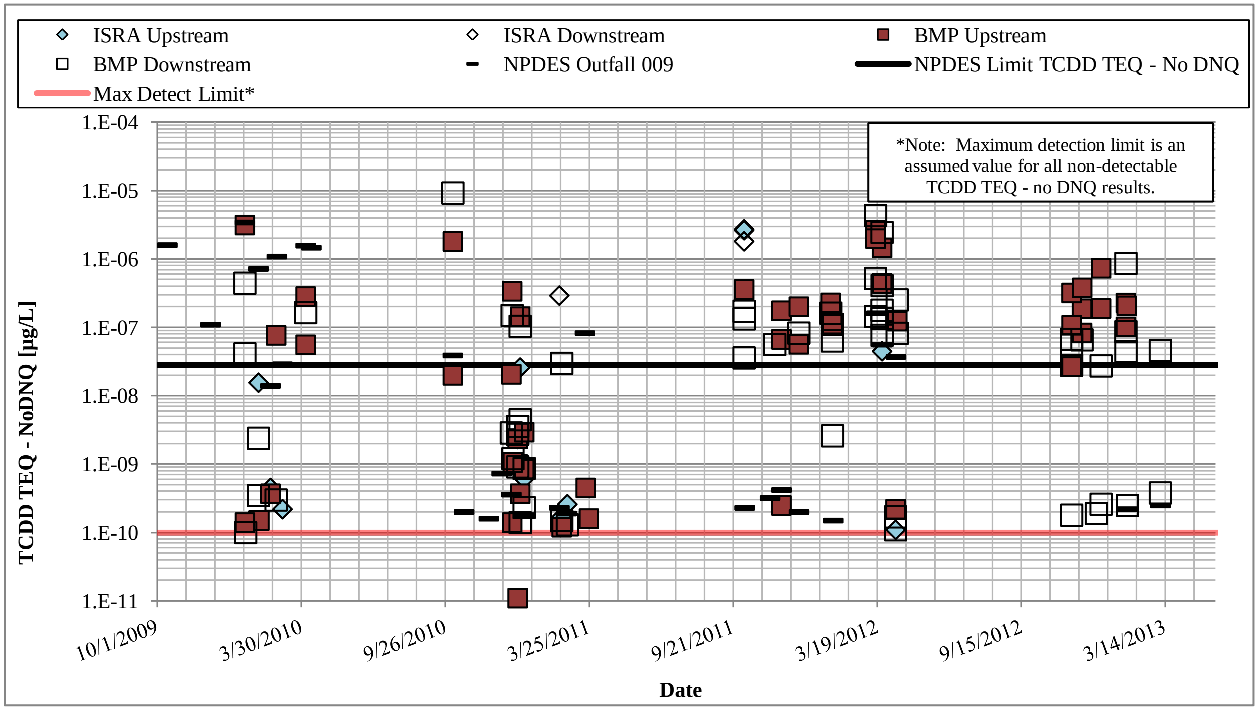


Background CM Upstream monitoring locations 8 and 11 were discontinued for the 2011-2012 monitoring season

Sample results measured below the detection limit have been excluded. Results shown below the maximum detection limit line correspond to samples with a detection limit less than the maximum detection limit.

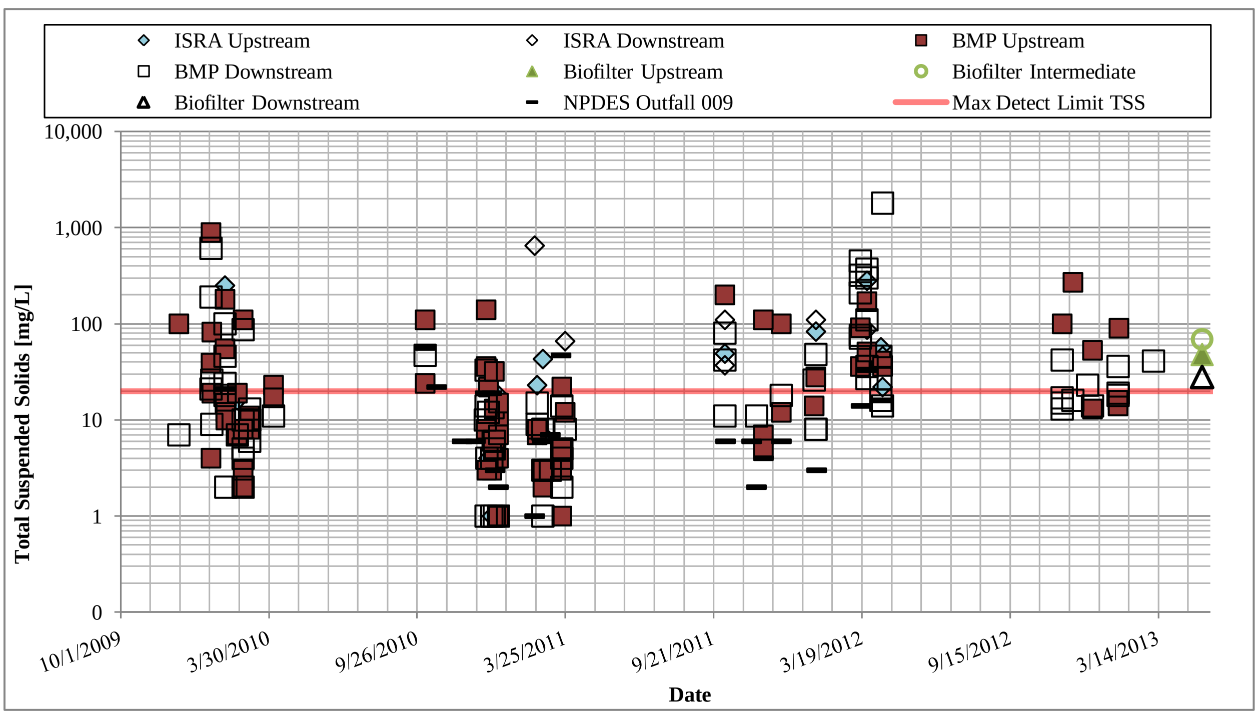
OUTFALL 009 TIMESERIES CHARTS
ISRA PERFORMANCE MONITORING PROGRAM

DIOXINS (TCDD-TEQ – no DNQ)



Background CM Upstream monitoring locations 8 and 11 were discontinued for the 2011-2012 monitoring season

TSS



Background CM Upstream monitoring locations 8 and 11 were discontinued for the 2011-2012 monitoring season

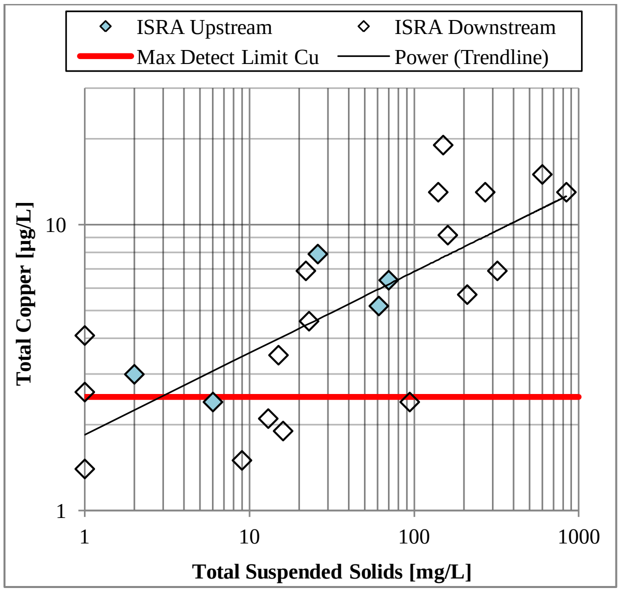
Sample results measured below the detection limit have been excluded. Results shown below the maximum detection limit line correspond to samples with a detection limit less than the maximum detection limit.

APPENDIX C-3

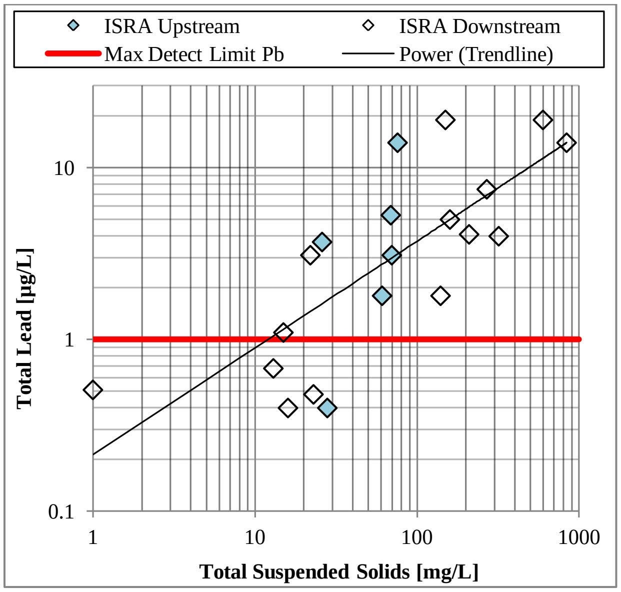
PERFORMANCE MONITORING DATA GRAPHS – COC CORRELATIONS

OUTFALL 008 CORRELATION CHARTS
ISRA PERFORMANCE MONITORING PROGRAM

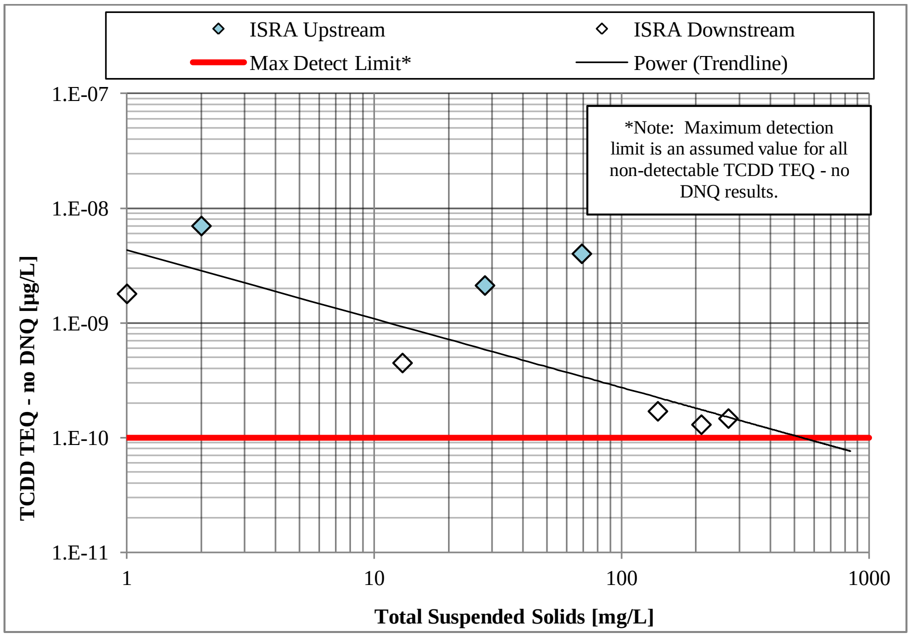
COPPER VS TSS



LEAD VS TSS



DIOXINS (TCDD-TEQ – no DNQ) VS TSS

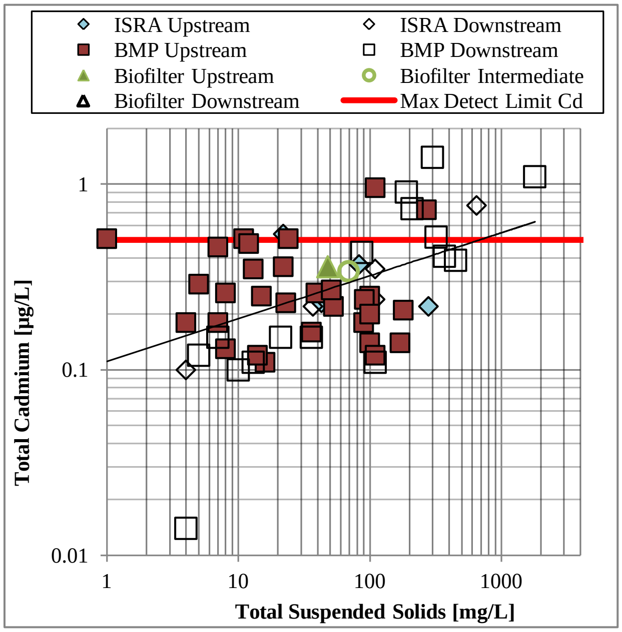


Sample results measured below the detection limit have been excluded. Results shown below the maximum detection limit line correspond to samples with a detection limit less than the maximum detection limit.

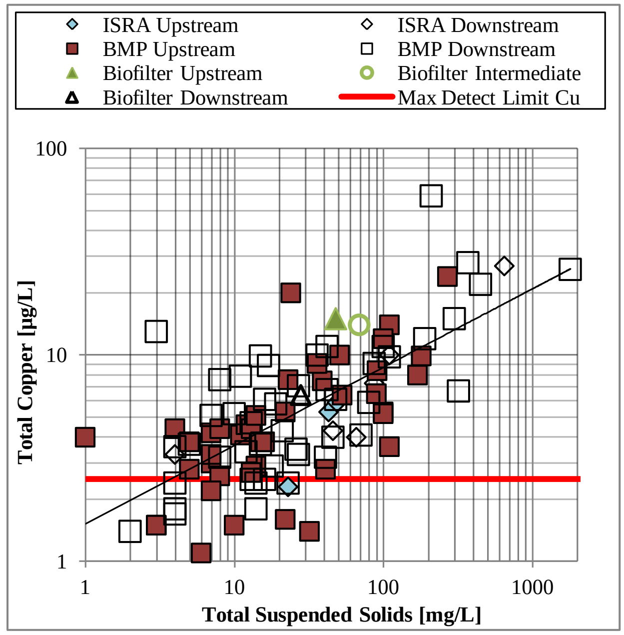
Several CM Upstream locations are also shown as background locations on the BMP Performance Monitoring plots.

OUTFALL 009 CORRELATION CHARTS
ISRA PERFORMANCE MONITORING PROGRAM

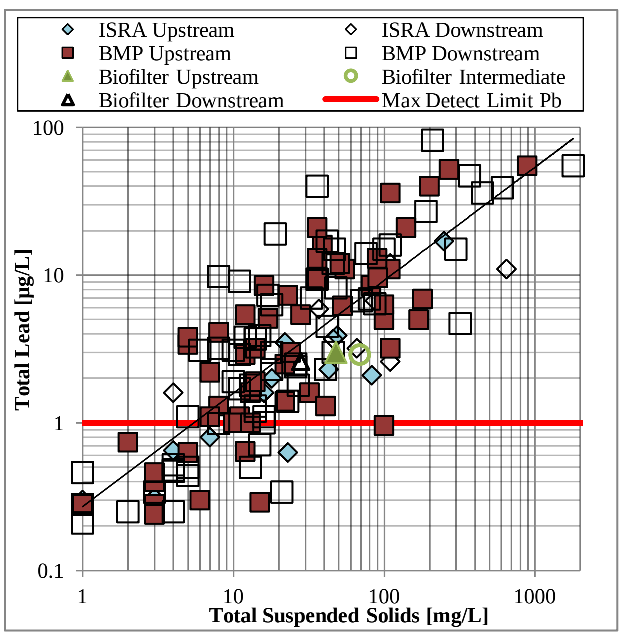
CADMIUM VS TSS



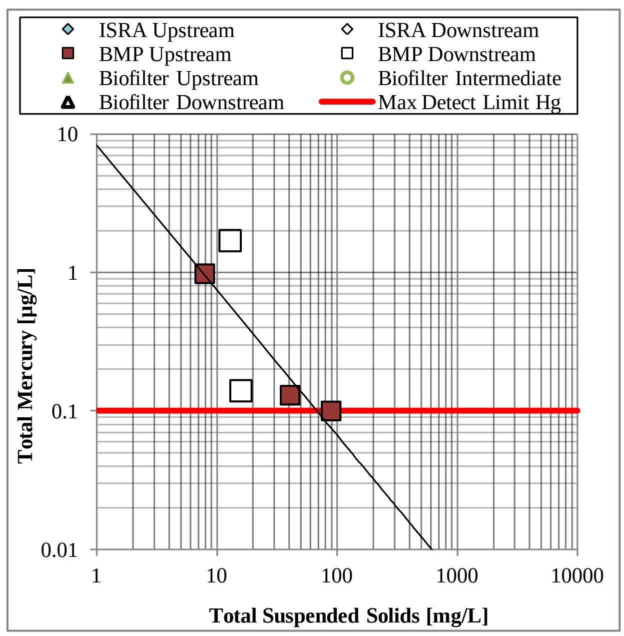
COPPER VS TSS



LEAD VS TSS



MERCURY VS TSS

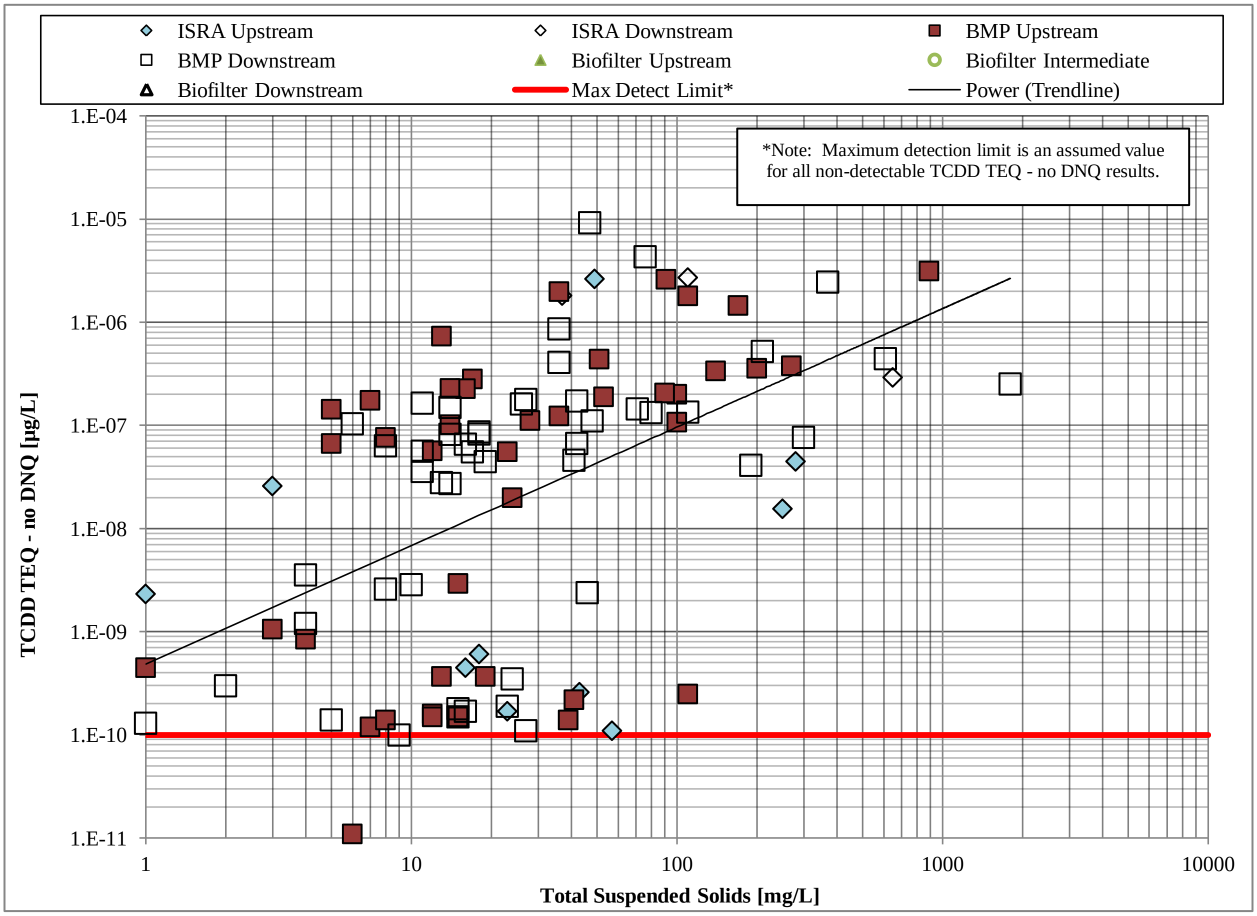


Sample results measured below the detection limit have been excluded. Results shown below the maximum detection limit line correspond to samples with a detection limit less than the maximum detection limit.

Several CM Upstream locations are also shown as background locations on the BMP Performance Monitoring plots.

OUTFALL 009 CORRELATION CHARTS
ISRA PERFORMANCE MONITORING PROGRAM

DIOXINS (TCDD-TEQ – no DNQ) VS TSS



Sample results measured below the detection limit have been excluded. Results shown below the maximum detection limit line correspond to samples with a detection limit less than the maximum detection limit.

Several CM Upstream locations are also shown as background locations on the BMP Performance Monitoring plots.

APPENDIX D

EXPERT PANEL SAMPLE SPLIT EVALUATION MEMORANDUM 2012/2013 RAINY SEASON

Memorandum

Date: 29 Aug, 2013

To: The Boeing Company, Santa Susana Field Laboratory

From: Geosyntec Consultants and the Santa Susana Site Surface Water Expert Panel

Subject: Sample Split Evaluation
Santa Susana Site
Geosyntec Project: SB0363T

Background

The Boeing Company's (Boeing's) Santa Susana Site (SSS) is located in the Simi Hills near the Los Angeles/Ventura county line. Part of Boeing's stormwater monitoring program includes sampling at Interim Source Removal Action (ISRA), culvert modification (CM), and potential and existing best management practices (BMPs) monitoring locations[1]. Stormwater sampling at these locations began in December of 2009. Sample splits have been analyzed as part of the stormwater monitoring quality control (QC) program since February of 2010. Splits are typically one sample divided into two subsamples (either in the field or at the laboratory), where one subsample (the "sample") is analyzed at the project lab and the other subsample (the "split") is analyzed at an independent lab (in this case, the Regional Water Quality Control Board [RWQCB] laboratory). Early in Boeing's sampling program, a replicate sample was collected by filling a secondary container (the split) after the primary container (the sample) was filled at the time of sample collection in the field. Due to inherent difficulties in collecting two similar samples containing relatively high concentrations of suspended solids, this method may not have resulted in the collection of a true split, or replicate sample. As such, a United States Geological Survey (USGS) Dekaport (cone) splitter (Rickly Hydrological Company, Columbus, Ohio) was implemented on February 16, 2011. The USGS developed this new sample splitter for use in the field to split a single collected sample into two or more identical samples. This was done after they found that prior methods resulted in errors, especially for surface water samples that contained significant amounts of larger suspended solids. In the 2012 Sample Split Evaluation

[1] Sample locations with paired data included in this analysis include B1 CM, B1-1A, B1-2, CM-1/A2LF-3, CM-11, CM-3, CM-8, CM-9/A1LF, CM-9/IEL, CTLI, CYN-1/DRG-1, DRG-1, HVS, HVS-1, HVS-2A/-2D, HVS-2B-1/-2, and HVS-3.

memo, it was found that the use of the splitter generally improved the correlation between the sample and the split for all compounds, except for copper. Reduced variability and scatter is consistent with other monitoring programs using the Dekaport splitter (Capel, Nacionales, and Larson, 1995); therefore, this report focuses on only those samples collected after implementation of the cone splitter. Proper sampling procedures for this location and the Dekaport sampling splitter can be found in the document *Environmental Sampling of Dioxins and Other Low Solubility Pollutants at Parts-Per-Billion and Lower Concentrations: Field Protocols for Collecting Santa Susana Field Laboratory (SSFL) ISRA Performance Samples and Obtaining Splits Using a Dekaport Cone Splitter* (WWE and Expert Panel, 2010).

Purpose

The 2012 Sample Split Evaluation Memo examined the correlation between sample splits quantified at two different labs, and evaluated the improvement in precision and accuracy due to implementation of the Dekaport splitter into the splits sampling method. **Two additional split samples were collected during the 2012/13 rainy season, and the purpose of this memo is to update the 2012 sample split evaluation with these most recent data to confirm the 2012 conclusions regarding the comparability of analytical results between the main and split labs.**

Methodology

To evaluate the correlation between samples and splits for TSS, TCDD, copper, and lead, several analyses were conducted. First, the means, coefficients of variation, and split-to-sample ratios were calculated. A split-to-sample ratio close to one indicates comparable split and sample results, >1 indicates that split results tended to be greater than sample results, and <1 indicates the opposite. For the calculation of the mean and coefficients of variation, all pairs of data where both sample and split results were below detection limits were removed from the dataset. When one of the results was below detection limits, the detection limit was used for the missing value for TSS, copper, and lead. TCDD total toxic equivalence (TEQ) assumed a value of 10^{-10} micrograms per liter (ug/L) for non-detect results (roughly equal to the lower TEQ [no DNQ] reported value), and J-flag results were included, again except for TCDD TEQ which did not include congener results quantified (DNQ) (i.e., these were treated as zero). For calculation of the coefficients of variation, pairs of data with either the sample or split below detection limits were removed from the analysis.

Second, the sample and split pairs were assigned a positive sign if the split results was higher than the sample result and a negative sign if the sample result was higher than the split result. A nonparametric one-sided sign test (a = 0.05) was applied to these signs to assess if the difference between the sample and split was statistically significant. P-values less than 0.05 indicate that a statistically significant difference exists between the sample and split results such that the split results are either statistically higher or lower than the sample results. For this calculation, all pairs of data where both the sample and split were below detection limits were removed from the dataset. To create a more robust statistical analysis, samples that were equal to the splits (which therefore had neither positive nor negative signs) were split equally and added to the number of positive and negative signs. Finally, the log-transformed sample results and the log-transformed split results were plotted, and a linear regression and 95% confidence intervals were calculated. For these plots, pairs of data with either result below the detection limit were removed. For those pollutants where the intercept coefficient of the linear regression had a p-value <0.05, indicating it was significant, the y-intercept not equal to 0 was used in the regression, reflecting a bias in the laboratory results for low concentrations. For those pollutants where the intercept coefficient of the linear regression had a p-value > 0.05, the regression was forced through the origin.

Results

A summary of the sample and split statistical analysis is summarized in Table 1. There were 176 pairs of observations analyzed, with approximately 23 to 48 pairs of data for each pollutant using the Dekaport splitter (excluding non-detect pairs).

The split-to-sample ratios for TSS and dioxins were both >1, while those for copper and lead were both <1, which would initially suggest that TSS and dioxins tended to have higher split results than samples, with the opposite for copper and lead. However, these ratios can be affected by a few pairs with large ratios one way or the other, so the nonparametric sign test was used to determine whether this bias exists. For TSS, most of the pairs had higher split results than sample results, which agrees with the positive average split-to-sample ratio of 2.8. The p-value was less than 0.05 for TSS, suggesting that there was a statistical bias towards higher split results compared to sample results for a pair of samples. However, for dioxins, most of the pairs actually had lower split results than sample results, even though the average split-to-sample ratio is well above 1 (12.4). The p-value is much less than 0.05, indicating that the bias towards lower split results relative to sample results was significant. Therefore, even though the split-to-sample ratio for dioxins is >1, the data actually show a bias towards *lower* split results relative to sample results. This can be shown graphically in Figure 2 (described later). The positive ratio is likely the result of a few of the pairs having very large ratios, such that the average is >1, even though most pairs have ratios <1. For both lead and copper, the majority of pairs have split results lower than the sample results, which agrees with their average split-to-sample ratios <1 (4.4 and 3.1, respectively). The p-values for these compounds are all below 0.05, suggesting a statistically significant bias towards lower split results compared to sample results. Lead shows a particularly strong bias towards lower split results compared to sample results.

Table 1. Sample Split Statistical Analysis (bolded p values are <0.05)

		TSS (mg/L)	TCDD (Dioxins) (µg/L)	Copper (µg/L)	Lead (µg/L)
Pairs of observations		48	23	31	46
% Detectable values		72%	43%	100%	99%
Average (COV)	Sample result	42 (2.4)	3.8e-07 (2.1)	5.8 (0.8)	3.8 (1.8)
	Split result	51 (2.1)	2.8e-07 (2.6)	4.4 (0.7)	3.1 (1.9)
	Split-to-sample ratio	2.4 (2.3)	9.3 (3.0)	0.82 (0.27)	0.81 (0.30)
p by paired nonparametric one-tailed sign test		**0.01 (+)**	**5.3e-03 (-)**	**1.6e-04 (-)**	**4.3e-10 (-)**

Figures 1 - 4 depict the log-transformed sample results plotted against the log-transformed split results for each of the four pollutants. Each plot also contains the linear regression (based on all detectable paired data after implementation of the cone splitter), 95% confidence limits on the regression, and a 1:1 line. A perfect correlation between sample and split would fall on the 1:1 line. The regression line represents the relationship between the log sample results and log splits results. The y-intercept is the average difference in background (very low) concentrations of the pollutant between the two labs, and the slope is the average log concentration that the splits lab would measure for a log concentration of 1 for the sample. When the p-value of the y-intercept was >0.05, the regression was forced through the origin. This was the case for dioxins and copper.

For all of the pollutants analyzed, the slope of the regression is less than 1, which would suggest a bias for lower concentration in the splits relative to the samples. However, the differences in background and the range of concentrations measured can lead to either the splits or samples being statistically higher, as was seen in the nonparametric sign tests.

The results from the nonparametric sign test for TSS indicated that the split results were higher than the sample results a statistically significant portion of the time. Looking at the results graphically in Figure 1, this is shown by most of the data falling to the left of the 1:1 line. The 1:1 line falls within the confidence intervals for about half of the range of measured concentrations (the higher half), so it is possible that the relationship is not strongly biased, especially for the pairs at higher concentrations. The data have much less scatter above concentrations of 10 mg/L TSS than those below 10 mg/L, which is usually near detection limits. This likely indicates that the split results are either more sensitive or have a higher background at low concentrations, but at higher TSS concentrations, the data fall very close to the 1:1 line, indicating good consistency between the two labs. This analysis does not tell us which lab is more accurate at low concentrations, only that the splits lab tends to measure higher TSS than the sample lab at low concentrations.

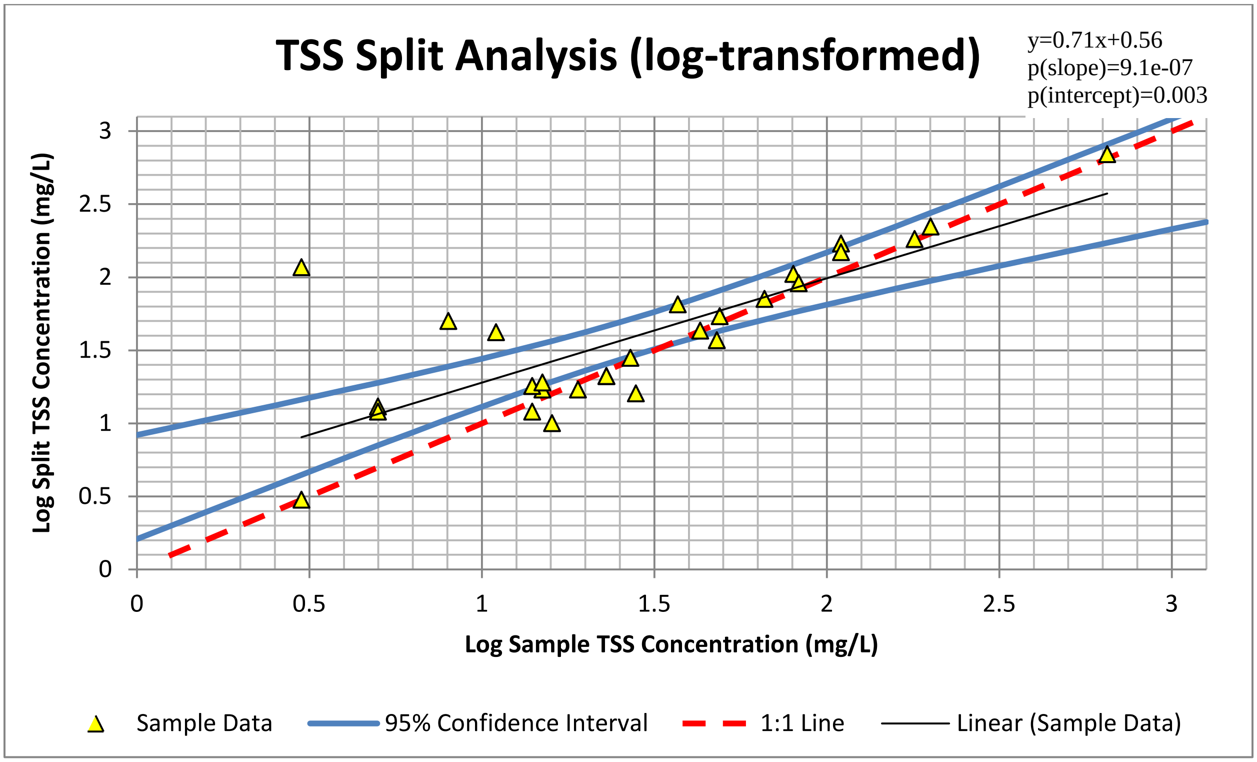


Figure 1. Log Sample vs. Log Split results for TSS. Non-detect results were excluded (non-detect result frequency of 38%).

The nonparametric sign test for dioxins showed that split results were lower than sample results a statistically significant portion of the time even though the average ratio was much greater than 1. This is shown graphically in Figure 2, in which most of the data falling to the right of the 1:1 line, though several of those that fall to the left are very far left of the line. The p-value for the y-intercept was 0.25, so the regression was forced through the origin, indicating reasonable consistency between the labs at low concentrations. The slope of the regression is very close to 1 (0.98), and the 1:1 line falls within the confidence intervals of the regression throughout the entire range of measured data. Therefore, a correlation close to 1:1 cannot be ruled out for dioxins, indicating good consistency between the two labs. However, there is considerably more scatter in the data for dioxins than for TSS, even at higher concentrations, suggesting somewhat lower precision. TSS is much easier to measure than dioxins, so a lower precision for dioxins is not unexpected.

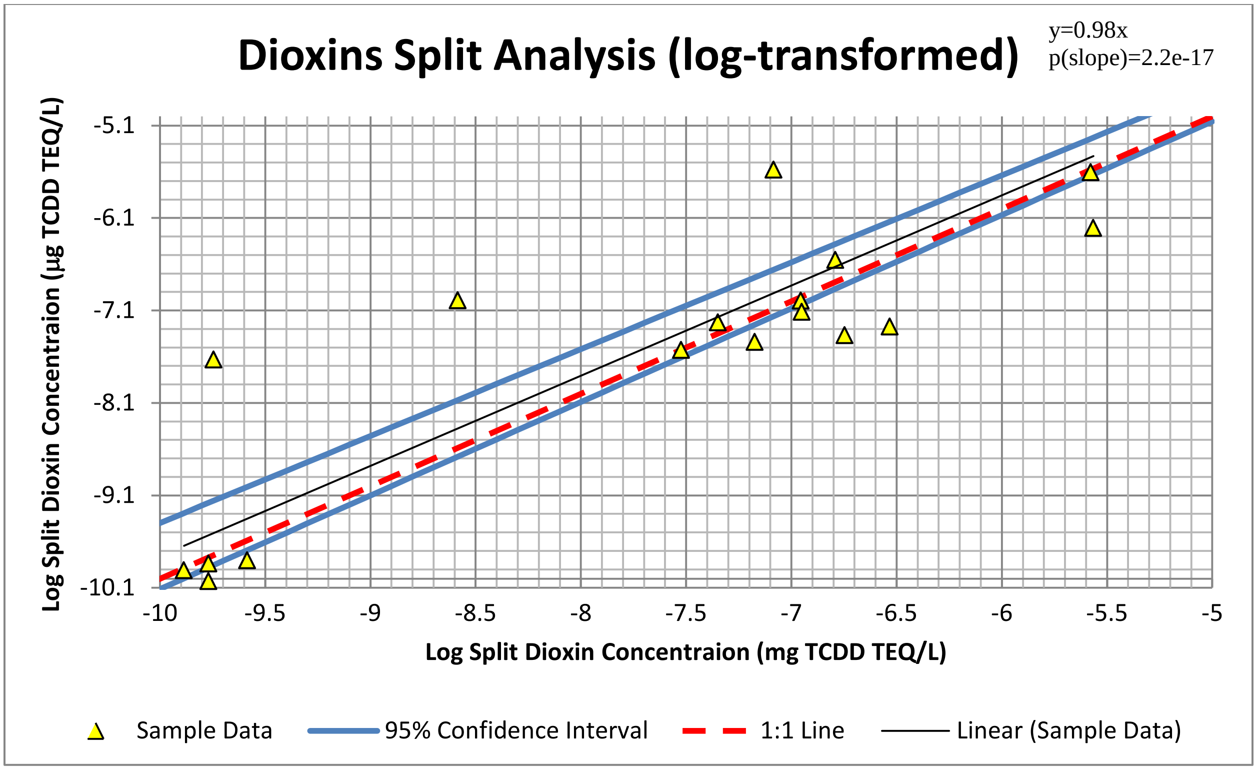


Figure 2. Log Sample vs. Log Split results for dioxins. Non-detect results were excluded (non-detect result frequency of 57%).

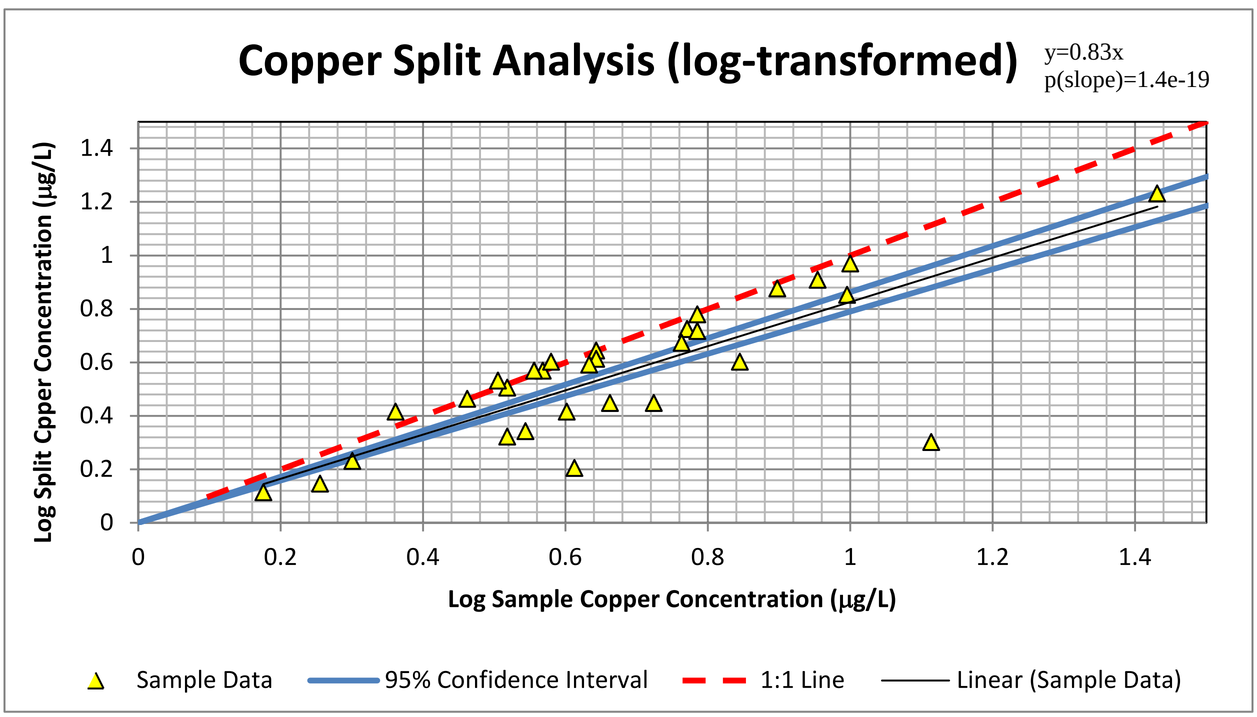


Figure 3. Log Sample vs. Log Split results for copper. No samples were below detection limits.

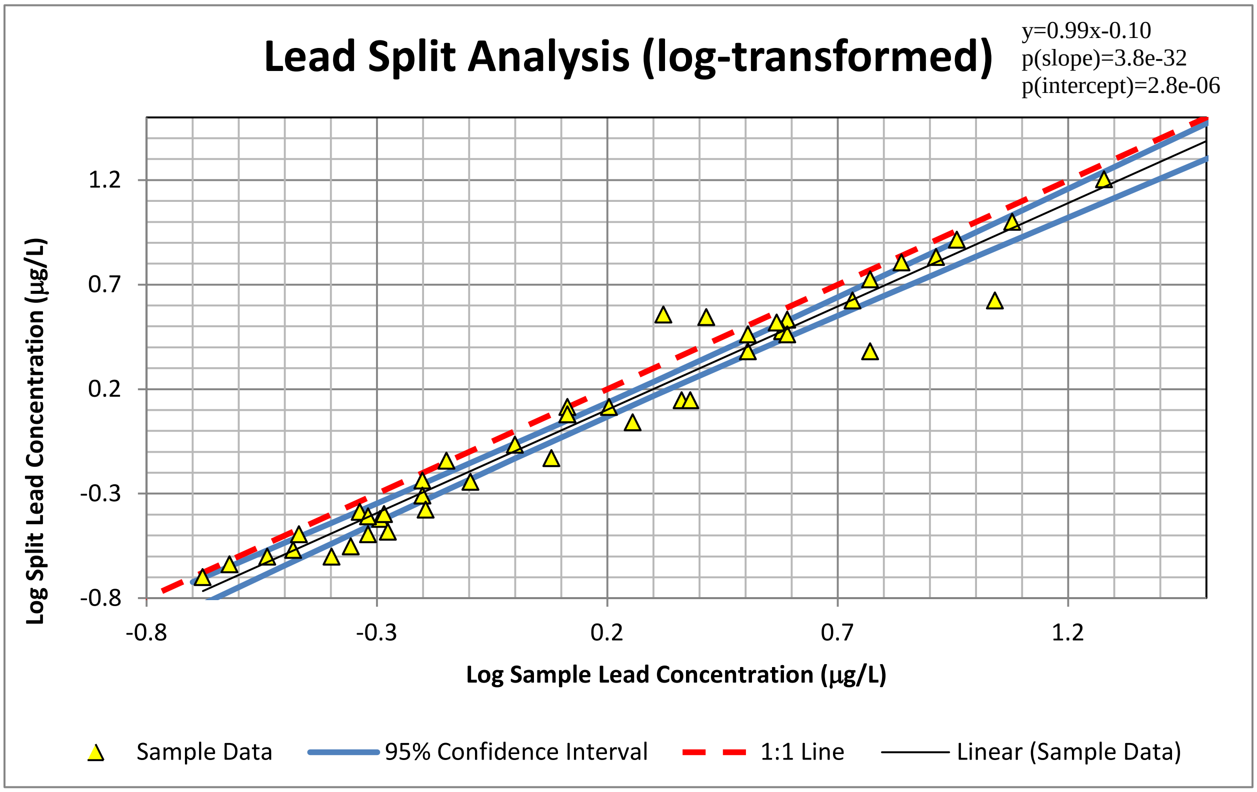


Figure 4. Log Sample vs. Log Split results for lead. Non-detect results were excluded (non-detect result frequency of 1%)

The nonparametric sign test for copper showed that split results were lower than sample results a statistically significant portion of the time. This is shown graphically in Figure 3, in which the vast majority of the data falling to the right of the 1:1 line. The p value for the y-intercept was 0.57, so the regression was forced through the origin, indicating that background concentrations were similar between the two labs. The slope of the regression is much less than 1 (0.83), indicating a likely bias towards lower split results compared to sample results. The 1:1 line is outside the confidence intervals throughout the entire range of values, indicating the high likelihood that there is a systematic bias towards lower split results compared to sample results for copper. This bias appears to be relatively constant throughout the range of values. This analysis does not tell us which is more accurate, only that the splits lab consistently measured lower concentrations than the sample lab for the same sample.

The nonparametric sign test for lead showed that split results were lower than sample results a statistically significant portion of the time. The p-values for lead were many orders of magnitude lower than those for the other pollutants, suggesting that this relationship was much more pronounced for lead than for the other pollutants. This is shown graphically in that virtually all of the lead data are to the right of the 1:1 line. The p-value of the y-intercept was 2.8e-06, so it was statistically significant and was therefore included in the regression. This suggests that the splits lab measured a lower background concentration than the sample lab. The confidence intervals do not contain the 1:1 line at any point, suggesting the strong likelihood of a systematic bias towards lower split results relative to sample results. However, the slope is very close to 1 and the scatter is relatively low, suggesting that the bias may result from a lower background concentration measured by the lab processing the splits. If that background was removed, the lead results for the two labs would agree very well throughout the range of values. This analysis does not tell us if the split or the sample results are more accurate, just that the split results were statistically lower than the sample results

Conclusions

- Based on the nonparametric sign test and the split-to-sample ratio, TSS results for splits were significantly higher than sample results. This difference is more pronounced at low concentrations, however, with fairly good agreement between the results from the two labs at higher concentrations.

- Based on the nonparametric sign test, significant differences were found between split and sample results for copper and lead, with the split results lower than sample results. Such split versus sample differences may be explained by various factors such as differences between laboratory quality assurance/quality control (QA/QC), analysis, and/or reporting practices. The differences for copper are consistent across the range of concentrations measured, suggesting that the differences are likely due to systematic differences in measured concentrations, whereas the differences for lead are more pronounced at lower concentrations.

References

Capel, Nacionales, and Larson, 1995. *Precision of a Splitting Device for Water Samples, U.S. Geological Survey, Open-File Report 95-293, Sacramento, California.*

WWE and Expert Panel, 2010. *Environmental Sampling of Dioxins and Other Low Solubility Pollutants at Parts-per-Billion and Lower Concentrations: Field Protocols for Collecting SSFL ISRA Performance Samples and Obtaining Replicate Splits Using a Dekaport Cone Splitter.* August 31.

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APPENDIX E

EXPERT PANEL ISRA AND CM UPSTREAM AND DOWNSTREAM ANALYSIS MEMORANDUM 2012/2013 RAINY SEASON

Memorandum

Date: 29 Aug 2013

To: The Boeing Company (Boeing), Santa Susana Field Laboratory (Santa Susana Site)

From: Geosyntec Consultants and the Santa Susana Site Surface Water Expert Panel

Subject: BMP Performance Analysis
Santa Susana Site
Geosyntec Project: SB0363T

The purpose of this memorandum is to update the annual stormwater quality evaluation being conducted at the Boeing Santa Susana Site (Site) to confirm whether the treatment Best Management Practices (BMPs) in conjunction with upgradient erosion control practices are decreasing pollutant of concern (POC) concentrations. This memorandum incorporates 2012-2013 rainy season data collected at the Site into a dataset that was initiated in December 2009. The National Pollutant Discharge Elimination System (NPDES) POCs addressed in this analysis include total suspended solids (TSS), total lead, total copper, and dioxins (TCDD TEQ, DNQ excluded, BAFs included). In particular, 2012-2013 data were collected to assess effectiveness of culvert modification (CM) installations and the lower lot biofilter all located in the NPDES outfall 009 watershed. Data for this sampling year were sparse due to the low overall precipitation amount and fewer storm events compared to previous years (average annual rainfall at SSFL from 1960-2006 was 18 inches, compared to 8.09 inches in the 2012/13 monitoring period). There was no flow from Outfall 008 or the Outfall 008 watershed monitoring sites during this monitoring season, therefore no samples were collected in the NPDES outfall 008 watershed in the 2012-13 monitoring season. In addition, no data pairs were collected at Interim Source Removal Action (ISRA) locations during the most recent monitoring season. As a result, ISRA sites and sites in the outfall 008 watershed are not discussed in this memo. Figures 2-1 through 2-6 in the Annual Report show locations of all stormwater controls and monitoring sites.

Paired data from both an influent and effluent sample location above and below the BMP and collected during the same storm event were evaluated. Split samples, used for lab comparison purposes, are excluded from this analysis, and are described in the split sample QA/QC report in Appendix D of the SSFL Annual Report. The number of paired samples varies by constituent but for all years combined generally ranges from eight to 18 pairs for each POC for each of the five CM sites discussed here (as described below, CM-3 was excluded from this analysis). Performance data for the lower lot biofilter (construction of which was completed in 2013) were collected from three locations within the system (influent, post-sedimentation basin, and effluent) during one event in the 2012-13 sampling year and therefore there are only three samples associated with this location to date.

With respect to sampling at the culvert modifications (CMs), influent grab samples are collected from flowing surface water upstream of the maximum extent of ponding caused by the weir as observed before that date.[1] All CMs include a media filter and a slipline HDPE lining through existing galvanized corrugated metal culvert pipes with the exception of B-1, which is a media bed with no slipline element. CM effluent grab samples are collected at the culvert outlets on the downstream side of the road, where the culvert pipes discharge to the Northern Drainage, with the exception of CM-9 and B-1, where effluent samples were collected from the underdrain outlets beginning in October 2011, rather than the culvert outlet. Flows from the culvert outlets may represent treated runoff (via sedimentation and media filtration) and partially treated runoff (flowing through or over the weir boards). At CM-3, the slipline HDPE pipes were inserted from both the influent and effluent sides and could not be sealed at the point where they meet, and subsurface flows through the road embankment are known to have entered the pipe during rain events from February 2010 through March 2011[2] because water was observed discharging from the HDPE pipe outlet when no water was flowing into the inlet. Therefore CM-3 performance as designed cannot be reliably assessed due to this bypassing of the media filter.

Finally, it should also be noted that CM-1 (upstream-east; see additional discussion in Section 1, below), CM-3, CM-8, and CM-11 receive runoff from drainage areas that do not include any known historic industrial activities, although the CM-3 area does include a clean soil borrow area at the top of the watershed. Therefore, influent sample results at these four CM locations (not including CM-1 upstream west) are relatively good quality and considered reflective of “background” stormwater concentrations, making it difficult to achieve additional POC reduction through these CMs. These “background” CM locations were therefore statistically evaluated separately from the other CM locations.

In the 2012-2013 season, there were nine monitored rain events, with eight new CM paired samples collected, as well as three data points (from a single storm) for the lower lot biofilter (influent, post-sedimentation basin, and biofilter outlet). As mentioned earlier, no paired ISRA data was collected this season. The BMPs discussed in this memo and their respective drainage areas are shown in Table 1.

Table 1. BMP Sites and Drainage Areas

BMP	Drainage Area (acres)
CM-1	41.11
CM-3	17.21
CM-8	2.55
CM-9	7.73
CM-11	8.27
B-1 Media Filter	4.65
Lower Lot Biofilter	26.85

[1] When the extent of ponding increased at the CM-1 and CM-3 culvert basins on December 22, 2010 during a heavy rainfall, the influent sample locations were moved upstream a sufficient distance to remain above the maximum ponded water footprint.

[2] Sampling at this site stopped after the 2010/11 season, so no observations have been made since March 2011.

1. LINE PLOTS

The following log-scale line plots illustrate the changes in measured concentrations between CM and biofilter upstream/downstream sample pairs. Paired data were obtained from CM locations B1, CM-1, CM-3, CM-8, CM-9, and CM-11, and the lower parking lot biofilter. Paired data are presented by POC in Figures 1 through 35. Pairs are color-coded based on the sampling year during which they were collected, and different symbology is used for different upstream and downstream sample collection locations (symbology is defined in each graph). Additionally, non-detect results are displayed as the detection limit. The statistical analysis of the datasets is presented in Section 2 below.

In addition to evaluating BMP performance, the monitoring data have also been used in the site selection evaluations for consideration for enhancements to selected CMs for improved performance in areas where the effluent remains problematic. This was the case at CM-9 based on previous year results, and upgradient improvements were added in 2013. Other improvements include asphalt removal or filter fabric installation. For these sites, separate graphs are shown for sample results that occurred before and after the improvements were made. At the B1 site, media filter bleed-through was observed during initial sampling dates in the 2011-2012 sampling season. Results collected during this period were removed from the analysis.

Several CM locations (CM-1, CM-9, and B1 CM) have multiple upstream drainage areas:

- CM-1 receives runoff from an eastern tributary that is considered to reflect background concentrations as well as a western tributary comprising paved road and ELV hillside runoff;
- CM-9 receives runoff from the Area I landfill and former Building 1324 parking lot (demolished Summer/Fall 2011), as well as the paved road to the east; and
- the B1 CM receives runoff from the north, comprised of paved road runoff, and the south, comprised of the upper B1 ISRA areas, the sedimentation basin, and paved runoff.

The selection of the upstream location used in the paired analysis was evaluated on a case by case basis, with similar sample dates taking precedence (between upstream and downstream); in instances when two upstream samples were available for the same downstream-sampling storm event, an impervious area-weighted average (used as an estimate of proportioned flowrate from each influent stream) was used to represent a single upstream value. With regards to the CM line plots, the CM effect on influent concentrations above the Permit limit is the most important since those below the Permit limit are already of acceptable quality and are generally considered to be at levels unlikely to be further reduced using typical stormwater controls, especially considering the conditions that have been experienced to date in terms of precipitation and watershed erosion. As with most stormwater quality controls, the water quality improvements are largest when the influent concentrations are highest.

These charts are included for general visual assessment purposes only; the statistical tests that follow are used to make evaluations on BMP performance. It should be noted that these samples are all grab samples, and therefore highly variable in terms of water quality results, and may represent collection times that vary throughout the storm event hydrograph. Therefore, relatively large numbers of samples are needed to represent the varying conditions with reasonable statistical confidence and power.

Although not recorded for every event, based on field notes the following five effluent samples were collected during overflow/bypass conditions. These conditions are noted on the plots and indicate decreased performance. No other sampling dates were observed for overflow, so whether or not this occurred for other dates cannot be determined. In addition, observations on weir board overflows were collected starting in the 2011/12 season. It is unknown which prior samples, if any, were collected during overflow. Future sampling notes will more carefully track this information.

CM-9, downstream underdrain samples:

- A2SW0009S001 on 10/5/2011
- A1SW0009S017 on 3/17/2012
- A1SW0009S004 on 3/25/2012

CM-1, downstream culvert outlet samples:

- A1SW0002S020 on 3/17/2012
- A2SW0002S021 on 3/25/2012

Table 1 summarizes rainfall events in which data were collected for the sampling dates from the 2009-2013 seasons ('non sample collection events' represent precipitation events where samples were not collected). Not all BMPs were monitored during each rain event.

Table 2. Sample collection event rainfall data summary (gray cells indicate dates that did not have data pairs sampled)

Date(s)	Average Intensity (in/hr)	Max Intensity (in/hr)	Event Total (in)	Event Duration (hrs)	Cumulative Rainfall for Sampled Events (in)
10/13/2009 - 10/14/2009	0.05	0.24	2.45	35	2.45
12/7/2009 - 12/13/2009	0.02	0.25	3.43	57	5.88
1/17/2010 – 1/22/2010	0.05	0.52	6.88	123	12.76
2/5/2010 – 2/6/2010	0.04	0.20	1.84	43	14.6
2/9/2010	0.01	0.17	0.20	3	14.8
2/19/2010-2/20/2010	0.01	0.05	0.14	8	14.94
2/24/2010	0.01	0.03	0.12	12	15.06
2/27/2010	0.06	0.34	1.52	17	16.58
3/6/2010	0.02	0.13	0.38	11	16.96
4/4/2010 - 4/5/2010	0.03	0.23	0.86	13	17.82
4/11/2010 - 4/12/2010	0.03	0.22	0.65	11	18.47
Non sample collection event total			0.57		
Total for 2009/10 monitoring period			**19.04**		
10/5/2010 - 10/6/2010	0.049	0.18	0.93	20	0.93
10/16/2010 - 10/25/2010	0.003	0.22	0.69	216	1.62
11/17/2010 - 11/21/2010	0.011	0.23	0.97	89	2.59
12/5/2010	0.018	0.09	0.41	10	3.0
12/17/2010 – 12/22/2010	0.054	0.37	7.22	131	10.22
12/25/2010 - 12/26/2010	0.03	0.22	0.57	9	10.79
12/29/2010	0.043	0.10	0.43	7	11.22
1/2/2011 - 1/3/2011	0.014	0.12	0.38	17	11.60
2/15/2011 – 2/20/2011	0.019	0.45	2.33	121	13.93
2/25/2011 - 2/26/2011	0.03	0.22	1.50	20	15.43
3/2/2011 - 3/3/2011	0.007	0.03	0.13	8	15.56

3/6/2011 - 3/7/2011	0.006	0.02	0.12	10	15.68
3/18/2011 - 3/27/2011	0.03	--	6.00	197	21.68
5/15/2011 - 5/18/2011	0.009	0.08	0.67	76	22.35
Non sample collection event total			1.03		
Total for 2010/11 monitoring period			**23.38**		
10/5/2011	0.09	0.18	0.90	9	0.90
11/4/2011 - 11/6/2011	0.041	0.23	0.58	59	1.48
11/11/2011 - 11/12/2011	0.035	0.26	0.76	22	2.24
11/19/2011 - 11/21/2011	0.031	0.29	0.78	35	3.02
12/12/2011 - 12/17/2011	0.006	0.21	0.80	137	3.82
1/21/2012 – 1/23/2012	0.017	0.15	1.06	62	4.88
2/27/2012	--	--	0.00		
3/16/2012 - 3/18/2012	0.052	0.31	1.51	29	6.39
3/25/2012	0.079	0.51	2.12	21	8.51
4/10/2012 – 4/13/2012	0.034	0.36	2.37	64	10.88
4/23/2012 - 4/26/2012	0.003	0.09	0.26	80	11.14
Non sample collection event total			0.27		
Total for 2011/12 monitoring period			**11.41**		
Data Summary for 2012/13 Rainy Season					
11/14/2012 – 11/18/2012	***0.01***	***0.36***	***0.99***	***99***	***0.99***
11/28/2012 – 12/4/2012	***0.011***	***0.12***	***1.49***	***139***	***2.48***
12/12/2012 – 12/18/2012	***0.005***	***0.07***	***0.68***	***129***	***3.16***
12/22/2012 – 12/26/2012	***0.013***	***0.18***	***1.13***	***87***	***4.29***
1/23/2013 – 1/27/2013	***0.02***	***0.18***	***1.78***	***89***	***6.07***
2/8/2013 – 2/9/2013	***0.008***	***0.07***	***0.12***	***15***	***6.19***
2/19/2013	***0.025***	***0.09***	***0.25***	***10***	***6.44***
3/7/2013 – 3/8/2013	***0.041***	***0.23***	***0.87***	***7***	***7.31***
5/5/2013 - 5/6/2013	***0.04***	***0.16***	***0.48***	***7***	***7.79***
Non sample collection event total			***0.30***		
Total for 2012/13 monitoring period			***8.09***		

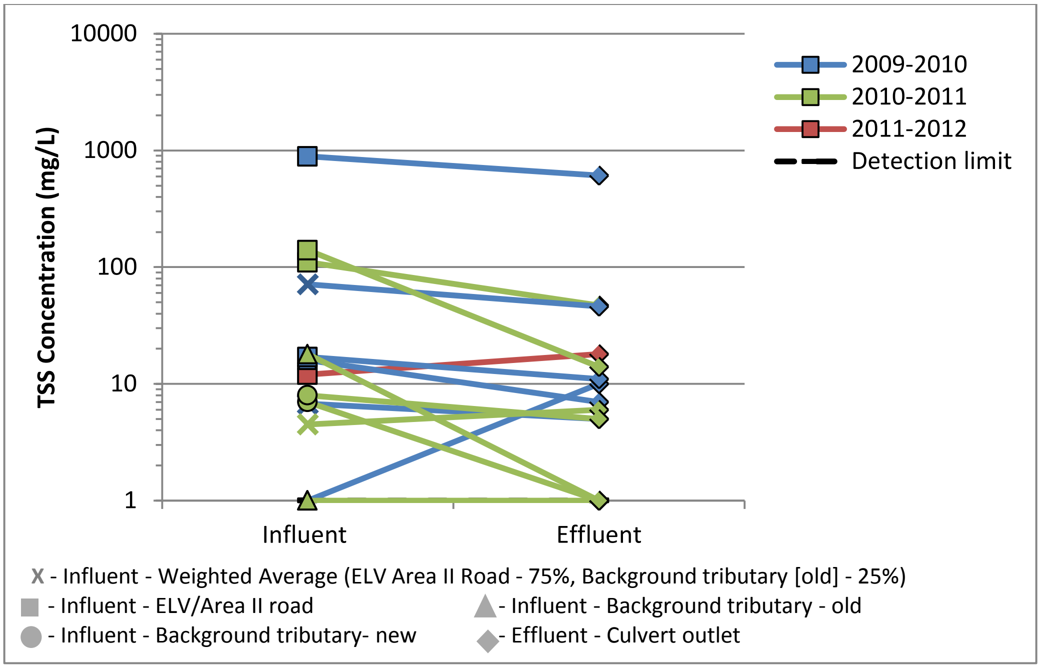


Figure 1. TSS at CM-1, pre filter fabric installation

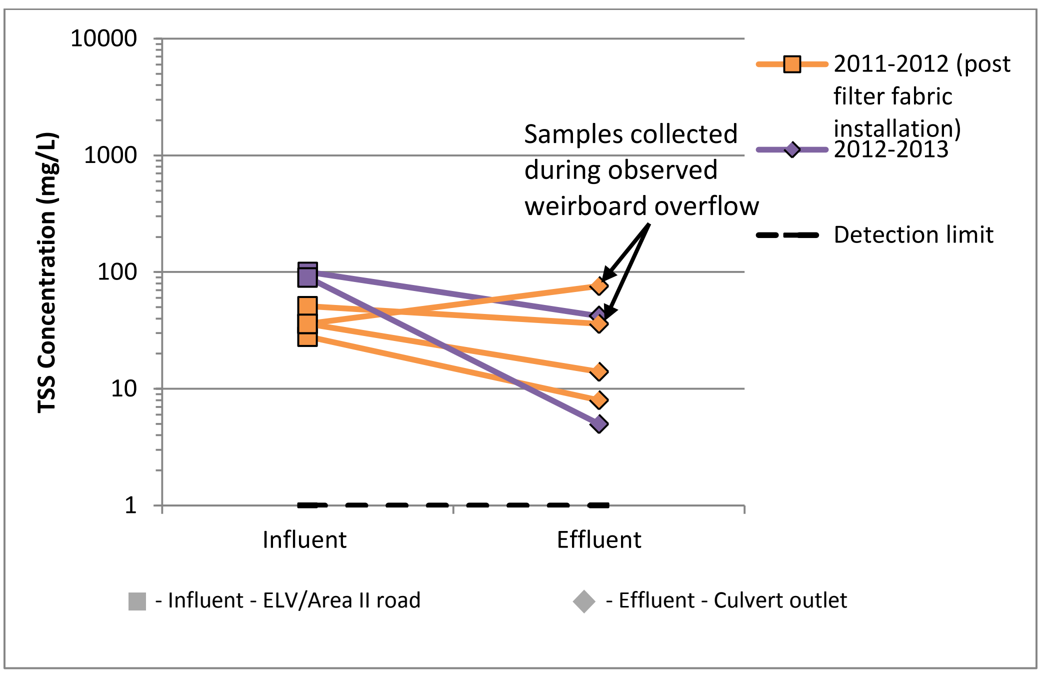


Figure 2. TSS at CM-1, post filter fabric installation

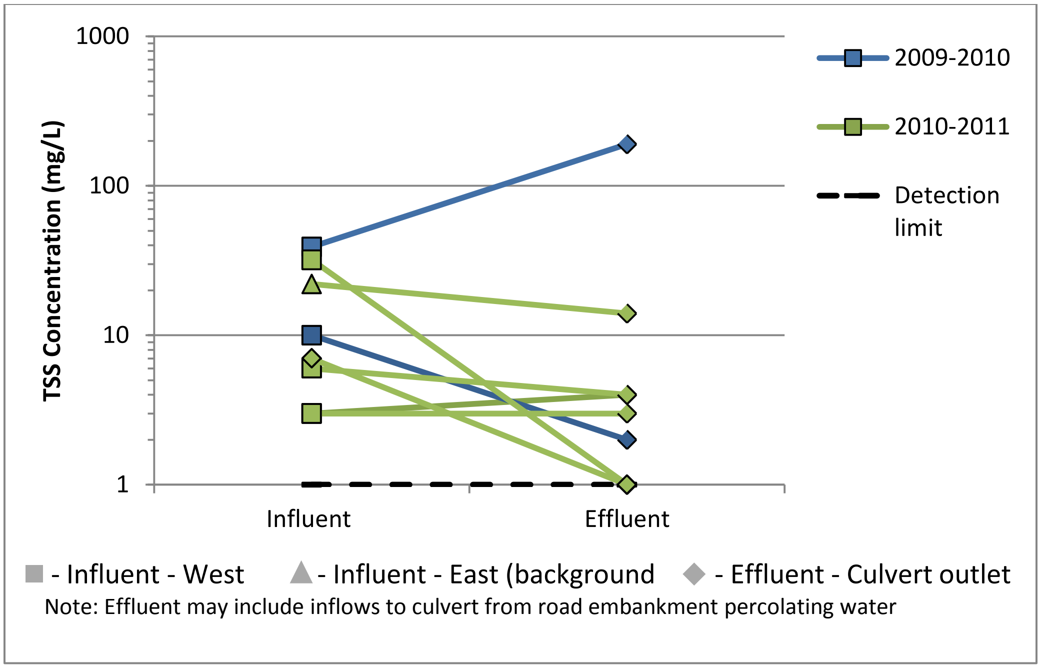


Figure 3. TSS at CM-3

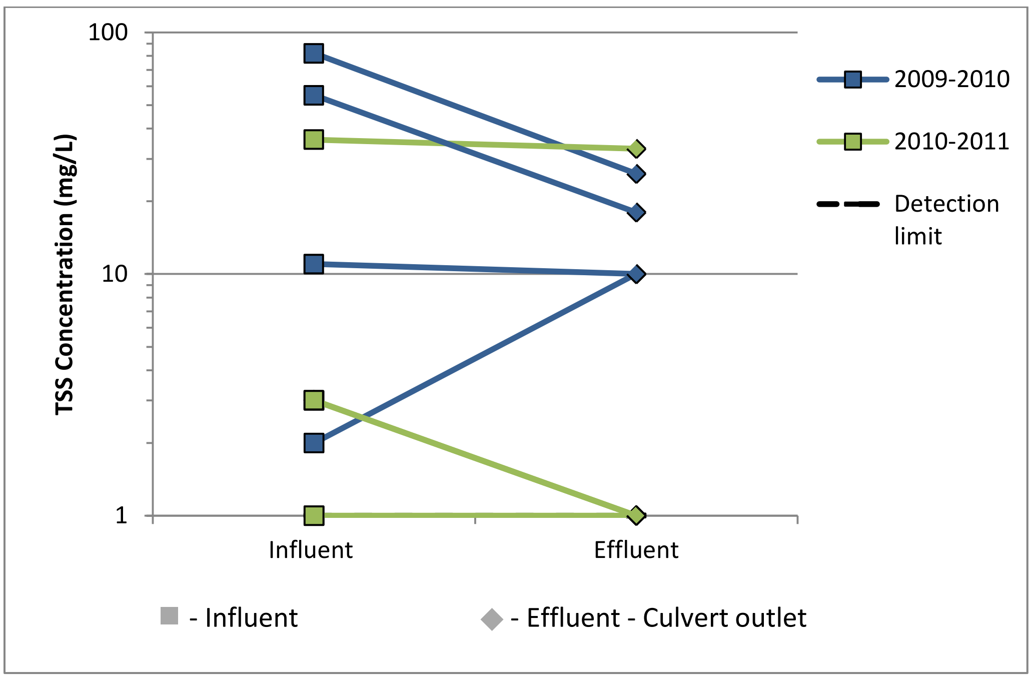


Figure 4. TSS at CM-8

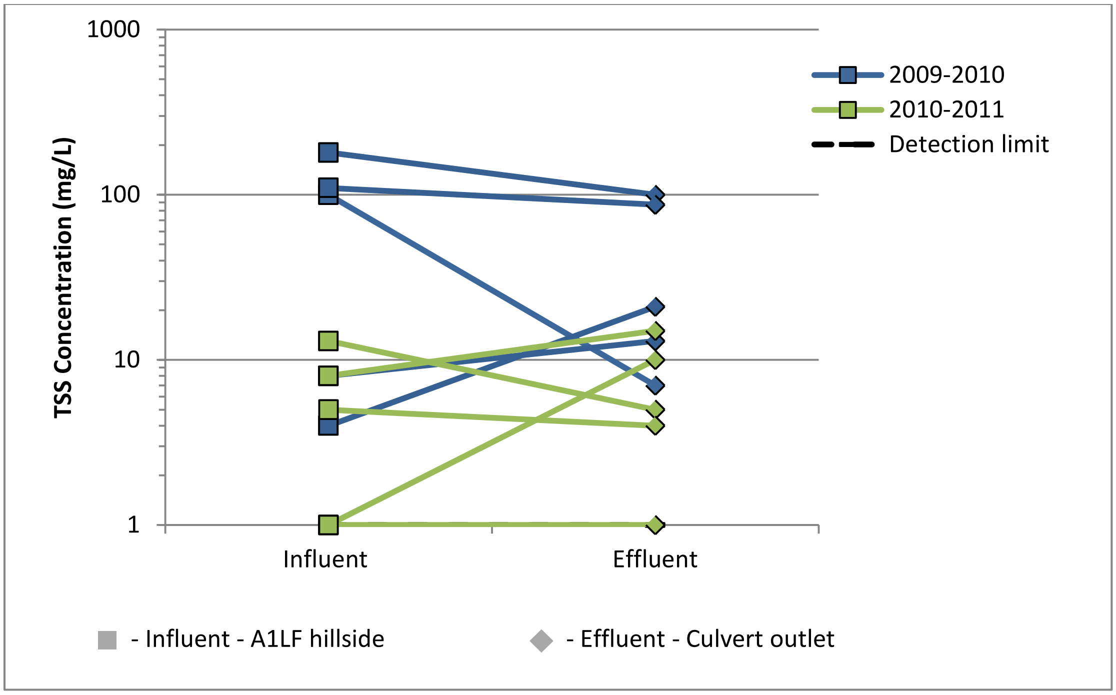


Figure 5. TSS at CM-9, pre improvements[3]

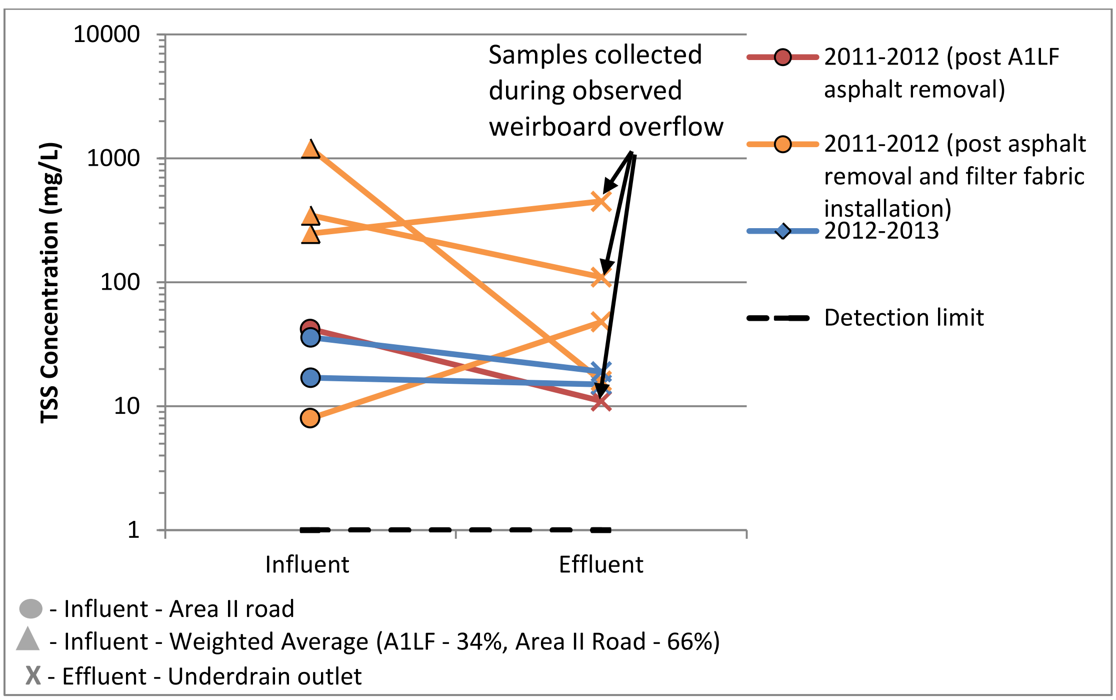


Figure 6. TSS at CM-9, post improvements

[3] CM9 Improvements include removal of A1LF asphalt and addition of CM weir board filter fabric.

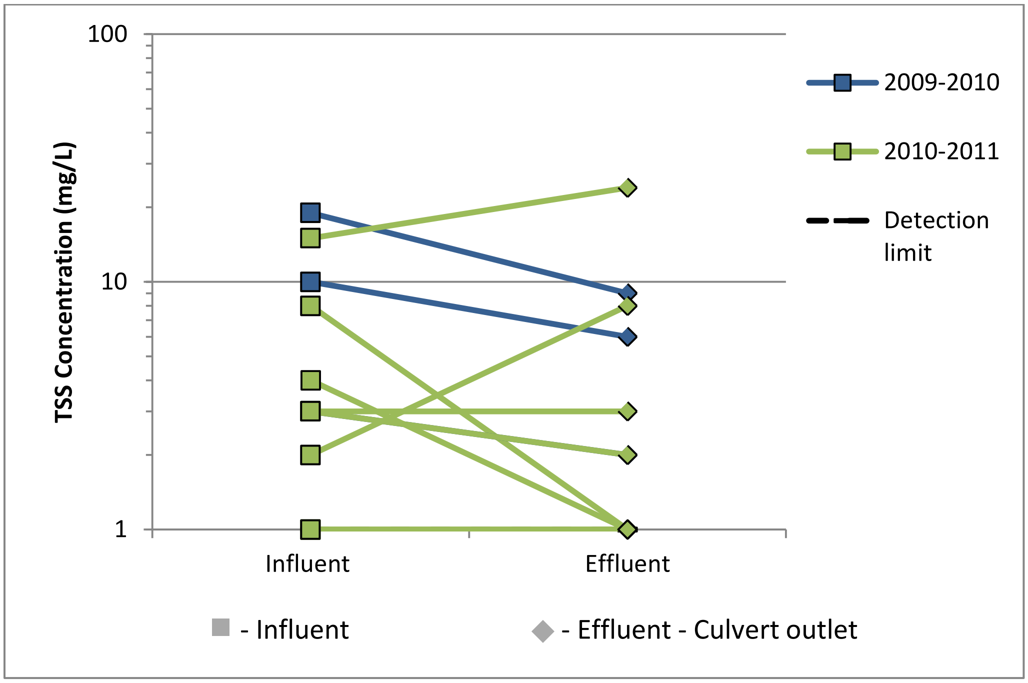


Figure 7. TSS at CM-11

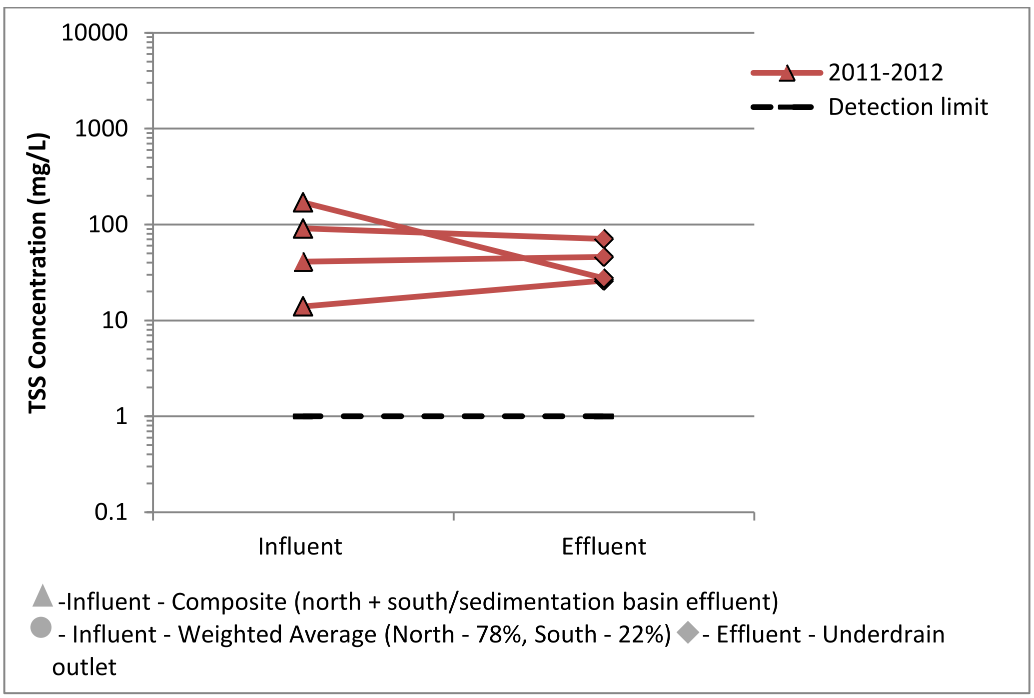


Figure 8. TSS at B-1 Media Filter (CM), pre curb cuts

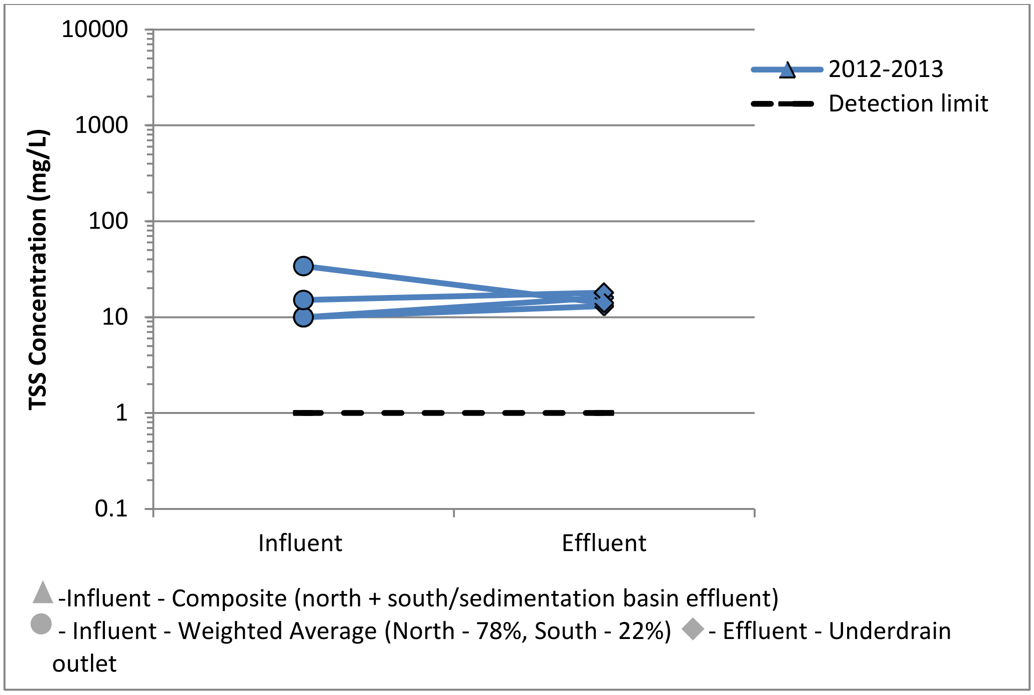


Figure 9. TSS at B-1 Media Filter (CM), post curb cuts

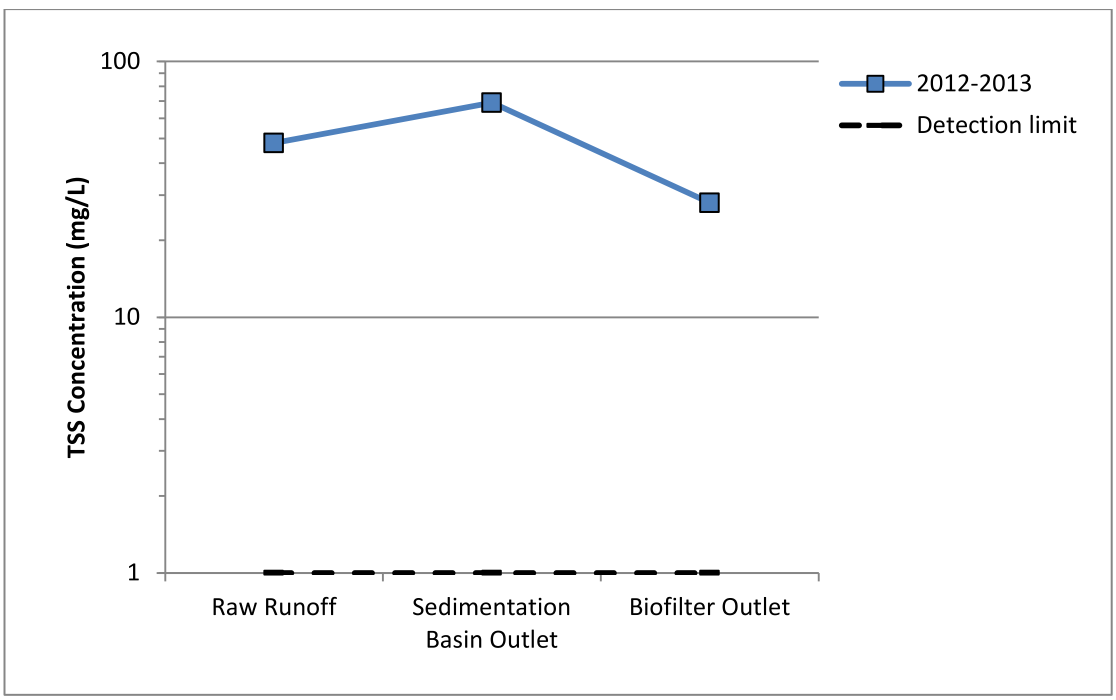


Figure 10. TSS at Lower Lot Biofilter, Watershed 009

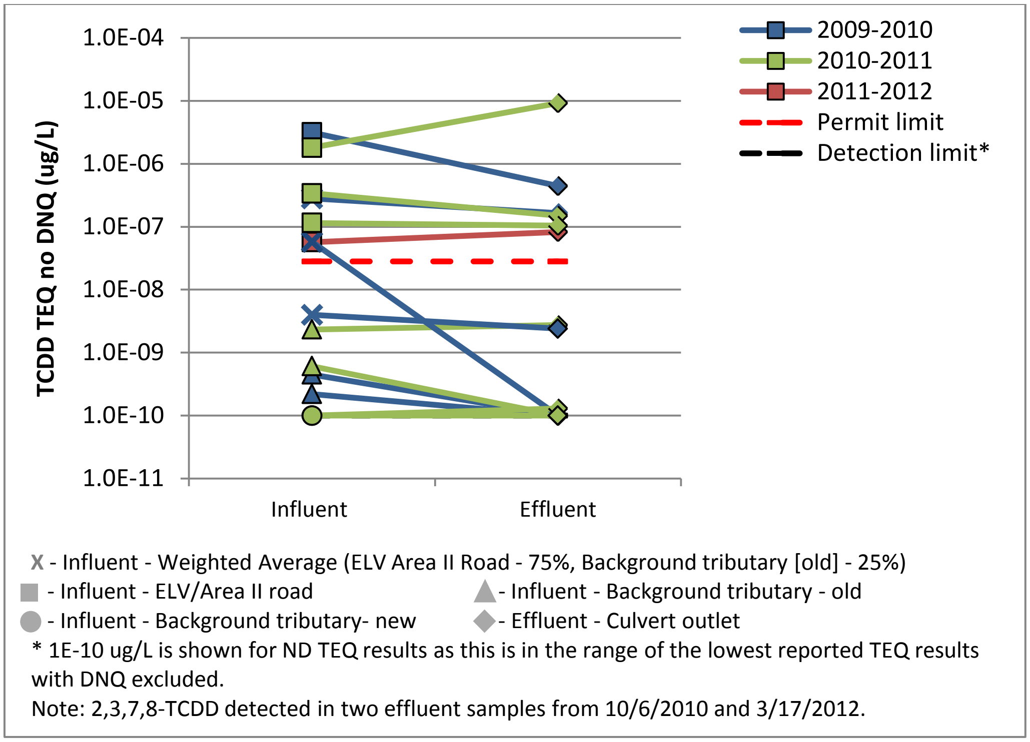


Figure 11. Dioxins at CM-1, pre filter fabric installation

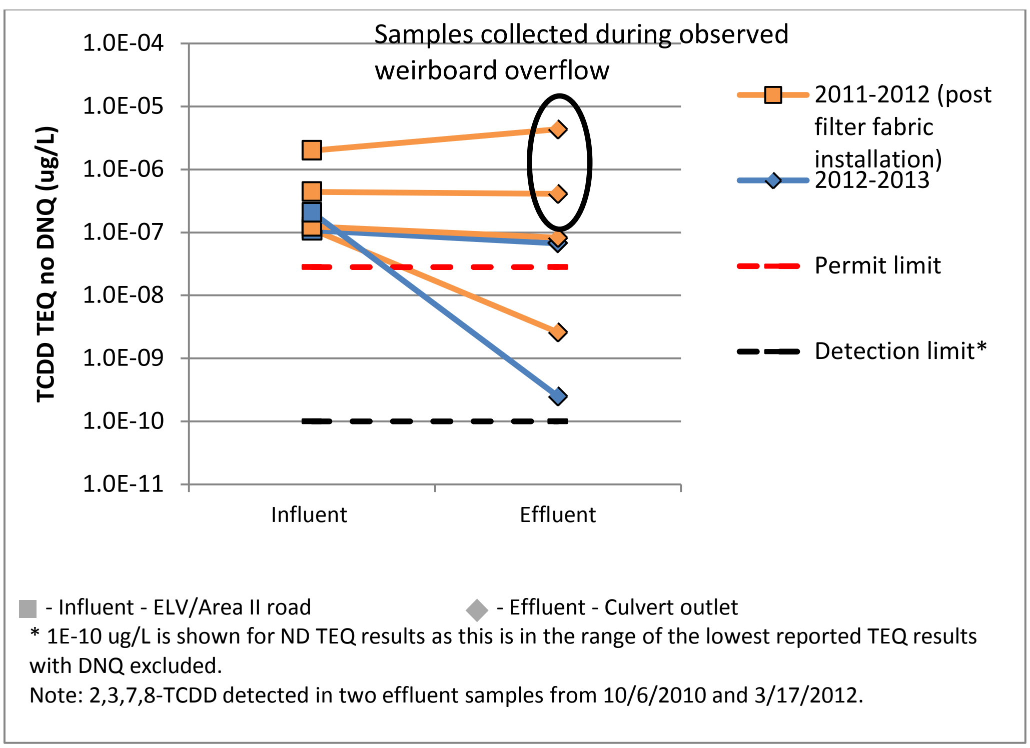


Figure 12. Dioxins at CM-1, post filter fabric installation

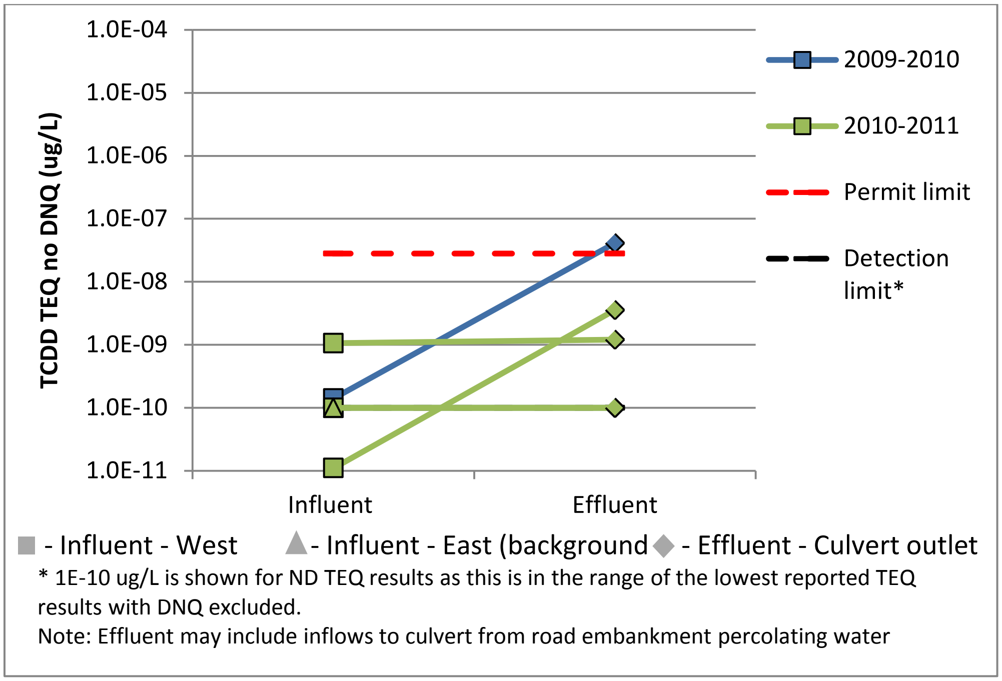


Figure 13. Dioxins at CM-3

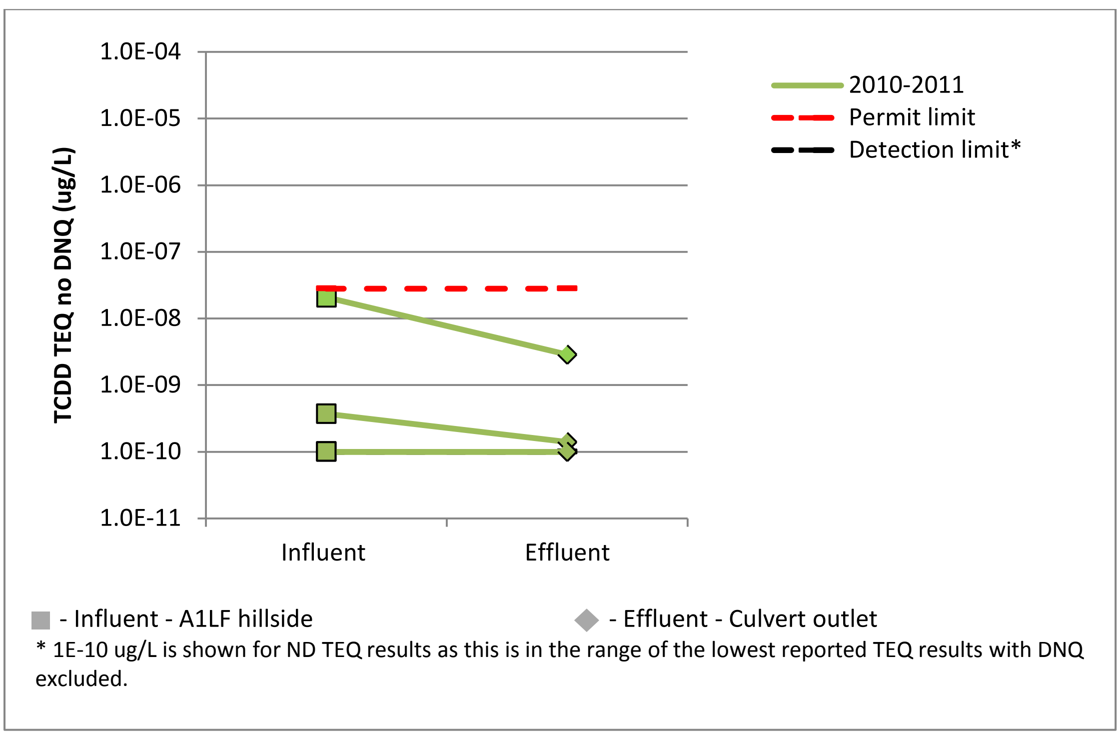


Figure 14. Dioxins at CM-9, pre improvements

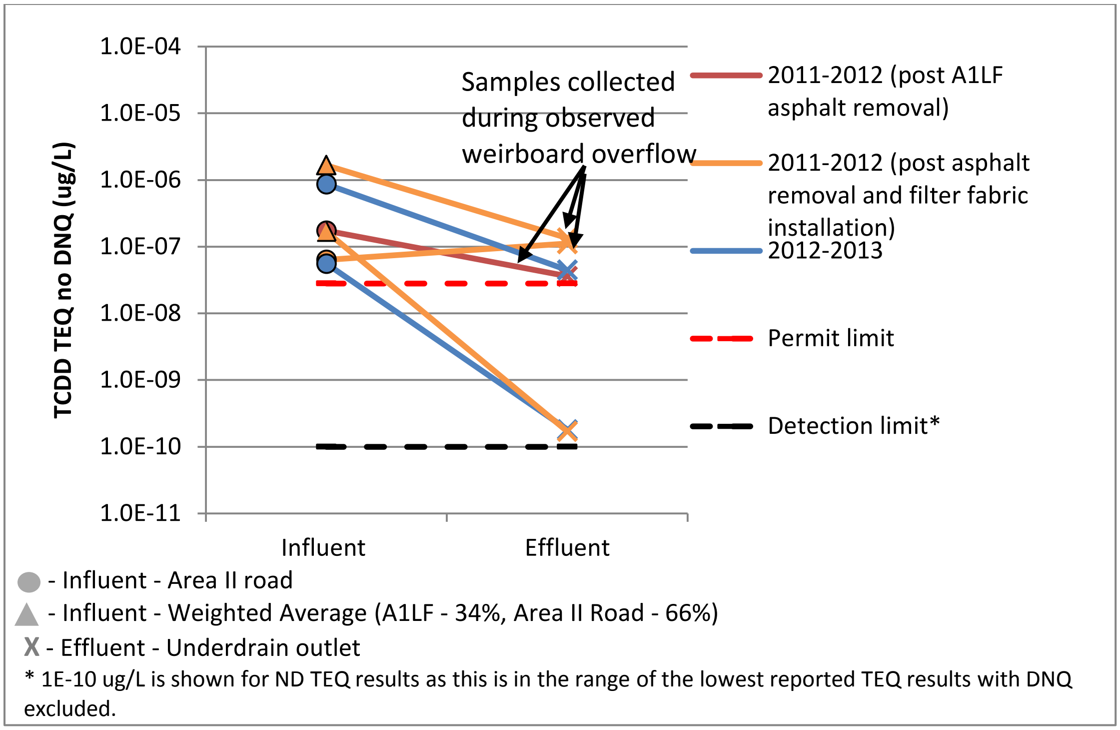


Figure 15. Dioxins at CM-9, post improvements

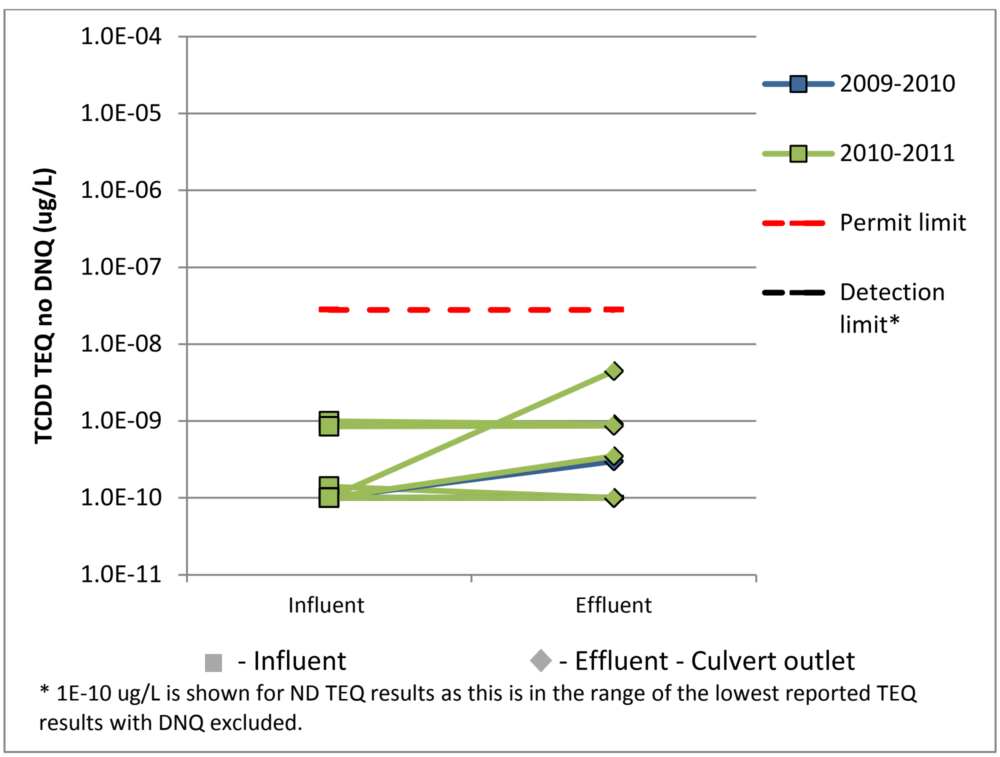


Figure 16. Dioxins at CM-11

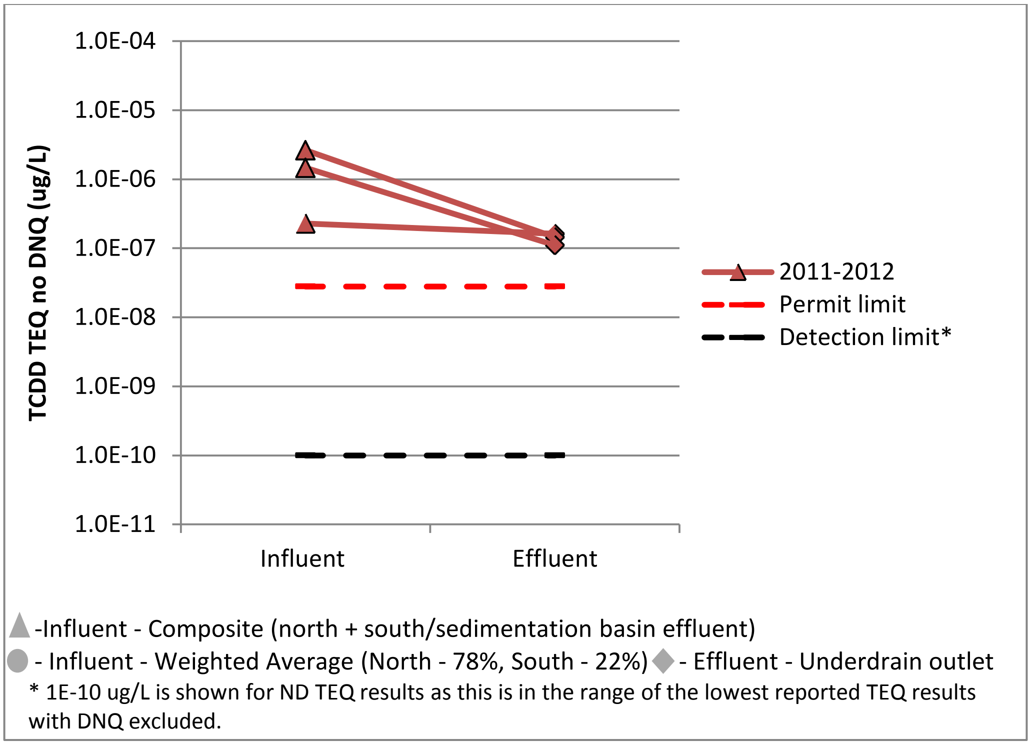


Figure 17. Dioxins at B1 Media Filter (CM), pre curb cuts

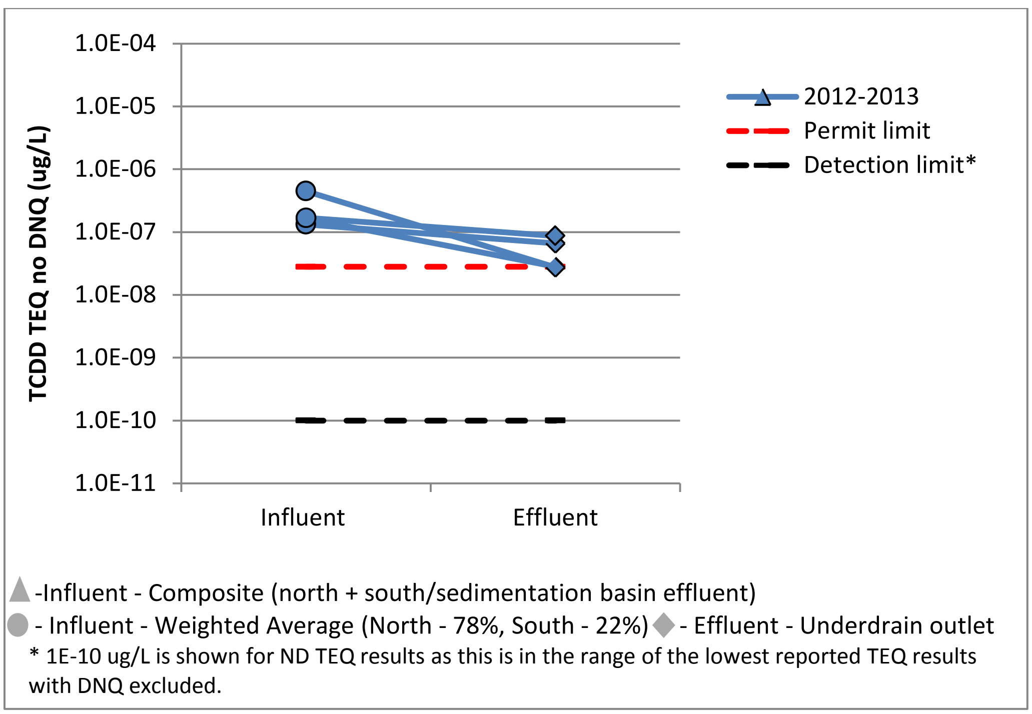


Figure 18. Dioxins at B1 Media Filter (CM), post curb cuts

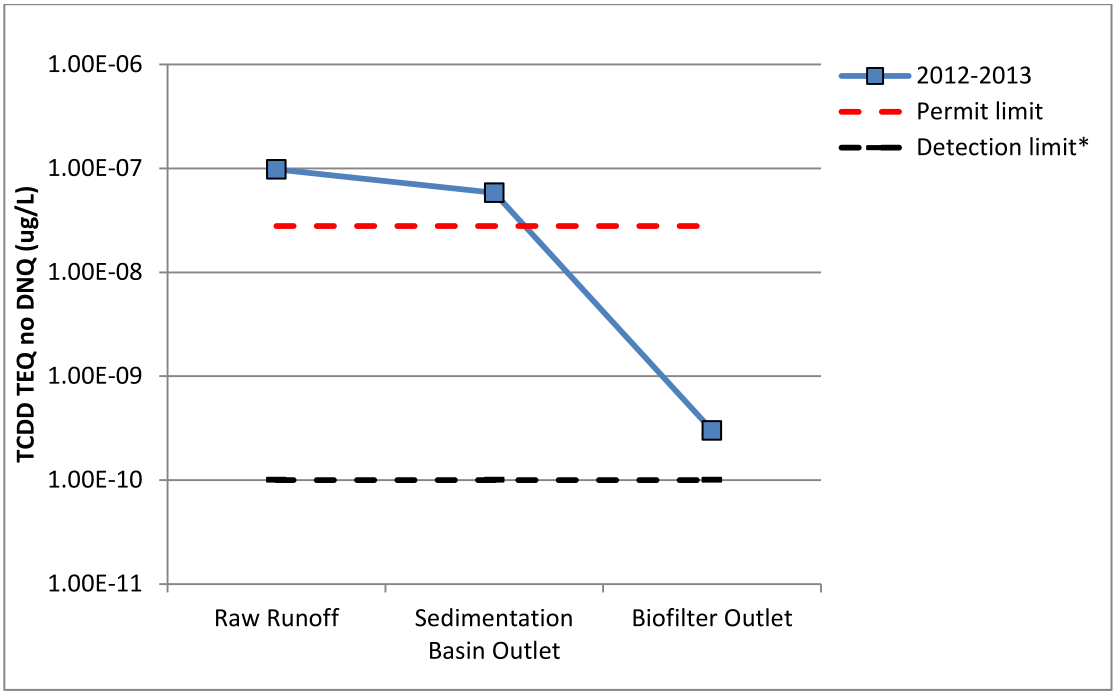


Figure 19. Dioxins at Lower Lot Biofilter, Watershed 009

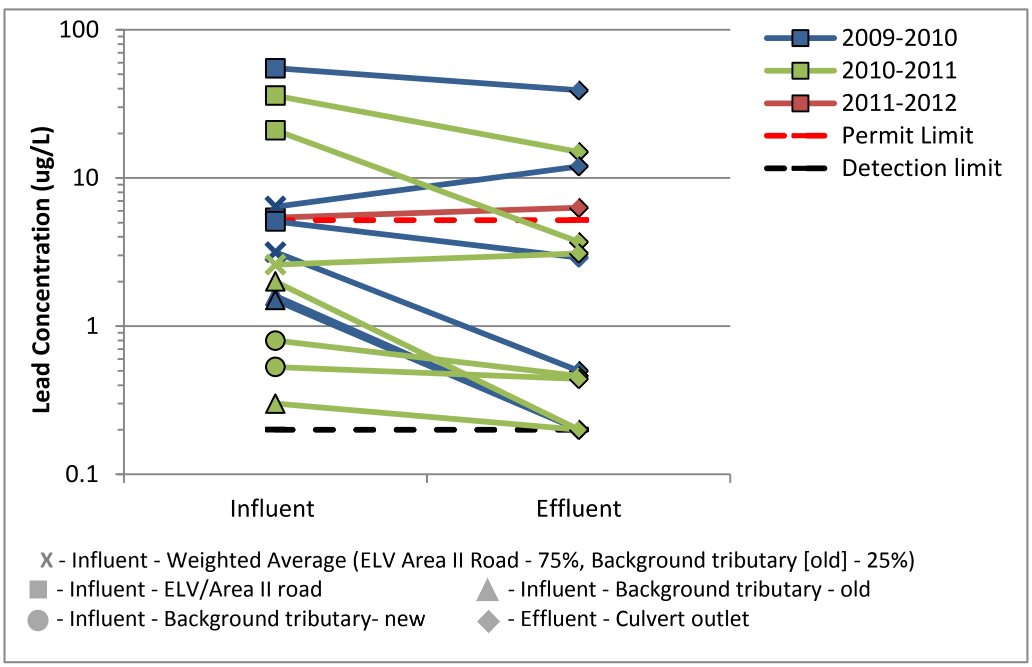


Figure 20. Lead at CM-1, pre filter fabric installation

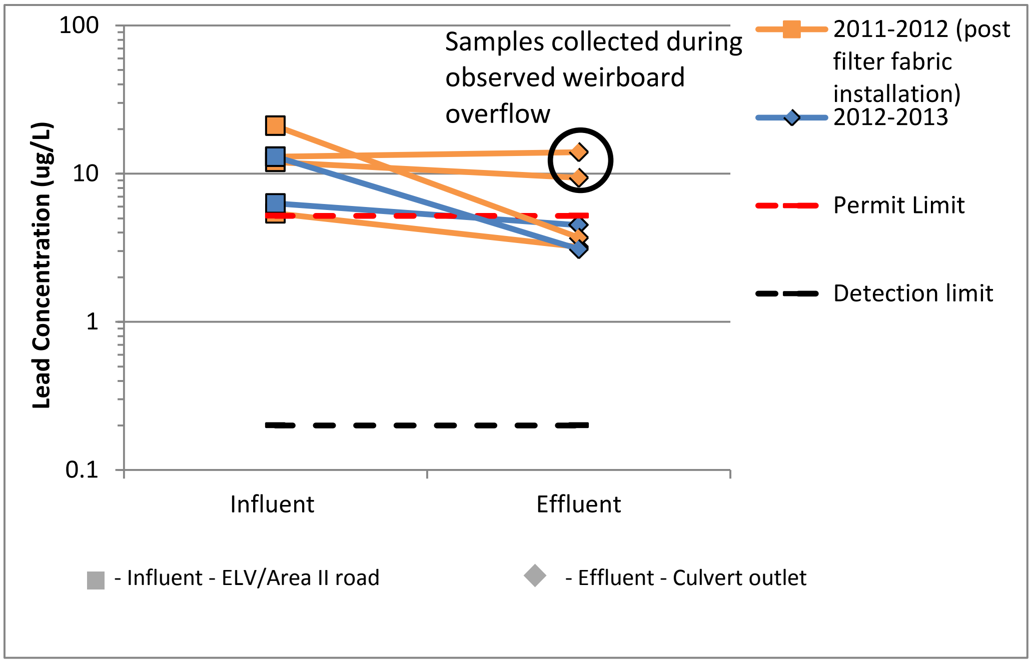


Figure 21. Lead at CM-1, post filter fabric installation

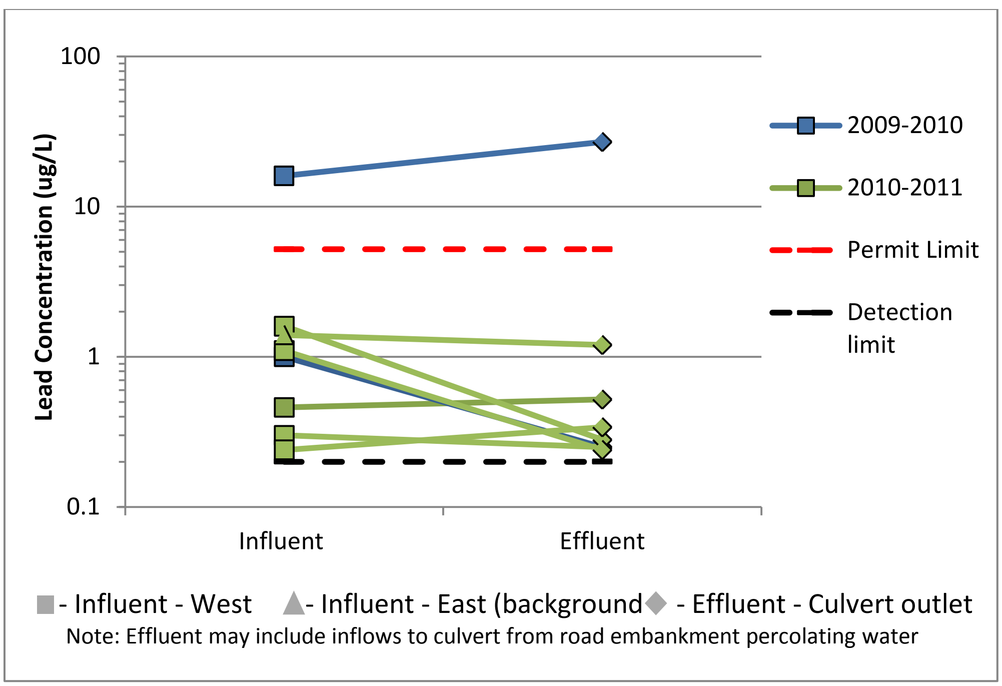


Figure 22. Lead at CM-3

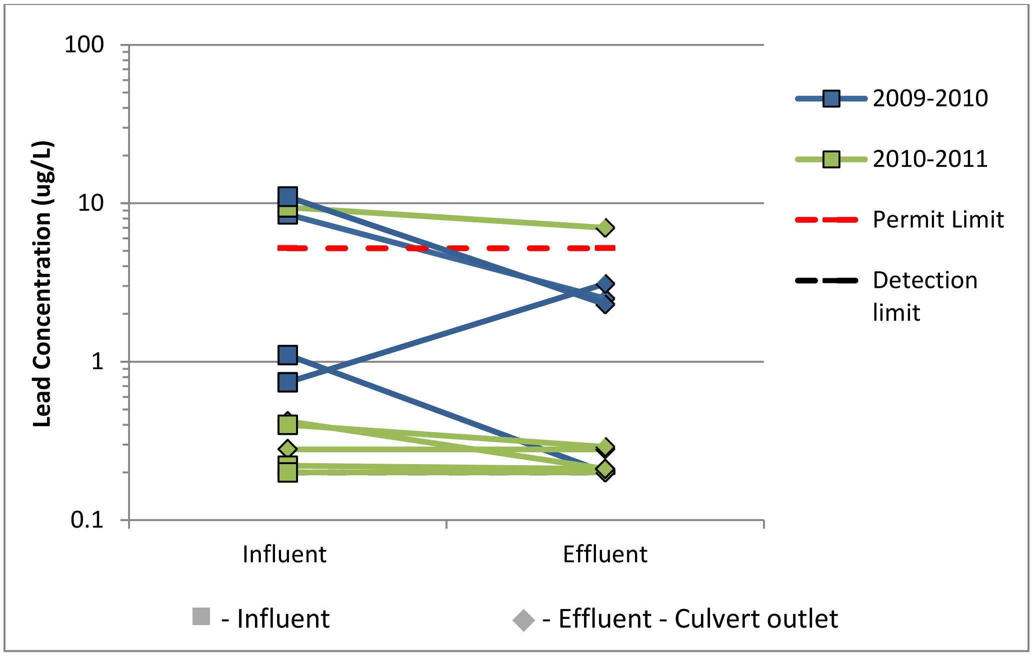


Figure 23. Lead at CM-8

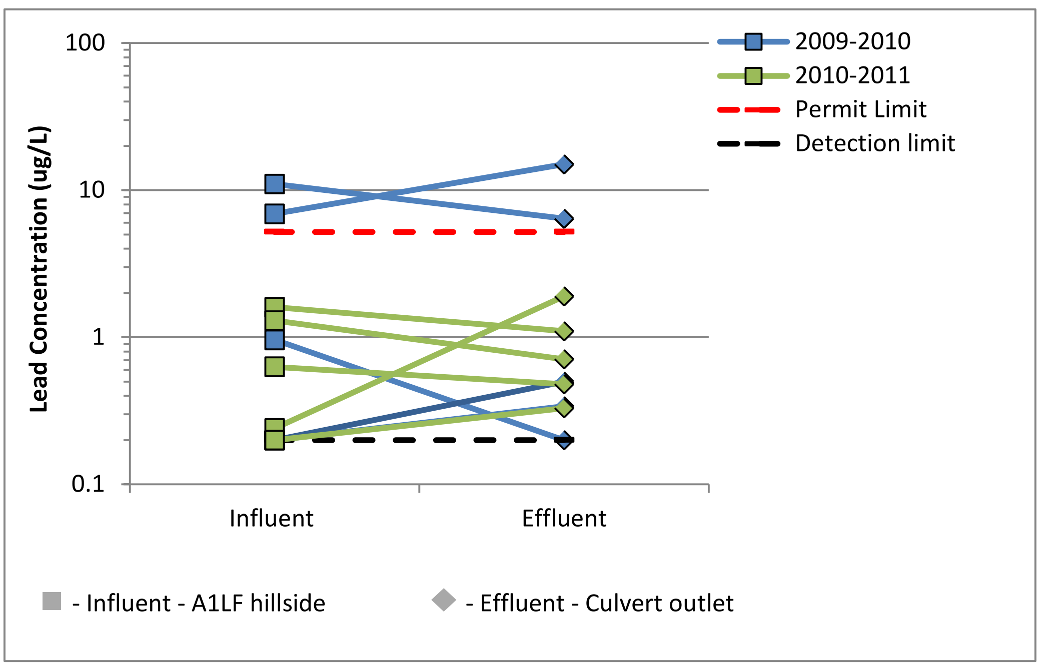


Figure 24. Lead at CM-9, pre improvements

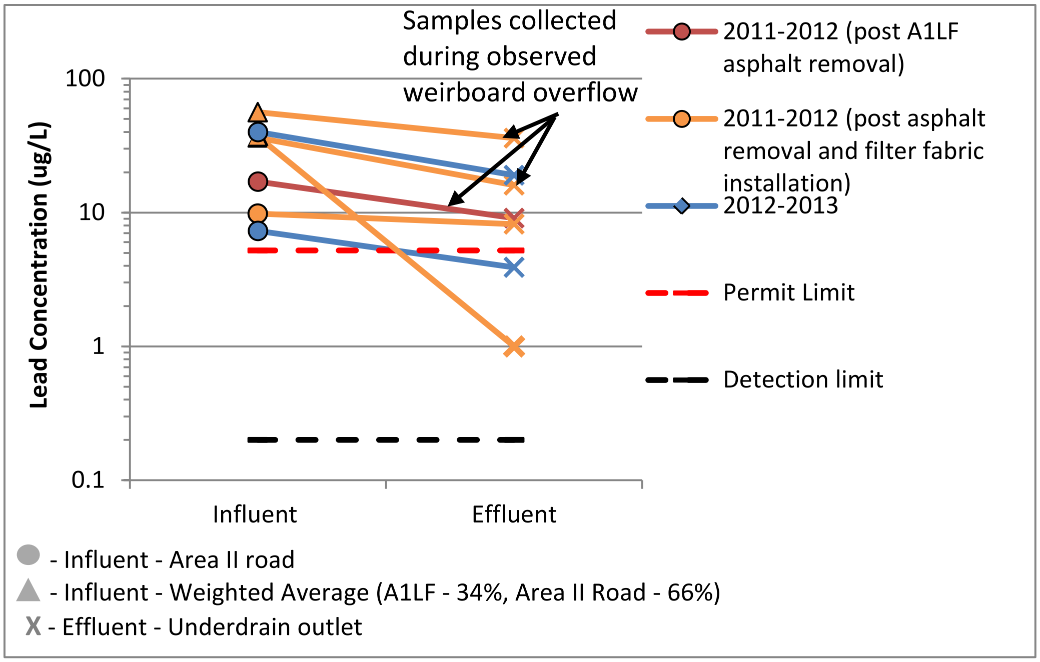


Figure 25. Lead at CM-9, post improvements

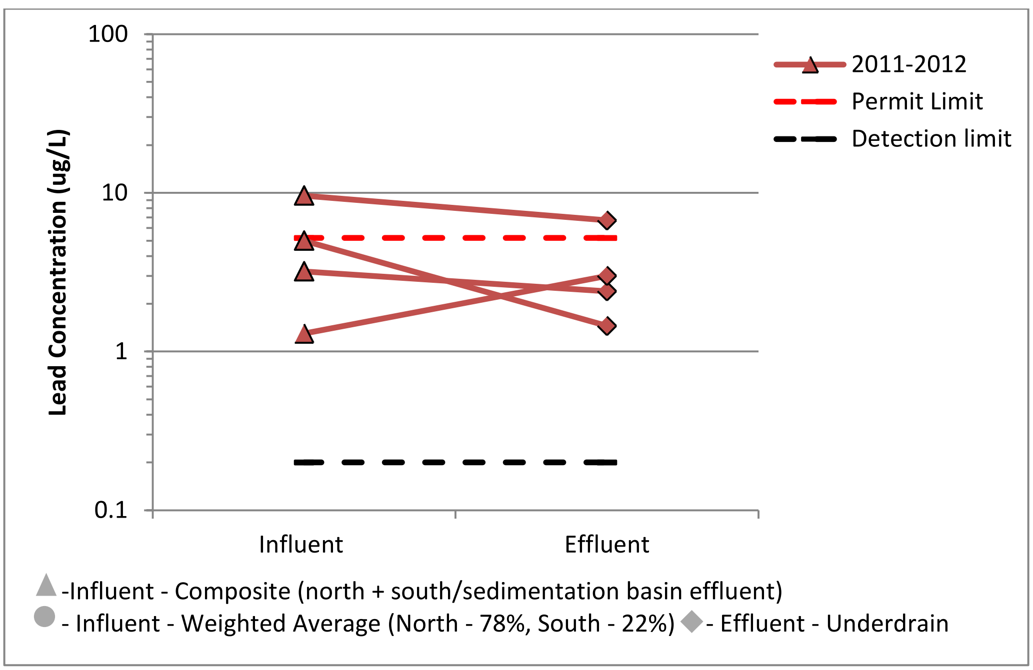


Figure 26. Lead at B1 Media Filter (CM), pre curb cuts

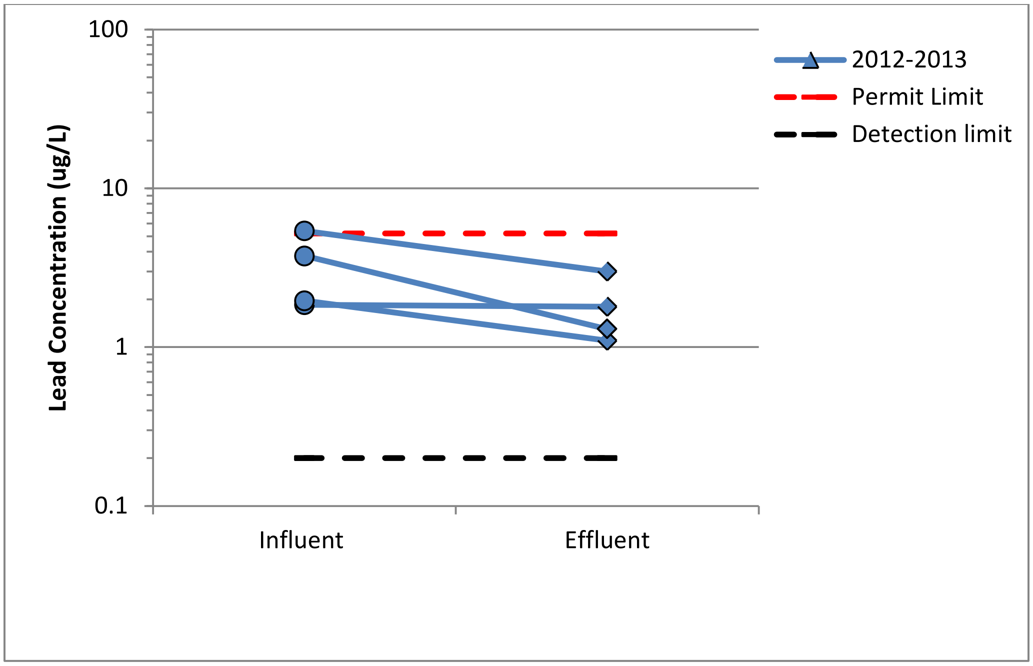


Figure 27. Lead at B1 Media Filter (CM), post curb cuts

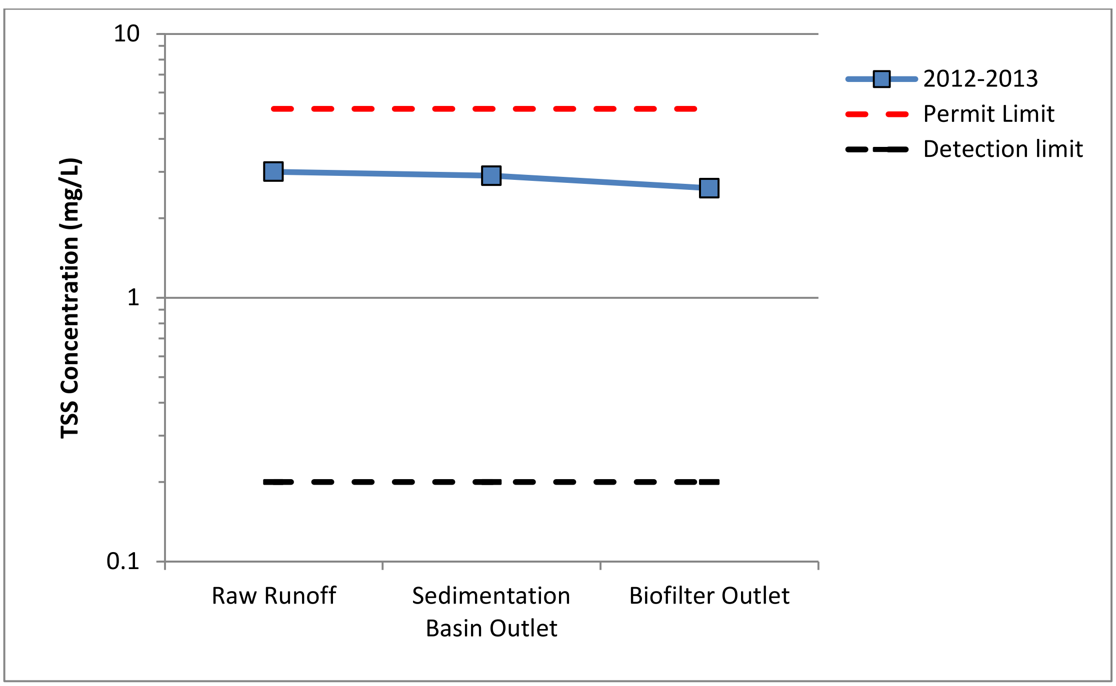


Figure 28. Lead at Lower Lot Biofilter, Watershed 009

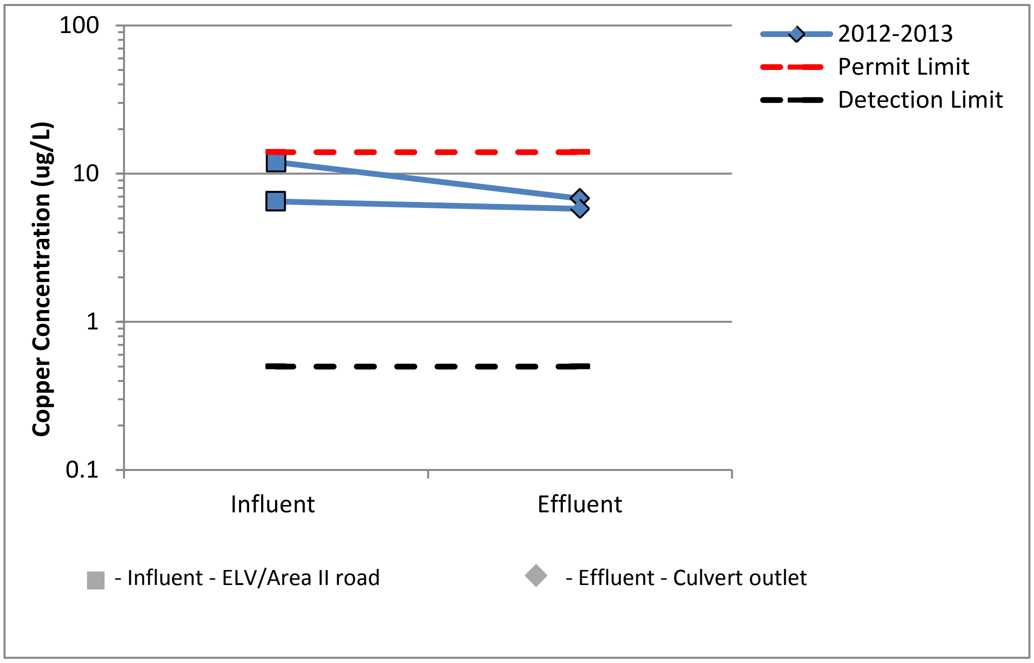


Figure 29. Copper at CM-1, post filter fabric installation

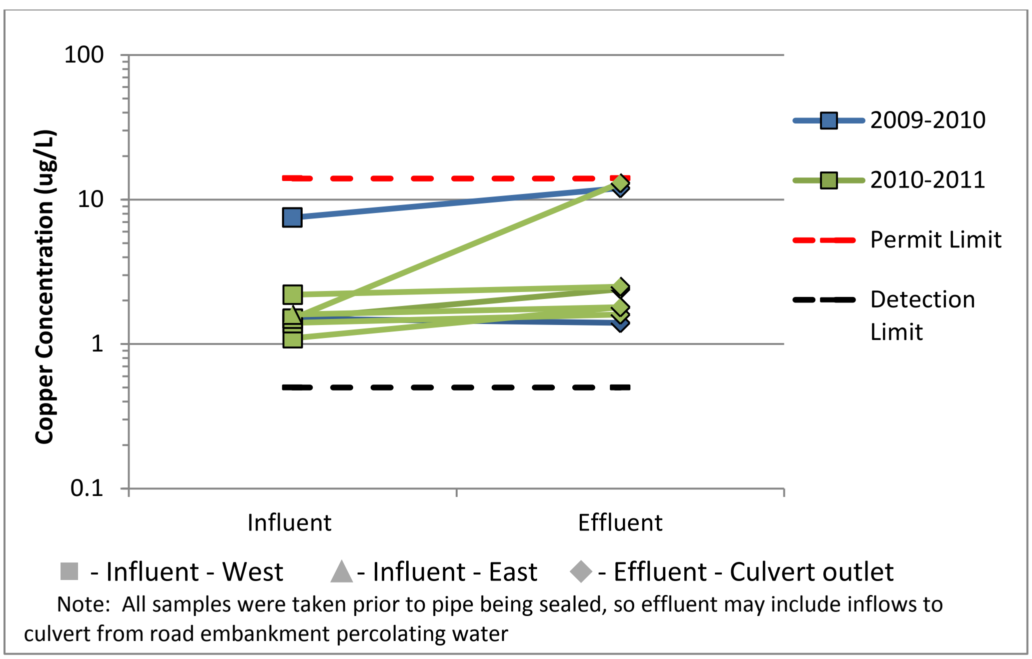


Figure 30. Copper at CM-3

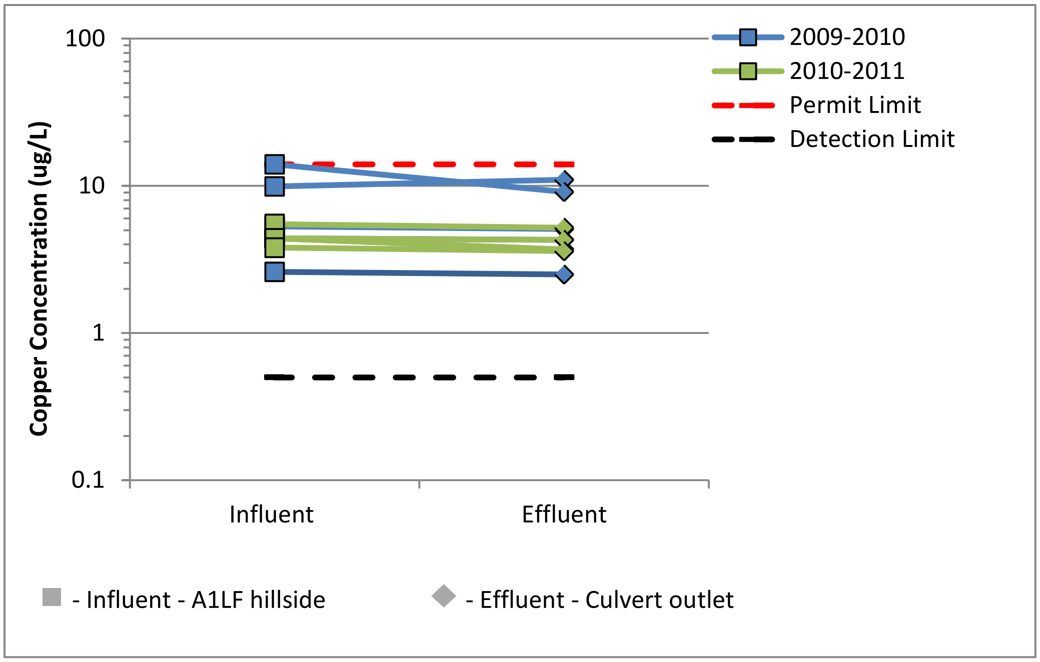


Figure 31. Copper at CM-9, pre improvements

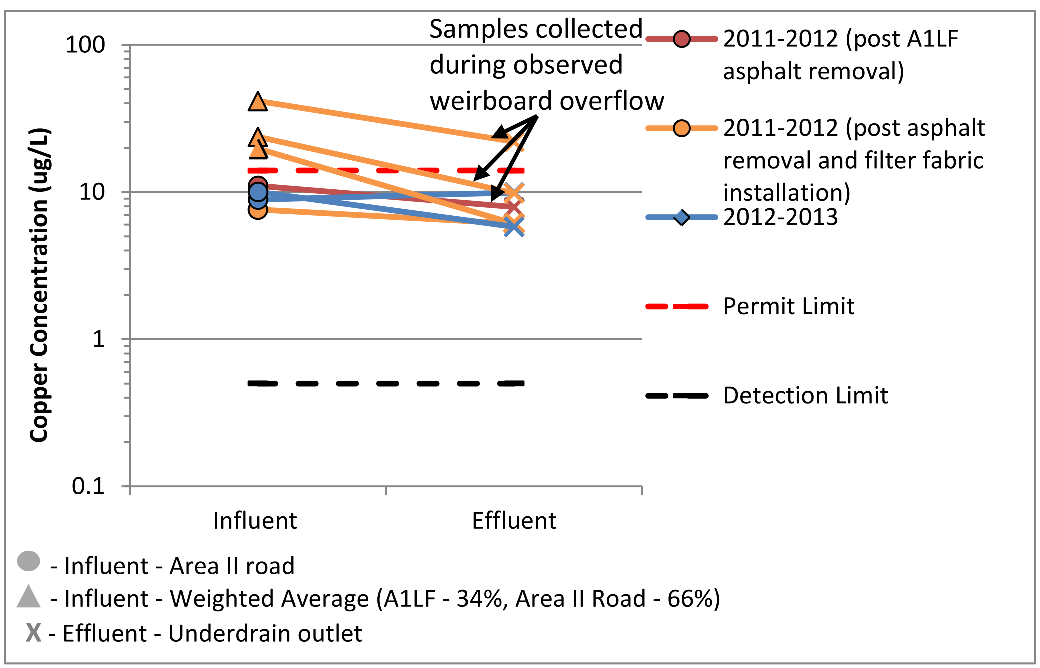


Figure 32. Copper at CM-9, post improvements

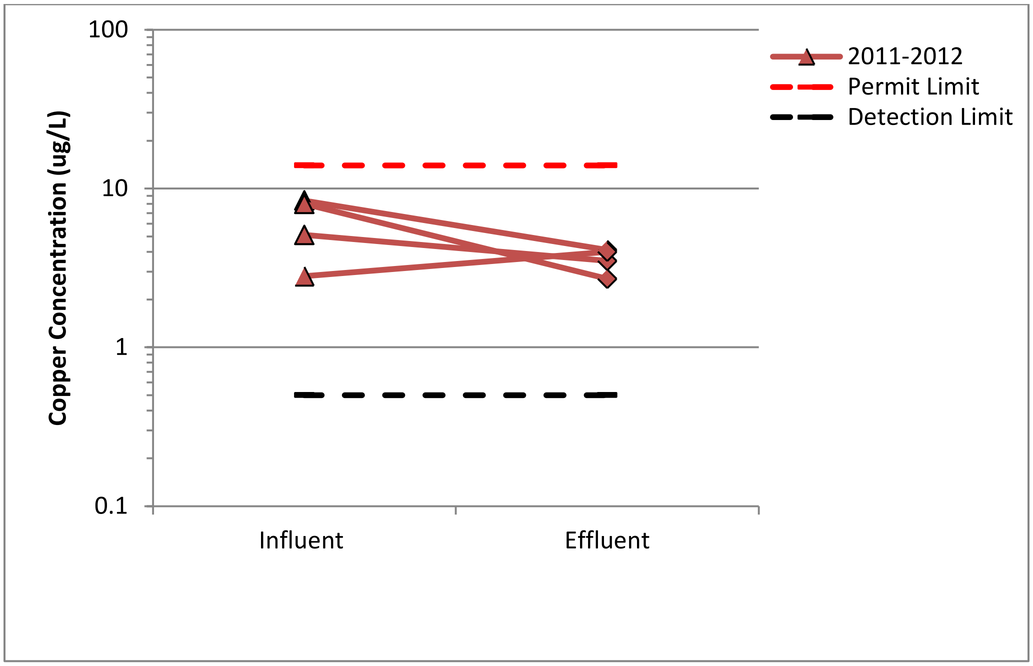


Figure 33. Copper at B1 Media Filter (CM), pre curb cuts

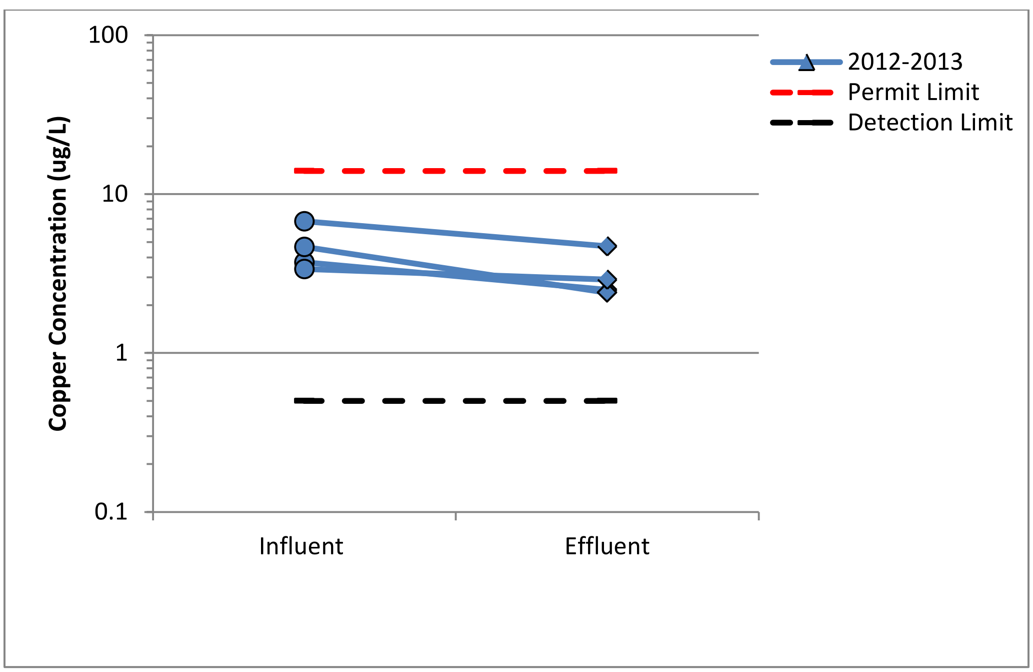


Figure 34. Copper at B1 Media Filter (CM), post curb cuts

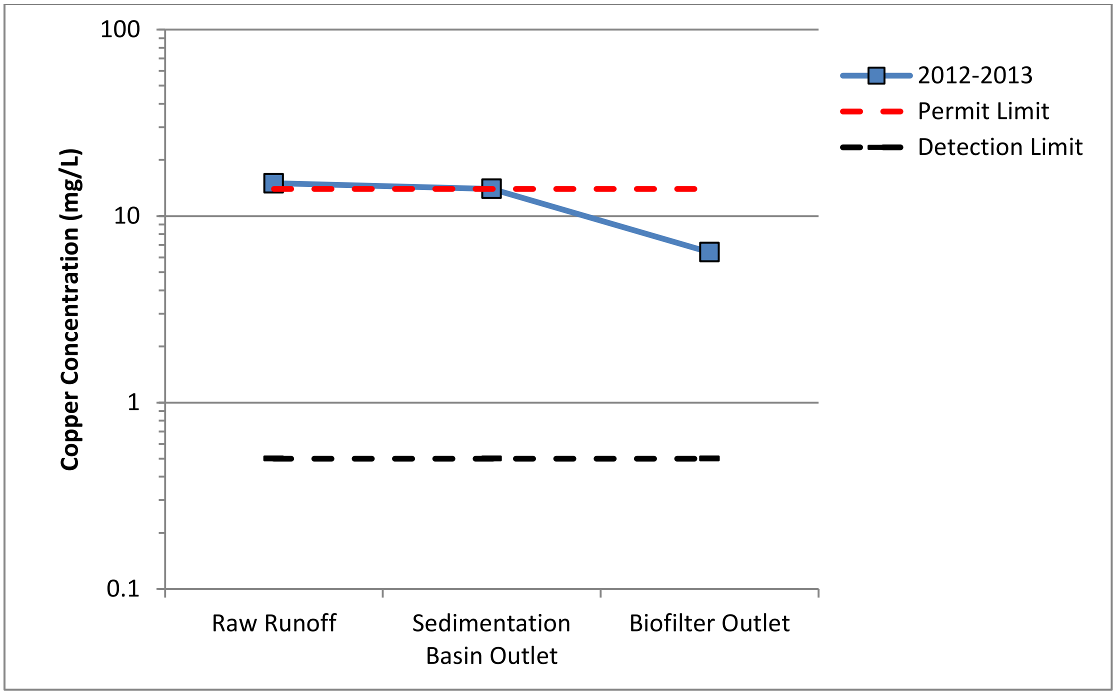


Figure 35. Copper at Lower Lot Biofilter, Watershed 009

2. STATISTICAL ANALYSIS

Statistical summaries of the Site cumulative paired data over the 2009-2013 sampling period using the non-parametric 1-tailed sign test are shown for the paired datasets in Tables 2 and 3. This test is used to evaluate statistical differences between paired data points, or in this case, between upstream and downstream (influent and effluent) stormwater samples. For this analysis, data pairs that were taken during observed bypass/overflow events were removed.

Culvert Modification Areas

Figure 36. Sediment accumulated behind weir boards at CM-9.

The six monitored CMs (B1, CM-1, CM-3, CM-8, CM-9, and CM-11) are in the 009 watershed. At the CM monitoring locations, the total number of collected influent and effluent pairs for all of the CM locations combined ranged from 24 (for copper) to 61 (for TSS). Tables 2 and 3 summarize the paired data statistics for these locations. CM-8, CM-11, and select CM-1 paired statistics are presented separately since the influent flows to these sites come largely from unimpaired/background sites, and therefore significant reduction of the POC concentrations (which are already generally very low) in those flows by CMs is unlikely. Data from the CM-3 background site were excluded since, as described earlier in this memo, this CM cannot be reliably assessed based on the downstream sample results. At the B1 site, media filter bleed-through was observed during initial sampling dates in the 2011-2012 sampling season. Since this was a malfunction, that was subsequently corrected, results from these sample dates were removed from the analysis. In the non-background sites, for TSS, 21 out of 34 (62%) of influent concentrations were greater than their paired effluent concentrations, with an average decrease of 60%. Figure 36 further demonstrates that significant sediment capture has been observed in the CM ponding areas. For lead, 25 out of 34 (74%) influent concentrations were greater than their paired effluent concentrations, with an average decrease of 46%. For copper, 21 out of 24 (88%) influent concentrations were greater than effluent concentrations with an average decrease of 28%. For dioxins, 22 out of 27 (81%) influent concentrations were greater than effluent concentrations with an average decrease of 13%, however it should be noted that this removal average is heavily influenced by one data pair taken during the 2010/11 season prior to the upgrade at CM-1. If this pair is removed from the analysis, the average removal is 83%. These results show that the comparison of influent concentrations are significantly larger than the effluent concentrations for copper, dioxins, and lead ($p < 0.05$).

Statistically significant decreases from influent to effluent were seen in TSS and lead in background sites (42% and 54% respectively), as shown in Table 3 (copper data was not collected for background sites). There was a statistically insignificant increase from influent to effluent for dioxins for the background sites, however, as noted earlier, the influent concentrations at these sites are very low (none of the dioxins samples at these sites, either influent or effluent, were above Permit limits), so further reductions would be difficult to achieve.

Table 3. CM1 ("background" samples excluded), CM9 and B1 Statistical Analysis

	TSS (mg/L)	Dioxins (µg/L)	Copper (µg/L)	Lead (µg/L)
Total pairs of observations[1]	34	27	24	34
Number of influent samples having larger concentrations than effluent samples	21	22	21	25
Number of effluent samples having larger concentrations than influent samples	12	3	3	9
p by paired nonparametric 1-tailed sign test[2]	0.081	0.0001	0.0001	0.005
Average (and COV) influent concentrations	105.5 (2.35)	4.73E-07 (1.74)	6.92 (0.58)	9.69 (1.37)
Average (and COV) effluent concentrations	41.9 (2.46)	4.12E-07 (4.29)	4.99 (0.46)	5.20 (1.46)
Average percent change (- sign indicating higher effluent results)	60%	13%[3]	28%	46%

[1] Some pairs consisted of upstream concentrations that were equal to downstream concentration; this explains why rows 2 and 3 do not necessarily sum to the total pairs of observations.

[2] One-tail sign test used to evaluate data. Results where upstream and downstream concentrations were equal were not used in sign test.

[3] Average change in dioxins is heavily influenced by one pair at CM-1 that was taken during the 2010/11 season and prior to improvements at that CM. Exclusion of this pair results in an average change of 83% (p = 0.00002). Without this sample, the average influent and effluent concentrations are 4.21E-07 and 7.26E-08 respectively, and the influent and effluent COVs are 1.88 and 1.31 respectively.

Table 4. CM-1[1], CM-8 and CM-11 Background Statistical Analysis[2]

	TSS (mg/L)	Dioxins (µg/L)	Copper (µg/L)	Lead (µg/L)
Total pairs of observations[3]	27	17	No data pairs available for copper at background sites	16
Number of influent samples having larger concentrations than effluent samples	17	5		13
Number of effluent samples having larger concentrations than influent samples	4	6		1
p by paired nonparametric 1-tailed sign test[4]	0.004	0.500		0.001
Average (and COV) influent concentrations	11.74 (1.58)	3.88E-10 (1.49)		2.44 (1.49)
Average (and COV) effluent concentrations	6.85 (1.27)	6.34E-10 (1.88)		1.12 (1.64)
Average percent change (- sign indicating higher effluent results)	42%	-64%		54%

[1] Only CM-1 samples that were taken from east/background tributary influent sites are included in this analysis

[2] As noted earlier in this memorandum, the CM-3 performance cannot be reliably assessed based on the downstream sample results. For this reason, the CM-3 paired data were excluded from the statistical analysis presented in this table.
[3] Some pairs consisted of upstream concentrations that were equal to downstream concentration; this explains why rows 2 and 3 do not necessarily sum to the total pairs of observations.
[4] One-tail sign test used to evaluate data. Results where upstream and downstream concentrations were equal were not used in sign test.

Lower Lot Biofilter Treatment Train

Construction of the lower lot biofilter, located in the 009 watershed, was completed in 2013. To date, samples were taken at this location only during the one rain event that occurred after the construction was completed, with samples collected at three locations within the biofilter treatment train (influent, post-sedimentation basin, and post-biofilter). Tables 4, 5, and 6 summarize the paired data for this location. For TSS, concentrations increased between the runoff and the sedimentation basin outlet locations (at that time, the sedimentation basin was eroding, which increased TSS levels at the outlet structure), but decreased from the sedimentation basin outlet to the biofilter outlet, resulting in a net reduction across the system of 42%. For lead and dioxins, influent concentrations were apparently greater than their paired effluent concentrations, with net reductions of 13% and 99.7% respectively. Since there is only one pair of data per location, statistical analyses could not be conducted for this dataset. It should be noted that effluent concentrations for dioxins, copper, and lead were all lower than Permit limits, while the influent dioxins and copper concentrations exceeded the Permit limits (influent lead was also below the Permit limit).

Table 5. Lower Lot Biofilter Performance Data – Runoff to Sedimentation Basin Outlet

	TSS (mg/L)	Dioxins (µg/L)	Copper (µg/L)	Lead (µg/L)
Total pairs of observations	1	1	1	1
Number of influent samples having larger concentrations than effluent samples	0	1	1	1
Number of effluent samples having larger concentrations than influent samples	1	0	0	0
Percent change (- sign indicating higher effluent results)	-44%	40%	7%	3%

Table 6. Lower Lot Biofilter Performance Data – Sedimentation Basin Outlet to Biofilter Outlet

	TSS (mg/L)	Dioxins (µg/L)	Copper (µg/L)	Lead (µg/L)
Total pairs of observations	1	1	1	1
Number of influent samples having larger concentrations than effluent samples	1	1	1	1
Number of effluent samples having larger concentrations than influent samples	0	0	0	0
Percent change (- sign indicating higher effluent results)	59%	99%	54%	10%

Table 7. Lower Lot Biofilter Performance Data – Runoff to Biofilter Outlet (showing net reduction)

	TSS (mg/L)	Dioxins (μg/L)	Copper (μg/L)	Lead (μg/L)
Total pairs of observations	1	1	1	1
Number of influent samples having larger concentrations than effluent samples	1	1	1	1
Number of effluent samples having larger concentrations than influent samples	0	0	0	0
Percent change (- sign indicating higher effluent results)	42%	99.7%	57%	13%

3. UPSTREAM v. DOWNSTREAM CORRELATION CHARTS

Figures 37 through 40 compare influent to effluent concentrations for the paired data presented above for CM sites (B-1, CM-9, CM-1 non-background sites; CM-1, CM-3, 8, and 11 background sites are excluded). This analysis will be done for the lower lot biofilter once more data are collected. A least-squares regression was used to fit a line to log-transformed data ($\log(y) = m\log(x) + b$). The slope of the lines, m, is shown in the lower right corner of the graph. In addition to the slope, the p-value is also shown to indicate the significance of the value of the reported slope. In other words, if the p-value is less than 0.05, the significance of the non-zero value of the slope, m, can be said to be 95%. A 1:1 line was also added to each plot. Data above the 1:1 line indicate a downstream increase in concentrations, while data below the 1:1 line indicate a downstream decrease in concentrations (or positive BMP performance in the case of the CMs). Pairs where one or both results were not detected were excluded from these graphs.

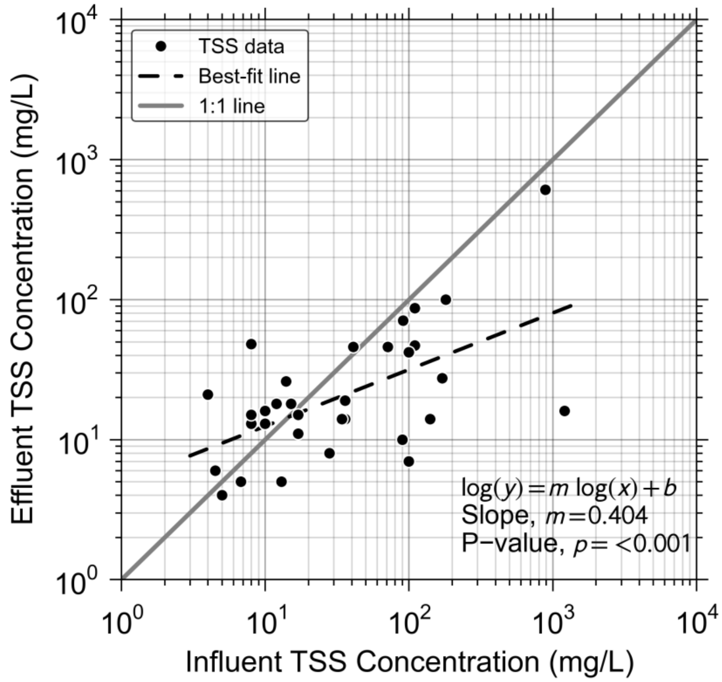


Figure 37: Paired TSS Concentrations at CM Sites

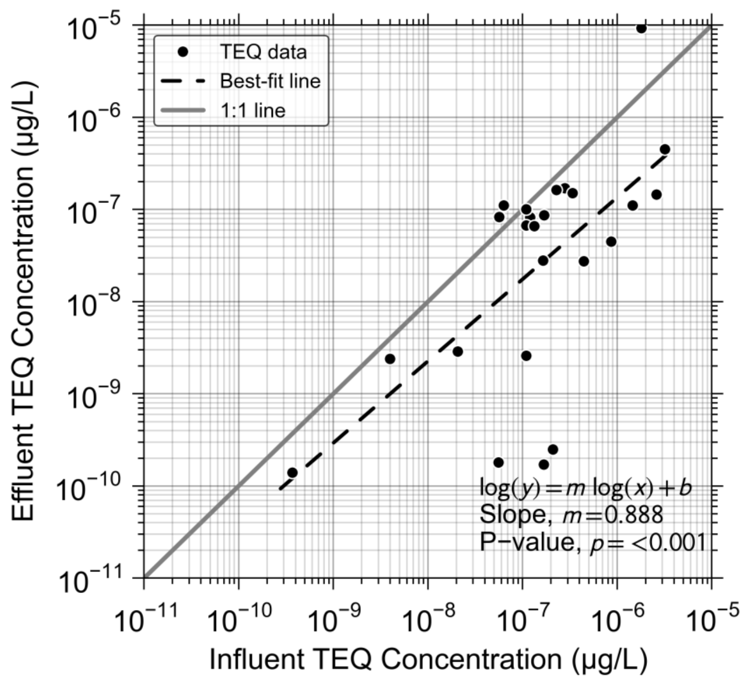


Figure 38: Paired Dioxins Concentrations at CM Sites

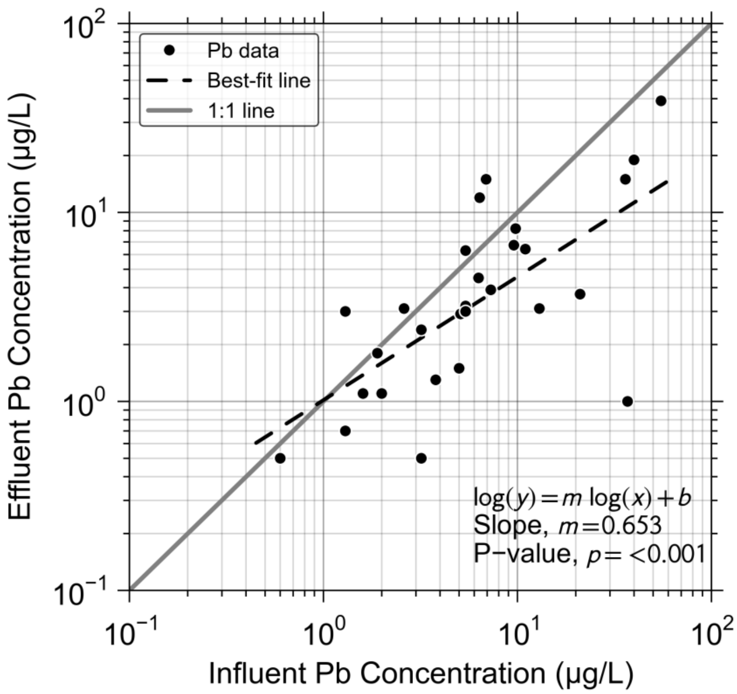


Figure 39: Paired Lead Concentrations at CM Sites

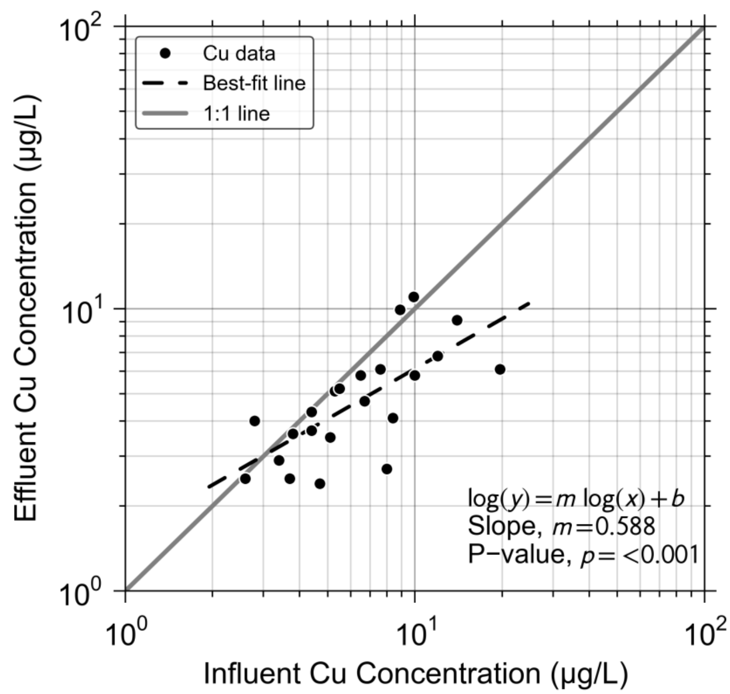


Figure 40: Paired Copper Concentrations at CM Sites

4. PROBABILITY PLOTS

Probability plots for CM sites (B-1, CM-9, and CM-1 non-background sites), excluding CM-1 background areas, CM-3, CM-8, and CM-11 (due to the substantial flows that they receive from unimpaired/background areas), are shown in Figures 41 through 44, are prepared by ranking the available data and calculating their probability of occurrence. There currently are not enough data to prepare probability plots for the lower lot biofilter sites. These probability values (shown on the vertical axis) are plotted against their concurrent concentrations. Where applicable, NPDES Permit limits for each POC are also shown on the charts for comparison and are presented as vertical lines. While determining the plotting positions, non-detect (ND) data were sorted independently and assigned to the lowest positions, effectively truncating the probability plots at the fraction of non-detected samples. Therefore, only detected results positions are plotted, which leads to the correct probability of occurrence for the observed data, while values less than the detection limit show their unknown specific occurrences. The figures also contain some basic statistics describing the data shown on the graphs. For each influent/upstream and effluent/downstream dataset, the number of ND results is compared to the total number of results in the dataset and the coefficient of determination (R^2), and the significance values resulting from an Anderson-Darling test for normal and lognormal distributions are shown. The coefficient of determination describes how well the (logarithmic) best-fit line fits the data. The Anderson-Darling results represent the confidence level with which one can say how consistent the data are with the examined distributions. For instance, in the case of influent lead at CM locations, one can be 99% confident that the data are consistent with a lognormal probability distribution, but less than 85% (i.e. not confident) that they are consistent with a normal distribution.

Where influent data (black circles) consistently fall to the right of the effluent points (open circles), consistent water quality improvement is occurring at these areas. The horizontal distance between the datasets (noting it is a log scale) also indicates the magnitude of the concentration change at these areas.

The relative difference in the amount of scatter observed in these plots indicates that BMP effectiveness may vary depending on the location and constituent. These plots indicate the influent concentrations above which the CMs are most effective (low concentrations are expected to represent concentrations unlikely to be significantly reduced by the BMP).

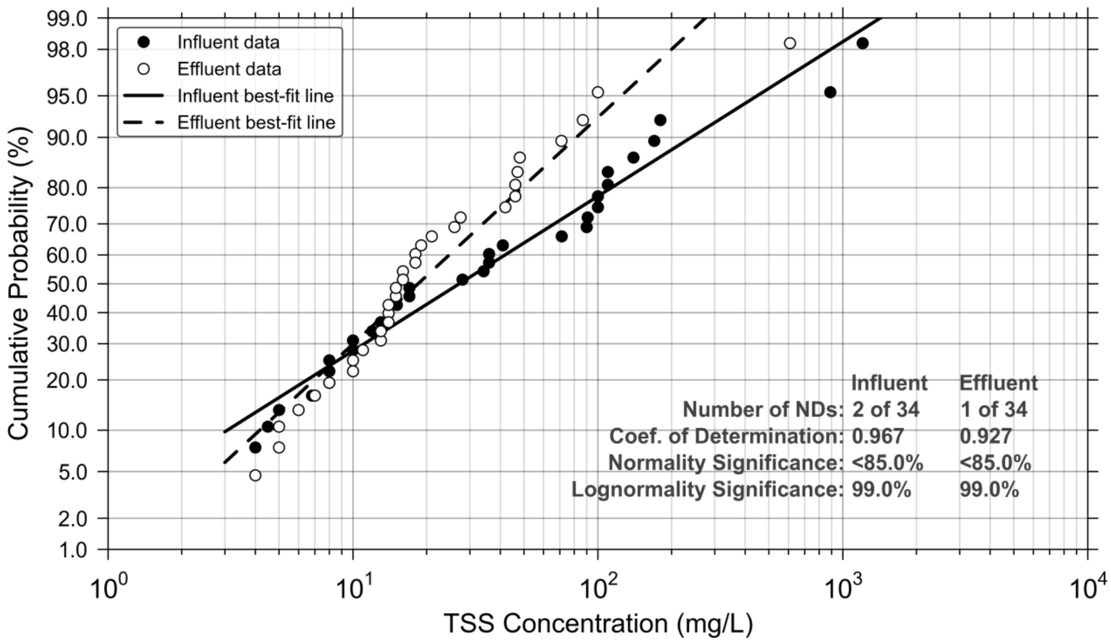


Figure 41: Probability Plot of TSS at CM Locations

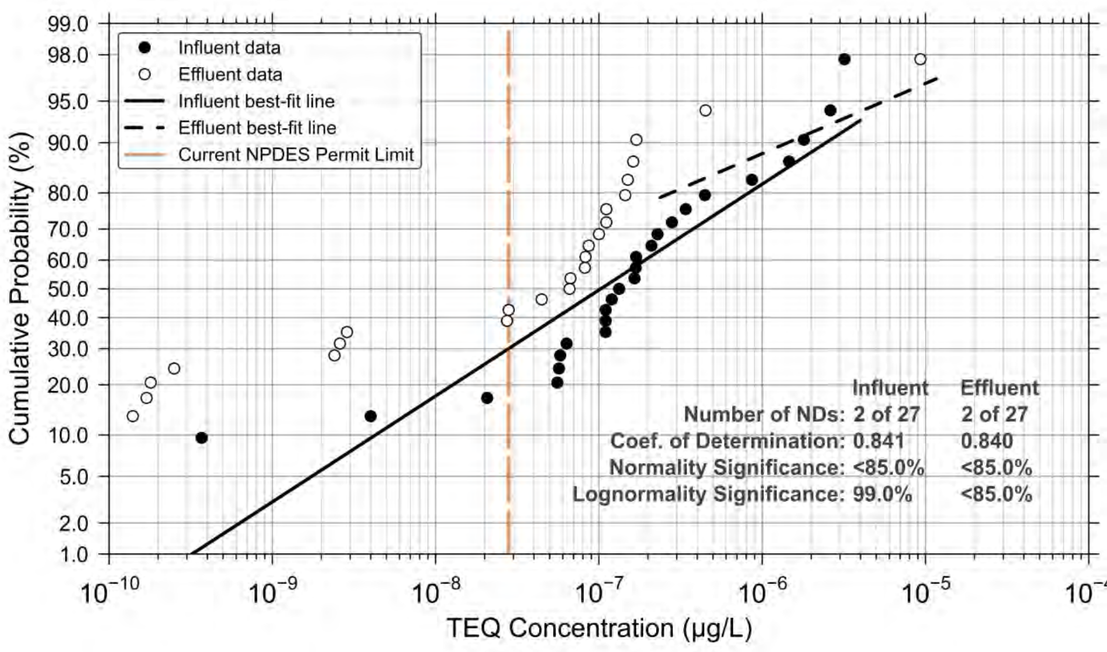


Figure 42: Probability Plot of Dioxins at CM Locations

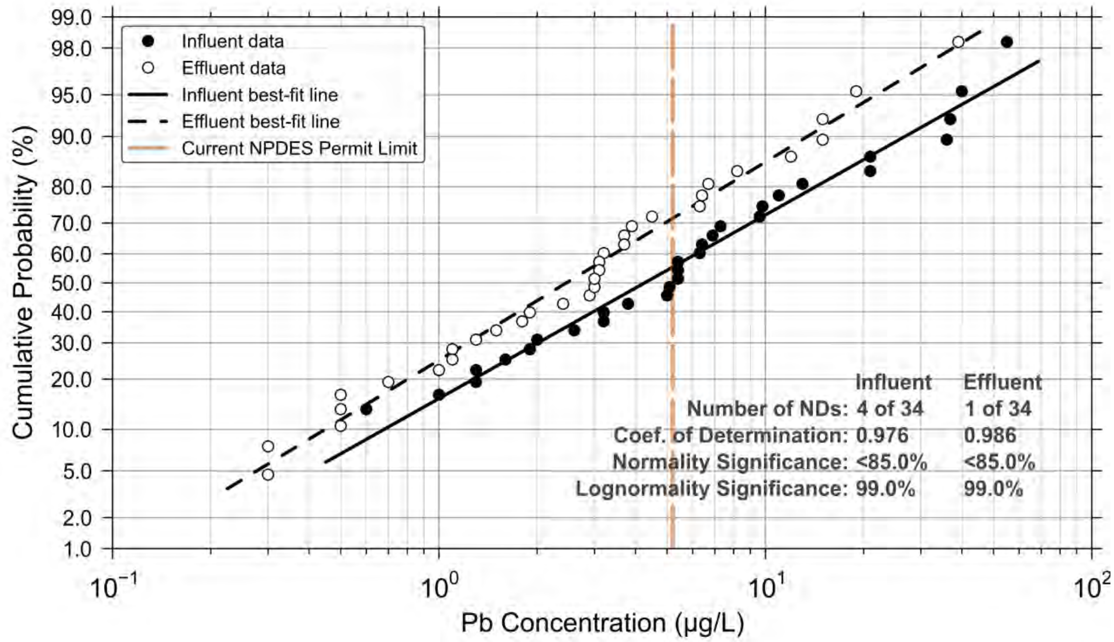


Figure 43: Probability Plot of Lead at CM Locations

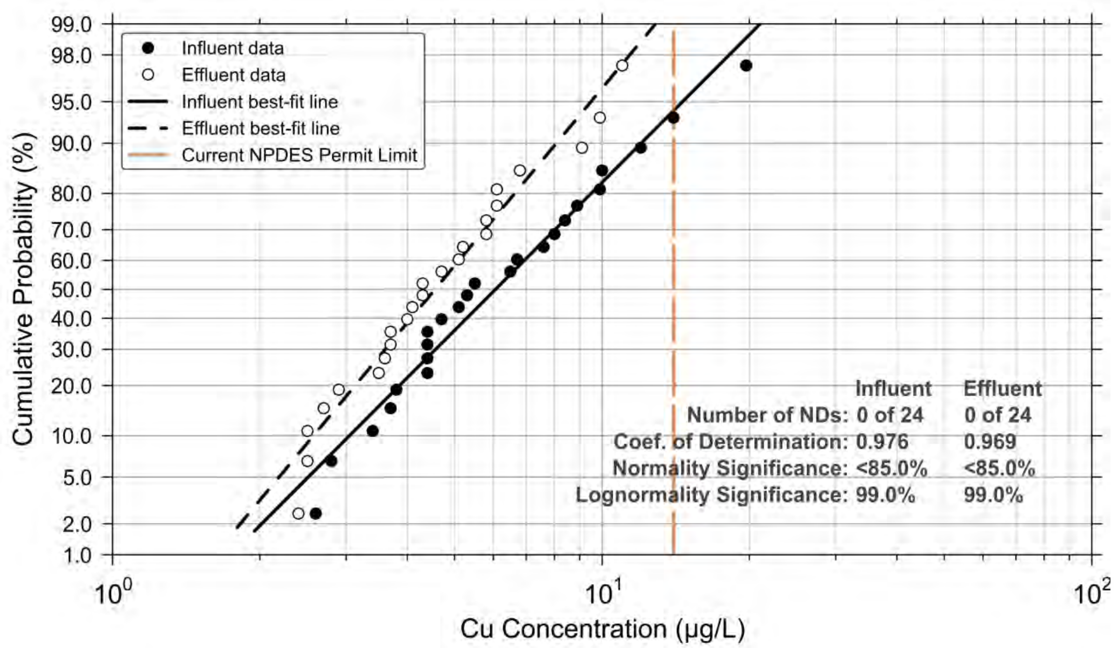


Figure 44: Probability Plot of Copper at CM Locations

5. DISCUSSION AND OBSERVATIONS

The following general observations were made based on an evaluation of the aforementioned data summary charts and tables.

1. The CMs were installed as provisional (pending further evaluation) stormwater controls that could be installed in areas where existing culverts carried the stormwater below the roads. As a result, they handle the wide range of flows during a typical rain year and experience relatively short treatment residence times and frequent overflows of the weirs. However, the monitored performance indicates the benefits of the sedimentation and media treatment unit processes. Cumulative data (as summarized by the statistical analysis tables, correlation charts, and probability plots) indicate that CM and biofilter effluent concentrations were lower than corresponding influent samples for all constituents considered for this analysis, with statistically significant pollutant removal observed for most POCs for these treatment systems, with the exception of TSS at the non-background CM sites, and dioxins at the CM background locations (i.e., some CM-1 pairs, CM-8 and CM-11, where influent concentrations were likely at levels low enough that they were unlikely to be significantly reduced by the specific BMPs installed). Average pollutant reductions in the non-background CMs (i.e., CM-1, CM-9, and B1) ranged from 13-60%. Only the average (non-background) effluent concentration for dioxins was above its Permit limit.

2. All constituents at non-background (Table 2) CM locations, and TSS and lead at the background sites (Table 3) were found to have effluent concentration reductions (i.e., water quality improvements). Non-background sites (Table 2) had a statistically significant decrease for dioxins, copper, and lead (1-tailed sign test p=0.0001, 0.0001, and 0.0045 respectively). Background sites had a statistically significant decrease for both TSS (1-tailed sign test p=0.004) and lead (1-tailed sign test p=0.001). In non-background sites, 81% of the 27 dioxin sample pairs indicated concentration reductions through the culvert modifications with an average decrease of 13%, however it should be noted that this removal average is heavily influenced by one data pair taken at the pre-improvement CM-1 during the 2010/11 season. If this pair is removed from the analysis, the average removal is 83%.

   The monitored performance demonstrates the benefits of the sedimentation and media treatment unit processes, as well as erosion control BMPs. The monitoring data have also been used in the subarea ranking evaluations for CM improvement consideration at locations where effluent quality remains problematic. CM-1 performance is expected to improve as a result of NASA implementing the Panel's recommended ELV runoff treatment system, which will reduce stormwater quantities to CM-1, and improve CM-1 influent (and effluent) quality.

3. Data collected to date at the newly constructed biofilter treatment train at the lower lot showed net TSS, dioxins, copper, and lead reductions of 42%, 99.7%, 57%, and 13%, respectively, for the single monitoring event available since completion of this stormwater control facility. Effluent concentrations for dioxins, copper, and lead were below Permit levels.

4. Since no runoff occurred at Outfall 008 during this monitoring period, no data were available to evaluate the performance of the new erosion and sediment controls that were installed in 2012 in

the 008 watershed. In addition, no data were collected at ISRA sites during this monitoring period. In general, based on data up until the last monitoring season, downstream ISRA concentrations were lower than corresponding upstream samples for a number of the constituents, suggesting positive performance of ISRA excavation and stabilization efforts. Exceptions were TSS, lead and copper, though it should be noted that, in the case of the ISRA locations, comparisons between the upstream and downstream concentrations for these constituents were not statistically significant. It should also be noted that for the ISRA areas, having comparable upstream and downstream datasets is considered a positive outcome as it suggests that these actions resulted in indistinguishable stormwater quality changes in comparison to unimpacted (upstream) runoff quality.

5. Several new monitoring sites were added during the 2012/13 season, notably to monitor performance at the new lower lot biofilter, and also near the Area II Helipad Road. Aside from the lower lot biofilter data pairs, none of the new sites had paired data.

   A number of the monitoring sites also had improvements made during the latest monitoring season, including new erosion controls near the Area II Road, a new ISRA site near the ELV building, and construction of a new stormwater treatment facility near the ELV area (see the Subarea Ranking Analysis Memo for further detail on improvements). No data pairs were collected after these improvements, however.

Overall and in general, these results suggest that stormwater treatment is occurring at the CMs and biofilter for all POCs evaluated.

7. RECOMMENDATIONS

1. Based on evaluation of CM performance, the Panel recommends there be continued inspection and maintenance including the following:

   - Inspection after large storms and at the start of the rainy season, removal of accumulated sediment and debris in ponded footprints above the weir boards (particularly when accumulation depth exceeds 10% of weir board height);
   - Inspection of underdrain flows during storms to ensure water is still flowing effectively through media beds;
   - Replacement of filter fabric when they are damaged or non-functioning;
   - Collection of field notes during sampling to note whether weirboard overflow is occurring, etc.

   Furthermore, the Panel will continue to provide specific improvement recommendations for CM areas during current and future monitoring periods, if warranted and likely to be effective.

2. If media clogging or media failure is a concern during field inspections and during sample collection, video inspections would be useful in order to inspect underdrains for signs of clogging, material movement into the pipe, or a cracked pipe. The Panel recommends doing video inspections while the system is dry, and then again after water is introduced upstream of the weir boards in a controlled manner, such as from a water truck. In the "water" inspection, it would be helpful to determine the drainage rate of the ponded water (check to see if ponded more than a day after the rain ended).

3. The Panel recommends discontinued influent/effluent performance sampling at background CM sites CM3, CM8, and CM11. These treatment controls have been adequately evaluated and existing datasets and performance conclusions are robust. CM1, CM9, and B1 however should continue to be monitored to confirm continued stormwater quality improvement as upstream controls have been added and revegetation continues.

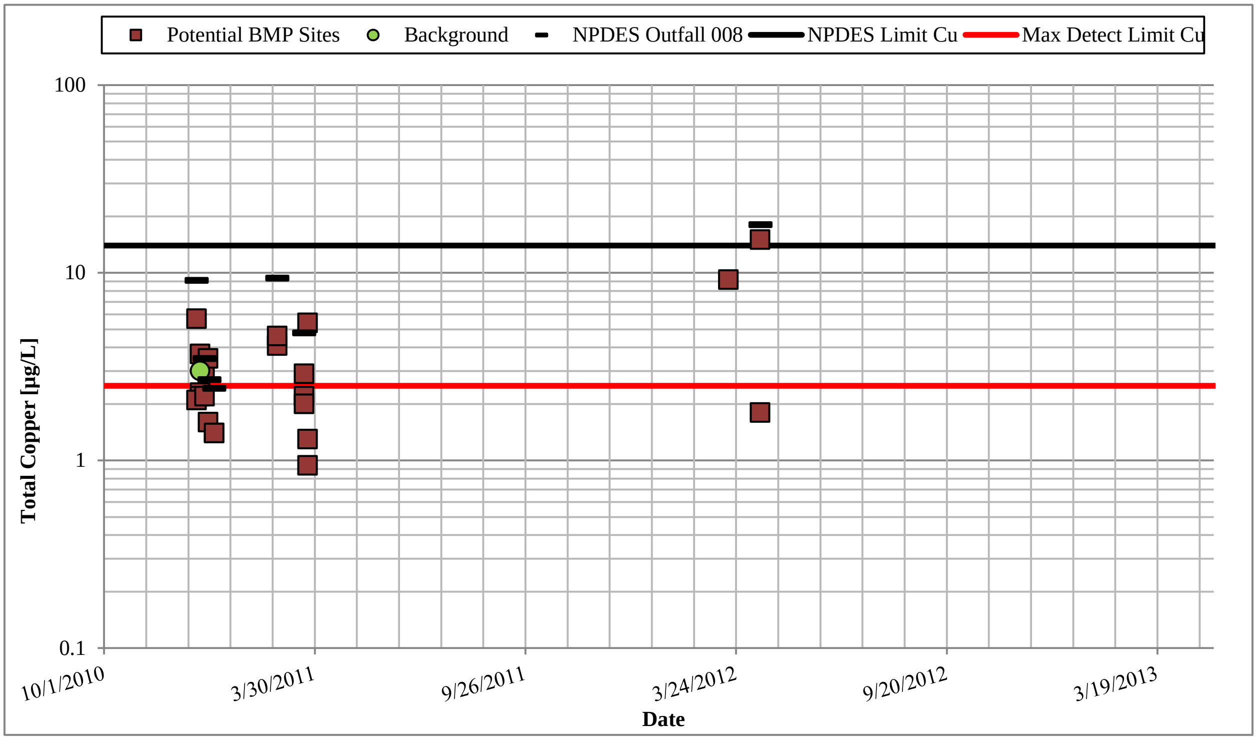
APPENDIX F
BMP MONITORING CHARTS
2012/2013 RAINY SEASON

APPENDIX F-1

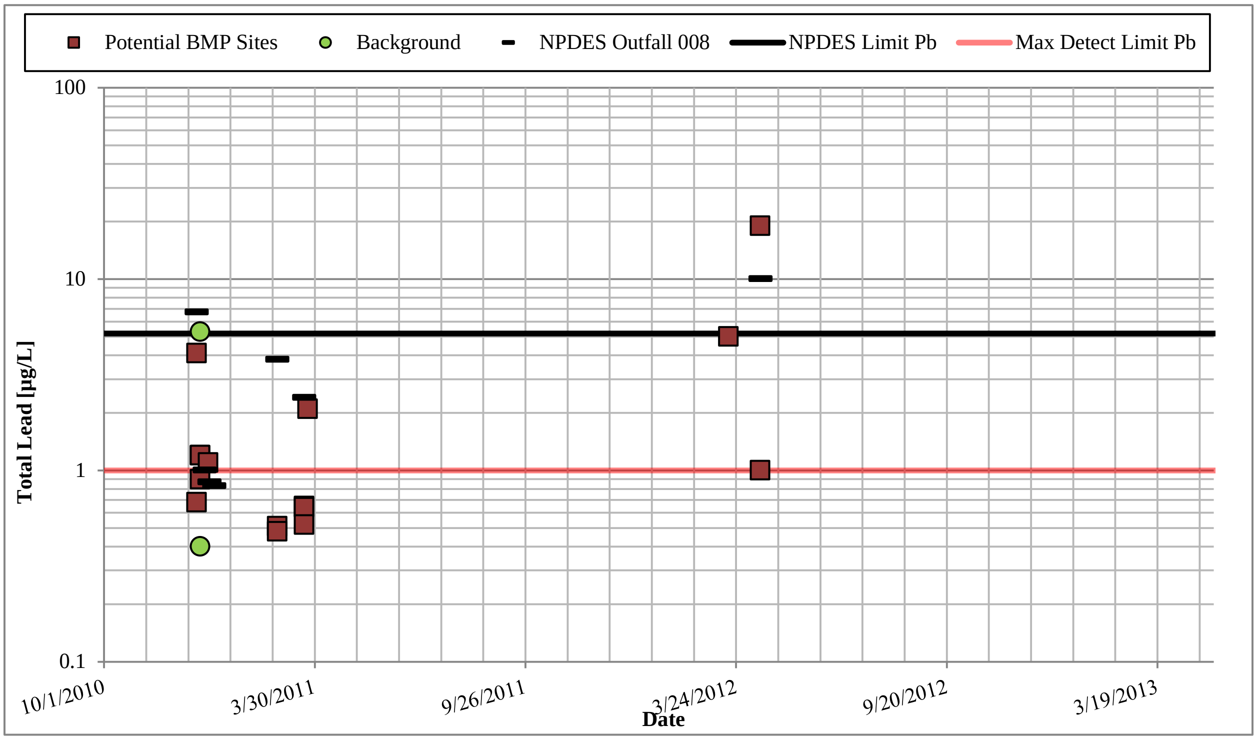
POTENTIAL BMP MONITORING DATA GRAPHS VS. TIME

OUTFALL 008 TIMESERIES CHARTS
POTENTIAL BMP SUBAREA MONITORING PROGRAM

COPPER



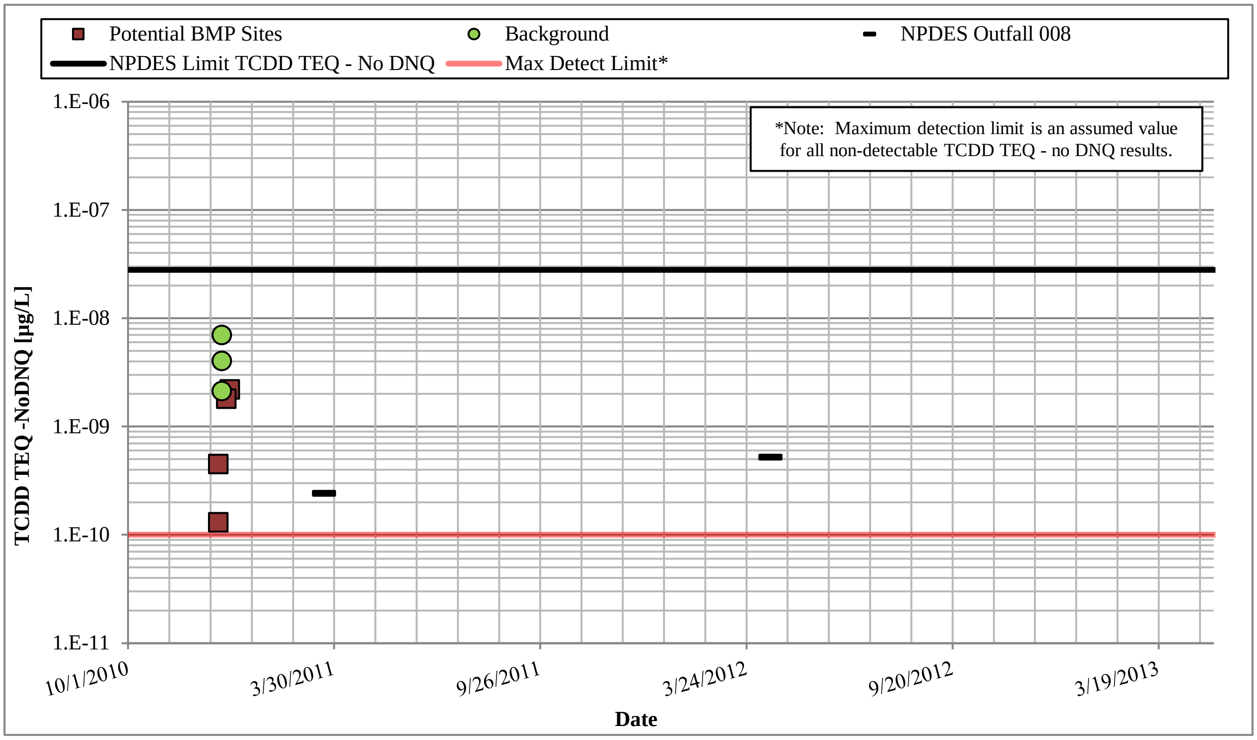
LEAD



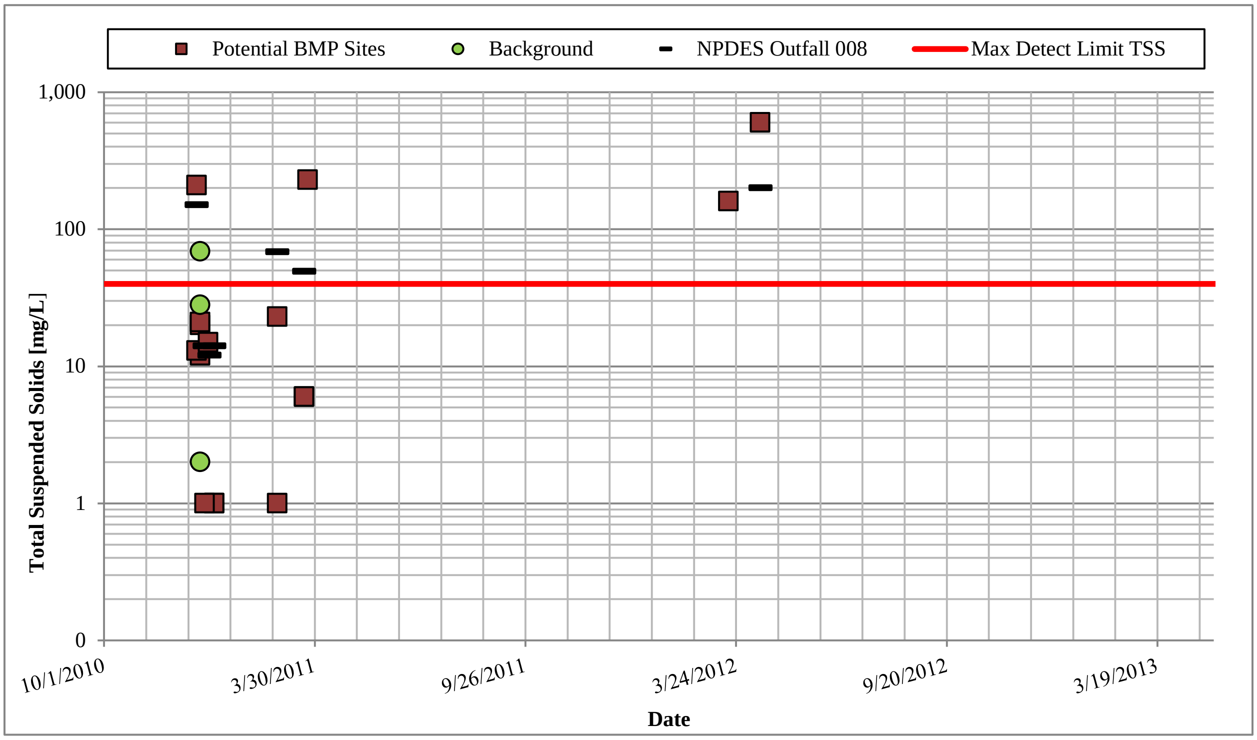
Sample results measured below the detection limit have been excluded. Results shown below the maximum detection limit line correspond to samples with a detection limit less than the maximum detection limit.

OUTFALL 008 TIMESERIES CHARTS
POTENTIAL BMP SUBAREA MONITORING PROGRAM

DIOXINS (TCDD-TEQ – no DNQ)



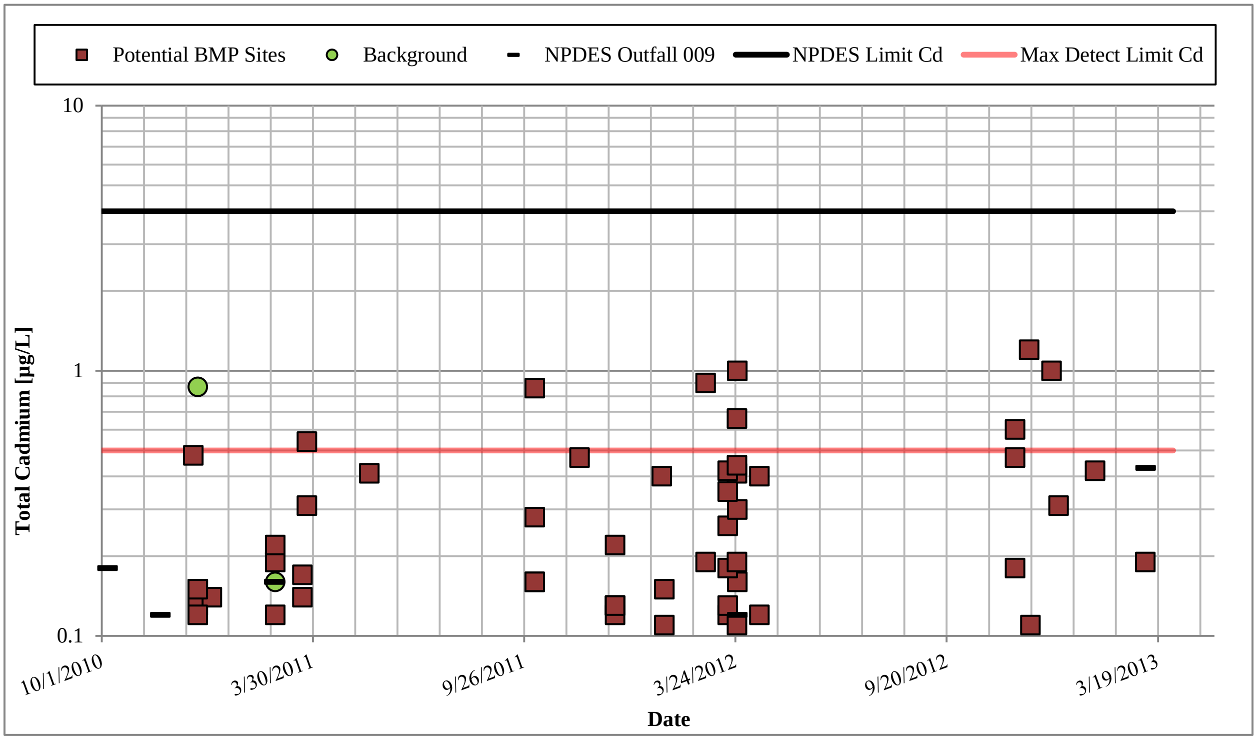
TSS



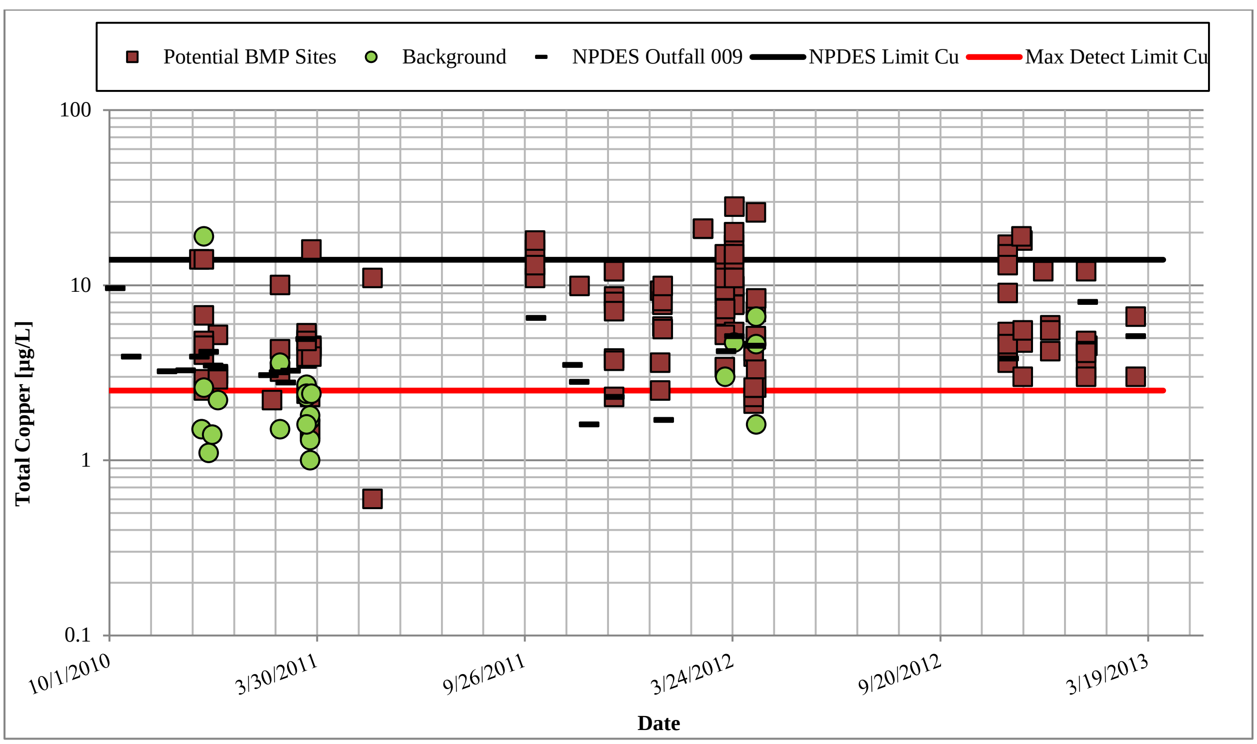
Sample results measured below the detection limit have been excluded. Results shown below the maximum detection limit line correspond to samples with a detection limit less than the maximum detection limit.

OUTFALL 009 TIMESERIES CHARTS
POTENTIAL BMP SUBAREA MONITORING PROGRAM

CADMIUM



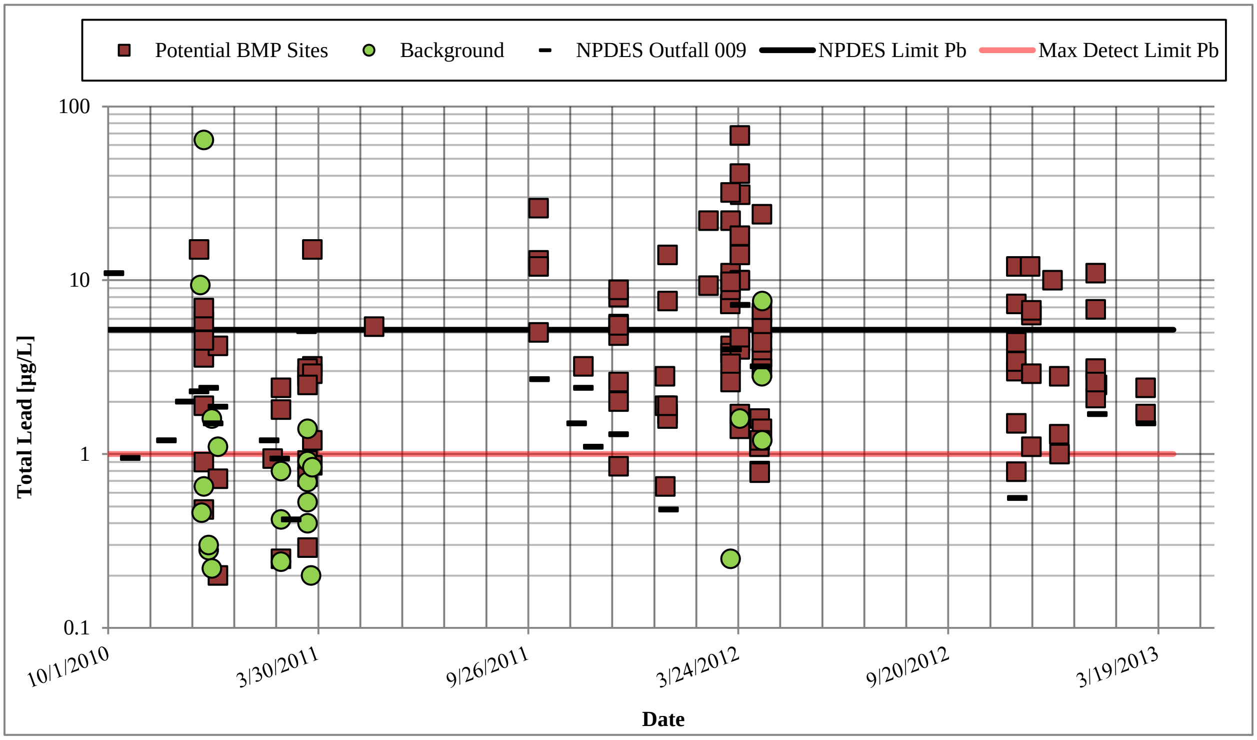
COPPER



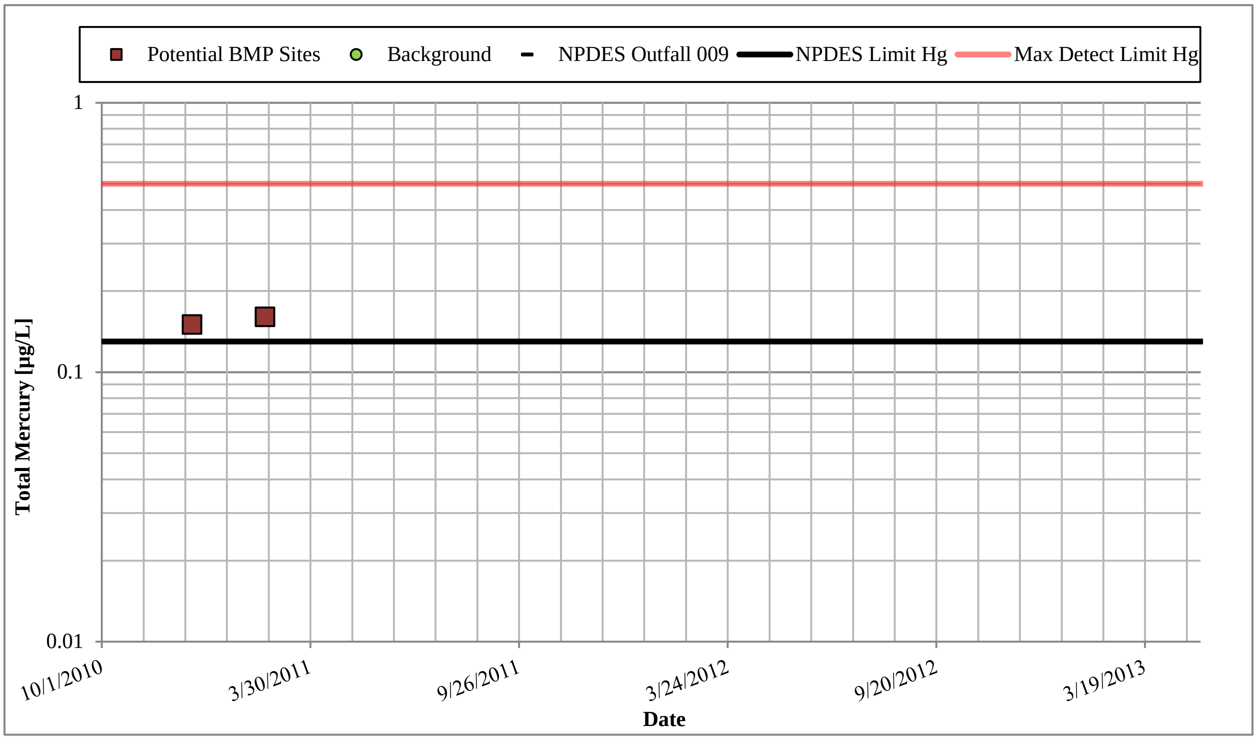
Sample results measured below the detection limit have been excluded. Results shown below the maximum detection limit line correspond to samples with a detection limit less than the maximum detection limit.

OUTFALL 009 TIMESERIES CHARTS
POTENTIAL BMP SUBAREA MONITORING PROGRAM

LEAD



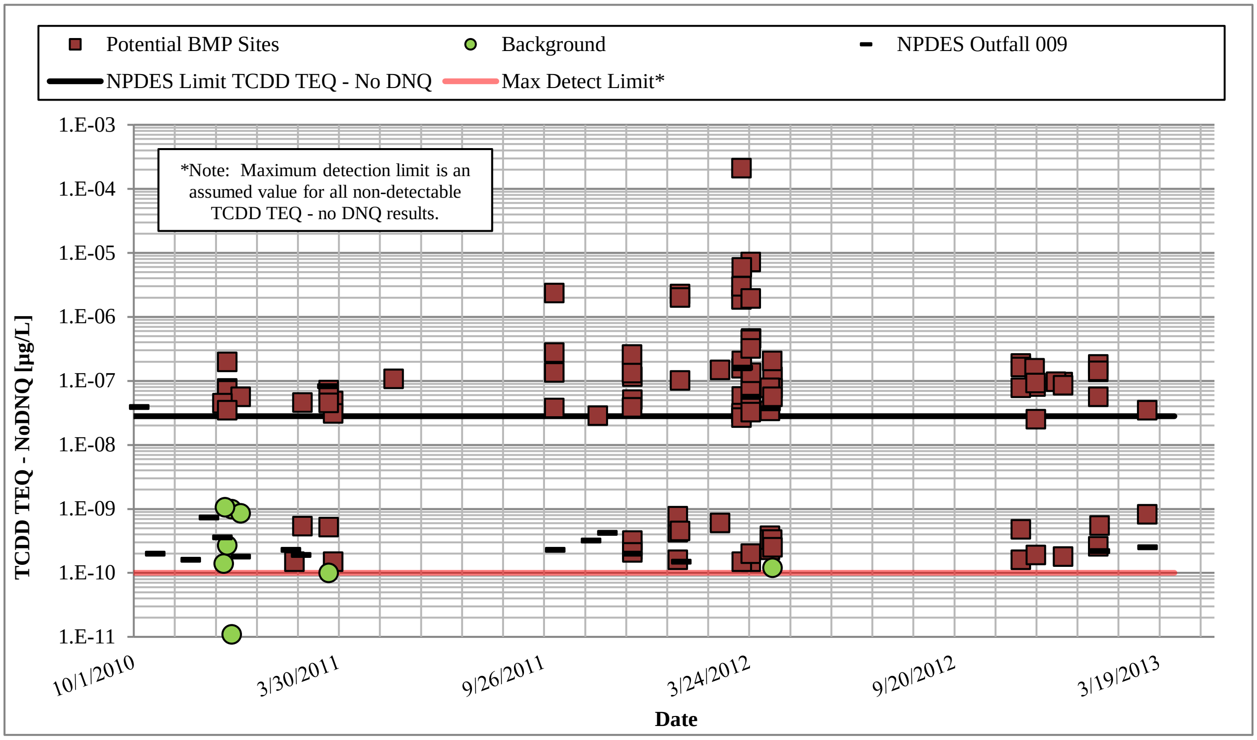
MERCURY



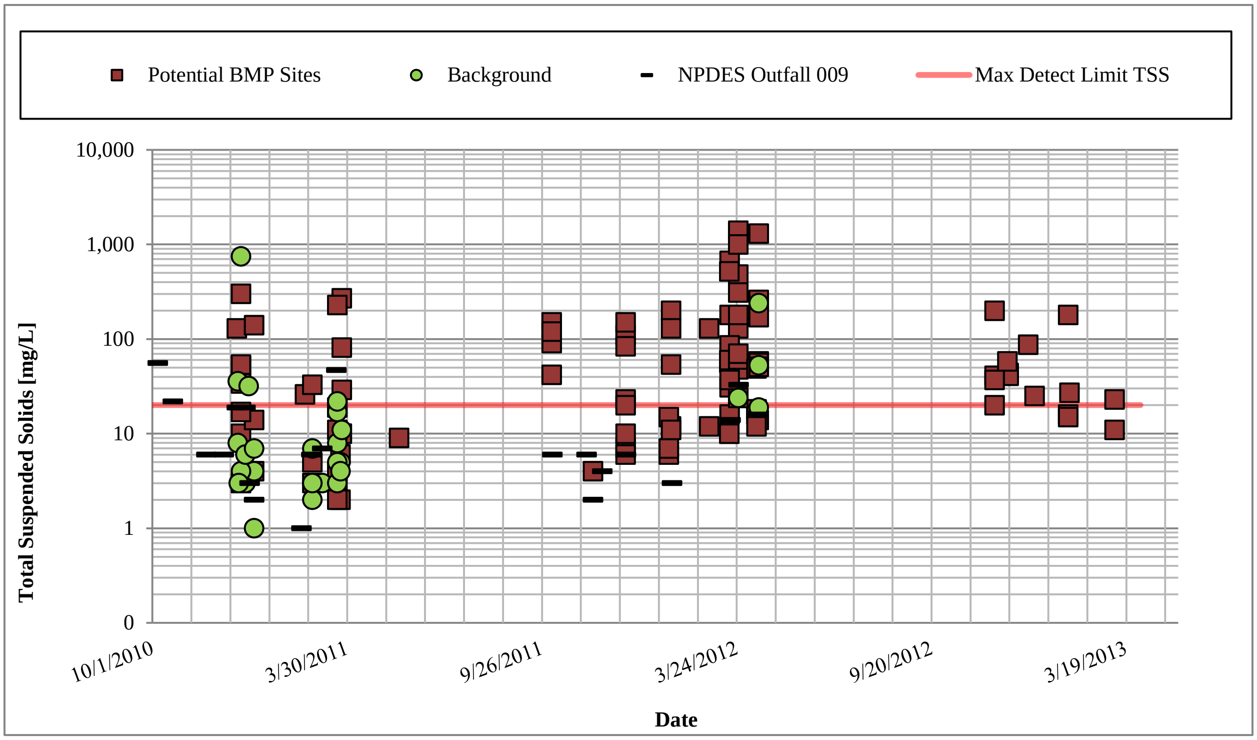
Sample results measured below the detection limit have been excluded. Results shown below the maximum detection limit line correspond to samples with a detection limit less than the maximum detection limit.

OUTFALL 009 TIMESERIES CHARTS
POTENTIAL BMP SUBAREA MONITORING PROGRAM

DIOXINS (TCDD-TEQ – no DNQ)



TSS



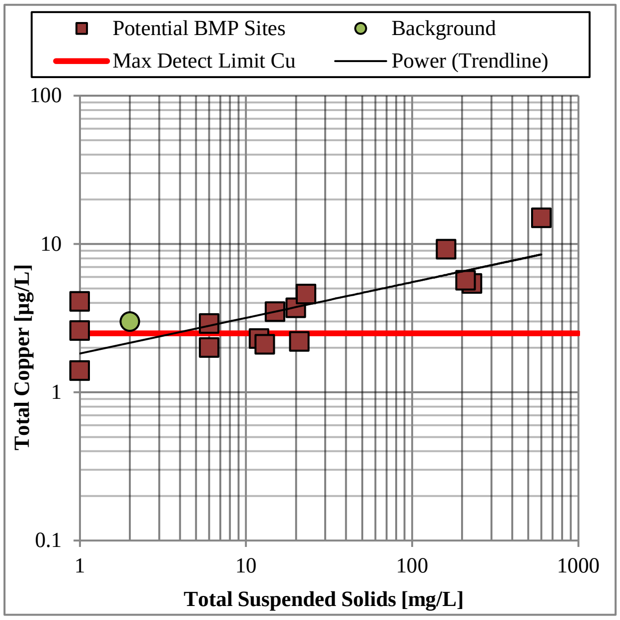
Sample results measured below the detection limit have been excluded. Results shown below the maximum detection limit line correspond to samples with a detection limit less than the maximum detection limit.

APPENDIX F-2

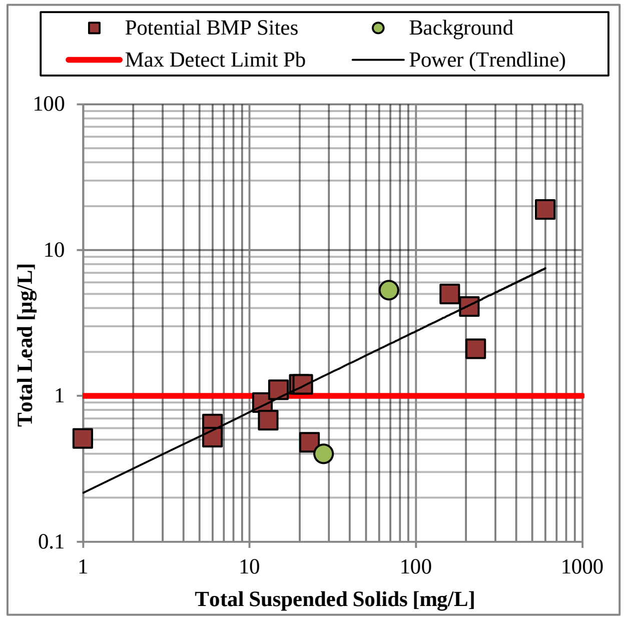
POTENTIAL BMP MONITORING DATA GRAPHS – COC CORRELATIONS

OUTFALL 008 CORRELATION CHARTS
POTENTIAL BMP SUBAREA MONITORING PROGRAM

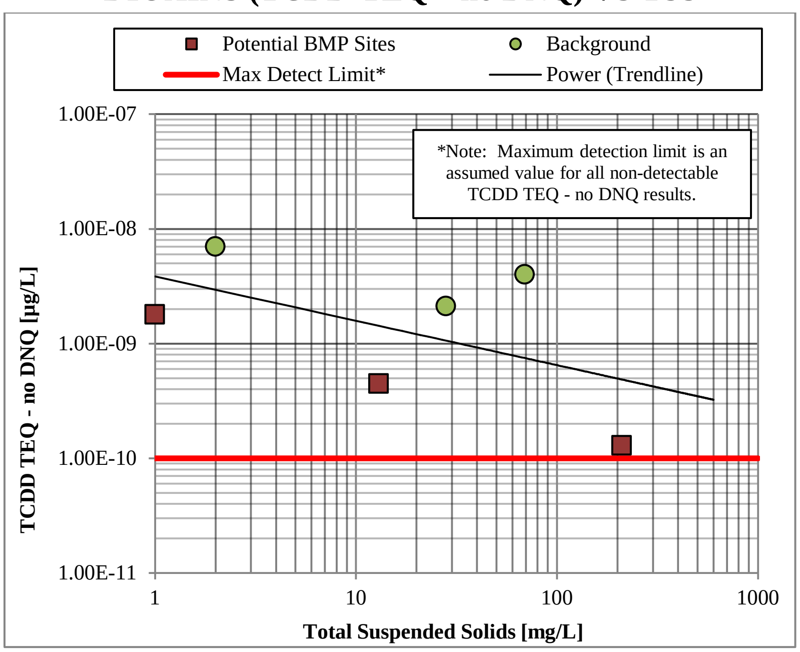
COPPER VS TSS



LEAD VS TSS



DIOXINS (TCDD-TEQ – no DNQ) VS TSS

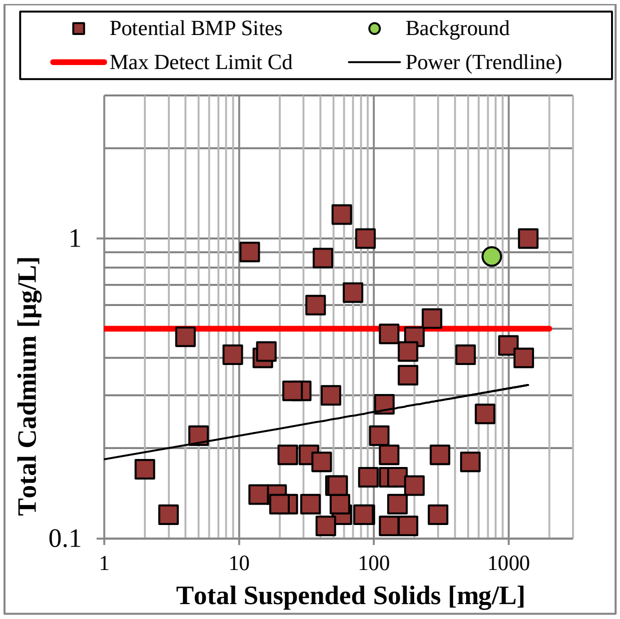


Sample results measured below the detection limit have been excluded. Results shown below the maximum detection limit line correspond to samples with a detection limit less than the maximum detection limit.

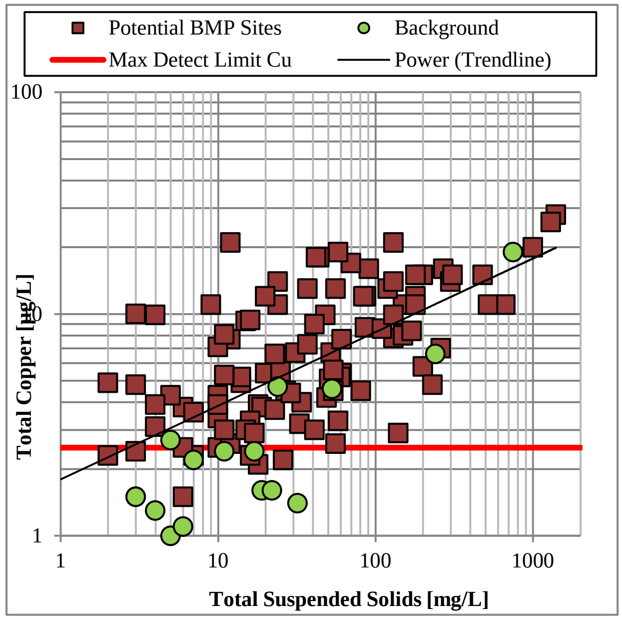
Several Background locations are also shown as CM Upstream locations on the ISRA Performance Monitoring plots.

OUTFALL 009 CORRELATION CHARTS
POTENTIAL BMP SUBAREA MONITORING PROGRAM

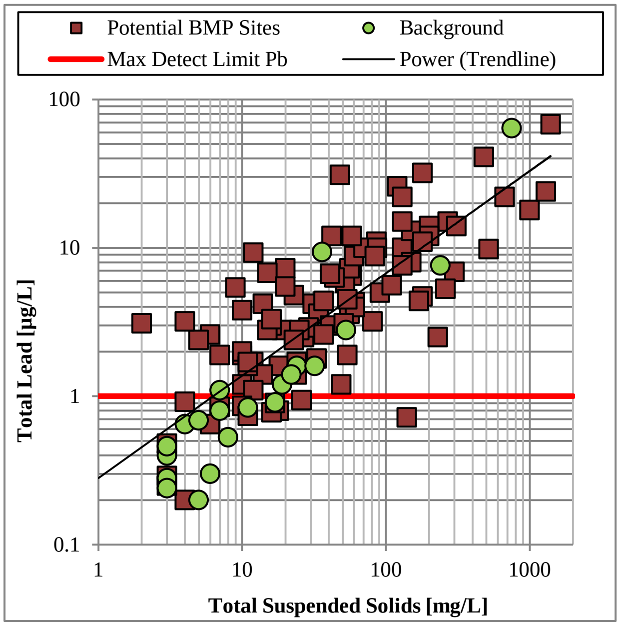
CADMIUM VS TSS



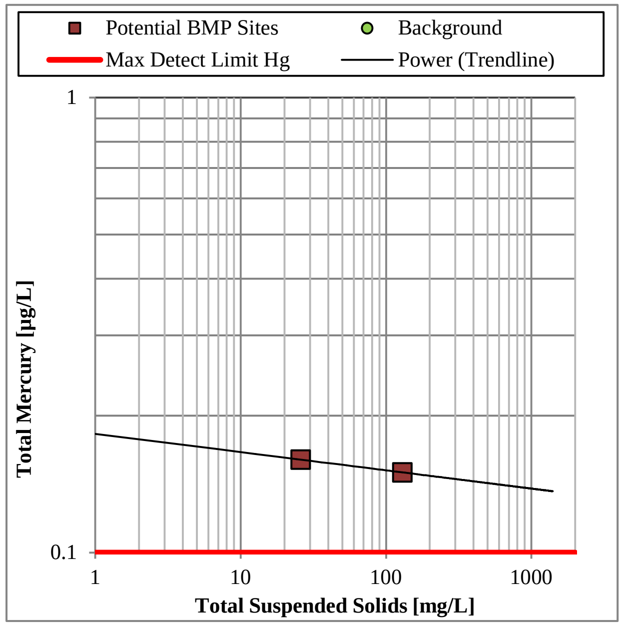
COPPER VS TSS



LEAD VS TSS



MERCURY VS TSS

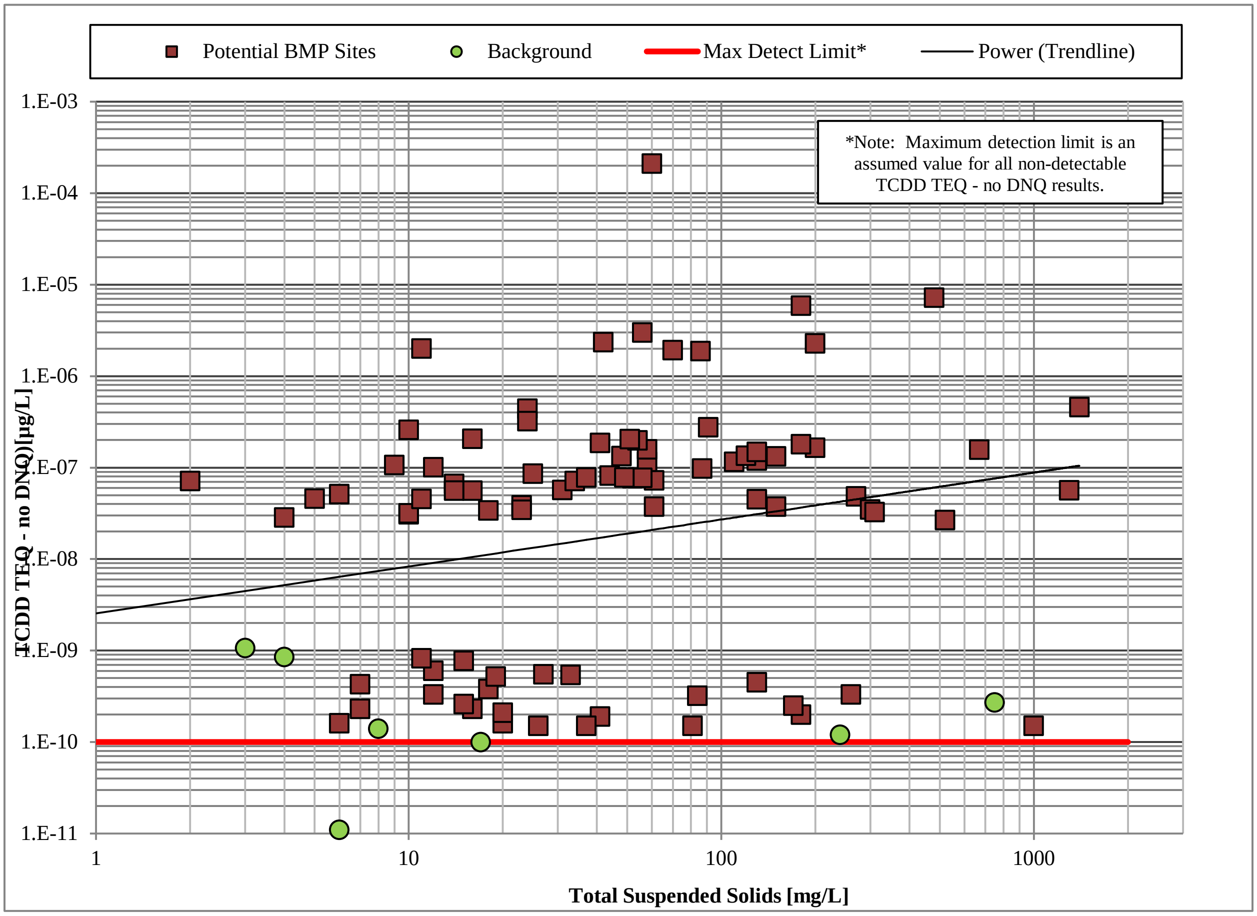


Sample results measured below the detection limit have been excluded. Results shown below the maximum detection limit line correspond to samples with a detection limit less than the maximum detection limit.

Several Background locations are also shown as CM Upstream locations on the ISRA Performance Monitoring plots.

OUTFALL 009 CORRELATION CHARTS
POTENTIAL BMP SUBAREA MONITORING PROGRAM

DIOXINS (TCDD-TEQ – no DNQ) VS TSS



Sample results measured below the detection limit have been excluded. Results shown below the maximum detection limit line correspond to samples with a detection limit less than the maximum detection limit.

Several Background locations are also shown as CM Upstream locations on the ISRA Performance Monitoring plots.

APPENDIX G

EXPERT PANEL’S BMP SITE RANKING ANALYSIS MEMORANDUM 2012/2013 RAINY SEASON

SANTA SUSANA SITE WATERSHED 008 AND 009 BMP SUBAREA RANKING ANALYSIS

August 29, 2013

Santa Susana Site Surface Water Expert Panel

Geosyntec Consultants

TABLE OF CONTENTS

ATTACHMENTS

TECHNICAL APPENDIX

LIST OF ACRONYMS

BEF	Bioaccumulation equivalency factors
BMP	Best management practice
Cd	Cadmium
CM	Culvert modification
COC	Constituent of concern
CV	Coefficient of variation
Cu	Copper
CWB	California Water Board
Det	Detected
DNQ	Detected not quantified
ISRA	Interim Source Removal Action
μg/kg	micrograms per kilogram
μg/L	micrograms per liter
mg/L	milligram per liter
ND	Not detected
NPDES	National Pollutant Discharge Elimination System
Pb	Lead
PL	Permit limit
PS	Particulate strength
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigations
RWQCB	Regional Water Quality Control Board
SSS	Santa Susana Site
SW	Stormwater
Tc	Time of concentration
TCDD	Tetrachlorodibenzo-*p*-dioxin
TEQ	Toxic equivalence
TSS	Total suspended solids
USEPA	U.S. Environmental Protection Agency

EXECUTIVE SUMMARY

The Santa Susana Site (SSS) Surface Water Expert Panel (Panel) was tasked by the Los Angeles Regional Water Quality Control Board (RWQCB) with evaluating subareas within the SSS Outfall 008 and 009 watersheds for potential implementation of new Best Management Practices (BMPs). These BMPs may include source controls (such as removal of impacted surface soils), erosion and sediment controls (such as straw wattles and hydromulch), instream measures (such as bank stabilization and grade control structures), and structural treatment controls (such as sediment basins and media filters, and biofilters). The purpose of any new proposed BMPs would be to improve National Pollutant Discharge Elimination System (NPDES) permit compliance at Outfalls 008 and 009 (Order No. R4-2010-0090)[1].

The purpose of this subarea ranking analysis is to rank subareas within Boeing's and NASA's 008 and 009 watersheds for potential implementation of new or enhanced stormwater controls and to evaluate existing measures, based on the most current available data and subarea specific considerations. The Expert Panel's recommended approach to this task is to rank potential BMP subarea monitoring locations based on the results of water quality sample comparisons between (a) stormwater concentrations and permit limits, and (b) subarea stormwater particulate strengths[2] and background stormwater particulate strengths. A statistical methodology was developed to rank the subareas based on these comparison results, while accounting for the number of useable data available at each subarea as well as number of data observations that fall above these thresholds (i.e., reflecting statistical confidence in how frequently each subarea will exceed the comparison thresholds). This methodology relied on "weighting factors" that are calculated for each POC for each subarea. In the end, the pollutant-specific weighting factors were summed to produce a multi-constituent score to allow for relative ranking amongst the potential BMP subareas.

The data included in this analysis fell into the following categories and periods of record:

1) Interim Source Removal Action (ISRA) and culvert modification (CM) performance monitoring data (2009-2013),

2) NPDES outfall monitoring data (2004-2013), and

3) Potential BMP subarea monitoring data (2010-2013).

Where available, data from co-located ISRA subareas were combined with data from BMP subareas in order to provide a more robust dataset at potential BMP locations. The exact periods of record varied by dataset and by sample subarea. This ranking evaluation occurs annually during the term of the 008/009 BMP Work Plan (i.e., through 2014); therefore this is the third of four annual BMP data analysis

[1] Outfall 009 had no NPDES exceedances in three NPDES-sampled events this year; however, total rainfall was only 8.1 inches (44 percent of average annual rainfall [18.4 inches]). No single day produced more than 1.49 inches, so the 1 year, 24 hour storm (2.3 inch depth) was never exceeded. Outfall 008 did not flow and was not sampled.

[2] Particulate strength is determined by taking the total concentrations of the compound minus its dissolved concentrations and dividing by the total suspended solids. It then provides a measure of the mass of particulate form of the compound per mass of suspended sediment. These values are very useful in identifying erosion and other sources of the particulate-bound pollutants in the runoff.

and recommendation reports. The first was presented by the Expert Panel and Geosyntec in September, 2011.

Subarea Specific Evaluation of Top-Ranked Subareas

Based on these analysis results, the following monitoring locations were identified as the highest ranked subareas, with multi-constituent scores ranging from 0.50 to 0.95 out of a maximum score of 1.0 (see Table ES-1[3]). Scores closer to 1.0 indicate the more problematic monitoring locations. Table ES-1 is limited to the top-ranked subareas discussed below; a complete summary table is provided in the main report as Table 9. Besides the multi-constituent scores, the following list is also of significance because it includes:

- Two of the three subareas (ILBMP0002, EVBMP0003, and B1BMP0005, which is the one not highly ranked) where 2,3,7,8-TCDD[4] was detected (but not quantified) in the 2012/2013 wet season;

- Seven of the fifteen subareas[5] with the highest reported lead concentrations and seven of the fifteen subareas[6] with the highest reported TCDD-TEQ concentrations (noting that the scores do not explicitly account for concentration *magnitude*s, but rather account for *frequency* of exceeding the concentration-based background and permit limit thresholds).

In some cases, these results reflect conditions prior to or following implementation of temporary measures or corrective actions and this is described in parentheses following the location designation (in bold). It should be noted that all 17 monitoring locations described below (the top-ranked locations with a multi-constituent ranking of 15 or above) are located in the 009 drainage area, with none in the 008 drainage area. Water quality at background locations was generally good with no location ranked above 30.5[7], though there were several instances of concentrations greater than NPDES permit limits at those locations. However, no flow or exceedances occurred at Outfall 008 during the current season, indicating that retention occurred within the watershed.

The following list of highest ranked subareas contains some historic subarea monitoring sites that are discontinued, indicated by gray text, and no Expert Panel recommendations are provided for these. Sites were discontinued for a number of reasons, including site improvements, changes in treatment type, and planned end of monitoring activities. It should also be noted that the 2012/13 season was unusually dry; therefore, there are relatively few new data this year for updating the site rankings.

[3] Subareas with zero samples have been excluded from table ES-1.
[4] 2,3,7,8-TCDD is a congener that potentially indicates unweathered anthropogenic contamination.
[5] ILBMP0002, EVBMP0003, EVBMP0001-A, LPBMP0001-A, APBMP0001, EVBMP0002, and LXBMP0006. The maximum lead concentration reported at each subarea is shown in Appendix A.
[6] EVBMP0001-A, LPBMP0001-A, ILBMP0001, ILBMP0002, B1SW0002, B1BMP004, and EVBMP0003. The maximum TCDD TEQ concentration reported at each subarea is shown in Appendix A.
[7] Some of the sites' ranks are not expressed as whole numbers because an average of ranks is used when multiple sites are tied with the same rank.

1. ILBMP0002 (road runoff to CM-9): This subarea reflects runoff from a 2.5-acre drainage area including paved road and undeveloped hillsides. Based on nine events, this subarea is ranked 1^{st} overall, 6^{th} for dioxins, 1^{st} for metals, and 28^{th} for TSS. ILBMP0002 drains to CM-9, which filters runoff through a horizontal media bed (estimated at 10% long-term average runoff volume capture[8] with the existing watershed conditions). Based on six events, the effluent from CM-9 (A1SW0009-B) is ranked 21^{st} overall, 21^{st} for dioxins, 15.5^{th}[9] for metals, and 24.5^{th} for TSS. There have been no samples collected from the effluent since its most recent improvements (A1SW0009-C), which were a result of last year's Expert Panel BMP recommendations. The most recent improvements include: erosion control blanket and straw wattles installed along the slopes adjacent to the Area II Road; a low-flow diversion inlet structure and diversion pipe with perforations; and a rock berm for ponding runoff as pretreatment prior to CM-9. The inlet and diversion pipe were installed to divert up to the one year design storm runoff flow rate and spread this runoff onto the vegetated slope south of the CM-9 media filter. No data have been collected since the BMP improvements have been installed; therefore, the first place ranking of the site does not reflect the potential benefits of the new BMP improvements. The Expert Panel recommends ongoing maintenance of the recently installed BMPs. In addition, the filter fabric on the CM-9 weir boards should be replaced when the fabric becomes clogged or damaged. Sediment accumulation at the inlet of the CM and at the new pretreatment rock berm should continue to be monitored. Water that has ponded upstream of the weir board for greater than 72 hours should be noted as it may suggest that media or underdrain maintenance is needed.

2. EVBMP0003 (CM-1 upstream west): This monitoring subarea reflects flow from approximately 11.8 acres including the ELV building and surrounding paved areas (including the NASA staging area), vegetated ELV hillside and ISRA areas (most of which were temporarily covered with tarps as of September 19, 2012), and the paved Area II (NASA) Road. ISRA area ELV-1C is located within this drainage area and was excavated in February and was substantially completed by March 2013. Plastic tarps and sandbags were placed over the excavation area to prevent contact with rainfall. Based on 17 events, this subarea ranks 2^{nd} overall (multi-constituent score = 0.94), 1^{st} for dioxins, 3^{rd} for metals, and 26^{th} for TSS. CM-1, to which EVBMP0003 drains, is an existing CM that also treats runoff from a 53-acre undisturbed subwatershed (estimated at around 7% long-term runoff volume capture under current conditions; however this is expected to increase after ELV drainage improvements are made). Based on eight events, the CM-1 effluent subarea (A2SW0002-A) is ranked 41^{st} overall (multi-constituent score = 0.07), ranked 38^{th} for dioxins, 35^{th} for metals, and 35^{th} for TSS. The ELV areas currently drain to EVBMP0003 and CM-1 due to an existing degraded asphalt channel below the ELV hillside that diverts runoff onto the Area II Road and to EVBMP0003. Improvements to the ELV ditch and area contributing runoff to CM-1 are discussed below in EVBMP0001-A recommendations. The Expert Panel recommends CM-1 filter fabric inspection

8 Overflows also get partial sedimentation through temporary ponding behind weir boards.

9 Some of the sites' ranks are not expressed as whole numbers because an average of ranks is used when multiple sites are tied with the same rank.

(replace when the fabric becomes clogged or damaged), monitoring of sediment accumulation in front of weir boards (removal when accumulation nears top of first weir board), and monitoring of water ponding after storms (ponding for greater than 72 hours should be noted as it may suggest that media or underdrain maintenance is needed).

3. EVBMP0001-A (composite of Helipad Road and lower ELV ditch): This discontinued monitoring subarea reflects flow from the 1.8-acre paved Area II (NASA) Helipad Road and ELV-1C and ELV-1D ISRA areas, composited (50/50) with flow from the 0.7-acre portion of the ELV vegetated hillside that enters, and remains in, the ELV asphalt ditch. The monitoring subarea was discontinued because the split flows were sampled individually in the rainy season 2012/13. Based on five events, this subarea was ranked 3rd overall (multi-constituent score = 0.67), 7th for dioxins, 17.5th for metals, and 13th for TSS. The highest measured TCDD TEQ (no DNQ) concentration (2.1×10^{-4} µg/L) was found here, including the detection of the 2,3,7,8-TCDD congener (2.2×10^{-5} µg/L). Prior to compositing with flows from the lower ELV ditch, this subarea (EVBMP0001) reflected runoff from only the Helipad Road gutter, and based on three events, was ranked 38th overall, 36th for dioxins, 26th for metals, and 13th for TSS, suggesting that flow from the lower ELV ditch contributes the majority of dioxins at this location. Working with the Expert Panel, NASA has developed certified-for-construction design drawings to construct a stormwater treatment facility using Panel-recommended filtration media. The design also incorporates minor regrading and curbing to facilitate diverting runoff from the upgradient paved ELV areas west of the Helipad toward the Helipad where sandbag berms and pumps are located. Construction is scheduled to be completed by end of September 2013 in advance of the 2013/14 rain season.

4. EVBMP0002 (Helipad pre-sandbag berms): This subarea reflects runoff from 4.1 acres of the paved Helipad area, pre-sandbag berms raised and pre-drainage holes in asphalt). Based on six events, this subarea was ranked 4th overall (multi-constituent score = 0.66), 10th for dioxins, 15.5th for metals, and 30.5th for TSS. This site has since been improved (EVBMP0002-B). The improved site ranks 34th overall (multi-constituent score = 0.20), 30th for dioxins, 32.5th for metals, and 30.5th for TSS. The improvements caused runoff from this area (EVBMP0002-B) to drain via overland flow through a series of temporary BMPs prior to being discharged via a paved asphalt channel on the east end of the Helipad. The temporary BMPs include two raised sandbag berms that collect and retain the runoff. Perforations in the pavement were installed upstream of the sandbag berms in September 2012 to promote infiltration. Captured runoff currently is pumped to the Silvernale treatment facility. Runoff capture efficiency may decrease in 2013/14 since a larger area is now draining toward these berms due to the ongoing construction. The Helipad sandbag berms are expected to receive significantly more runoff once NASA’s new ELV drainage routing plan is implemented; therefore the Panel recommends an evaluation of Boeing’s pumping setup so that the frequency of discharge from the Helipad area to OF009 continues to be controlled, as feasible. The Panel also recommends continued operation of this temporary capture system or equivalent runoff capture and treatment as a temporary interim control strategy until NASA is able to finalize plans and remove the asphalt from the Helipad area during planned demolition.

5.5. EVBMP0005 (2012/13 ELV drainage ditch [pre-ELV-1C ISRA]): Monitoring in this subarea, added during the 2012/13 water year, reflects 11 acres of ELV hillside runoff from the ELV asphalt swale prior to ISRA removal, which was substantially completed by March, 2013. There are no post-ISRA data for this location. Based on two events, the pre-ISRA subarea is ranked 5.5th overall (multi-constituent score = 0.63), 9th for dioxins, 21st for metals, and tied for 58th (last) for TSS. Runoff from the upgradient ELV paved areas will be diverted to the Helipad, and ELV hillside runoff will be treated through the stormwater treatment facility discussed above for EVBMP0001-A. The Expert Panel recommends no new actions at this time to address runoff from this subarea beyond the currently planned (and under construction) stormwater treatment facility.

5.5 A1SW0009-A (CM-9 downstream underdrain outlet, post-Building 1324 parking lot asphalt removal, pre-filter fabric over weir boards): Monitoring in this subarea, added during the 2012/13 water year, reflects treated runoff (estimated at 15% capture[10]) from a 16.4-acre drainage area, consisting of road runoff (ILBMP0002), a stabilized dirt road, rocky hillsides, and the AILF. Based on one event, this subarea is ranked 5.5th overall (multi-constituent score = 0.63), 21st for dioxins, 4th for metals, and tied for 58th (last) for TSS. In January of 2012, filter fabric was installed over the weir boards to reduce and filter seepage flows. Based on six events, this subarea (now named A1SW0009-B) is ranked 21st overall, 21st for dioxins, 15.5th for metals, and 24.5th for TSS. There have been no samples collected since its most recent improvements, completed in April 2013 and described above for ILBMP0002. The Panel recommends continued performance monitoring, inspection, and maintenance as necessary for this recently updated CM control.

7. EVBMP0004 (2012/13 Lower Helipad road): Monitoring in this subarea was added during the 2012/13 water year and reflects flow from the 1.8-acre paved Area II (NASA) Helipad Road. Based on three events, this subarea is ranked 7th overall (multi-constituent score = 0.62), 31.5th for dioxins, 2nd for metals, and 58th (last) for TSS. The Helipad road flows contributing to this BMP sampling location are planned to be collected in the reconstructed ELV ditch, after which they will be captured and treated through the stormwater treatment facility discussed above in the EVBMP0001-A recommendations. As a result, the Expert Panel recommends no new actions at this time to address runoff from this subarea beyond the currently planned (and currently under construction) stormwater treatment facility.

8. APBMP0001 (Ash Pile culvert inlet/road runoff): This Area II (NASA) subarea is 34 acres, including several flat ISRA areas distributed throughout a relatively flat drainage area; however, runoff has only been observed along the south side of the Area II road. Based on two events, this subarea is ranked 8th overall (multi-constituent score = 0.60), 21st for dioxins, 5th for metals, and 58th (lowest) for TSS. Both samples were collected after the ISRA areas had been partially excavated and covered with plastic, which may have disturbed the soil leading to increased pollutant discharges. This is expected to be a temporary issue until the ISRA area is permanently stabilized. The Expert

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[10] Overflows also get partial treatment by sedimentation through temporary ponding behind weir boards.

Panel recommends no new actions at this time to address runoff from this subarea because it is currently being addressed by ISRA activities.

9. ILBMP0001 (Lower Lot 24-inch storm drain outlet): This monitoring subarea reflects flow from 23 acres of paved parking areas, building rooftops, paved storage areas, and undeveloped hillsides. Runoff from these areas is conveyed by a storm drain collection system to a 24-inch storm drain located beneath the Lower Parking Lot. This storm drain discharges via a concrete outlet spillway to the Northern Drainage on Sage Ranch property. Based on 16 events, this subarea is ranked 9th overall (multi-constituent score = 0.57), 8th for dioxins, 23rd for metals, and 39.5th for TSS. A portion of this flow (approximately 11% long-term average runoff volume capture) is treated through the Lower Lot Biofilter. Additionally, Building 1436 is planned to be demolished and removed in the fall of 2013, leaving an open dirt area that will be addressed by erosion controls, such as wattles and hydroseed. The Building 1436 demolition will remove approximately one acre of impervious area, resulting in reduced runoff volumes and a minor (1%) increase in percent capture by the low-flow diversion for biofilter treatment. The demolition will also reduce the potential stormwater contaminant sources associated with building materials. The Expert Panel recommends ongoing inspection of the low-flow diversion, comprehensive erosion controls post-building demolition, upper parking lot asphalt removal where possible, and treatment of runoff from the paved storage area near Building 1436. Treatment may be through passive Low Impact Development-type controls, or through detention if it is shown to provide equivalent water quality benefit.

10. B1BMP0004 (B-1 media filter inlet north): This monitoring subarea reflects runoff from approximately 3.7 acres of paved road and post-ISRA restored hillside. Based on 11 events, this subarea is ranked 10th overall (multi-constituent score = 0.53), 2nd for dioxins, 29th for metals, and 30.5th for TSS. This subarea drains to a series of rock check dams and the B-1 media filter which, after filtering runoff, discharges to a natural vegetated drainage across the main entrance at Facility Road. In 2012, hillside erosion controls were improved and curb cuts were added to even the distribution of inflows to the B-1 media filter on the south and north sides. Based on six events, the B-1 media filter effluent (B1SW0014-C) is ranked 35th overall (multi-constituent score = 0.2), 29th for dioxins, 63rd (last) for metals, and 58th (last) for TSS. Runoff from the paved area and road to the north, which otherwise enters a pipe that conveys runoff under the road and toward B1BMP0004, is slowed by sand bags surrounding the grate inlet. The Expert Panel recommends continued maintenance of the filter media bed, hillside erosion controls, pretreatment check dams, and curb cuts.

14.5. LPBMP0001-A (Lower Parking Lot sheetflow, post-gravel bag berms): This discontinued monitoring subarea, which has been replaced by the cistern influent sample at LPBMP0002, reflects runoff from 5.1 acres of mostly paved parking and road areas, after the gravel bag berms were installed in September of 2011 to slow runoff and allow for some detention. Soil management and contractor staging activities are also planned to occur here, but were not present during the period reflected by this dataset. Based on six events, this subarea is ranked 14.5th overall (multi-constituent score = 0.50), 3rd for dioxins, 37.5th for metals, and 24.5th for TSS. This same subarea, based on two events prior to the installation of the gravel bag berms (LPBMP0001), was ranked 14.5 overall (multi-constituent score = 0.50), 21st for dioxins, 10th for metals, and 13th for TSS. This area is currently being treated with a sedimentation basin and biofilter, in anticipation of increased soil stockpile activity.

14.5. B1SW0002 (Woolsey Canyon Road runoff): This discontinued monitoring subarea, which has been replaced by sampling location B1BMP0004, reflects overland and shallow concentrated runoff from approximately 1.3 acres of mostly paved road at the intersection of Facility Road and Woolsey Canyon Road. Based on two events, this subarea is ranked 14.5th overall (multi-constituent score = 0.50), 21st for dioxins, 10th for metals, and 13th for TSS. This area drains toward the north inlet of the B-1 media filter along an earthen channel with rip rap check structures.

14.5. B1BMP0001 (B-1 media filter inlet (post-media filter installation)): This discontinued monitoring subarea, which has been replaced by sampling location B1BMP0005, reflects runoff from approximately 4.5 acres of stormwater influent to the B-1 media filter. This subarea represents untreated stormwater (before it is treated through the media bed and then discharged by the media bed). Based on three events, this subarea is ranked 14.5th overall (multi-constituent score = 0.50), 21st for dioxins, 10th for metals, and 13th for TSS.

14.5. LXBMP0006 (LOX east, runoff along dirt road): This monitoring subarea reflects runoff from approximately 0.43 acres of the LOX area before it is discharged to the Northern Drainage. Based on one event, this subarea is ranked 14.5th overall (multi-constituent score = 0.50), 21st for dioxins, 10th for metals, and 13th for TSS. NASA is currently performing ISRA actions in this subarea, which began in July 2013 and are planned to be completed by the end of 2013. The Expert Panel recommends robust erosion and sediment controls during and following this soil removal work.

14.5. LPBMP0002 (Lower parking lot influent to cistern): This monitoring subarea reflects runoff from approximately 4.2 acres of mostly impervious parking lot that is collected in a trench drain. The subarea represents untreated stormwater before it is collected in the trench drain, which drains to the cistern for pre-treatment before being pumped to the sedimentation basin and biofilter. Based on one event, this subarea is ranked 14.5th overall (multi-constituent score = 0.50), 21st for dioxins, 10th for metals, and 58th (lowest) for TSS. The Expert Panel recommends no new actions at this time to address runoff from this subarea because the sedimentation basin and biofilter are in place.

14.5. EVBMP0006 (2012/13 Area II Road near ELV ditch): This monitoring subarea, added during the 2012/13 water year, reflects runoff from approximately 11 acres of Area II Road to the west of the intersection with Helipad Road. Based on one event, this subarea is ranked 14.5th overall (multi-constituent score = 0.50), 21st for dioxins, 10th for metals, and 13th for TSS. Runoff from this area drains along the north edge of the Area II road toward CM-1. The Expert Panel recommends no new actions at this time to address runoff from this subarea because the subarea will either be treated by NASA's new ELV treatment system or will be part of very minor residual flows that will go to CM-1.

14.5. B1SW0014-A (B-1 media filter effluent (pre-media filter reconstruction)): This discontinued subarea reflects 4.7 acres of treated stormwater runoff from Facility Road that discharged through the originally constructed B-1 media filter. This sampling location was discontinued after the B-1 media filter was reconstructed with a new underdrain system in December 2011. Based on one event, this subarea is ranked 14.5th overall (multi-constituent score = 0.50), 21st for dioxins, 10th for metals, and 13th for TSS. This area contributing to this former sampling location was also improved through the addition of improved hillside erosion controls and curb cuts, which occurred in December of 2011, respectively. Based on six events, this subarea (now named B1SW0014-C) is now ranked 35th overall, 29th for dioxins, 63rd for metals, and 58th (last) for TSS but has been discontinued and replaced with location B1BMP0006, which reflects effluent from the reconstructed B-1 media filter.

14.5. LPBMP0001 (Lower Parking Lot sheetflow, pre-gravel bag berms): This discontinued subarea, which has been replaced by the monitoring at the trench drain of the new sedimentation basin and biofilter (LPBMP0002), reflects runoff from 5.1 acres of mostly paved parking and road areas, before the gravel bag berms were installed in September of 2011 to slow runoff and allow for some detention (see LPBMP0001-A discussion above) . Based on two events, this subarea ranked 14.5th overall, (multi-constituent score = 0.50), 21st for dioxins, 10th for metals, and 13th for TSS. This area is now being treated with a sedimentation basin and biofilter BMP, in anticipation of increased soil stockpile activity.

Table ES-1. Subareas Ranked by Multi-Constituent Score

Rank	Potential BMP Subarea (Co-locations)	Description	BMP Status	Approximate Upgradient Drainage Area (ac)	Multi-Constituent Score	Rank from Maximum Metal Weighting	Rank from Maximum Dioxins Weighting	Total Number of Events Sampled
1	**ILBMP0002**[a]	Road runoff to CM-9	Addressed by current BMP; Influent site	2.5	0.95	1[c]	6	9
2	**EVBMP0003 (A2SW0001)**[a]	CM-1 upstream west	Addressed by current BMP; Influent site	11.8	0.94	3[c]	1	17
3	EVBMP0001-A [b]	ELV culvert inlet (Helipad road and ELV ditch, composite)	Will be addressed by BMP; discontinued	2.5	0.67	17.5	7	5
4	**EVBMP0002**[a b]	Helipad (pre-sandbag berms)	Addressed by current BMP	4.1	0.66	15.5	10	10
5.5	**EVBMP0005** [b]	2012/13 ELV drainage ditch (pre-ELV-1C ISRA)	Will be addressed by BMP	11	0.63	21	9	2
5.5	**A1SW0009-A**	CM-9 downstream-underdrain outlet (post-AILF asphalt removal, pre-filter fabric over weir boards)	BMP site has since been improved (old site)	16.4	0.63	4	21	1
7	**EVBMP0004** [b]	2012/13 Lower Helipad Road	Will be addressed by BMP	1.8	0.62	2	31.5	3
8	**APBMP0001** [b]	Ashpile culvert inlet/ road runoff	NA	34	0.60	5	21	2
9	**ILBMP0001** [b]	Lower lot 24" stormdrain outlet	Addressed by current BMP and planned building demolition	23	0.57	23	8	16
10	B1BMP0004 (B1SW0015, B1BMP0004-5)	B-1 media filter north	Addressed by current BMP; Influent site	3.7	0.53	29	2	6
14.5	LPBMP0001-A	Lower lot sheetflow (post-gravel bag berms)	Addressed by current BMP; discontinued	5.1	0.50	37.5	3	6
14.5	B1SW0002[a]	Woolsey Canyon Road runoff	Addressed by current BMP; Influent site;	1.3	0.50	10	21	2

Rank	Potential BMP Subarea (Co-locations)	Description	BMP Status	Approximate Upgradient Drainage Area (ac)	Multi-Constituent Score	Rank from Maximum Metal Weighting	Rank from Maximum Dioxins Weighting	Total Number of Events Sampled
			discontinued					
14.5	B1BMP0001 (B1SW0010)	B-1 media filter inlet (post-media filter installation)	BMP site has since been improved (old site); Influent site; discontinued	4.5	0.50	10	21	3
14.5	LXBMP0006	LOX east, runoff along dirt road	ISRA planned	0.43	0.50	10	21	1
14.5	LPBMP0002	Lower parking lot influent to cistern	Addressed by current BMP; Influent site	4.2	0.50	10	21	0
14.5	**EVBMP0006** [b]	2012/13 Area II Road near ELV ditch	Will be addressed by BMP	11	0.50	10	21	1
14.5	B1SW0014-A (B1BMP0006)	B-1 media filter effluent (pre-media filter reconstruction)	BMP has since been improved (old site), discontinued	4.7	0.50	10	21	7
14.5	LPBMP0001	Lower lot sheetflow (pre-gravel bag berms)	BMP site has since been improved (old site); discontinued	5.1	0.50	10	21	2

Notes

- Potential BMP subareas sorted by multi-constituent score, computed as described in Section 5.
- ([a]) These potential BMP subarea monitoring locations are upstream of existing stormwater quality treatment controls.
- ([b])These potential BMP subarea monitoring locations have new planned (i.e., designed and ready for construction) stormwater quality treatment controls.
- ([c]) 2,3,7,8-TCDD detected in the 2012/13 water year in these subareas.
- The rounding of weights may account for similar weights being ranked differently.
- Approximate drainage areas based on the cumulative drainage area of the SWMM catchment in which the monitoring location is located (Geosyntec, 2011). At locations where the monitoring point is upstream of the catchment outfall a "<" sign is used.
- **Bolded** locations indicate that both the NPDES permit limit and 95th percentile background particulate strength threshold were exceeded for any one POC.
- Gray text indicates historic subarea monitoring sites that are discontinued.
- All sites ranked in the top 15 of the multi-constituent table are located in Outfall 009.

Table ES-2 summarizes the top 15 ranked sites from the multi-constituent ranking analysis that are also associated with a paired effluent site, demonstrating that for each pair, treatment through the BMP resulted in improved water quality. For example, three influent streams within the B-1 area (ranked 10, 14.5, and 14.5) are all ranked higher than the B-1 effluent, which is ranked 35. A similar occurrence is observed for the influent/effluent ranks for CM-1, CM-9, CM-8, and the lower parking lot sedimentation basin and biofilter. Sites B1SW0014-A and A1SW0009-A are not included in this table, because they are old monitoring sites that are no longer being monitored.

Table ES-2. Ranking Comparison of Top Ranked Sites and Their Pairs

BMP Area	Influent			Effluent			Rank Drop
	Location/ Colocation	Description	Influent Rank	Location/ Colocation	Description	Effluent Rank	
CM-9	**ILBMP0002**	Road runoff to CM-9	1	A1SW0009(-B)	CM-9 downstream-underdrain outlet (post-filter fabric over weir boards, post-AILF asphalt removal)	21	20
CM-1	**EVBMP0003**	CM-1 upstream west	2	A2SW0002(-A)/ A2BMP0007	CM-1 effluent (post-filter fabric over weir boards)	41	39
B-1 Media Filter	**B1BMP0004**	B-1 media filter inlet north	10	B1SW0014(-C)/ B1BMP0006	B-1 media filter effluent (post-media filter reconstruction, post-curb cuts)	35	25
Lower Lot Sediment Basin	**LPBMP0002[a]/** **LPBMP0001/** **LPBMP0001-A**	Lower lot influent to cistern	14.5/ 14.5/ 14.5	LPBMP0004[a]	Lower parking lot biofilter outlet	66.5	52[b]
B-1 Media Filter	**B1BMP0004/** **B1SW0002/** **B1BMP0001**	B1 media filter inlet north/ Woolsey Canyon Road runoff (old north inlet)/ B1 media filter, south inlet (old) post-media filter installation	10/ 14.5/ 14.5	B1SW0014(-C)/ B1BMP0006	B-1 media filter effluent (post-media filter reconstruction, post-curb cuts)	35	20.5
B-1 Media Filter[b]	B1BMP0003 [B1BMP0002]/ B1SW0014 (-C) [B1BMP0006]	B-1 parking lot and road runoff to culvert inlet/ B-1 media filter effluent (post-media filter reconstruction, post-curb cuts)	19/ 35	B1BMP0007	B-1 lower parking lot area	42	23

NOTES

- **Bolded** locations indicate that the site is ranked within the top fifteen of the multi-constituent table (Table 9).
- Gray text indicates historic subarea monitoring sites that are discontinued.
- ([a]) Based on a single influent/effluent sampling event.
- ([b]) Influent and effluent sites for this entry were not within the top-ranked site; however, this pair is included to more fully describe improvements in B-1 area.

2012 BMP Recommendations Status Update

Based on the 2012 ranking results, the following recommendations were made by the Expert Panel in the 2012 Annual Report.

1. **ELV/CM-1 (NASA):** The Expert Panel's 2012 treatment system recommendations are currently being constructed. Construction began in June 2013. The Panel also recommended that the upper paved ELV and Helipad areas be swept, and that regular maintenance of pumps and berms be performed. Maintenance of infiltration holes is optional, since cumulative infiltration through these holes is not known.

2. **Helipad (NASA):** In 2012, the Expert Panel recommended asphalt removal and contouring. This plan is currently on hold. Additional runoff will be routed toward the Helipad from the western paved area around the ELV building. NASA's long-term plan is to remove the asphalt from the Helipad area (anticipated to occur in 2014) and then re-vegetate. The Panel's current recommendations for this area were described earlier.

3. **24-inch drain beneath Lower Lot (Boeing):** In 2012, the Expert Panel recommended biofiltration or equivalent above ground natural treatment systems around storm drain inlets and remaining impervious areas, and post-demolition erosion controls around Building 1436 and any removed asphalt areas of the upper parking lot. The current demolition plan is for removal of Building 1436 in 2013. The Panel's existing recommendations for this area were described earlier.

4. **B-1 Area (Boeing):** In 2012 the Expert Panel recommended continued maintenance activities to enhance the performance of the existing media filter. Expert Panel recommendations in the 2012 report were completed in 2012. These recommendations included curb cuts along the entrance road northwest of the existing rock check dams. These curb cuts divert runoff from the pavement to the north side of the B-1 media filter, rather than the south side, to better balance influent delivery to the two sides of the treatment system. Additional improvements installed in 2012 in this area included rock stabilization at the outlet of the curb cuts and stabilization measures (e.g., hydroseed) on denuded and exposed sloped soils.

5. **CM-9 (Boeing):** The Expert Panel's 2012 recommendations for this drainage were implemented in 2012. These recommendations included erosion control measures of straw wattles and hydromulch installed on the steep roadside embankments on both sides of the Area II Road. Additional recommendations including wattles along the channel or dirt path below and west of the former Building 1300 were installed in 2012. Recommended controls along the Area II Road included a low-flow diversion to collect runoff from the Area II Road and divert these flows into a perforated pipe to distribute this runoff onto the vegetated sloped area to the south of the CM-9 location. A rock grade control structure (i.e., rock check dam) was installed in the drainage upstream of the CM-9 to provide storage volume and settle suspended sediment

before runoff reaches the media filter downstream. Additional recommendations installed in 2012 include replacing the filter fabric on the weir boards of the CM-9 culvert headwall.

6. **LOX Area (NASA):** In the 2012 BMP Ranking Memo, the LOX ISRA excavation was described as being tentatively planned for 2013. In August 2013, at the request of Boeing, the Expert Panel reviewed existing data (including stormwater concentrations, soil concentrations, and runoff flowrate estimates) for certain LOX areas (LOX 1A, 1B-4, 1C, and 1D) to evaluate the prudence of conducting ISRA excavations at each. Following discussion with Boeing and their remediation consultants, the Panel recommended that ISRA activities at these areas be considered for integration into the larger site-wide AOC cleanup efforts planned by NASA. The Expert Panel currently recommends that the sites be isolated hydrologically to the extent feasible and stabilized with vegetation and BMPs, and that monitoring in the area continue.

7. **Outfall 008:** Several improvements have been made to Outfall 008 in accordance with the *Santa Susanna Field Laboratory: Recommendations from Field Investigation of Outfall 008 Watershed* Memo (2012):

    - The temporary silt fence and straw bale road barriers were removed and replaced with rock berms.
    - The original recommendations included to extend an existing culvert standpipe to increase the inlet elevation of the standpipe and install a gravel mound around the standpipe. However, after mobilization the contractor identified that the culvert outlet was clogged with sediment and that the outlet was lower in elevation than the adjacent ground surface. The revised recommendation was to leave the culvert as found and rely on the rock berms to treat runoff through this area as described in the above bullet.
    - Gravel water bars were extended to divert flow into the vegetation to the north or south of the access road. The discharge side of the road (i.e., at the down slope outlet of the gravel water bars) was excavate to create a side drain.
    - Two riprap check dams were installed in the eastern tributary of the Outfall 008 flume.
    - The riprap apron at the outfall flume was restored and enhanced and loose materials were stabilized on the side of the slopes immediately upstream of the flume inlet and around the sample box. The Expert Panel recommends consideration of extending the northeast flume inlet wall to improve flow measurement accuracy and to decrease erosion potential adjacent to the monitoring location.

Although this analysis primarily focuses on the selection of potential stormwater treatment control locations, the Expert Panel continues to strongly recommend the rigorous application of erosion and sediment control practices and stream channel stabilization measures throughout the 008 and 009 watersheds, including and especially at areas where substantial soil removal may be planned at steep areas and/or in proximity to drainage courses (such as at ELV, LOX, or the A2LF ISRA areas). The Expert Panel also continues to recommend the stabilization of unpaved roads and the implementation of source controls (including source removal, such as through the ISRA and demolition programs). Culverts should also continue to be inspected for evidence of piping, not only for water quality purposes, but also for safety concerns near the roadways. Finally, it is important that routine maintenance be undertaken at all CM locations and where sedimentation basins have been constructed (e.g., above B-1).

The Expert Panel believes that new and planned activities, taken together, will improve the likelihood of NPDES compliance at Outfalls 008 and 009, based on currently available information.

1. INTRODUCTION

The purpose of this analysis is to rank subareas in the Santa Susana Site (SSS) Outfall 008 and 009 watersheds for potential implementation of new or enhanced stormwater controls[11], to improve National Pollutant Discharge Elimination System (NPDES) permit compliance at Outfalls 008 and 009. The SSS Stormwater Expert Panel's (Panel's) recommended approach[12] is to:

1. Compare potential BMP subarea[13] monitoring results with subarea-specific stormwater background[14] data and NPDES permit limits;
2. Determine pollutant-specific "weighting factors" for each potential BMP subarea monitoring subarea based on this comparison (using a statistical methodology that accounts for sample size and number of results that are above both of these thresholds), with the highest weighting factors assigned to subareas that most frequently exceed both of these thresholds;
3. Determine multi-constituent ranking "scores" for each subarea based on the pollutant-specific weighting factors; and
4. Rank the potential best management practices (BMPs) monitoring subareas based on these multi-constituent ranking scores.

This general approach is summarized in the flow chart included as Attachment 1. SSS stormwater background concentrations are established based on data from Interim Source Removal Action (ISRA) performance and potential BMP subarea monitoring locations that represent runoff from drainage areas with minimal to no RCRA Facility Investigations (RFI), ISRA, or developed (i.e., roof or pavement) areas. The selection of potential BMP subarea monitoring locations is described in the December 16, 2010

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[11] For the purpose of this report, the overarching term "stormwater controls" will be used to describe the standard suite of passive control practices, including erosion controls, sediment controls, and treatment controls. For detailed definitions or examples of erosion and sediment controls, see the CASQA Construction BMP Handbook at http://www.cabmphandbooks.com; for a detailed definition or examples of treatment controls, see the Ventura County Technical Guidance Manual for Stormwater Quality Control Measures at http://www.vcstormwater.org/documents/workproducts/technicalguidancemanual/2010final/Ventura_TGM%2011-4-10.pdf. The more general term, "Best Management Practice" (or BMP), is used in this report as a synonym for "stormwater control" but is used only for referencing the "potential BMP subarea monitoring subareas," or monitoring locations where new stormwater controls are being contemplated based on a review of available monitoring results.

[12] The recommended approach outlined herein was developed jointly by the SSS Stormwater Expert Panel and Geosyntec Consultants, with review from The Boeing Company, NASA, and the Los Angeles Regional Water Quality Control Board.

[13] "Potential BMP subarea monitoring locations" are defined here as drainage areas with an outlet location for stormwater runoff sampling, and including land uses that include ISRA, RCRA Facility Investigation (RFI), and/or developed areas (i.e., subareas containing buildings, asphalt parking lots, roads, etc.) so that impacted runoff quality might be expected and/or treatment BMPs might be necessary, pending an evaluation of the monitoring results.

[14] "Stormwater background monitoring locations" are defined here as locations in these watersheds that generally represent stormwater runoff from unimpacted areas, or areas that do not include ISRA, RFI, or significant development, thereby representing subarea-specific background (or reference) stormwater quality.

sampling recommendations memo from the Expert Panel and Geosyntec (Geosyntec, 2010). Although this analysis is based on concentrations and does not account for pollutant load or watershed size, monitoring locations were selected based on the goal of capturing runoff from nearly all known areas of potential anthropogenic pollutant sources within these two watersheds. In cases where the drainage areas are small, they generally include mostly paved surfaces so that runoff volumes are still significant.

The Outfall 008 and 009 watershed monitoring locations used for this BMP evaluation are shown in Table 1. The locations of the monitoring subareas listed in Table 1 are shown in the Attachment 2 map. In Table 1, each subarea is listed with its category (or data type), watershed, co-location (i.e., an alternate subarea identifier for the same location), a location description, and approximate drainage area. Potential BMP subareas include the letters “BMP” in the subarea identifier, while ISRA performance monitoring locations include the letters “SW” in the subarea identifier. At the Expert Panel’s recommendation, some ISRA and Culvert Modification (CM) performance monitoring locations are included here for BMP siting consideration, to verify/test the performance of some stormwater controls, and to verify that runoff from below an ISRA area is comparable to the runoff from above the ISRA area. NPDES compliance monitoring outfalls 008 and 009 were also included here for comparison and method testing purposes. The data summarized and their periods of record in this report are as follows:

- ISRA performance monitoring data: 12/2009 – 5/2013
- Culvert modification (CM) performance monitoring data: 12/2009 – 3/2013
- NPDES outfall monitoring data: 10/2004 – 3/2013
- Potential and active BMP subarea monitoring data: 12/2010 – 5/2013

The number of sampling event results currently available for each of the BMP subarea monitoring locations is relatively small - generally one to sixteen storms sampled depending on the location – since this program has only been in place since late December 2010, and subareas on Sage Ranch property were not sampled until March 2011. In comparison, the ISRA performance monitoring program has been in place for nearly four wet seasons[15] (2009/10, 2010/11, 2011/12, and 2012/13), so these monitoring subareas have more stormwater sample event results available. As such, where available, data from co-located ISRA subareas were combined with data from BMP subarea subareas in order to provide a more robust dataset at potential BMP locations. Additionally, the number of samples collected from subareas within the 008 watershed is considerably fewer than the number of samples collected in the 009 watershed due in part to fewer events with sufficient runoff to enable sampling. The smaller frequency of runoff in the 008 watershed is likely due to the absence of directly connected impervious areas and hardened conveyance systems (e.g., paved roads, inlets, storm drains, and lined channels). As a result, there are currently significant limitations to the available stormwater background and potential BMP subarea monitoring datasets; consequently, only a limited number of stormwater control recommendations can be made at this point based on this initial round of data for the Outfall

[15] Measured precipitation varied by wet season, with 15 inches recorded over 2009/2010, 26 inches recorded over 2010/2011, and 10 inches recorded over 2011/2012.

008 watershed. This data collection and analysis process will be updated annually for the duration of the BMP work plan schedule (presently scheduled through 2014), which will result in more robust datasets and the potential addition of new treatment control recommendations in the future.

All stormwater sampling data reported here were provided by MWH and select analytes were validated by qualified lab quality review professionals[16]. All TCDD TEQ results include Bioaccumulation Equivalency Factors (BEFs), consistent with NPDES reporting requirements (see Appendix A of the 2012 BMP Subarea Ranking Analysis memo for more information on the effects of BEFs on calculated TEQ results). For all parameters, lab results that are estimated (or "J-flagged," or results that are above the detection limit but below the reporting limit) are included in the analysis since it is the Expert Panel's view that statistical confidence in these individual results is greater than confidence in the sample summary statistics due to the limited number of data available for many locations (and it is these summary statistics that serve as the basis for the Expert Panel's BMP recommendations).

Although this analysis focuses on the identification of subareas that may require new treatment controls, the Expert Panel continues to strongly recommend the rigorous application of erosion and sediment control practices and stream channel stabilization measures throughout the 008 and 009 watersheds. The Panel also continues to recommend the stabilization of roadways and the implementation of source controls, including source removal, such as through the successful ongoing ISRA program.

This analysis follows prior reports prepared by the Panel on dioxins and metals stormwater background sources at the SSS (SSS Stormwater Expert Panel, 2010; SSS Stormwater Expert Panel, 2009), and is based on the October 2011 BMP Plan for the Outfall 008 and 009 Watersheds (MWH et al, 2011). This analysis is the most refined of several generations of alternatives that were iteratively developed and tested by the Expert Panel and Geosyntec for the selection of potential BMP locations.

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[16] Data validation is the process of evaluating data for program, method and laboratory quality control compliance, and will determine the validity and usability of the data. A Level II validation was performed on all dioxins results for the BMP monitoring program and for dioxins results above the permit limit for the performance monitoring program. In addition, validation was performed to investigate anomalous results at a Level II and validation was performed to investigate the performance of the Dekaport Cone Splitter at a Level IV. A Level II validation involves a review of field methods and a high level review of laboratory methods. The primary purpose of performing a Level II validation on the dioxin results was to address blank contamination and estimated maximum possible concentration (EMPC) values. An EMPC value is assigned to a dioxin isomer when a peak is within the retention time window of a target dioxin or furan isomer; however, at least one of the identification criteria from the method was not met for that peak. Therefore this peak cannot be positively identified as a dioxin or furan. The Level II validation process would evaluate the EMPC values and revise these values to non-detects at either the level of interference or the reporting limit, whichever is higher. A Level IV validation is a definitive evaluation of the data and involves a very detailed review of the field and laboratory processes including the raw data files used to identify and quantitate dioxins and furan. This level of validation requires the validator to reproduce a percentage of the result from the raw data files to ensure that systemic errors or errors of omission or transcription errors are not present in the final reported data.

Table 1. SSS 008 and 009 Watershed BMP Evaluation Monitoring Subareas (See Attachment 2 for Location Map)[1]

Site Identifier (and Co-location)	Subcategory	Prioritization Category	Watershed	Description	Approximate Upstream Drainage Area (ac)
A1BMP0001	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	AILF downstream - OLD	1.2
A1BMP0002 (A1SW0004)	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	CM-9 upstream toward AILF (pre-AILF asphalt removal)	6.3
A1BMP0002-A (A1SW0004)	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	CM-9 upstream toward AILF (post-AILF asphalt removal)	6.3
A1SW0002	Existing BMP Performance	Onsite SW Background	Outfall 009	Background – CM-8 upstream	2.5
A1SW0003	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	CM-8 downstream (pre-filter fabric over weir boards) - OLD	2.5
A1SW0003-A	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	CM-8 downstream (post-filter fabric over weir boards)	2.5
A1SW0005	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	CM-9 downstream (pre-filter fabric over weir boards) - OLD	16.4
A1SW0005-A	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	CM-9 downstream (post-filter fabric over weir boards)	16.4
A1SW0006	Existing BMP Performance	Onsite SW Background	Outfall 009	Background – CM-11 upstream	8.3
A1SW0007	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	CM-11 downstream (pre-filter fabric over weir boards) - OLD	8.3
A1SW0007-A	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	CM-11 downstream (post-filter fabric over weir boards)	8.3
A1SW0009	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	CM-9 downstream-underdrain outlet (pre-AILF asphalt removal, pre-filter fabric over weir boards)	16.4
A1SW0009-A	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	CM-9 downstream-underdrain outlet (post-AILF asphalt removal, pre-filter fabric over weir boards)	16.4
A1SW0009-B	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	CM-9 downstream-underdrain outlet (post-filter fabric over weir boards, post-AILF asphalt removal)	16.4
A1SW0009-C	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	CM-9 downstream-underdrain outlet (post-perforated pipe and upper basin installed)	9.9

Site Identifier (and Co-location)	Subcategory	Prioritization Category	Watershed	Description	Approximate Upstream Drainage Area (ac)
A2BMP0001	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	A2 northeast	2.3
A2BMP0002	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	A2 road runoff	3.6
A2BMP0003	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	A2 u/s of ND confluence	100
A2BMP0004	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	Helipad culvert outlet	4.2
A2BMP0005	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	A2 u/s of CM-1 confluence	35
A2SW0002 (A2BMP0007)	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	CM-1 effluent (pre-filter fabric over weir boards)	52.8
A2SW0002-A (A2BMP0007)	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	CM-1 effluent (post-filter fabric over weir boards)	52.8
A2SW0003	ISRA Performance	Onsite SW Background	Outfall 009	A2LF1 upstream	431.9
A2SW0004	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	A2 downstream	432
APBMP0001	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	Ashpile culvert/inlet road runoff	34
APSW0005	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	AP upstream	0.7
APSW0006	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	AP downstream (pre-ISRA excavation)	0.6
APSW0006-A	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	AP downstream (post-ISRA excavation)	0.6
APSW0011	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	AP downstream	1.8
APSW0012	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	AP upstream	1.6
APSW0013 (APBMP0002)	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	AP downstream	34
B1BMP0001	Existing BMP	Subarea for BMP	Outfall 009	B-1 media filter inlet (post-media filter installation)	4.5

Site Identifier (and Co-location)	Subcategory	Prioritization Category	Watershed	Description	Approximate Upstream Drainage Area (ac)
(B1SW0010)	Performance	Siting Analysis			
B1BMP0003 (B1BMP0002)	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	B-1 parking lot / road runoff to culvert inlet	5.2
B1BMP0004 (B1SW0015, B1BMP0004-5)	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	B-1 media filter inlet north	3.7
B1BMP0004-5	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	B-1 combined media filter influent	4.5
B1BMP0005 (B1SW0013, B1SW0011, B1BMP0004-5)	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	B-1 media filter inlet south	0.8
B1BMP0007	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	B-1, Lower parking lot area	47.7
B1SW0002	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	Woolsey Canyon Road runoff	1.3
B1SW0003	ISRA Performance	Onsite SW Background	Outfall 009	B-1 upstream	0.01
B1SW0004	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	B-1 downstream (pre-ISRA excavation)	0.08
B1SW0004-A	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	B-1 downstream (post-ISRA excavation)	0.08
B1SW0005	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	B-1 downstream (pre-ISRA excavation)	0.1
B1SW0005-A	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	B-1 downstream (post-ISRA excavation)	0.1
B1SW0006	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	B-1 downstream (pre-ISRA excavation)	0.54
B1SW0006-A	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	B-1 downstream (post-ISRA excavation)	0.54
B1SW0007	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	B-1 downstream	0.75
B1SW0008	ISRA Performance	Subarea for BMP	Outfall 009	B-1 upstream	0.79

Site Identifier (and Co-location)	Subcategory	Prioritization Category	Watershed	Description	Approximate Upstream Drainage Area (ac)
		Siting Analysis			
B1SW0009	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	B-1 downstream	0.84
B1SW0012	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	B-1 north road runoff - OLD	0.05
B1SW0014 (B1BMP0006)	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	B-1 culvert effluent (no media filter)	4.7
B1SW0014-A (B1BMP0006)	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	B-1 media filter effluent (pre-media filter reconstruction)	4.7
B1SW0014-B (B1BMP0006)	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	B-1 media filter effluent (post-media filter reconstruction)	4.7
B1SW0014-C (B1BMP0006)	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	B-1 media filter effluent (post-media filter reconstruction, post-curb cuts)	3.6
BGBMP0001 (A2SW0007)	Existing BMP Performance	Onsite SW Background	Outfall 009	Background - CM -1 upstream east tributary (new)	41.1
BGBMP0002 (LXSW0003)	Existing BMP Performance	Onsite SW Background	Outfall 009	Background – CM-3 upstream	17.2
BGBMP0003	Subarea for BMP Siting Analysis	Onsite SW Background	Outfall 009	Background - Sage Ranch near LOX	23.6
BGBMP0004	Subarea for BMP Siting Analysis	Onsite SW Background	Outfall 009	Background - Sage Ranch near CM-5	81.4
BGBMP0005	Subarea for BMP Siting Analysis	Onsite SW Background	Outfall 009	Background - Sage Ranch near entrance	25
BGBMP0006 (A2SW0006)	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	Background – CM-1 upstream east tributary (ponded footprint) - OLD	41.1
BGBMP0007 (LXSW0001)	Existing BMP Performance	Onsite SW Background	Outfall 009	Background – CM-3 upstream - OLD	17.2
EVBMP0001	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	ELV culvert inlet (Helipad road gutter)	1.8
EVBMP0001-A	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	ELV culvert inlet (Helipad road and ELV ditch, composite)	2.5
EVBMP0002	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	Helipad (pre-sandbag berms)	4.1

Site Identifier (and Co-location)	Subcategory	Prioritization Category	Watershed	Description	Approximate Upstream Drainage Area (ac)
EVBMP0002-A	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	Helipad (post-sandbag berms)	4.1
EVBMP0002-B	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	Helipad (post-sandbag berms raised, post-drainage holes in asphalt)	4.3
EVBMP0003 (A2SW0001)	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	CM-1 upstream west	11.8
EVBMP0004	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	2012/13 Lower Helipad Road	1.8
EVBMP0005	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	2012/13 ELV drainage ditch (pre-ELV-1C ISRA)	11
EVBMP0005-A	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	ELV drainage ditch (post-ELC-1C ISRA)	11
EVBMP0006	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	2012/13 Area II Road near ELV ditch	11
HZBMP0001 (HZSW0007)	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 008	Happy Valley downstream (pre-improvements)	21.4
HZBMP0001-A (HZSW0007)	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 008	Happy Valley downstream (post-improvements)	20.4
HZBMP0002 (HZSW0004)	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 008	DRG downstream	23.2
HZBMP0003 (HZSW0003)	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 008	DRG downstream (furthest downstream)	29.6
HZSW0001	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 008	Happy Valley downstream - OLD	<29
HZSW0002	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 008	Happy Valley downstream - OLD	<29
HZSW0005	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 008	DRG upstream	21
HZSW0006	ISRA Performance	Onsite SW Background	Outfall 008	CYN upstream	NA/small
HZSW0008	ISRA Performance	Onsite SW Background	Outfall 008	Background - Happy Valley upstream	NA/small
HZSW0009	ISRA Performance	Subarea for BMP	Outfall 008	Happy Valley downstream	0.2

Site Identifier (and Co-location)	Subcategory	Prioritization Category	Watershed	Description	Approximate Upstream Drainage Area (ac)
		Siting Analysis			
HZSW0010	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 008	Happy Valley downstream	2.2
HZSW0011	ISRA Performance	Onsite SW Background	Outfall 008	Background - Happy Valley upstream	0.1
HZSW0012	ISRA Performance	Onsite SW Background	Outfall 008	Background - Happy Valley upstream	0.4
HZSW0013	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 008	Happy Valley downstream	0.3
HZSW0014	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 008	Happy Valley upstream	0.1
HZSW0015	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 008	Happy Valley downstream	0.4
HZSW0016	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 008	Happy Valley downstream	4.8
HZSW0018	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 008	Happy Valley downstream	1.4
HZSW0019	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 008	CYN downstream	2.6
HZSW0020 (HZSW0017)	ISRA Performance	Onsite SW Background	Outfall 008	Background - Happy Valley upstream	0.2
ILBMP0001	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	Lower lot 24" stormdrain outlet	23
ILBMP0002	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	Road runoff to CM-9	2.5
ILBMP0003	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	AILF parking lot - OLD	9.5
ILSW0001	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	IEL-3 upstream	0.1
ILSW0002	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	IEL-3 downstream (pre-ISRA excavation)	0.2
ILSW0002-A	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	IEL-1 downstream (post-ISRA excavation)	0.2

Site Identifier (and Co-location)	Subcategory	Prioritization Category	Watershed	Description	Approximate Upstream Drainage Area (ac)
ILSW0003	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	IEL-2 upstream	2.4
ILSW0004	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	IEL-2 downstream (pre-ISRA excavation)	2.8
ILSW0004-A	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	IEL-2 downstream (post-ISRA excavation)	2.8
ILSW0006	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	IEL-3 downstream (pre-ISRA excavation)	0.4
ILSW0006-A	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	IEL-3 downstream (post-ISRA excavation)	0.4
LFSW0001	ISRA Performance	Onsite SW Background	Outfall 009	CTLI upstream	NA/small
LFSW0002	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	CTLI downstream (pre-ISRA excavation)	5.1
LFSW0002-A	ISRA Performance	Subarea for BMP Siting Analysis	Outfall 009	CTLI downstream (post-ISRA excavation)	5.1
LPBMP0001	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	Lower lot sheetflow (pre-gravel bag berms)	5.1
LPBMP0001-A	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	Lower lot sheetflow (post-gravel bag berms)	5.1
LPBMP0002	Existing BMP performance	Subarea for BMP Siting Analysis	Outfall 009	Lower parking lot influent to cistern	4.2
LPBMP0003	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	Lower parking lot sediment basin outlet	4.2
LPBMP0004	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	Lower parking lot biofilter outlet	4.4
LXBMP0001	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	LOX west - OLD	1.5
LXBMP0002	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	LOX mid - OLD	1.5
LXBMP0003	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	LOX east tributary - OLD	0.4
LXBMP0004	Existing BMP	Subarea for BMP	Outfall 009	LOX southwest downstream of sandbag berm	10.6

Site Identifier (and Co-location)	Subcategory	Prioritization Category	Watershed	Description	Approximate Upstream Drainage Area (ac)
	Performance	Siting Analysis			
LXBMP0005	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	LOX southeast downstream of sandbag berm	2.5
LXBMP0006	Subarea for BMP Siting Analysis	Subarea for BMP Siting Analysis	Outfall 009	LOX east, runoff along dirt road	0.43
LXSW0002	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	CM-3 downstream (pre-filter fabric over weir boards) - OLD	17.2
LXSW0002-A	Existing BMP Performance	Subarea for BMP Siting Analysis	Outfall 009	CM-3 downstream (post-filter fabric over weir boards)	17.2
Outfall 008*	NPDES	NPDES Outfall 008	Outfall 008	NPDES outfall 008	62
Outfall 009*	NPDES	NPDES Outfall 009	Outfall 009	NPDES outfall 009	536

Notes

- Gray text indicates historic subarea monitoring sites that are discontinued.
- ([1]) Sites with zero samples collected are excluded from this table.
- (*) NPDES outfall monitoring data are included in this analysis for comparison and method testing purposes only. New stormwater controls are not being contemplated at these locations.

2. DATA SUMMARY

Table 2A summarizes the various monitoring locations that were selected to be representative of stormwater background runoff quality because they represent locations that are not expected to be impacted by historic or ongoing subarea activities. Due to the varying objectives of each of the monitoring programs, not all pollutants of concern (POCs) were sampled at all subareas. For this BMP subarea ranking analysis, the POCs are defined as total suspended solids (TSS), cadmium (Cd), copper (Cu), lead (Pb), mercury (Hg), TCDD TEQ, and 2,3,7,8-TCDD because these constituents have periodically been measured at concentrations above the current NPDES permit limits at the 008 and 009 monitoring stations, with the exception of TSS and 2,3,7,8-TCDD which are without permit limits but are included here as alternative indicators of POC generation. The number of samples for each POC at each stormwater background subarea is summarized in Table 2A. These samples were collected for all events that occurred when flow was observed; few samples were collected due to little flow at many locations because of the unusually dry 2012/13 season. Table 2B provides a similar summary for the locations where control practice needs are being evaluated. A map that shows the locations of the stormwater monitoring subareas is included as Attachment 2.

Table 2A. Stormwater background locations and number of sample results for indicated parameters (locations denoted as 'OLD' were not monitored for the 2011/2012 season or the most recent 2012/2013 season)

SW Background Location (Co-location)	Description	Number of Sample Results for Indicated Parameters						
		TSS	Cd	Cu	Pb	Hg	TCDD TEQ	2,3,7,8-TCDD
A1SW0002	Background – CM-8 upstream	10	0	0	10	0	0	0
A1SW0006	Background – CM-11 upstream	12	0	0	0	0	12	12
BGBMP0001 (A2SW0007, A2BMP0006)	Background – CM-1 upstream east tributary (new)	4	4	4	4	4	4	4
BGBMP0002 (LXSW0003)	Background – CM-3 upstream	4	4	4	4	4	4	4
BGBMP0003	Background - Sage Ranch near LOX	5	5	5	5	5	5	5
BGBMP0004	Background - Sage Ranch near CM-5	3	3	3	3	3	3	3
BGBMP0005	Background - Sage Ranch near entrance	1	1	1	1	1	1	1
BGBMP0007 (LXSW0001)	Background – CM-3 upstream - OLD	7	7	7	7	7	7	7
HZSW0008	Background - Happy Valley upstream	1	0	0	1	0	1	1
HZSW0011	Background - Happy Valley upstream	2	0	2	0	0	2	2
HZSW0012	Background - Happy Valley upstream	1	0	0	1	0	0	0
HZSW0020 (HZSW0017)	Background - Happy Valley upstream	2	0	0	2	0	2	2
	Total	52	24	26	38	24	41	41

Notes

- Gray text indicates historic subarea monitoring sites that are discontinued.
- Stormwater background locations with zero samples collected are excluded from this table.

Table 2B. Locations where control practices are being evaluated and number of sample results for indicated parameters

Location (Co-Location)	Description	Number of Sample Results for Indicated Parameters						
		TSS	Cd	Cu	Pb	Hg	TCDD TEQ	2,3,7,8-TCDD
A1BMP0001	AILF downstream - OLD	5	5	5	5	4	5	5
A1BMP0002 (A1SW0004)	CM-9 upstream toward AILF (pre-AILF asphalt removal)	15	15	15	15	15	8	8
A1BMP0002-A (A1SW0004)	CM-9 upstream toward AILF (post-AILF asphalt removal)	3	3	3	3	3	2	2
A1SW0003	CM-8 downstream (pre-filter fabric over weir boards) - OLD	10	0	0	10	0	0	0
A1SW0005	CM-9 downstream (pre-filter fabric over weir boards) - OLD	10	10	10	10	10	5	5
A1SW0007	CM-11 downstream (pre-filter fabric over weir boards) - OLD	12	0	0	0	0	12	12

Location (Co-Location)	Description	Number of Sample Results for Indicated Parameters						
		TSS	Cd	Cu	Pb	Hg	TCDD TEQ	2,3,7,8-TCDD
A1SW0009-A	CM-9 downstream-underdrain outlet (post-AILF asphalt removal, pre-filter fabric over weir boards)	1	1	1	1	1	1	1
A1SW0009-B	CM-9 downstream-underdrain outlet (post-filter fabric over weir boards, post-AILF asphalt removal)	6	6	6	6	6	5	5
A2BMP0002	A2 road runoff	1	1	1	1	1	1	1
A2BMP0003	A2 u/s of ND confluence	7	7	7	7	7	7	7
A2BMP0004	Helipad culvert outlet	3	3	3	3	3	3	3
A2BMP0005	A2 u/s of CM-1 confluence	3	3	3	3	3	3	3
A2SW0002 (A2BMP0007)	CM-1 effluent (pre-filter fabric over weir boards)	16	0	0	16	0	16	16
A2SW0002-A (A2BMP0007)	CM-1 effluent (post-filter fabric over weir boards)	8	4	4	8	4	8	8
APBMP0001	Ashpile culvert/inlet road runoff	2	2	2	2	2	2	2
B1BMP0001 (B1SW0010)	B-1 media filter inlet (post-media filter installation)	1	1	1	1	1	1	1
B1BMP0003 (B1BMP0002)	B-1 parking lot / road runoff to culvert inlet	16	16	16	16	16	16	16
B1BMP0004 (B1SW0015, B1BMP0004-5)	B-1 media filter inlet north	11	11	11	11	11	11	11
B1BMP0005 (B1SW0013, B1SW0011, B1BMP0004-5)	B-1 media filter inlet south	14	14	14	14	14	14	14
B1BMP0007	B-1, Lower parking lot area	3	3	3	3	3	3	3
B1SW0002	Woolsey Canyon Road runoff	2	2	2	2	2	2	2
B1SW0008	B-1 upstream	2	2	0	0	0	2	2
B1SW0014-A (B1BMP0006)	B-1 media filter effluent (pre-media filter reconstruction)	1	1	1	1	1	1	1
B1SW0014-B (B1BMP0006)	B-1 media filter effluent (post-media filter reconstruction)	4	4	4	4	4	3	3
B1SW0014-C (B1BMP0006)	B-1 media filter effluent (post-media filter reconstruction, post-curb cuts)	6	6	6	6	6	6	6
BGBMP0006 (A2SW0006)	Background – CM-1 upstream east tributary (ponded footprint) - OLD	7	1	1	7	1	7	7
EVBMP0001	ELV culvert inlet (Helipad road gutter)	3	3	3	3	3	3	3
EVBMP0001-A	ELV culvert inlet (Helipad road and ELV ditch, composite)	5	5	5	5	5	5	5
EVBMP0002	Helipad (pre-sandbag berms)	6	6	6	6	6	6	6
EVBMP0002-A	Helipad (post-sandbag berms)	5	5	5	5	5	5	5
EVBMP0002-B	Helipad (post-sandbag berms raised, post-drainage holes in asphalt)	4	4	4	4	4	4	4
EVBMP0003	CM-1 upstream west	17	9	9	17	9	17	17

Location (Co-Location)	Description	Number of Sample Results for Indicated Parameters						
		TSS	Cd	Cu	Pb	Hg	TCDD TEQ	2,3,7,8-TCDD
(A2SW0001)								
EVBMP0004	2012/13 Lower Helipad Road	3	3	3	3	3	3	3
EVBMP0005	2012/13 ELV drainage ditch (pre-ELV-1C ISRA)	2	2	2	2	2	2	2
EVBMP0006	2012/13 Area II Road near ELV ditch	1	1	1	1	1	1	1
HZBMP0001 (HZSW0007)	Happy Valley downstream (pre-improvements)	13	6	13	13	6	12	12
HZBMP0002 (HZSW0004)	DRG downstream	3	4	4	4	4	4	4
HZBMP0003 (HZSW0003)	DRG downstream (furthest downstream)	14	6	14	14	6	14	14
HZSW0005	DRG upstream	1	0	0	0	0	1	1
HZSW0014	Happy Valley upstream	3	0	3	3	0	0	0
ILBMP0001	Lower lot 24" stormdrain outlet	16	16	16	16	16	16	16
ILBMP0002	Road runoff to CM-9	9	9	9	9	9	9	9
ILBMP0003	AILF parking lot - OLD	4	4	4	4	4	4	4
ILSW0003	IEL-2 upstream	2	2	0	2	2	0	0
ILSW0004-A	IEL-2 downstream (post-ISRA excavation)	1	1	0	1	1	0	0
LFSW0002-A	CTLI downstream (post-ISRA excavation)	3	0	3	3	0	3	3
LPBMP0001	Lower lot sheetflow (pre-gravel bag berms)	2	2	2	2	2	2	2
LPBMP0001-A	Lower lot sheetflow (post-gravel bag berms)	6	6	6	6	6	6	6
LPBMP0002	Lower parking lot influent to cistern	0	1	1	1	1	1	1
LPBMP0003	Lower parking lot sediment basin outlet	0	1	1	1	1	1	1
LPBMP0004	Lower parking lot biofilter outlet	0	1	1	1	1	1	1
LXBMP0002	LOX mid - OLD	2	2	2	2	2	2	2
LXBMP0003	LOX east tributary - OLD	6	6	6	6	6	6	6
LXBMP0004	LOX southwest downstream of sandbag berm	5	5	5	5	5	5	5
LXBMP0005	LOX southeast downstream of sandbag berm	5	5	5	5	5	5	5
LXBMP0006	LOX east, runoff along dirt road	1	1	1	1	1	1	1
LXSW0002	CM-3 downstream (pre-filter fabric over weir boards) - OLD	9	9	9	9	9	9	8

Notes

- Gray text indicates historic subarea monitoring sites that are discontinued.
- Locations where control practices are being evaluated where zero samples have been collected are excluded from this table.

Table 3A summarizes the total samples, non-detects (NDs), and J-flagged (DNQ) numbers of observations, along with the minimum, median, and maximum concentration values for each of the POCs for the complete combined stormwater background dataset. TSS values are summarized by watershed as well as combined for both watersheds. All stormwater background mercury and 2,3,7,8-TCDD results are ND. Stormwater background concentration values for POCs that are higher than current permit limits (which apply only at the NPDES compliance outfalls) are highlighted in yellow. These results confirm previous observations by the Expert Panel and others regarding natural background stormwater quality at the SSS that occasionally exceeds NPDES permit limits for some metals (including copper and lead) as well as TCDD TEQ. Table 3B provides a similar summary for all locations combined where control practices are being evaluated as well as for Outfalls 008 and 009 data.

Table 3A. Stormwater background samples (all subareas combined) – Concentrations (mg/L for TSS, µg/L otherwise)

POC	# Samples	# NDs	# DNQ	Min	Median	95th Percentile	Max	Permit Limit for OF008 & OF009	% Samples Exceeding Permit Limit
TSS - 008	6	0	3	2	17.5	74.3	76	NA	0%
TSS - 009	46	6	21	<1.0	6.5	75.3	750	NA	0%
TSS	52	6	24	<1.0	7	78.7	750	NA	0%
Cadmium	24	21	3	<0.1	<0.1	0.3	0.87	4	0%
Copper	26	0	11	1	2.4	7.3	19	14	4%
Lead	38	5	19	<0.2	0.8	14.3	64	5.2	21%
Mercury	24	24	0	<0.1	<0.1	0.1	<0.1	0.13	0%
TCDD TEQ	41	12	0	<1.0e-10	4.9E-10	3.3E-07	8.5E-07	2.80E-08	17%
2,3,7,8-TCDD	41	41	0	<5.0e-08	<8.8e-07	4.7E-06	<5.4e-06	NA	0%

Notes

- No substitution assumptions were made in the attempt to quantify NDs. For example, "< 0.20" refers to a non-detect with a detection limit of 0.20 µg/L.
- RWQCB split sample results excluded. A separate analysis will be provided in the July ISRA/BMP report to compare split results versus primary sample results.
- All data from 'PS_Trigger_Analysis.xlsx'.
- Highlighted values exceed the permit limit for that POC.
- J flagged/DNQ results are included for all POCs.
- With the exception of cadmium, which had all ND or J-flagged/estimated results, assumptions regarding the treatment of J-flag (or DNQ) results do not impact the 95th percentile stormwater background thresholds for any POC.
- Metals results shown here are for the total form only, consistent with the permit limits.

Table 3B. Locations where control practices are being evaluated (all subareas combined) – Concentrations (mg/L for TSS, µg/L otherwise)

POC	# Samples	# NDs	# DNQ	Min	Median	95th Percentile	Max	Permit Limit for OF008 & OF009	% Samples Exceeding Permit Limit
TSS - 008	34	5	8	<1.0	18	418	840	NA	0%
TSS - 009	286	34	55	<1.0	18	295	1800	NA	0%
TSS	320	39	63	<1.0	18	301	1800	NA	0%
Cadmium	245	123	107	<0.1	<0.5	0.6	1.4	4	0%
Copper	261	0	21	0.6	5.1	18.0	59	14	10%
Lead	308	26	68	<0.2	2.9	25.3	82	5.2	30%
Mercury	242	234	6	<0.1	<0.1	0.1	1.7	0.13	2%
TCDD TEQ	291	19	0	<1.0e-10	9.7E-08	1.8E-05	2.1E-04	2.8E-08	61%
2,3,7,8-TCDD	290	280	9	<2.0e-08	<1.1e-06	6.7E-06	2.2E-05	NA	3%

Notes

- No substitution assumptions were made in the attempt to quantify NDs. For example, "< 0.20" refers to a non-detect with a detection limit of 0.20 µg/L.
- RWQCB split sample results excluded. A separate analysis will be provided in the July ISRA/BMP report to compare split results versus primary sample results.
- NA = No permit limit is defined for the given POC.
- All data from 'PS_Trigger_Analysis.xlsx'.
- Highlighted values exceed the permit limit for that POC.
- J flagged/DNQ results are included for all POCs.
- With the exception of cadmium, which had all ND or J-flagged/estimated results, assumptions regarding the treatment of J-flag (or DNQ) results do not impact the 95th percentile stormwater background thresholds for any POC.
- Metals results shown here are for the total form only, consistent with the permit limits.

3. STORMWATER BACKGROUND SAMPLE DATA SUMMARY – PARTICULATE STRENGTH

Particulate strength (PS) is a means to normalize stormwater pollutant concentrations by TSS and also indicate the treatability of the constituents. Normalizing pollutant concentrations by TSS is helpful for evaluating locations that have high POC concentrations in the runoff as a result of high TSS concentrations[17]. This is especially true for the POCs that are highly associated with particulates and are not found in significant quantities in dissolved forms. This normalization with TSS was performed here to help identify critical POC source areas that may otherwise have mass discharges diluted by large flows. PS is computed as total POC concentration minus dissolved POC concentration divided by TSS concentration, or the estimated particulate POC mass per mass of suspended solids. PS values have

[17] By applying particulate strengths, the Panel is not suggesting that stormwater at SSS be regulated using such metrics, but rather the Panel is recommending the use of this solely as a diagnostic metric for the identification of source areas and for the ranking of potential BMP monitoring subareas for placement of new stormwater controls.

been previously used by the Expert Panel to assess sources of metals in SSS NPDES outfall compliance monitoring data (SSFL Stormwater Expert Panel, 2009).

Calculations of PS are complicated by the fact that some of the dissolved metal data are not available (e.g., for ISRA samples since this monitoring program does not include analyses for dissolved metals); therefore procedures were established to make assumptions in lieu of missing information. These procedures also address situations where total, dissolved, or TSS results are not detected (ND, below the detection limit as reported by the analytical laboratory). The procedure used to calculate PS is described in Section 3 of the 2012 BMP Subarea Ranking Analysis memo (Santa Susana Site Surface Water Expert Panel and Geosyntec Consultants, 2012).

Dissolved metals were only analyzed at 6 of the 12 sampled stormwater background monitoring locations since the other 6 locations are ISRA performance (upstream) sample locations. Therefore, to obtain PS estimates for the ISRA stormwater background locations, dissolved concentrations were estimated by assuming that dissolved fractions (i.e., percentage of the total metal concentration) for each sample was equal to the average dissolved fraction at Outfalls 008 or 009. Dissolved concentrations were then estimated for ISRA stormwater background subareas based on the watershed in which each subarea is located. This methodology was not necessary for the stormwater background subareas, since dissolved metal measurements were available for those locations.

Only samples at Outfalls 008 and 009, where both the total and dissolved concentrations were detectable, were used to determine the average dissolved fractions. These average dissolved fractions used in the PS calculations are shown in Table 4. TCDD TEQ and 2,3,7,8-TCDD are assumed to have a dissolved fraction of zero because of their extremely low solubility and high affinity for solids. Dissolved cadmium was detected once at a single sampling event in the Outfall 008 watershed. At the recommendation of the Expert Panel, the average dissolved fraction of cadmium in the Outfall 008 watershed was computed using the detection limits of the total cadmium analyses as a conservative estimate for dissolved cadmium. Future data will include additional dissolved and total analyses for these metals and these fractions will then be re-evaluated during the subsequent annual subarea ranking analyses.

Table 4. Average dissolved fraction of POCs based on all available monitoring data in defined watershed; used in determination of particulate strength when dissolved POC not measured (e.g., ISRA and CM performance monitoring datasets)

POC	Outfall 008			Outfall 009		
	% Dissolved	# Samples	CV	% Dissolved	# Samples	CV
Copper	58	24	0.48	59	192	0.42
Lead	22	12	0.82	16	161	0.86
Cadmium	40	19	NA	54	26	0.41

Notes

- CV = Coefficient of variation
- # samples = samples with both total and dissolved detected and total > dissolved (results with total < dissolved were excluded from the analysis)
- Only one sample in the Outfall 008 watershed was analyzed for dissolved cadmium as of May 2013. Dissolved fraction was estimated based on the detection limits of the total cadmium analyses.

Stormwater background sample PS estimates were computed for the POCs using the method described above. Results are shown in Table 5 for all stormwater background data combined. The 95th percentile and maximum values are generally unaffected by the ND or missing dissolved data assumptions that were made for the PS estimates.

Table 5. Stormwater background results - particulate strength (mg/kg)

POC	# PS results	# NDs	Min	Median	95th Percentile	Max
Cadmium	23	21	ND	ND	ND	11
Copper	21	0	0	79	310	630
Mercury	24	24	ND	ND	ND	ND
Lead	37	5	ND	67	240	340
TCDD TEQ	41	12	ND	5.8E-08	2.9E-05	4.8E-05
TCDD TEQ_NoDNQ	41	34	ND	ND	1.0E-08	1.9E-08
2,3,7,8-TCDD	41	41	ND	ND	ND	ND

Notes

- Cells with ND refer to values based on total concentration non-detect results.
- RWQCB split sample results excluded
- All data from 'PS_Trigger_Analysis.xlsx'
- # NDs reflect the number of non-detects in the total concentration.
- Particulate strength computation: PS = (Total concentration – Dissolved concentration) / Total Suspended Solids
- Five copper samples were reported as having dissolved concentrations greater than total concentrations. These samples were omitted from the analysis.
- One lead sample was reported as having dissolved concentrations greater than total concentrations. This sample was omitted from the analysis.

4. DATA SUMMARY CHARTS

To allow for a visual and probabilistic comparison of the available stormwater sampling data, Figures 2 through 11 show probability plots of the POCs at locations grouped into the following categories:

- Stormwater background
- Potential BMP subarea
- Outfall 008 (for comparison)
- Outfall 009 (for comparison)
  Note: Outfall 008 and 009 results have been separated into pre-2009 and post-2009. Pre-2009 results represent grab samples and post-2009 results represent flow-weighted composite samples.

The x-axes show POC concentrations or PS and the y-axes show the probability of non-exceedance (or probability that values are below) the given x-axis values. The Cunnane equation (Helsel and Hirsch, 1992) was used to compute the plotting positions, and a best-fit line (assuming a lognormal distribution) is shown for the stormwater background data. Note that non-detect results were included in computing the plotting positions, but are not actually plotted (the other data observations are offset in their plotting position to appropriately consider the non-detect data in order to accurately estimate probability values). In general, these plots show that stormwater background concentrations frequently exceed[18] NPDES permit limits for lead (~18% probability) and TCDD TEQ (~18% probability, although this estimated probability is zero when DNQ results are excluded), and infrequently for copper (~1% probability), but do not exceed the NPDES permit limits for cadmium. The 2,3,7,8-TCDD charts show very few data points because this congener is so rarely detected. Also, most of these 2,3,7,8-TCDD detections are lab estimates (i.e., DNQ) and not quantified at high reliability values. 2,3,7,8-TCDD was also never detected in a stormwater background sample. Furthermore, **dioxin congener DNQ results are included for this analysis in contrast to NPDES reporting practice which does not include DNQs, therefore the NPDES outfall results that are shown above the permit limit here do not reflect past NPDES exceedances at concentrations shown.**

Figure 1 provides a key for the POC probability charts. The yellow-orange area includes observations that were less than background conditions, but still exceeded the permit limits. The blue area includes observations that were less than both the stormwater background best-fit line and the permit limit. The red area includes data that exceeded both the stormwater background conditions and permit limits, while the purple area includes observations that exceeded the stormwater background conditions but not the permit limits. Fundamentally, the question is which subareas most likely contribute to downstream permit limit exceedances as a result of elevated POC concentrations that are most likely due to particulate strengths that are above subarea-specific background levels? These subareas will be

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[18] The term "exceed" is being used here as a statistical term only of the likely probability of occurrence. It is only accurate if the data perfectly matched the statistical distribution, which is rare. It indicates values that are greater than a given threshold. It is not intended to have regulatory or non-compliance implications. This is particularly true for TCDD TEQ data which include DNQ results here for statistical analysis purposes, in contrast to NPDES compliance assessment procedures, which require greater reliability for reporting and do not include DNQ results.

identified by potential BMP subarea stormwater sampling results that fall to the right of the Permit limit in the concentration chart (red and orange areas) **and** fall to the right of the stormwater background best-fit line on the particulate strength chart (in the purple and red areas), or in other words, those samples and subareas which may contribute to downstream permit limit exceedances but their elevated POC concentrations are most likely due to particulate strengths that are above subarea-specific stormwater background levels. As will be discussed later in this report, the subareas with data that fall within the red area will receive the highest scores for prioritizing subareas for new or enhanced stormwater controls. Depending on the results for other POCs at an evaluation location, data within the purple and yellow-orange areas may also become a factor in prioritizing potential BMP subareas.

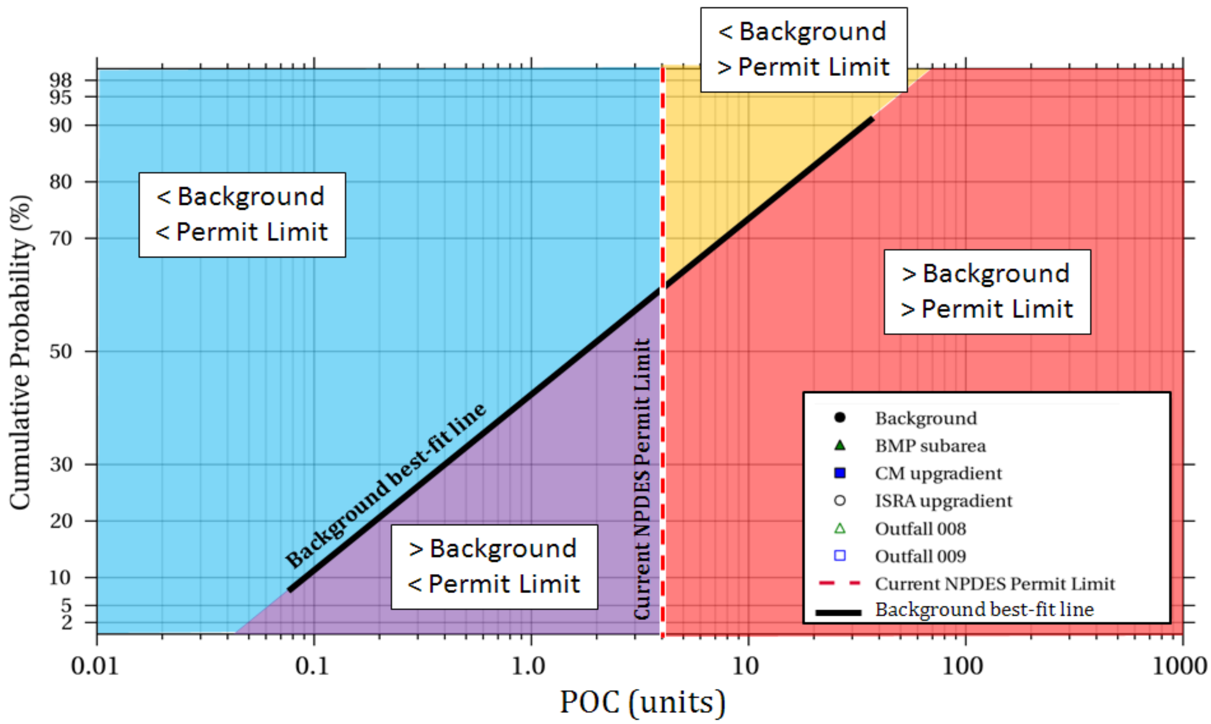

Figure 1. Probability plot key

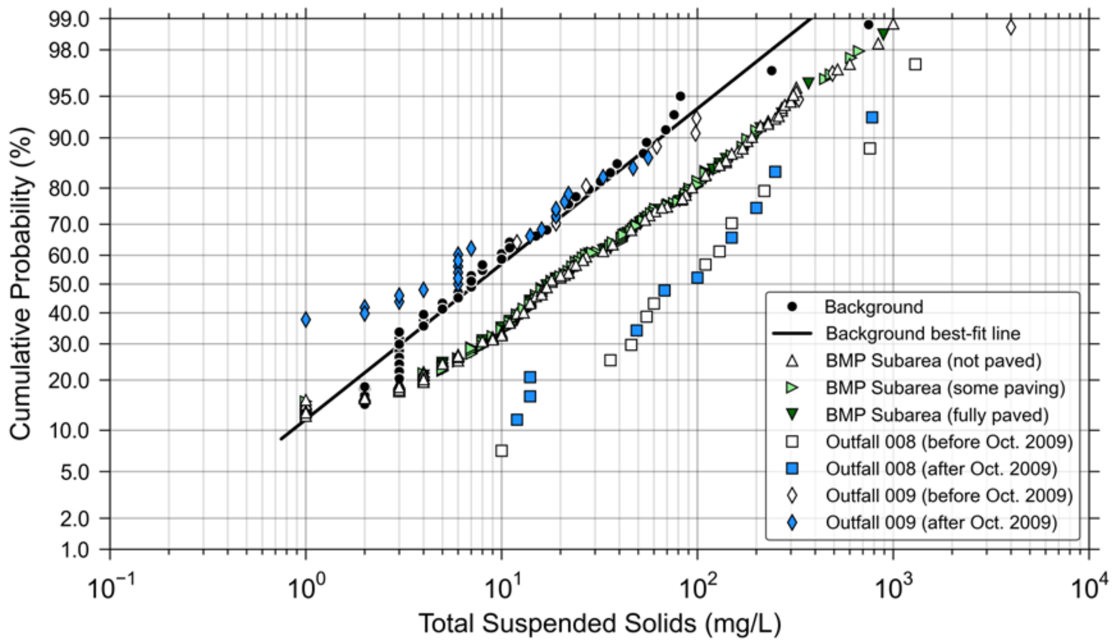

Figure 2. Probability plot for TSS concentrations[19]

[19] Note: Following the 2005 wildfire, an uncharacteristically high TSS value (4000 mg/L) was measured at Outfall 009 on 10/17/2005. This data point is shown near the upper right corner of Figure 2.

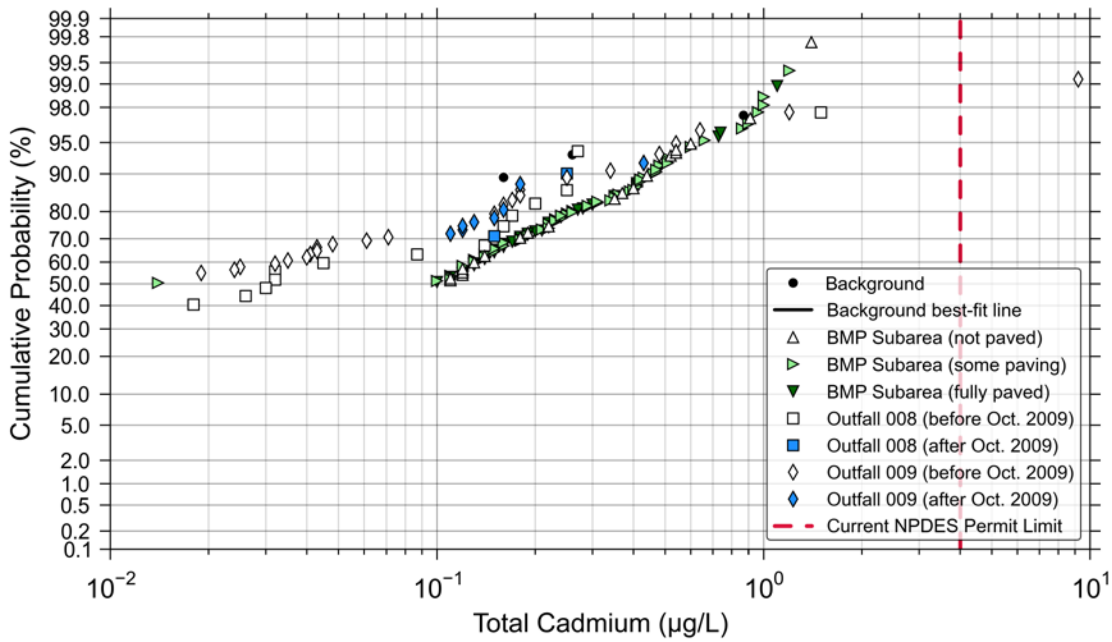

Figure 3. Probability plot for cadmium concentrations[20, 21]

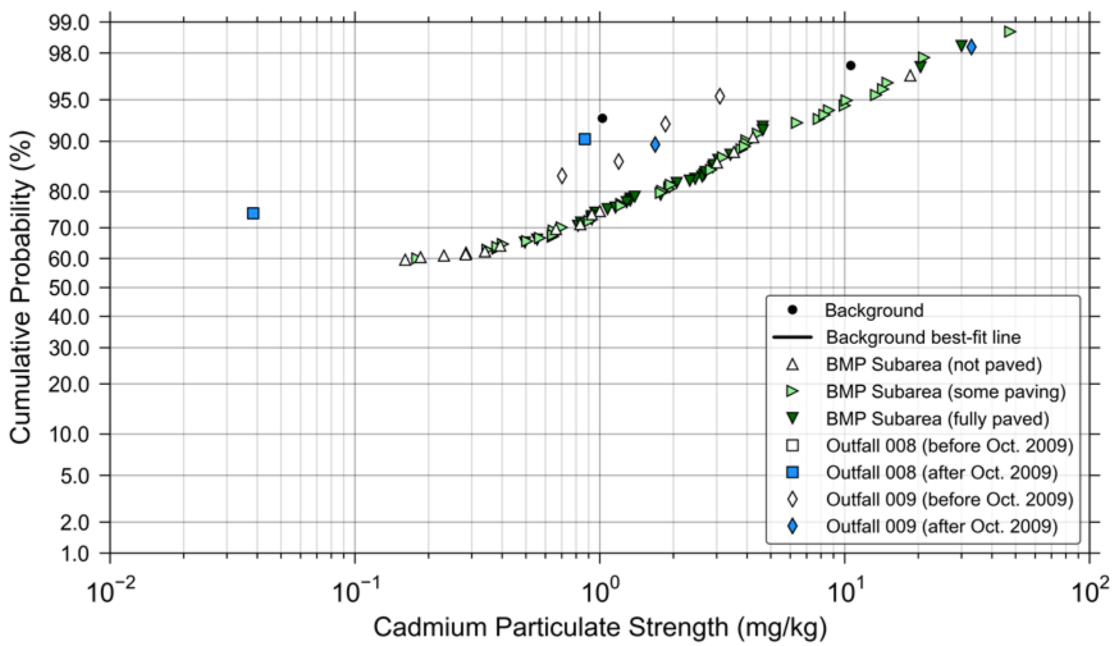

Figure 4. Probability plot for cadmium particulate strengths

[20] Following the 2005 wildfires, an uncharacteristically high cadmium concentration (9.2 µg/L) was measured at Outfall 009 on 10/17/2005. This data point is shown in the upper right corner of Figure 3.

[21] A background best-fit line was not provided for total cadmium due to the limited number of detected results.

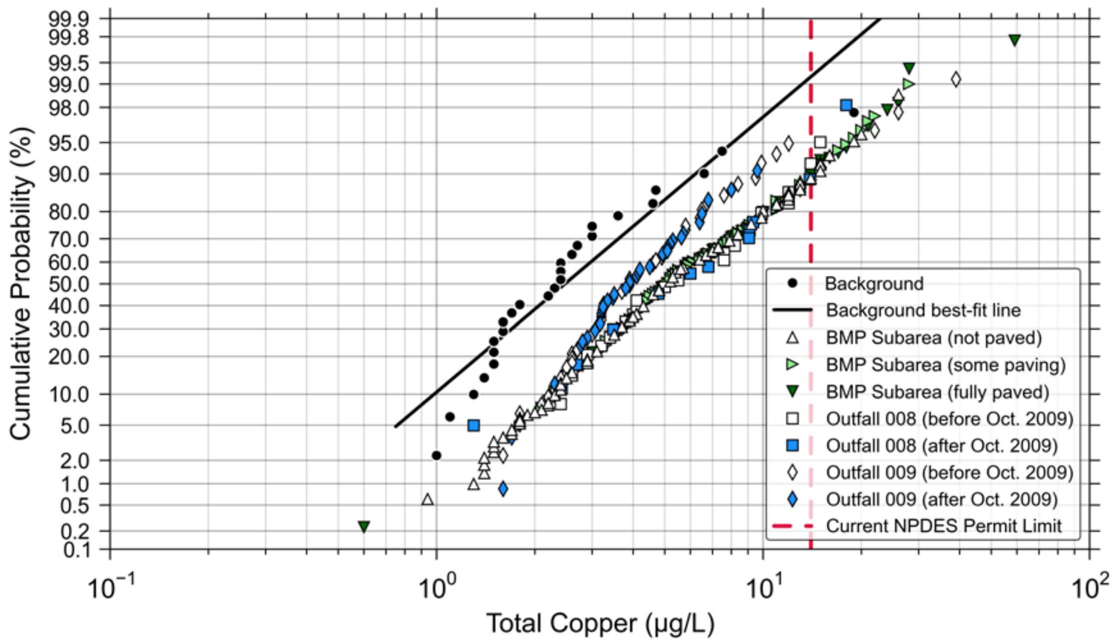

Figure 5. Probability plot for copper concentrations[22]

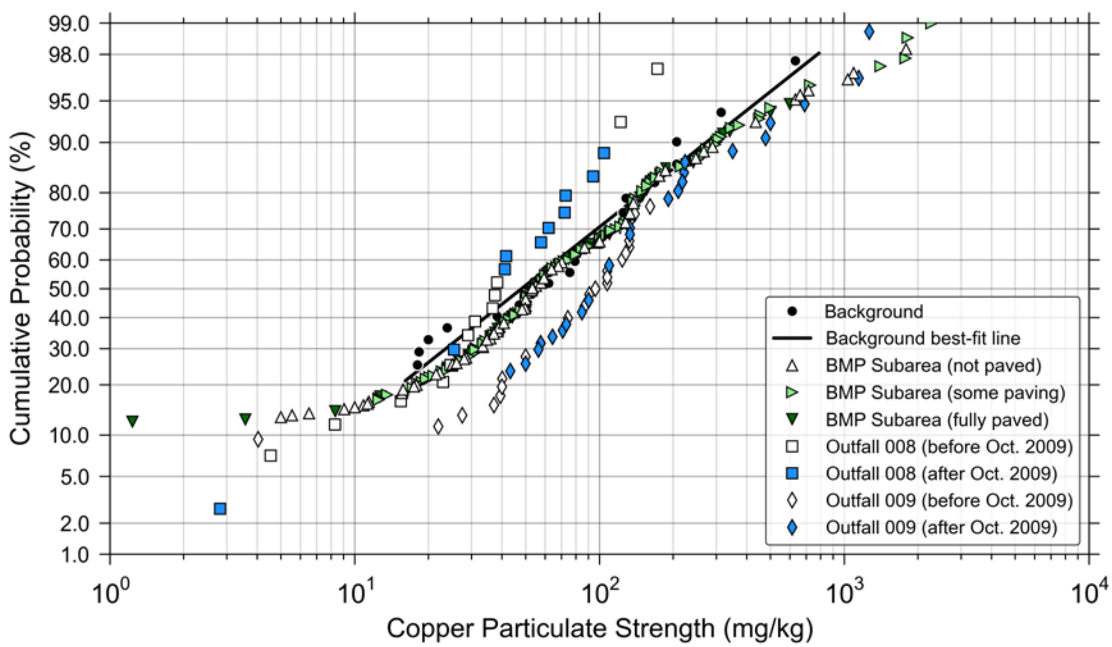

Figure 6. Probability plot for copper particulate strengths

[22] Following the 2005 wildfires, an uncharacteristically high copper concentration (212 μg/L) was measured at Outfall 009 on 10/17/2005. This data point is shown near the upper right corner of Figure 5.

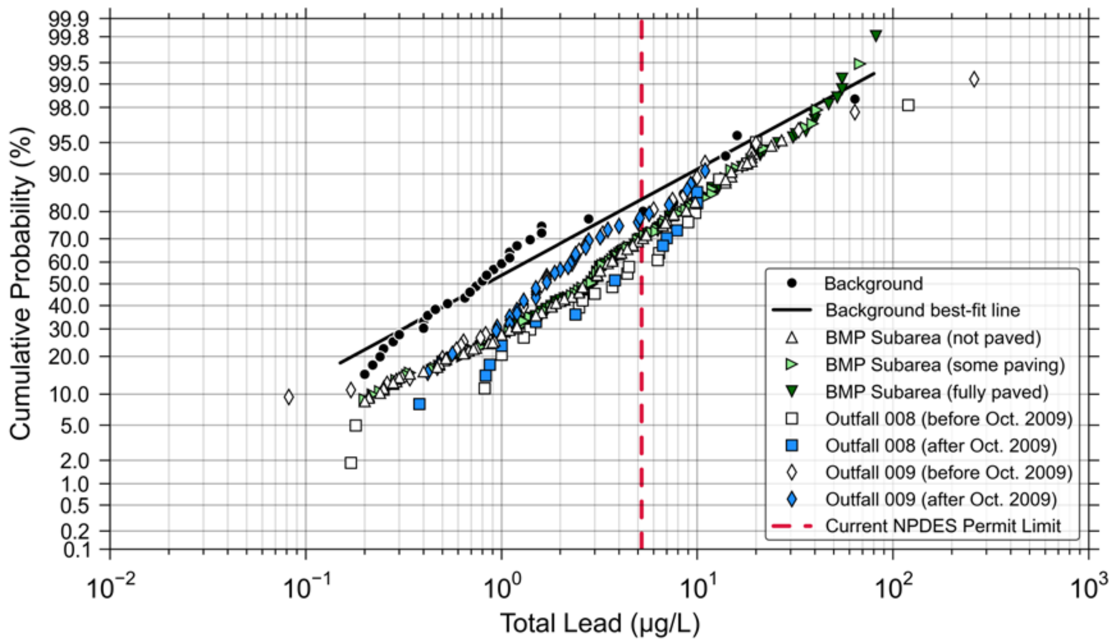

Figure 7. Probability plot for lead concentrations[23]

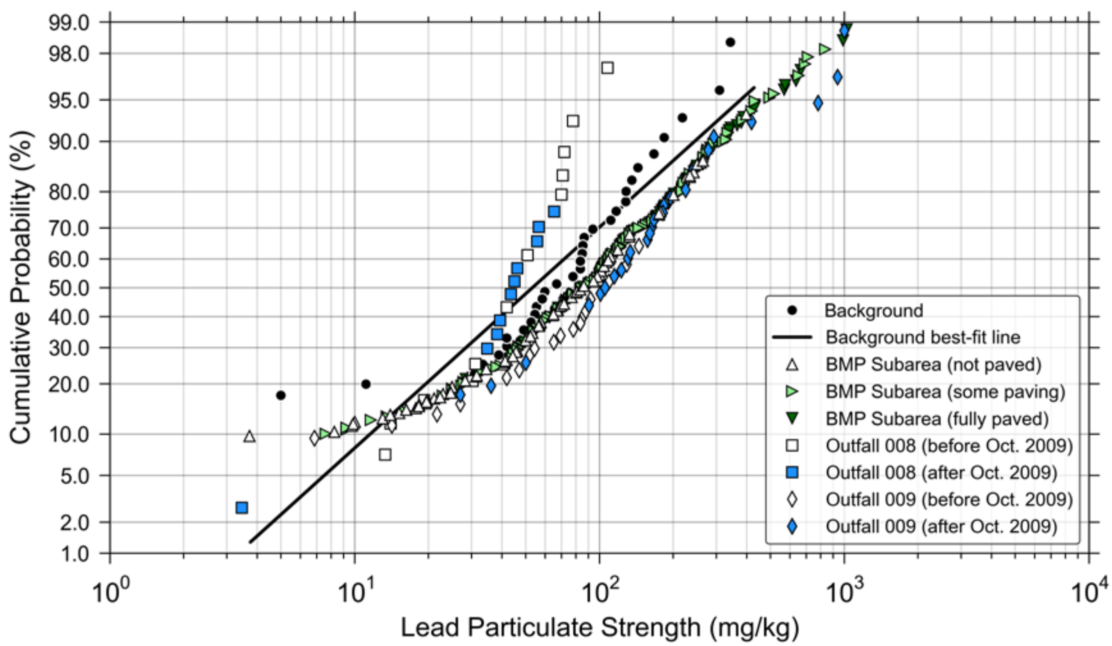

Figure 8. Probability plot for lead particulate strengths

[23] Following the 2005 wildfires, an uncharacteristically high lead concentration (260 µg/L) was measured at Outfall 009 on 10/17/2005. This data point is shown near the upper right corner of Figure 7.

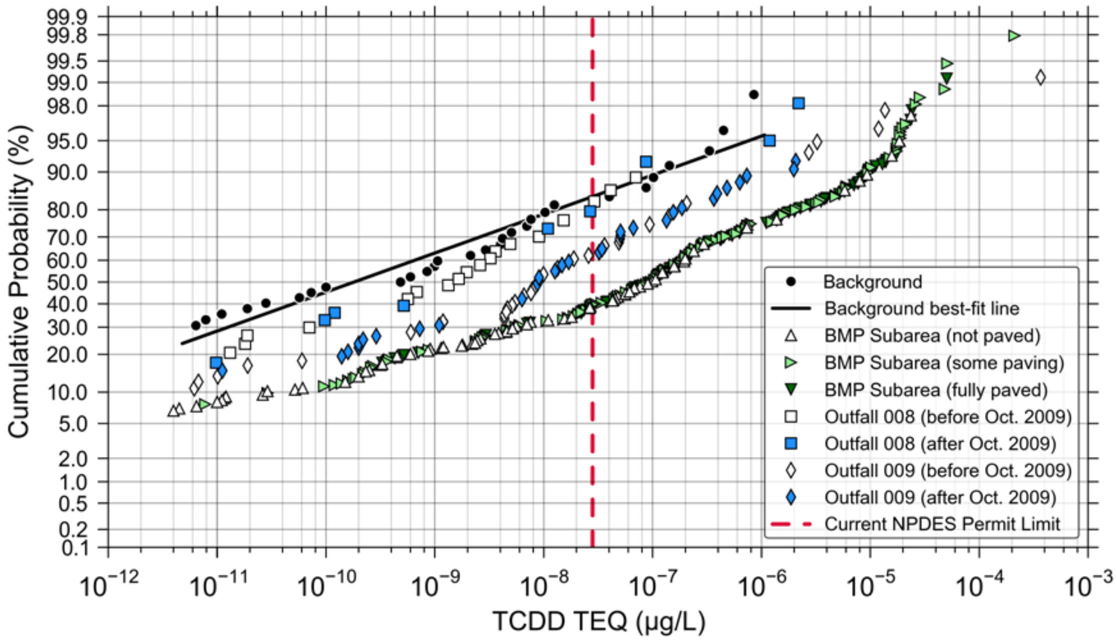

Figure 9. Probability plot for TCDD TEQ concentrations[24]

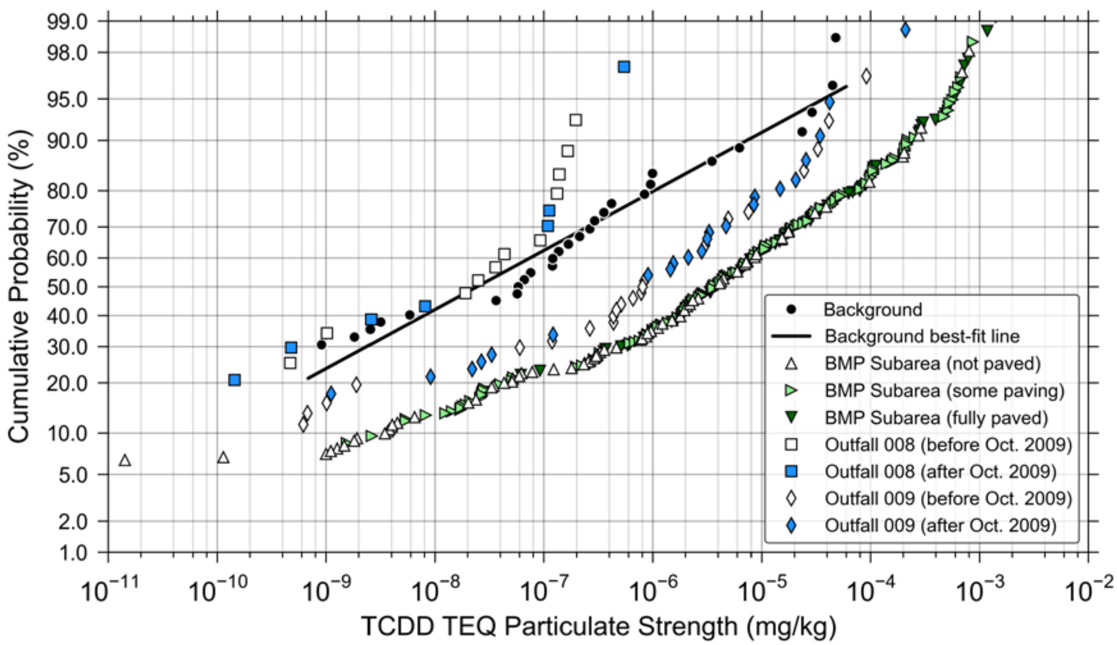

Figure 10. Probability plot for TCDD TEQ particulate strengths

[24] Following the 2005 wildfires, an uncharacteristically high TCDD TEQ concentration (3.6×10^{-4} µg/L) was measured at Outfall 009 on 10/17/2005. This data point is shown in the upper right corner of Figure 9.

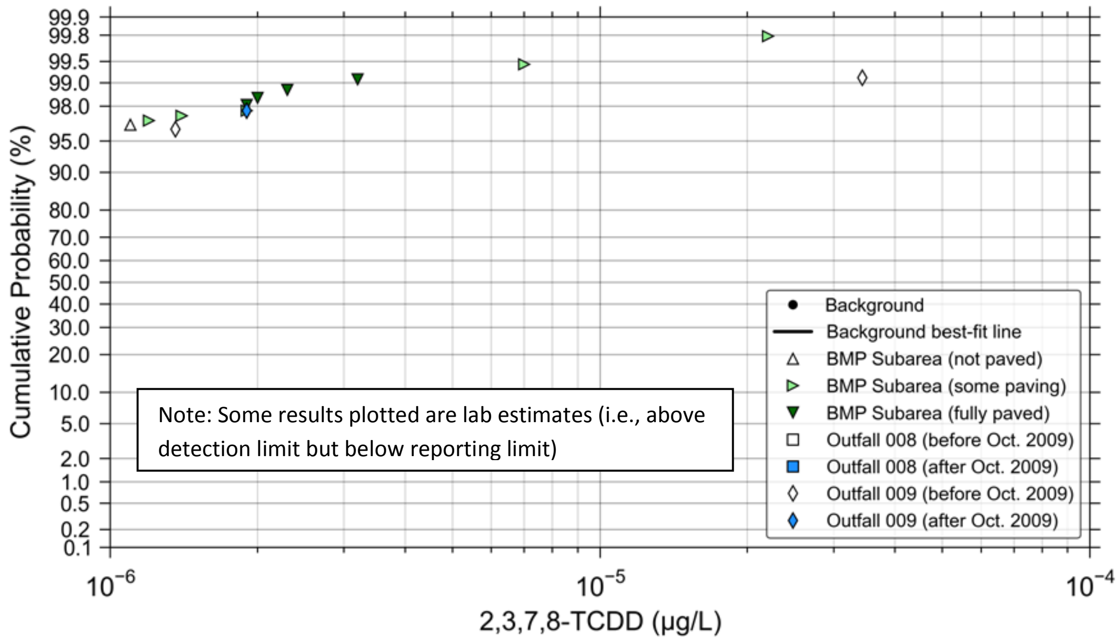

Figure 11. Probability plot for 2,3,7,8-TCDD concentrations[25]

[25] Following the 2005 wildfires, an uncharacteristically high 2,3,7,8-TCDD concentration (3.4×10^{-5} µg/L) was measured at Outfall 009 on 10/17/2005. This data point is shown in the upper right corner of Figure 11.

5. SUBAREA RANKING ANALYSIS

Subareas were ranked based on the results of comparisons between (a) stormwater concentrations and permit limits, and (b) stormwater particulate strengths and stormwater background particulate strengths to identify potential stormwater control locations. A statistical methodology was developed to rank the subareas based on these comparison results, while accounting for the number of useable data available at each subarea as well as number of data observations that fall above these thresholds (i.e., reflecting statistical confidence in how frequently each subarea will exceed the comparison thresholds). This methodology relies on "weighting factors" that are calculated for each POC for each subarea. The potential BMP subareas have been weighted based on general guidelines for small sample sets. The weighting methodology is described in more detail in Section 5 of the 2012 BMP Subarea Ranking Analysis Memo (Santa Susana Site Surface Water Expert Panel and Geosyntec Consultants, 2012).

In the end, the pollutant-specific weighting factors are summed to produce a multi-constituent score to allow for relative ranking amongst the potential BMP subareas. The highest ranked subareas are then recommended for consideration for new or enhanced stormwater control placement. In the case of ties, the average of the ranks is assigned to both subareas. Results for each BMP subarea and background monitoring subarea are summarized in Tables 6, 7, and 8 (subareas are organized by weight, ranked highest to lowest) and illustrated in Attachments 3 and 4.

Table 6. Metals Weighting Factor Results, by Subarea

Rank	Potential BMP Subarea (Co-location)	Watershed	Description	Maximum Metal Score
1	ILBMP0002[a]	Outfall 009	Road runoff to CM-9	0.95
2	EVBMP0004[b]	Outfall 009	2012/13 Lower Helipad Road	0.89
3	EVBMP0003 (A2SW0001)[a]	Outfall 009	CM-1 upstream west	0.89
4	A1SW0009-A	Outfall 009	CM-9 downstream-underdrain outlet (post-AILF asphalt removal, pre-filter fabric over weir boards)	0.75
5	APBMP0001[b]	Outfall 009	Ashpile culvert/inlet road runoff	0.69
10	B1SW0002[a]	Outfall 009	Woolsey Canyon Road runoff	0.50
10	LXBMP0004	Outfall 009	LOX southwest downstream of sandbag berm	0.50
10	LXBMP0006	Outfall 009	LOX east, runoff along dirt road	0.50
10	EVBMP0006[b]	Outfall 009	2012/13 Area II Road near ELV ditch	0.50
10	B1SW0014-A (B1BMP0006)	Outfall 009	B-1 media filter effluent (pre-media filter reconstruction)	0.50
10	B1BMP0001 (B1SW0010)	Outfall 009	B-1 media filter inlet (post-media filter installation)	0.50
10	HZSW0020 (HZSW0017)	Outfall 008	Background - Happy Valley upstream	0.50
10	LPBMP0001	Outfall 009	Lower lot sheetflow (pre-gravel bag berms)	0.50
10	LPBMP0002[a]	Outfall 009	Lower parking lot influent to cistern	0.50
15.5	EVBMP0002[a]	Outfall 009	Helipad (pre-sandbag berms)	0.39
15.5	A1SW0009-B	Outfall 009	CM-9 downstream-underdrain outlet (post-filter fabric over weir boards, post-AILF asphalt removal)	0.39

Rank	Potential BMP Subarea (Co-location)	Watershed	Description	Maximum Metal Score
17.5	EVBMP0001-A [b]	Outfall 009	ELV culvert inlet (Helipad road and ELV ditch, composite)	0.38
17.5	A1BMP0001[a]	Outfall 009	AILF downstream - OLD	0.38
19	A1BMP0002-A (A1SW0004) [a]	Outfall 009	CM-9 upstream toward AILF (post-AILF asphalt removal)	0.34
21	EVBMP0005 [b]	Outfall 009	2012/13 ELV drainage ditch (pre-ELV-1C ISRA)	0.31
21	LXBMP0002	Outfall 009	LOX mid - OLD	0.31
21	HZSW0011	Outfall 008	Background - Happy Valley upstream	0.31
23	ILBMP0001 [b]	Outfall 009	Lower lot 24" stormdrain outlet	0.19
26	EVBMP0001 [b]	Outfall 009	ELV culvert inlet (Helipad road gutter)	0.11
26	BGBMP0004	Outfall 009	Background - Sage Ranch near CM-5	0.11
26	LFSW0002-A	Outfall 009	CTLI downstream (post-ISRA excavation)	0.11
26	A2BMP0004 [b]	Outfall 009	Helipad culvert outlet	0.11
26	A2BMP0005 [b]	Outfall 009	A2 u/s of CM-1 confluence	0.11
29	B1BMP0004 (B1SW0015, B1BMP0004-5) [a]	Outfall 009	B-1 media filter inlet north	0.07
30	LXBMP0005	Outfall 009	LOX southeast downstream of sandbag berm	0.05
32.5	B1SW0014-B (B1BMP0006)	Outfall 009	B-1 media filter effluent (post-media filter reconstruction)	0.04
32.5	EVBMP0002-B[a b]	Outfall 009	Helipad (post-sandbag berms raised, post-drainage holes in asphalt)	0.04
32.5	BGBMP0001 (A2SW0007, A2BMP0006)[a]	Outfall 009	Background – CM-1 upstream east tributary (new)	0.04
32.5	BGBMP0002[a] (LXSW0003)	Outfall 009	Background – CM-3 upstream	0.04
35	A2SW0002-A (A2BMP0007)	Outfall 009	CM-1 effluent (post-filter fabric over weir boards)	0.04
36	BGBMP0006 (A2SW0006) [a]	Outfall 009	Background – CM-1 upstream east tributary (ponded footprint) - OLD	0.03
37.5	LXBMP0003[a]	Outfall 009	LOX east tributary - OLD	0.02
37.5	LPBMP0001-A	Outfall 009	Lower lot sheetflow (post-gravel bag berms)	0.02
40.5	EVBMP0002-A[a b]	Outfall 009	Helipad (post-sandbag berms)	0.01
40.5	A2BMP0003 [b]	Outfall 009	A2 u/s of ND confluence	0.01
40.5	A2SW0002 (A2BMP0007)	Outfall 009	CM-1 effluent (pre-filter fabric over weir boards)	0.01
40.5	BGBMP0007 (LXSW0001)	Outfall 009	Background – CM-3 upstream - OLD	0.01
43	A1SW0002	Outfall 009	Background – CM-8 upstream	0.01
44	LXSW0002	Outfall 009	CM-3 downstream (pre-filter fabric over weir boards) - OLD	0.00
45.5	A1SW0003	Outfall 009	CM-8 downstream (pre-filter fabric over weir boards) - OLD	0.00
45.5	A1SW0005	Outfall 009	CM-9 downstream (pre-filter fabric over weir boards) - OLD	0.00
47	B1BMP0003 (B1BMP0002)	Outfall 009	B-1 parking lot / road runoff to culvert inlet	0.00
48	A1BMP0002 (A1SW0004)[a]	Outfall 009	CM-9 upstream toward AILF (pre-AILF asphalt removal)	0.00

Rank	Potential BMP Subarea (Co-location)	Watershed	Description	Maximum Metal Score
49	B1BMP0005 (B1SW0013, B1SW0011, B1BMP0004-5)[a]	Outfall 009	B-1 media filter inlet south	0.00
50	HZBMP0001 (HZSW0007)	Outfall 008	Happy Valley downstream (pre-improvements)	0.00
51.5	HZBMP0003 (HZSW0003)	Outfall 008	DRG downstream (furthest downstream)	0.00
51.5	Outfall 008**	Outfall 008	NPDES outfall 008	0.00
63	Outfall 009**	Outfall 009	NPDES outfall 009	0.00
63	A1SW0007	Outfall 009	CM-11 downstream (pre-filter fabric over weir boards) - OLD	0.00
63	A2BMP0002	Outfall 009	A2 road runoff	0.00
63	HZSW0005	Outfall 008	DRG upstream	0.00
63	HZSW0008	Outfall 008	Background - Happy Valley upstream	0.00
63	HZBMP0002 (HZSW0004)	Outfall 008	DRG downstream	0.00
63	HZSW0012	Outfall 008	Background - Happy Valley upstream	0.00
63	HZSW0014	Outfall 008	Happy Valley upstream	0.00
63	BGBMP0005	Outfall 009	Background - Sage Ranch near entrance	0.00
63	A1SW0006[a]	Outfall 009	Background – CM-11 upstream	0.00
63	BGBMP0003	Outfall 009	Background - Sage Ranch near LOX	0.00
63	ILBMP0003	Outfall 009	AILF parking lot - OLD	0.00
63	B1SW0008	Outfall 009	B-1 upstream	0.00
63	ILSW0003[a]	Outfall 009	IEL-2 upstream	0.00
63	ILSW0004-A	Outfall 009	IEL-2 downstream (post-ISRA excavation)	0.00
63	B1BMP0007	Outfall 009	B-1, Lower parking lot area	0.00
63	B1SW0014-C (B1BMP0006)	Outfall 009	B-1 media filter effluent (post-media filter reconstruction, post-curb cuts)	0.00
63	LPBMP0003	Outfall 009	Lower parking lot sediment basin outlet	0.00
63	LPBMP0004	Outfall 009	Lower parking lot biofilter outlet	0.00

Notes

- Potential BMP subareas sorted by maximum weight for the POC group, computed as described in Section 5.
- ([a]) These potential BMP subarea monitoring subareas are upstream of existing stormwater quality treatment controls
- ([b])These potential BMP subarea monitoring subareas have new planned (i.e., designed and ready for construction) stormwater quality treatment controls.
- (**)NPDES outfalls are included for comparison and method testing purposes only; stormwater controls are not being contemplated at these locations.
- The rounding of weights may account for similar weights being ranked differently.
- **Bolded** locations indicate that both the metals NPDES permit limit and 95th percentile background particulate strength threshold were exceeded (for at least one metals POC).
- Gray text indicates historic subarea monitoring sites that are discontinued.
- Sites with zero samples collected are excluded from this table.

Table 7. Dioxins Weighting Factor Results, by Subarea

Rank	Potential BMP Subarea (Co-location)	Watershed	Description	Maximum Dioxins Score
1	EVBMP0003 (A2SW0001)[a]	Outfall 009	CM-1 upstream west	1.00[c]
2	B1BMP0004 (B1SW0015, B1BMP0004-5)[a]	Outfall 009	B-1 media filter inlet north	0.99
3	LPBMP0001-A	Outfall 009	Lower lot sheetflow (post-gravel bag berms)	0.98
4	B1BMP0003 (B1BMP0002)	Outfall 009	B-1 parking lot / road runoff to culvert inlet	0.97
5	B1BMP0005 (B1SW0013, B1SW0011, B1BMP0004-5)	Outfall 009	B-1 media filter inlet south	0.96
6	ILBMP0002[a]	Outfall 009	Road runoff to CM-9	0.95[c]
7	EVBMP0001-A [b]	Outfall 009	ELV culvert inlet (Helipad road and ELV ditch, composite)	0.95
8	ILBMP0001 [b]	Outfall 009	Lower lot 24" stormdrain outlet	0.94
9	EVBMP0005 [b]	Outfall 009	2012/13 ELV drainage ditch (pre-ELV-1C ISRA)	0.94
10	EVBMP0002[a b]	Outfall 009	Helipad (pre-sandbag berms)	0.93
11	B1SW0008	Outfall 009	B-1 upstream	0.69
12	A2BMP0005 [b]	Outfall 009	A2 u/s of CM-1 confluence	0.66
13	A2SW0002 (A2BMP0007)	Outfall 009	CM-1 effluent (pre-filter fabric over weir boards)	0.57
21	APBMP0001 [b]	Outfall 009	Ashpile culvert/inlet road runoff	0.50
21	B1SW0002[a]	Outfall 009	Woolsey Canyon Road runoff	0.50
21	A1SW0009-B	Outfall 009	CM-9 downstream-underdrain outlet (post-filter fabric over weir boards, post-AILF asphalt removal)	0.50
21	B1SW0014-B (B1BMP0006)	Outfall 009	B-1 media filter effluent (post-media filter reconstruction)	0.50
21	B1BMP0001 (B1SW0010)	Outfall 009	B-1 media filter inlet (post-media filter installation)	0.50
21	LXBMP0006	Outfall 009	LOX east, runoff along dirt road	0.50
21	A1BMP0002-A (A1SW0004)[a]	Outfall 009	CM-9 upstream toward AILF (post-AILF asphalt removal)	0.50
21	A1SW0009-A	Outfall 009	CM-9 downstream-underdrain outlet (post-AILF asphalt removal, pre-filter fabric over weir boards)	0.50
21	LPBMP0002[a]	Outfall 009	Lower parking lot influent to cistern	0.50
21	EVBMP0006 [b]	Outfall 009	2012/13 Area II Road near ELV ditch	0.50
21	LPBMP0003	Outfall 009	Lower parking lot sediment basin outlet	0.50
21	B1SW0014-A (B1BMP0006)	Outfall 009	B-1 media filter effluent (pre-media filter reconstruction)	0.50
21	LFSW0002-A	Outfall 009	CTLI downstream (post-ISRA excavation)	0.50
21	LPBMP0001	Outfall 009	Lower lot sheetflow (pre-gravel bag berms)	0.50
21	LXBMP0002	Outfall 009	LOX mid - OLD	0.50
29	B1SW0014-C	Outfall 009	B-1 media filter effluent (post-media filter	0.39

Rank	Potential BMP Subarea (Co-location)	Watershed	Description	Maximum Dioxins Score
	(B1BMP0006)		reconstruction, post-curb cuts)	
30	EVBMP0002-B[a b]	Outfall 009	Helipad (post-sandbag berms raised, post-drainage holes in asphalt)	0.36
31.5	EVBMP0004 [b]	Outfall 009	2012/13 Lower Helipad Road	0.34
31.5	A2BMP0004 [b]	Outfall 009	Helipad culvert outlet	0.34
33.5	EVBMP0002-A[a b]	Outfall 009	Helipad (post-sandbag berms)	0.17
33.5	LXBMP0005	Outfall 009	LOX southeast downstream of sandbag berm	0.17
36	B1BMP0007	Outfall 009	B-1, Lower parking lot area	0.11
36	EVBMP0001 [b]	Outfall 009	ELV culvert inlet (Helipad road gutter)	0.11
36	BGBMP0004	Outfall 009	Background - Sage Ranch near CM-5	0.11
38	A2SW0002-A (A2BMP0007)	Outfall 009	CM-1 effluent (post-filter fabric over weir boards)	0.11
39	A2BMP0003 [b]	Outfall 009	A2 u/s of ND confluence	0.09
40	LXBMP0003[a]	Outfall 009	LOX east tributary - OLD	0.07
41	A1BMP0001[a]	Outfall 009	AILF downstream - OLD	0.05
42	BGBMP0002 (LXSW0003)[a]	Outfall 009	Background – CM-3 upstream	0.04
43	A1SW0006[a]	Outfall 009	Background – CM-11 upstream	0.03
44	BGBMP0006 (A2SW0006)[a]	Outfall 009	Background – CM-1 upstream east tributary (ponded footprint) - OLD	0.03
45	A1SW0007	Outfall 009	CM-11 downstream (pre-filter fabric over weir boards) - OLD	0.01
46.5	BGBMP0003	Outfall 009	Background - Sage Ranch near LOX	0.01
46.5	LXBMP0004	Outfall 009	LOX southwest downstream of sandbag berm	0.01
48	LXSW0002	Outfall 009	CM-3 downstream (pre-filter fabric over weir boards) - OLD	0.00
49.5	HZBMP0001 (HZSW0007)	Outfall 008	Happy Valley downstream (pre-improvements)	0.00
49.5	HZBMP0003 (HZSW0003)	Outfall 008	DRG downstream (furthest downstream)	0.00
62	HZSW0005	Outfall 008	DRG upstream	0.00
62	HZSW0008	Outfall 008	Background - Happy Valley upstream	0.00
62	HZSW0011	Outfall 008	Background - Happy Valley upstream	0.00
62	HZSW0012	Outfall 008	Background - Happy Valley upstream	0.00
62	HZSW0014	Outfall 008	Happy Valley upstream	0.00
62	HZSW0020 (HZSW0017)	Outfall 008	Background - Happy Valley upstream	0.00
62	ILBMP0003	Outfall 009	AILF parking lot - OLD	0.00
62	A2BMP0002	Outfall 009	A2 road runoff	0.00
62	Outfall 008**	Outfall 008	NPDES outfall 008	0.00
62	Outfall 009**	Outfall 009	NPDES outfall 009	0.00
62	A1SW0003	Outfall 009	CM-8 downstream (pre-filter fabric over weir boards) - OLD	0.00
62	A1SW0005	Outfall 009	CM-9 downstream (pre-filter fabric over weir boards) - OLD	0.00

Rank	Potential BMP Subarea (Co-location)	Watershed	Description	Maximum Dioxins Score
62	HZBMP0002 (HZSW0004)	Outfall 008	DRG downstream	0.00
62	BGBMP0007 (LXSW0001)	Outfall 009	Background – CM-3 upstream - OLD	0.00
62	BGBMP0005	Outfall 009	Background - Sage Ranch near entrance	0.00
62	BGBMP0001 (A2SW0007, A2BMP0006)[a]	Outfall 009	Background – CM-1 upstream east tributary (new)	0.00
62	A1BMP0002 (A1SW0004)[a]	Outfall 009	CM-9 upstream toward AILF (pre-AILF asphalt removal)	0.00
62	A1SW0002	Outfall 009	Background – CM-8 upstream	0.00
62	ILSW0003[a]	Outfall 009	IEL-2 upstream	0.00
62	ILSW0004-A	Outfall 009	IEL-2 downstream (post-ISRA excavation)	0.00
62	LPBMP0004	Outfall 009	Lower parking lot biofilter outlet	0.00

Notes

- Potential BMP subareas sorted by maximum weight for the POC group, computed as described in Section 5.
- ([a]) These potential BMP subarea monitoring subareas are upstream of existing stormwater quality treatment controls
- ([b])These potential BMP subarea monitoring subareas have new planned (i.e., designed and ready for construction) stormwater quality treatment controls.
- ([c]) 2,3,7,8-TCDD detected in the 2012/13 water year in these subareas.
- (**)NPDES outfalls are included for comparison and method testing purposes only; stormwater controls are not being contemplated at these locations.
- The rounding of weights may account for similar weights being ranked differently.
- **Bolded** locations indicate that both the dioxins NPDES permit limit and 95th percentile background particulate strength threshold were exceeded (for at least one dioxin POC).
- Gray text indicates historic subarea monitoring sites that are discontinued.
- Sites with zero samples collected are excluded from this table.

Table 8. TSS Weighting Factor Results, by Subarea

Rank	Potential BMP Subarea (Co-location)	Watershed	Description	TSS Score
1	LXBMP0004	Outfall 009	LOX southwest downstream of sandbag berm	0.97
2	Outfall 008**	Outfall 008	NPDES outfall 008	0.58
13	LPBMP0001	Outfall 009	Lower lot sheetflow (pre-gravel bag berms)	0.50
13	LXBMP0002	Outfall 009	LOX mid - OLD	0.50
13	LXBMP0003[a]	Outfall 009	LOX east tributary - OLD	0.50
13	HZBMP0001 (HZSW0007)	Outfall 008	Happy Valley downstream (pre-improvements)	0.50
13	HZSW0020 (HZSW0017)	Outfall 008	Background - Happy Valley upstream	0.50
13	BGBMP0004	Outfall 009	Background - Sage Ranch near CM-5	0.50
13	EVBMP0001 [b]	Outfall 009	ELV culvert inlet (Helipad road gutter)	0.50
13	LXBMP0005	Outfall 009	LOX southeast downstream of sandbag berm	0.50
13	LXBMP0006	Outfall 009	LOX east, runoff along dirt road	0.50
13	A2BMP0004 [b]	Outfall 009	Helipad culvert outlet	0.50
13	A2BMP0005 [b]	Outfall 009	A2 u/s of CM-1 confluence	0.50
13	B1SW0002[a]	Outfall 009	Woolsey Canyon Road runoff	0.50
13	B1SW0008	Outfall 009	B-1 upstream	0.50
13	ILSW0003	Outfall 009	IEL-2 upstream	0.50
13	A1BMP0002-A (A1SW0004)[a]	Outfall 009	CM-9 upstream toward AILF (post-AILF asphalt removal)	0.50
13	B1SW0014-A (B1BMP0006)	Outfall 009	B-1 media filter effluent (pre-media filter reconstruction)	0.50
13	ILSW0004-A	Outfall 009	IEL-2 downstream (post-ISRA excavation)	0.50
13	LFSW0002-A	Outfall 009	CTLI downstream (post-ISRA excavation)	0.50
13	B1BMP0001 (B1SW0010)	Outfall 009	B-1 media filter inlet (post-media filter installation)	0.50
13	EVBMP0006 [b]	Outfall 009	2012/13 Area II Road near ELV ditch	0.50
13	EVBMP0001-A [b]	Outfall 009	ELV culvert inlet (Helipad road and ELV ditch, composite)	0.50
24.5	LPBMP0001-A	Outfall 009	Lower lot sheetflow (post-gravel bag berms)	0.34
24.5	A1SW0009-B	Outfall 009	CM-9 downstream-underdrain outlet (post-filter fabric over weir boards, post-AILF asphalt removal)	0.34
26	EVBMP0003 (A2SW0001)[a]	Outfall 009	CM-1 upstream west	0.31
27	BGBMP0002 (LXSW0003)[a]	Outfall 009	Background – CM-3 upstream	0.31
28	ILBMP0002[a]	Outfall 009	Road runoff to CM-9	0.25
29	A2BMP0003 [b]	Outfall 009	A2 u/s of ND confluence	0.23
30.5	B1BMP0004 (B1SW0015, B1BMP0004-5)	Outfall 009	B-1 media filter inlet north	0.11
30.5	EVBMP0002[a b]	Outfall 009	Helipad (pre-sandbag berms)	0.11

Rank	Potential BMP Subarea (Co-location)	Watershed	Description	TSS Score
32	B1BMP0005 (B1SW0013, B1SW0011, B1BMP0004-5)[a]	Outfall 009	B-1 media filter inlet south	0.09
33	BGBMP0006 (A2SW0006)[a]	Outfall 009	Background – CM-1 upstream east tributary (ponded footprint) - OLD	0.06
34	A1SW0005	Outfall 009	CM-9 downstream (pre-filter fabric over weir boards) - OLD	0.05
35	A2SW0002-A (A2BMP0007)	Outfall 009	CM-1 effluent (post-filter fabric over weir boards)	0.04
36	HZBMP0003 (HZSW0003)	Outfall 008	DRG downstream (furthest downstream)	0.03
37.5	A1BMP0002 (A1SW0004)[a]	Outfall 009	CM-9 upstream toward AILF (pre-AILF asphalt removal)	0.02
37.5	LXSW0002	Outfall 009	CM-3 downstream (pre-filter fabric over weir boards) - OLD	0.02
39.5	B1BMP0003 (B1BMP0002)	Outfall 009	B-1 parking lot / road runoff to culvert inlet	0.01
39.5	ILBMP0001 [b]	Outfall 009	Lower lot 24" stormdrain outlet	0.01
41	A1SW0002	Outfall 009	Background – CM-8 upstream	0.01
42	A2SW0002 (A2BMP0007)	Outfall 009	CM-1 effluent (pre-filter fabric over weir boards)	0.00
58	APBMP0001 [b]	Outfall 009	Ashpile culvert/inlet road runoff	0.00
58	EVBMP0002-A[a b]	Outfall 009	Helipad (post-sandbag berms)	0.00
58	A1SW0009-A	Outfall 009	CM-9 downstream-underdrain outlet (post-AILF asphalt removal, pre-filter fabric over weir boards)	0.00
58	B1SW0014-B (B1BMP0006)	Outfall 009	B-1 media filter effluent (post-media filter reconstruction)	0.00
58	LPBMP0003	Outfall 009	Lower parking lot sediment basin outlet	0.00
58	LPBMP0004	Outfall 009	Lower parking lot biofilter outlet	0.00
58	B1BMP0007	Outfall 009	B-1, Lower parking lot area	0.00
58	EVBMP0004 [b]	Outfall 009	2012/13 Lower Helipad Road	0.00
58	B1SW0014-C (B1BMP0006)	Outfall 009	B-1 media filter effluent (post-media filter reconstruction, post-curb cuts)	0.00
58	EVBMP0005 [b]	Outfall 009	2012/13 ELV drainage ditch (pre-ELV-1C ISRA)	0.00
58	EVBMP0002-B[a b]	Outfall 009	Helipad (post-sandbag berms raised, post-drainage holes in asphalt)	0.00
58	LPBMP0002[a]	Outfall 009	Lower parking lot influent to cistern	0.00
58	A1SW0006[a]	Outfall 009	Background – CM-11 upstream	0.00
58	BGBMP0001 (A2SW0007, A2BMP0006)[a]	Outfall 009	Background – CM-1 upstream east tributary (new)	0.00
58	BGBMP0003	Outfall 009	Background - Sage Ranch near LOX	0.00
58	BGBMP0007 (LXSW0001)	Outfall 009	Background – CM-3 upstream - OLD	0.00

Rank	Potential BMP Subarea (Co-location)	Watershed	Description	TSS Score
58	BGBMP0005	Outfall 009	Background - Sage Ranch near entrance	0.00
58	A1BMP0001[a]	Outfall 009	AILF downstream - OLD	0.00
58	HZBMP0002 (HZSW0004)	Outfall 008	DRG downstream	0.00
58	HZSW0005	Outfall 008	DRG upstream	0.00
58	HZSW0008	Outfall 008	Background - Happy Valley upstream	0.00
58	HZSW0011	Outfall 008	Background - Happy Valley upstream	0.00
58	HZSW0012	Outfall 008	Background - Happy Valley upstream	0.00
58	HZSW0014	Outfall 008	Happy Valley upstream	0.00
58	A1SW0007	Outfall 009	CM-11 downstream (pre-filter fabric over weir boards) - OLD	0.00
58	A2BMP0002	Outfall 009	A2 road runoff	0.00
58	Outfall 009**	Outfall 009	NPDES outfall 009	0.00
58	A1SW0003	Outfall 009	CM-8 downstream (pre-filter fabric over weir boards) - OLD	0.00
58	ILBMP0003	Outfall 009	AILF parking lot - OLD	0.00

Notes

- ([a]) These potential BMP subarea monitoring subareas are upstream of existing stormwater quality treatment controls
- ([b])These potential BMP subarea monitoring subareas have new planned (i.e., designed and ready for construction) stormwater quality treatment controls.
- (**)NPDES outfalls are included for comparison and method testing purposes only, stormwater controls are not being contemplated at these locations.
- The rounding of weights may account for similar weights being ranked differently.
- Gray text indicates historic subarea monitoring sites that are discontinued.
- Sites with zero samples collected are excluded from this table.

A "multi-constituent" score was then calculated for each potential BMP subarea monitoring subarea by taking the arithmetic mean of the maximum metals and the maximum dioxins weighting factor values (Table 9). These two pollutant category values were weighted equally for the multi-constituent score based on their very roughly comparable relative exceedance probabilities at Outfalls 008 and 009 -- the dioxins permit limit exceedance probability is approximately 5% at Outfall 008 and approximately 30% at Outfall 009, while the lead (most problematic metal) permit limit exceedance probability is approximately 38% at Outfall 008 and approximately 25% at Outfall 009.

A complete summary of the weights computed by potential BMP subarea monitoring subarea (including number of samples, number of NDs, median, maximum, comparison to background percentiles, weight, and rank) is included as Appendix A.

Table 9. Subareas Ranked by Multi-constituent Score

Rank	Potential BMP Subarea (Co-locations)	Watershed	Description	Approximate Upgradient Drainage Area (ac)	Multi-Constituent Score	Rank from Maximum Metal Weighting	Rank from Maximum Dioxins Weighting	Total Number of Events Sampled	Number of Events Sampled in 2012/13
1	**ILBMP0002**[a]	Outfall 009	Road runoff to CM-9	2.5	0.95	1	6[c]	9	2
2	**EVBMP0003 (A2SW0001)**[a]	Outfall 009	CM-1 upstream west	11.8	0.94	3	1[c]	17	3
3	**EVBMP0001-A**[b]	Outfall 009	ELV culvert inlet (Helipad road and ELV ditch, composite)	2.5	0.67	17.5	7	5	0
4	**EVBMP0002**[a b]	Outfall 009	Helipad (pre-sandbag berms)	4.1	0.66	15.5	10	10	0
5.5	**EVBMP0005**[b]	Outfall 009	2012/13 ELV drainage ditch (pre-ELV-1C ISRA)	11	0.63	21	9	2	2
5.5	**A1SW0009-A**	Outfall 009	CM-9 downstream-underdrain outlet (post-AILF asphalt removal, pre-filter fabric over weir boards)	16.4	0.63	4	21	1	0
7	**EVBMP0004**[b]	Outfall 009	2012/13 Lower Helipad Road	1.8	0.62	2	31.5	3	3
8	**APBMP0001**[b]	Outfall 009	Ashpile culvert/inlet road runoff	34	0.60	5	21	2	0
9	**ILBMP0001**[b]	Outfall 009	Lower lot 24" stormdrain outlet	23	0.57	23	8	16	6
10	**B1BMP0004 (B1SW0015, B1BMP0004-5)**	Outfall 009	B-1 media filter inlet north	3.7	0.53	29	2	6	4
14.5	**LPBMP0001-A**	Outfall 009	Lower lot sheetflow (post-gravel bag berms)	5.1	0.50	37.5	3	6	0
14.5	**B1SW0002**[a]	Outfall 009	Woolsey Canyon Road runoff	1.3	0.50	10	21	2	0
14.5	B1BMP0001 (B1SW0010)	Outfall 009	B-1 media filter inlet (post-media filter installation)	4.5	0.50	10	21	3	0
14.5	LXBMP0006	Outfall 009	LOX east, runoff along dirt road	0.43	0.50	10	21	1	0
14.5	LPBMP0002[a]	Outfall 009	Lower parking lot influent to cistern	4.2	0.50	10	21	0	1
14.5	EVBMP0006[b]	Outfall 009	2012/13 Area II Road near ELV ditch	11	0.50	10	21	1	1
14.5	B1SW0014-A (B1BMP0006)	Outfall 009	B-1 media filter effluent (pre-media filter reconstruction)	4.7	0.50	10	21	7	0
14.5	LPBMP0001	Outfall 009	Lower lot sheetflow (pre-gravel bag berms)	5.1	0.50	10	21	2	0

Rank	Potential BMP Subarea (Co-locations)	Watershed	Description	Approximate Upgradient Drainage Area (ac)	Multi-Constituent Score	Rank from Maximum Metal Weighting	Rank from Maximum Dioxins Weighting	Total Number of Events Sampled	Number of Events Sampled in 2012/13
19	**B1BMP0003 (B1BMP0002)**	Outfall 009	B-1 parking lot / road runoff to culvert inlet	5.2	0.49	47	4	16	4
20	**B1BMP0005 (B1SW0013, B1SW0011, B1BMP0004-5)**[a]	Outfall 009	B-1 media filter inlet south	0.8	0.48	49	5	9	4
21	A1SW0009-B	Outfall 009	CM-9 downstream-underdrain outlet (post-filter fabric over weir boards, post-AILF asphalt removal)	16.4	0.45	15.5	21	4	2
22	A1BMP0002-A (A1SW0004)[a]	Outfall 009	CM-9 upstream toward AILF (post-AILF asphalt removal)	6.3	0.42	19	21	18	0
23	LXBMP0002	Outfall 009	LOX mid - OLD	1.5	0.41	21	21	2	0
24	**A2BMP0005** [b]	Outfall 009	A2 u/s of CM-1 confluence	35	0.39	26	12	3	0
25	**B1SW0008**	Outfall 009	B-1 upstream	0.79	0.35	63	11	2	0
26	**LFSW0002-A**	Outfall 009	CTLI downstream (post-ISRA excavation)	5.1	0.31	26	21	3	0
27	**A2SW0002 (A2BMP0007)**	Outfall 009	CM-1 effluent (pre-filter fabric over weir boards)	52.8	0.29	40.5	13	20	0
28	B1SW0014-B (B1BMP0006)	Outfall 009	B-1 media filter effluent (post-media filter reconstruction)	4.7	0.27	32.5	21	10	0
29	LXBMP0004	Outfall 009	LOX southwest downstream of sandbag berm	10.6	0.26	10	46.5	5	0
30.5	LPBMP0003	Outfall 009	Lower parking lot sediment basin outlet	4.2	0.25	63	21	2	1
30.5	HZSW0020 (HZSW0017)	Outfall 008	Background - Happy Valley upstream	0.2	0.25	10	62	2	0
32	A2BMP0004 [b]	Outfall 009	Helipad culvert outlet	4.2	0.23	26	31.5	3	0
33	**A1BMP0001**[a]	Outfall 009	AILF downstream - OLD	1.2	0.22	17.5	41	5	0
34	**EVBMP0002-B**[a b]	Outfall 009	Helipad (post-sandbag berms raised, post-drainage holes in asphalt)	4.3	0.20	32.5	30	4	4
35	**B1SW0014-C (B1BMP0006)**	Outfall 009	B-1 media filter effluent (post-media filter reconstruction, post-	3.6	0.20	63	29	6	6

Rank	Potential BMP Subarea (Co-locations)	Watershed	Description	Approximate Upgradient Drainage Area (ac)	Multi-Constituent Score	Rank from Maximum Metal Weighting	Rank from Maximum Dioxins Weighting	Total Number of Events Sampled	Number of Events Sampled in 2012/13
			curb cuts)						
36	HZSW0011	Outfall 008	Background - Happy Valley upstream	0.1	0.16	21	62	2	0
38	**LXBMP0005**	Outfall 009	LOX southeast downstream of sandbag berm	2.5	0.11	30	33.5	5	0
38	EVBMP0001 [b]	Outfall 009	ELV culvert inlet (Helipad road gutter)	1.8	0.11	26	36	3	0
38	BGBMP0004	Outfall 009	Background - Sage Ranch near CM-5	81.4	0.11	26	36	3	0
40	EVBMP0002-A [a b]	Outfall 009	Helipad (post-sandbag berms)	4.1	0.09	40.5	33.5	5	0
41	**A2SW0002-A (A2BMP0007)**	Outfall 009	CM-1 effluent (post-filter fabric over weir boards)	52.8	0.07	35	38	8	4
42	B1BMP0007	Outfall 009	B-1, Lower parking lot area	47.7	0.06	63	36	3	3
43	**A2BMP0003** [b]	Outfall 009	A2 u/s of ND confluence	100	0.05	40.5	39	7	2
44	**LXBMP0003** [a]	Outfall 009	LOX east tributary - OLD	0.4	0.05	37.5	40	6	0
45	BGBMP0002 (LXSW0003) [a]	Outfall 009	Background – CM-3 upstream	17.2	0.04	32.5	42	4	0
46	**BGBMP0006 (A2SW0006)** [a]	Outfall 009	Background – CM-1 upstream east tributary (ponded footprint) - OLD	41.1	0.03	36	44	7	0
47	BGBMP0001 (A2SW0007, A2BMP0006) [a]	Outfall 009	Background – CM-1 upstream east tributary (new)	41.1	0.02	32.5	62	4	0
48	**A1SW0006** [a]	Outfall 009	Background – CM-11 upstream	8.3	0.02	63	43	12	0
49	**A1SW0007**	Outfall 009	CM-11 downstream (pre-filter fabric over weir boards) - OLD	8.3	0.01	63	45	12	0
50.5	BGBMP0003	Outfall 009	Background - Sage Ranch near LOX	23.6	0.01	63	46.5	5	0
50.5	**BGBMP0007 (LXSW0001)**	Outfall 009	Background – CM-3 upstream - OLD	17.2	0.01	40.5	62	7	0
52	**LXSW0002**	Outfall 009	CM-3 downstream (pre-filter fabric over weir boards) - OLD	17.2	0.00	44	48	9	0
53	**A1SW0002**	Outfall 009	Background – CM-8 upstream	2.5	0.00	43	62	10	0

Rank	Potential BMP Subarea (Co-locations)	Watershed	Description	Approximate Upgradient Drainage Area (ac)	Multi-Constituent Score	Rank from Maximum Metal Weighting	Rank from Maximum Dioxins Weighting	Total Number of Events Sampled	Number of Events Sampled in 2012/13
54.5	**A1SW0003**	Outfall 009	CM-8 downstream (pre-filter fabric over weir boards) - OLD	2.5	0.00	45.5	62	10	0
54.5	**A1SW0005**	Outfall 009	CM-9 downstream (pre-filter fabric over weir boards) - OLD	16.4	0.00	45.5	62	10	0
56	**HZBMP0001 (HZSW0007)**	Outfall 008	Happy Valley downstream (pre-improvements)	21.4	0.00	50	49.5	13	0
57	**A1BMP0002 (A1SW0004)**[a]	Outfall 009	CM-9 upstream toward AILF (pre-AILF asphalt removal)	6.3	0.00	48	62	15	0
58	**HZBMP0003 (HZSW0003)**	Outfall 008	DRG downstream (furthest downstream)	29.6	0.00	51.5	49.5	14	0
59	Outfall 008**	Outfall 008	NPDES outfall 008	62	0.00	51.5	62	32	0
66.5	HZSW0005	Outfall 008	DRG upstream	21	0.00	63	62	1	0
66.5	HZSW0008	Outfall 008	Background - Happy Valley upstream	NA/small	0.00	63	62	1	0
66.5	HZSW0012	Outfall 008	Background - Happy Valley upstream	0.4	0.00	63	62	1	0
66.5	HZSW0014	Outfall 008	Happy Valley upstream	0.1	0.00	63	62	3	0
66.5	ILBMP0003	Outfall 009	AILF parking lot - OLD	9.5	0.00	63	62	4	0
66.5	A2BMP0002	Outfall 009	A2 road runoff	3.6	0.00	63	62	1	0
66.5	**Outfall 009****	Outfall 009	NPDES outfall 009	536	0.00	63	62	70	3
66.5	HZBMP0002 (HZSW0004)	Outfall 008	DRG downstream	23.2	0.00	63	62	4	0
66.5	BGBMP0005	Outfall 009	Background - Sage Ranch near entrance	25	0.00	63	62	1	0
66.5	ILSW0003	Outfall 009	IEL-2 upstream	2.4	0.00	63	62	2	0
66.5	ILSW0004-A	Outfall 009	IEL-2 downstream (post-ISRA excavation)	2.8	0.00	63	62	1	0
66.5	LPBMP0004	Outfall 009	Lower parking lot biofilter outlet	4.4	0.00	63	62	2	1

Notes

- Potential BMP subareas sorted by multi-constituent score, computed as described in Section 5.
- ([a]) These potential BMP subarea monitoring locations are upstream of existing stormwater quality treatment controls.
- ([b])These potential BMP subarea monitoring locations have new planned (i.e., designed and ready for construction) stormwater quality treatment controls.
- ([c]) 2,3,7,8-TCDD detected in the 2012/13 water year in these subareas.
- (**) NPDES outfalls are included for comparison and method testing purposes only, stormwater controls are not being contemplated at these locations.
- The rounding of weights may account for similar weights being ranked differently.
- Approximate drainage areas based on the cumulative drainage area of the SWMM catchment in which the monitoring location is located (Geosyntec, 2011). At locations where the monitoring point is upstream of the catchment outfall a "<" sign is used.
- **Bolded** locations indicate that both the NPDES permit limit and 95th percentile background particulate strength threshold were exceeded for any one POC.
- Gray text indicates historic subarea monitoring sites that are discontinued.

6. RESULTS DISCUSSION

- Dioxins TCDD TEQ and lead are the POCs most frequently responsible for producing high dioxins and metals weighting factors, respectively. Permit limit exceedances were only observed at Outfall 009 for these same parameters.
- Table 10 summarizes the sites ranked in the top 15 from the multi-constituent ranking that are associated with a paired effluent site, demonstrating that for each pair, treatment through the BMP resulted in improved water quality. For example, three influent streams within the B-1 area (ranked 10, 14.5, and 14.5) are all ranked higher than the B-1 effluent, which is ranked 35. A similar occurrence is observed for the influent/effluent ranks for CM-1, CM-9, CM-8, and the lower parking lot sedimentation basin and biofilter. B-1 parking lot and road runoff have been included to more fully describe improvements in the B-1 area, though influent and effluent sites for this entry were not within the top-ranked sites. Sites B1SW0014-A and A1SW0009-A are not included in this table because they are old monitoring sites that are no longer being monitored.

Table 10. Ranking Comparison of Top Ranked Sites and their Pairs

BMP Area	Influent			Effluent			Rank Drop
	Location/ Colocation	Description	Influent Rank	Location/ Colocation	Description	Effluent Rank	
CM-9	**ILBMP0002**	Road runoff to CM-9	1	A1SW0009(-B)	CM-9 downstream-underdrain outlet (post-filter fabric over weir boards, post-AILF asphalt removal)	21	20
CM-1	**EVBMP0003**	CM-1 upstream west	2	A2SW0002(-A)/ A2BMP0007	CM-1 effluent (post-filter fabric over weir boards)	41	39
Lower Lot Sediment Basin	**LPBMP0002[a]/** **LPBMP0001/** **LPBMP0001-A**	Lower lot influent to cistern	14.5/ 14.5/ 14.5	LPBMP0004[a]	Lower parking lot biofilter outlet	66.5	52[b]
B-1 Media Filter	**B1BMP0004/** **B1SW0002/** **B1BMP0001**	B1 media filter inlet north/ Woolsey Canyon Road runoff (old north inlet)/ B1 media filter, south inlet (old) post-media filter installation	10/ 14.5/ 14.5	B1SW0014(-C)/ B1BMP0006	B-1 media filter effluent (post-media filter reconstruction, post-curb cuts)	35	20.5
B-1 Media Filter[b]	B1BMP0003 [B1BMP0002]/ B1SW0014 (-C) [B1BMP0006]	B-1 parking lot and road runoff to culvert inlet/ B-1 media filter effluent (post-media filter reconstruction, post-curb cuts)	19/ 35	B1BMP0007	B-1 lower parking lot area (vegetated area downstream of B1 media filter effluent)	42	23

NOTES

- **Bolded** locations indicate that the site is ranked within the top fifteen of the multi-constituent table (Table 9).
- Gray text indicates historic subarea monitoring sites that are discontinued.
- ([a]) Based on a single influent/effluent sampling event.
- ([b]) These upstream and downstream sample locations were not top-ranked sites; however, this pair is included to more fully demonstrate water quality improvements around the B-1 area.

- Table 11 summarizes a select subset of sites ranked in the top 15 that are associated with a BMP modifications. In most cases, the site rank based on the multi-constituent score fell after the BMP was implemented, demonstrating that the BMP helped improved water quality at the site.

Table 11. Ranking Comparison of Top Ranked Sites Pre- vs. Post-BMP

Original Site Name	Description	Rank	Site	Implementation Date	Description	Rank	Site	Implementation Date	Description	Rank
EVBMP0002	Helipad	4	EVBMP0002-A	11/14/2011	post-sandbag berms	40	EVBMP0002-B	9/5/2012	post-sandbag berms raised, post-drainage holes in asphalt	34
A1SW0009	CM-9 downstream-underdrain outlet	N/A[1]	**A1SW0009-A**	9/1/2011[2]	post-Building 1324 parking lot asphalt removal, pre-filter fabric over weir boards	5.5	A1SW0009-B	1/20/2012	post-filter fabric over weir boards	21

NOTES

- ([1]) "N/A" means there were no samples collected at this site under the specified name designation and therefore the site is not ranked.
- ([2]) Dates of 9/1/20XX assume work completed sometime in the summer, prior to the start of the wet season, but are not confirmed.
- **Bold** sites are ranked in the top-15 of the multi-constituent table (Table 9).

- All CM effluent monitoring locations are ranked lower (i.e., better water quality) than their most impacted influent streams (i.e., where two influent streams enter a CM, the effluent ranking is lower than that of the poorer quality influent), indicating that the CMs are performing well. This finding is consistent with the conclusions of the statistical analysis of influent/effluent data in the 2012 Performance Evaluation Memorandum (Geosyntec and Expert Panel, 2012). However, this finding may also be associated with dilution by the less impacted influent stream.

- The most highly ranked subareas for TSS include LOX downstream of the sandbag berm (LXBMP0004) and Outfall 008. Panel-recommended BMPs were installed at the LOX site in 2012 as part of the Northern Drainage RMMP. These BMPs included sand bag diversion berm, slope drains to convey flow from the sandbag berms into the Northern Drainage, and rock stabilization at eroded channels and gullies. Minor repairs have been made to the LOX area BMPs following completion of the Northern Drainage RMMP including repairing split sand bags at the LOX area.

- The top ten ranked subareas represent drainage areas with either full or mixed runoff contributions from paved surfaces (mostly parking lots and roads). This may indicate that elevated POC concentrations in the 009 watershed may be derived from asphalt or atmospheric deposition onto asphalt.

- 2,3,7,8-TCDD – a dioxin congener that is typically associated with anthropogenic sources -- was detected four times this 2012/2013 monitoring season, and these detections were at a J-flagged (estimated) level. It was detected at B1BMP0005 (B-1 media filter inlet south), ILBMP0002 (Road runoff to CM-9), and EVBMP0003 (CM-1 upstream west). TCDD TEQ (no DNQ) was also recorded at the same sites on the same days.

- The top 15-ranked subareas based on the multi-constituent score include ten subareas on Boeing property – B1BMP0004 (the B-1 media filter inlet north), ILBMP0001 (Lower lot 24" stormdrain outlet), ILBMP0002 (road runoff to CM-9), A1SW0009-A(CM-9 downstream underdrain outlet – post-improvements), LPBMP0001 and LPBMP0001-A (lower lot sheetflow (pre- and post-gravel bag berms)), B1SW0002 (Woolsey Canyon Road runoff), B1BMP0001 (B-1 media filter inlet (post-media filter installation)), LPBMP0002 (Lower parking lot influent to cistern), B1SW0014-A (B-1 media filter effluent (pre-media filter reconstruction)), and LPBMP0001 (lower lot sheetflow (pre-gravel bag berms)). These sites already have robust treatment controls (in the case of ILBMP0001, this is treatment of low flows only). No new data have been collected at ILBMP0002 since the BMPs have been implemented, so potential improvements are not yet reflected in the results. Of these subareas, B1BMP0004 is ranked highest for dioxins.

- Eight subareas in the top 15-ranked subareas are located on NASA property and include, in order of rank, EVBMP0003 (CM-1 upstream west), EVBMP0001-A (ELV culvert inlet – Helipad road and ELV ditch composite), EVBMP0002 (Helipad (pre-sandbag berms)), EVBMP0005 (2012/13 ELV drainage ditch (pre-ELV-1C ISRA)), EVBMP0004 (2012/13 Lower Helipad Road), and APBMP0001 (ashpile culvert inlet/road runoff), LXBMP0006 (LOX east, runoff along dirt road), and EVBMP0006 (2012/13 Area II Road near ELV ditch). Of these subareas, EVBMP0003 was ranked highest for dioxins.

- Very similar rankings resulted from previously tested approaches, suggesting that results are robust and not highly sensitive to the particular statistical methodology employed. This methodology has the advantage of considering the number of observations available, and can be updated as more data become available. In addition, this method also helps determine when sufficient data have been collected to satisfy statistically based confidence and power objectives which would then enable reduced future sampling efforts.

- Five of the top five and three of the top five subareas weighted highest based on maximum metals and dioxins weighting factors respectively are included in the top ten subareas based on the multi-constituent score, suggesting once again that rankings are robust and not highly sensitive to the particular methodology employed (or to the pollutants used to calculate the rankings).

- As shown in Figure 2, channel processes appear to be a significant source of TSS for Watershed 008 and less so for Watershed 009 (near background). Northern Drainage improvements and stabilization measures are expected to continue providing a water quality benefit to the 009 drainage area.

- While the analysis approach is concentration based rather than load based, because such a large percentage of the watersheds (and of the watersheds developed or known impacted areas) are represented by the monitoring locations, the approach roughly addresses load reduction aspects, noting that actual runoff coefficients do vary between subareas.

7. BMP RECOMMENDATIONS

Subarea Specific Evaluation of Top Ranked Subarea

Based on these analysis results, the following monitoring locations were identified as the highest ranked[26] subareas, with multi-constituent scores ranging from 0.50 to 0.95 out of a maximum score of 1.0 (see Table 9[27]). Scores closer to 1.0 indicate the more problematic monitoring locations. Besides their multi-constituent scores, the following list is also of significance because it included:

- Two of the three subareas (ILBMP0002, EVBMP0003, and B1BMP0005, which is the one not highly ranked) where 2,3,7,8-TCDD[28] was detected (but not quantified) in the 2012/2013 wet season;

- Seven of the fifteen subareas[29] with the highest reported lead concentrations and seven of the fifteen subareas[30] with the highest reported TCDD-TEQ concentrations (noting that the scores do not explicitly account for concentration *magnitude*s, but rather account for *frequency* of exceeding the concentration-based background and permit limit thresholds).

In some cases, these results reflect conditions prior to or following implementation of temporary measures or corrective actions and this is described in parentheses following the location designation (in bold). It should be noted that all 17 monitoring locations described below (the top-ranked locations with a multi-constituent ranking of fifteen or above) based on available data) are located in the 009 drainage area, with none in the 008 drainage area, Water quality at background locations was generally good with no location ranked above 30.5, though there were several instances of concentrations greater than NPDES permit limits at those locations. However, no flow or exceedances occurred at Outfall 008 during the current season, indicating that retention occurred within the watershed.

The following list of highest ranked subareas contains some historic subarea monitoring sites that are discontinued, indicated by gray text, and no Panel recommendations are provided for these. Sites were discontinued for a number of reasons, including site improvements, changes in treatment type, planned end of monitoring activities. It should also be noted that the 2012/13 season was unusually dry; therefore, there are relatively little new data this year for updating the site rankings.

1. **ILBMP0002 (road runoff to CM-9**): This subarea reflects runoff from a 2.5 acre drainage area including paved road and undeveloped hillsides. Based on nine events, this subarea is ranked 1st

[26] In the case of ties, the average rank was assigned to both subareas.
[27] Subareas with zero samples have been excluded from Table 9.
[28] 2,3,7,8-TCDD is a congener that potentially indicates unweather anthropogenic contamination.
[29] ILBMP0002, EVBMP0003, EVBMP0001-A, LPBMP0001-A, APBMP0001, EVBMP0002, and LXBMP0006. The maximum lead concentration reported at each subarea is shown in Appendix A.
[30] EVBMP0001-A, LPBMP0001-A, ILBMP0001, ILBMP0002, B1SW0002, B1BMP004, and EVBMP0003. The maximum TCDD TEQ concentration reported at each subarea is shown in Appendix A.

overall, 6th for dioxins, 1st for metals, and 28th for TSS. ILBMP0002 drains to CM-9, which filters runoff through a horizontal media bed (estimated at 10% long-term average runoff volume capture[31] with the existing watershed conditions). Based on six events, the effluent from CM-9 (A1SW0009-B) is ranked 21st overall, 21st for dioxins, 15.5th[32] for metals, and 24.5th for TSS. There have been no samples collected from the effluent since its most recent improvements (A1SW0009-C) which were a result of last year's Expert Panel BMP recommendations. The most recent improvements include: erosion control blanket and straw wattles installed along the slopes adjacent to the Area II Road; a low flow diversion inlet structure and diversion pipe with perforations; and a rock berm for ponding runoff as pretreatment prior to CM-9. The inlet and diversion pipe were installed to divert up to the one year design storm runoff flow rate and spread this runoff onto the vegetated slope south of the CM-9 media filter. No data have been collected since the BMP improvements have been installed; therefore, the first place ranking of the site does not reflect the potential benefits of the new BMP improvements. The Expert Panel recommends ongoing maintenance of the BMPs installed this year. In addition, the filter fabric on the CM-9 weir boards should be replaced when the fabric becomes clogged or damaged. Sediment accumulation at the inlet of the CM and at the new pretreatment rock berm should continue to be monitored. Water that has ponded upstream of the weir board for greater than 72 hours should be noted as it may suggest that media or underdrain maintenance is needed.

2. EVBMP0003 (CM-1 upstream west): This monitoring subarea reflects flow from approximately 11.8 acres including the ELV building and surrounding paved areas (including the NASA staging area), vegetated ELV hillside and ISRA areas (most of which were temporarily covered with tarps as of September 19, 2012), and the paved Area II (NASA) Road. ISRA area ELV-1C is located within this drainage area and was excavated in February and was substantially completed by March 2013. Plastic tarps and sandbags were placed over the excavation area to prevent contact with rainfall. Based on 17 events, this subarea ranks 2nd overall (multi-constituent score = 0.94), 1st for dioxins, 3rd for metals, and 26th for TSS. CM-1, to which EVBMP0003 drains, is an existing CM that also treats runoff from a 53 acre undisturbed subwatershed (estimated at around 7% long-term runoff volume capture under current conditions, however this is expected to increase after ELV drainage improvements are made). Based on eight events, the CM-1 effluent subarea (A2SW0002-A) is ranked 41st overall (multi-constituent score = 0.07), ranked 38th for dioxins, 35th for metals, and 35th for TSS. The ELV areas currently drain to EVBMP0003 and CM-1 due to an existing degraded asphalt channel below the ELV hillside that diverts runoff onto the Area II Road and to EVBMP0003. Improvements to the ELV ditch and area contributing runoff to CM-1 are discussed below in EVBMP0001-A recommendations. The Expert Panel recommends CM-1 filter fabric inspection (replace when the fabric becomes clogged or damaged), monitoring of sediment accumulation in front of weir boards (removal when accumulation nears top of first weir board), and monitoring of

[31] Overflows also get partial sedimentation through temporary ponding behind weir boards.
[32] Some of the sites' ranks are not expressed as whole numbers because an average of ranks is used when multiple sites are tied with the same rank.

water ponding after storms (ponding for greater than 72 hours should be noted as it may suggest that media or underdrain maintenance is needed).

3. EVBMP0001-A (composite of Helipad Road and lower ELV ditch): This discontinued monitoring subarea reflects flow from the 1.8 acre paved Area II (NASA) Helipad Road and ELV-1C and ELV-1D ISRA areas, composited (50/50) with flow from the 0.7 acre portion of the ELV vegetated hillside that enters, and remains in, the ELV asphalt ditch. The monitoring subarea was discontinued because the split flows were sampled individually in the rainy season 2012/13. Based on five events, this subarea was ranked 3rd overall (multi-constituent score = 0.67), 7th for dioxins, 17.5th for metals, and 13th for TSS. The highest measured TCDD TEQ (no DNQ) concentration (2.1×10^{-4} µg/L) was found here, including the detection of the 2,3,7,8-TCDD congener (2.2×10^{-5} µg/L). Prior to compositing with flows from the lower ELV ditch, this subarea (EVBMP0001) reflected runoff from only the Helipad Road gutter, and based on three events, was ranked 38th overall, 36th for dioxins, 26th for metals, and 13th for TSS, suggesting that flow from the lower ELV ditch contributes the majority of dioxins at this location. Working with the Expert Panel, NASA has developed certified-for-construction design drawings to construct a stormwater treatment facility using Panel-recommended filtration media. The design also incorporates minor regrading and curbing to facilitate diverting runoff from the upgradient paved ELV areas west of the Helipad toward the Helipad where sandbag berms and pumps are located. Construction is scheduled to be completed by end of September 2013 in advance of the 2013/14 rain season.

4. EVBMP0002 (Helipad pre sandbag berms): This subarea reflects runoff from 4.1 acres of the paved Helipad area, pre-sandbag berms raised and pre-drainage holes in asphalt). Based on six events, this subarea was ranked 4th overall (multi-constituent score = 0.66), 10th for dioxins, 15.5th for metals, and 30.5th for TSS. This site has since been improved (EVBMP0002-B). The improved site ranks 34th overall (multi-constituent score = 0.20), 30th for dioxins, 32.5th for metals, and 30.5th for TSS. The improvements caused runoff from this area (EVBMP0002-B) to drain via overland flow through a series of temporary BMPs prior to being discharged via a paved asphalt channel on the east end of the Helipad. The temporary BMPs include two raised sandbag berms that collect and retain the runoff. Perforations in the pavement were installed upstream of the sand bag berms in September 2012 to promote infiltration. Captured runoff currently is pumped to the Silvernale treatment facility. Runoff capture efficiency may decrease in 2013/14 since a larger area is now draining toward these berms due to the ongoing construction. The Helipad sandbag berms are expected to receive significantly more runoff once NASA's new ELV drainage routing plan is implemented; therefore the Panel recommends an evaluation of Boeing's pumping setup so that the frequency of discharge from the Helipad area to OF009 continues to be controlled, as feasible. The Panel also recommends continued operation of this temporary capture system or equivalent runoff capture and treatment as a temporary interim control strategy until NASA is able to finalize plans and remove the asphalt from the Helipad area during planned demolition.

5.5. EVBMP0005 (2012/13 ELV drainage ditch (pre-ELV-1C ISRA)): Monitoring in this subarea, added during the 2012/13 water year, reflects 11 acres of ELV hillside runoff from the ELV asphalt swale prior to ISRA removal, which was substantially completed by March, 2013. There are no post-ISRA data for this location. Based on two events, the pre-ISRA subarea is ranked 5.5th overall (multi-constituent score = 0.63), 9th for dioxins, 21st for metals, and tied for 58th (last) for TSS. Runoff from the upgradient ELV paved areas will be diverted to the Helipad, and ELV hillside runoff will be treated through the stormwater treatment facility discussed above for EVBMP0001-A. The Expert Panel recommends no new actions at this time to address runoff from this subarea beyond the currently planned (and under construction) stormwater treatment facility.

5.5 A1SW0009-A (CM-9 downstream underdrain outlet, post-Building 1324 parking lot asphalt removal, pre-filter fabric over weir boards): Monitoring in this subarea, added during the 2012/13 water year, reflects treated runoff (estimated at 15% capture[33]) from a 16.4 acres drainage area, consisting of road runoff (ILBMP0002), a stabilized dirt road, rocky hillsides, and the AILF. Based on one event, this subarea is ranked 5.5th overall (multi-constituent score = 0.63), 21st for dioxins, 4th for metals, and tied for 58th (last) for TSS. In January of 2012, filter fabric was installed over the weir boards to reduce and filter seepage flows. Based on six events, this subarea (now named A1SW0009-B) is ranked 21st overall, 21st for dioxins, 15.5th for metals, and 24.5th for TSS. There have been no samples collected since its most recent improvements completed in April 2013 and described above for ILBMP0002. The Panel recommends continued performance monitoring, inspection, and maintenance as necessary for this recently updated CM control.

7. EVBMP0004 (2012/13 Lower Helipad road): Monitoring in this subarea was added during the 2012/13 water year and reflects flow from the 1.8 acre paved Area II (NASA) Helipad Road. Based on three events, this subarea is ranked 7th overall (multi-constituent score = 0.62), 31.5th for dioxins, 2nd for metals, and 58th (last) for TSS. The Helipad road flows contributing to this BMP sampling location are planned to be collected in the reconstructed ELV ditch which will be captured and treated through the stormwater treatment facility discussed above in the EVBMP0001-A recommendations. As a result, the Expert Panel recommends no new actions at this time to address runoff from this subarea beyond the currently planned (and currently under construction) stormwater treatment facility.

8. APBMP0001 (Ash Pile culvert inlet/road runoff): This Area II (NASA) subarea is 34 acres, including several flat ISRA areas distributed throughout a relatively flat drainage area; however, runoff has only been observed along the south side of the Area II road. Based on two events, this subarea is ranked 8th overall (multi-constituent score = 0.60), 21st for dioxins, 5th for metals, and 58th (lowest) for TSS. Both samples were collected after the ISRA areas had been partially excavated and covered with plastic, which may have disturbed the soil leading to increased pollutant discharges. This is expected to be a temporary issue until the ISRA area is permanently stabilized. The Expert Panel recommends no new actions at this time to address runoff from this subarea because it is currently being addressed by ISRA activities.

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[33] Overflows also get partial treatment by sedimentation through temporary ponding behind weir boards.

9. ILBMP0001 (Lower Lot 24-inch storm drain outlet): This monitoring subarea reflects flow from 23 acres of paved parking areas, building rooftops, paved storage areas, and undeveloped hillsides. Runoff from these areas is conveyed by a storm drain collection system to a 24-inch storm drain located beneath the Lower Parking Lot. This storm drain discharges via a concrete outlet spillway to the Northern Drainage on Sage Ranch property. Based on sixteen events, this subarea is ranked 9th overall (multi-constituent score = 0.57), 8th for dioxins, 23rd for metals, and 39.5th for TSS. A portion of this flow (approximately 11% long-term average runoff volume capture) is treated through the Lower Lot Biofilter. Additionally, Building 1436 is planned to be demolished and removed in the fall of 2013, leaving an open dirt area that will be addressed by erosion controls, such as wattles and hydroseed. The Building 1436 demolition will remove approximately one acre of impervious area, resulting in reduced runoff volumes and a minor (1%) increase in percent capture by the low flow diversion for biofilter treatment. The demolition will also reduce the potential stormwater contaminant sources associated with building materials. The Expert Panel recommends ongoing inspection of the low flow diversion, comprehensive erosion controls post-building demolition, upper parking lot asphalt removal where possible, and treatment of runoff from the paved storage area near Building 1436. Treatment may be through passive Low Impact Development-type controls, or through detention if shown to provide equivalent water quality benefit.

10. B1BMP0004 (B-1 media filter inlet north): This monitoring subarea reflects runoff from approximately 3.7 acres of paved road and post-ISRA restored hillside. Based on eleven events, this subarea is ranked 10th overall (multi-constituent score = 0.53), 2nd for dioxins, 29th for metals, and 30.5th for TSS. This subarea drains to a series of rock check dams and the B-1 media filter which, after filtering runoff, discharges to a natural vegetated drainage across the main entrance at Facility Road. In 2012, hillside erosion controls were improved and curb cuts were added to even the distribution of inflows to the B-1 media filter on the south and north sides. Based on six events, the B-1 media filter effluent (B1SW0014-C) is ranked 35th overall (multi-constituent score = 0.2), 29th for dioxins, 63rd (last) for metals, and 58th (last) for TSS. Runoff from the paved area and road to the north, which otherwise enters a pipe that conveys runoff under the road and toward B1BMP0004, is slowed by sand bags surrounding the grate inlet. The Expert Panel recommends continued maintenance of the filter media bed, hillside erosion controls, pretreatment check dams, and curb cuts.

14.5. LPBMP0001-A (Lower Parking Lot sheetflow, post-gravel bag berms): This discontinued monitoring subarea, which has been replaced by the cistern influent sample at LPBMP0002, reflects runoff from 5.1 acres of mostly paved parking and road areas, after the gravel bag berms were installed in September of 2011 to slow runoff and allow for some detention. Soil management and contractor staging activities are also planned to occur here, but were not present during the period reflected by this dataset. Based on six events, this subarea is ranked 14.5th overall (multi-constituent score = 0.50), 3rd for dioxins, 37.5th for metals, and 24.5th for TSS. This same subarea, based on two events prior to the installation of the gravel bag berms (LPBMP0001), was ranked 14.5 overall (multi-constituent score = 0.50), 21st for dioxins, 10th for metals, and 13th for TSS. This area is currently being treated with a sedimentation basin and biofilter, in anticipation of increased soil stockpile activity.

14.5. B1SW0002 (Woolsey Canyon Road runoff): This discontinued monitoring subarea, which has been replaced by sampling location B1BMP0004, reflects overland and shallow concentrated runoff from approximately 1.3 acres of mostly paved road at the intersection of Facility Road and Woolsey Canyon Road. Based on two events, this subarea is ranked 14.5th overall (multi-constituent score = 0.50), 21st for dioxins, 10th for metals, and 13th for TSS. This area drains toward the north inlet of the B-1 media filter along an earthen channel with rip rap check structures.

14.5. B1BMP0001 (B-1 media filter inlet (post-media filter installation)): This discontinued monitoring subarea, which has been replaced by sampling location B1BMP0005, reflects runoff from approximately 4.5 acres of stormwater influent to the B-1 media filter. This subarea represents untreated stormwater before being treated through the media bed and then discharged by the media bed. Based on three events, this subarea is ranked 14.5th overall (multi-constituent score = 0.50), 21st for dioxins, 10th for metals, and 13th for TSS.

14.5. LXBMP0006 (LOX east, runoff along dirt road): This monitoring subarea reflects runoff from approximately 0.43 acres of the LOX area prior to being discharged to the Northern Drainage. Based on one event, this subarea is ranked 14.5th overall (multi-constituent score = 0.50), 21st for dioxins, 10th for metals, and 13th for TSS. NASA is currently performing ISRA actions in this subarea , which began in July 2013 and are planned to be completed by the end of 2013. The Expert Panel recommends robust erosion and sediment controls during and following this soil removal work.

14.5. LPBMP0002 (Lower parking lot influent to cistern): This monitoring subarea reflects runoff from approximately 4.2 acres of mostly impervious parking lot that is collected in a trench drain. The subarea represents untreated stormwater before it is collected in the trench drain that drains to the cistern for pre-treatment before being pumped to the sedimentation basin and biofilter. Based on one event, this subarea is ranked 14.5th overall (multi-constituent score = 0.50), 21st for dioxins, 10th for metals, and 58th (lowest) for TSS. The Expert Panel recommends no new actions at this time to address runoff from this subarea because the sedimentation basin and biofilter are in place.

14.5. EVBMP0006 (2012/13 Area II Road near ELV ditch): This monitoring subarea, added during the 2012/13 water year, reflects runoff from approximately 11 acres of Area II Road to the west of the intersection with Helipad Road. Based on one event, this subarea is ranked 14.5th overall (multi-constituent score = 0.50), 21st for dioxins, 10th for metals, and 13th for TSS. Runoff from this area drains along the north edge of the Area II road toward CM-1. The Expert Panel recommends no new actions at this time to address runoff from this subarea because the subarea will either be treated by NASA's new ELV treatment system or it will be part of very minor residual flows that will go to CM-1.

14.5. B1SW0014-A (B-1 media filter effluent (pre-media filter reconstruction)): This discontinued subarea reflects 4.7 acres of treated stormwater runoff from Facility Road that discharged through the originally constructed B-1 media filter. This sampling location was discontinued after the B-1 media filter was reconstructed with a new underdrain system in December 2011. Based on one event, this subarea is ranked 14.5th overall (multi-constituent score = 0.50), 21st for dioxins, 10th for metals, and 13th for TSS. This area contributing to this former sampling location was also improved through the addition of improved hillside erosion controls and curb cuts, which occurred in December of 2011, respectively. Based on six events, this subarea (now named B1SW0014-C) is now ranked 35th overall, 29th for dioxins, 63rd for metals, and 58th (last) for TSS but has been discontinued and replaced with location B1BMP0006, which reflects effluent from the reconstructed B-1 media filter.

14.5. LPBMP0001 (Lower Parking Lot sheetflow, pre-gravel bag berms): This discontinued subarea, which has been replaced by the monitoring at the trench drain of the new sedimentation basin and biofilter (LPBMP0002), reflects runoff from 5.1 acres of mostly paved parking and road areas, before the gravel bag berms were installed in September of 2011 to slow runoff and allow for some detention (see LPBMP0001-A discussion above) . Based on two events, this subarea ranked 14.5th overall, (multi-constituent score = 0.50), 21st for dioxins, 10th for metals, and 13th for TSS. This area is now being treated with a sedimentation basin and biofilter BMP, in anticipation of increased soil stockpile activity.

2012 BMP Recommendations and Status Updates

Based on the 2012 ranking results, the following recommendations were made by the Expert Panel in the 2012 Annual Report.

1. **ELV/CM-1 (NASA):** The Expert Panel's 2012 treatment system recommendations are currently being constructed. Construction began in June 2013. The Panel also recommended that the upper paved ELV and Helipad areas be swept, and that regular maintenance of pumps and berms be performed. Maintenance of infiltration holes is optional since cumulative infiltration through these holes is not known.

2. **Helipad (NASA):** In 2012, the Expert Panel recommended asphalt removal and contouring. This plan is currently on hold. Additional runoff will be routed toward the Helipad from the western paved area around the ELV building. NASA's long term plan is to remove the asphalt from the Helipad area (anticipated to occur in 2014) and then re-vegetate. The Panel's current recommendations for this area were described earlier.

3. **24-inch drain beneath Lower Lot (Boeing):** In 2012, the Expert Panel recommended biofiltration or equivalent above ground natural treatment systems around storm drain inlets and remaining impervious areas, and post-demolition erosion controls around Building 1436 and any removed asphalt areas of the upper parking lot. The current demolition plan is for removal of Building 1436 in 2013. The Panel's existing recommendations for this area were described earlier.

4. **B-1 Area (Boeing):** In 2012 the Expert Panel recommended continued maintenance activities to enhance the performance of the existing media filter. Expert Panel recommendations in the 2012 report were completed in 2012. These recommendations included curb cuts along the entrance road northwest of the existing rock check dams. These curb cuts divert runoff from the pavement to the north side of the B-1 media filter, rather than the south side, to better balance influent delivery to the two sides of the treatment system. Additional improvements installed in 2012 in this area included rock stabilization at the outlet of the curb cuts and stabilization measures (e.g., hydroseed) on denuded and exposed sloped soils.

5. **CM-9 (Boeing):** Expert Panel's 2012 recommendations for this drainage were implemented in 2012. These recommendations included erosion control measures of straw wattles and hydromulch installed on the steep roadside embankments on both sides of the Area II Road. Additional recommendations including wattles along the channel or dirt path below and west of the former Building 1300 were installed in 2012. Recommended controls along the Area II Road included a low flow diversion to collect runoff from the Area II Road and divert these flows into a perforated pipe to distribute this runoff onto the vegetated sloped area to the south of the CM-9 location. A rock grade control structure (i.e., rock check dam) was installed in the drainage upstream of the CM-9 to provide storage volume and settle suspended sediment prior to reaching the media filter downstream. Additional recommendations installed in 2012 include replacing the filter fabric on the weir boards of the CM-9 culvert headwall.

6. **LOX Area (NASA):** In the 2012 BMP Ranking Memo, the LOX ISRA excavation was described as being tentatively planned for 2013. In August 2013, at the request of Boeing, the Expert Panel reviewed existing data (including stormwater concentrations, soil concentrations, and runoff flowrate estimates) for certain LOX areas (LOX 1A, 1B-4, 1C, and 1D) to evaluate the prudence of conducting ISRA excavations at each. Following discussion with Boeing, and their remediation consultants, the Panel recommended that ISRA activities be considered for integration into the larger site wide AOC cleanup efforts planned by NASA. The Expert Panel currently recommends that the sites be isolated hydrologically to the extent feasible and stabilized with vegetation and BMPs, and that monitoring in the area continue.

7. **Outfall 008:** Several improvements have been made to Outfall 008 in accordance with the *Santa Susanna Field Laboratory: Recommendations from Field Investigation of Outfall 008 Watershed* Memo (2012):

    - The temporary silt fence and straw bale road barriers were removed and replaced with rock berms.

    - The original recommendations included to extend an existing culvert standpipe to increase the inlet elevation of the standpipe and install a gravel mound around the standpipe. However, after mobilization the contractor identified that the culvert outlet was clogged with sediment and that the outlet was lower in elevation than the adjacent ground surface. The revised recommendation was to leave the culvert as found and rely on the rock berms to treat runoff through this area as described in the above bullet.

- Gravel water bars were extended to divert flow into the vegetation to the north or south of the access road. The discharge side of the road (i.e., at the down slope outlet of the gravel water bars) was excavate to create a side drain.
- Two riprap check dams were installed in the eastern tributary of the Outfall 008 flume.
- The riprap apron at the outfall flume was restored and enhanced and loose materials were stabilized on the side of the slopes immediately upstream of the flume inlet and around the sample box. The Expert Panel recommends consideration of extending the northeast flume inlet wall to improve flow measurement accuracy and to decrease erosion potential adjacent to the monitoring location.

Although this analysis primarily focuses on the selection of potential stormwater treatment control locations, the Expert Panel continues to strongly recommend the rigorous application of erosion and sediment control practices and stream channel stabilization measures throughout the 008 and 009 watersheds, including and especially at areas where substantial soil removal may be planned at steep areas and/or in proximity to drainage courses (such as at ELV, LOX, or the A2LF ISRA areas). The Expert Panel also continues to recommend the stabilization of unpaved roads and the implementation of source controls (including source removal, such as through the ISRA and demolition programs). Culverts should also continue to be inspected for evidence of piping, not only for water quality purposes, but also for safety concerns near the roadways.   Finally, it is important that routine maintenance be undertaken at all CM locations and where sedimentation basins have been constructed (e.g. above B-1).

The Expert Panel believes that new and planned activities, taken together, will improve the likelihood of NPDES compliance at Outfalls 008 and 009, based on currently available information.

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