S8.B Commercial and High Density Residential Sites Stormwater Quality Status and Trend Monitoring Report WY2010-2019

Under Washington's Phase I Municipal Stormwater Permit, Clark County has invested significant resources in stormwater characterization monitoring of two drainages dominated by either commercial (COM) or high density residential (HDR) land uses to evaluate both the status and changes over time in the quality of stormwater runoff from these drainages. Permit Appendix 9 requires that after several years of data gathering, the annual monitoring report shall include trend analyses. No specific guidance is provided regarding which parameters to analyze or which statistical methods to utilize for the trend analyses.

Since most of the monitored parameters were dominated by non-detect results, the analyses presented here focuses on "constituents in stormwater of major concern" as identified by Minton (Minton, G, 2002, p.28) that also had detectable concentrations in most samples. Additionally, the National Stormwater Quality Database (NSQD) report (Pitt et al., 2004) notes that the number of samples needed to provide statistically relevant conclusions is dependent on a study's objectives, data variation, and allowable errors (confidence and power). The NSQD report states that with a reasonable confidence of 95% (acceptable type 1 or false positive error rate of 5%), power of 80% (probability of correctly rejecting the null hypothesis when it is false), and commonly accepted allowable error of 25%, the number of samples needed to characterize conditions would likely range from 25 to 50. Additionally, a minimum of five years of data is often recommended for trend analyses (NYC Department of Environmental Protection, 2001, p. 479 and Jakowyna and Donohue, 2008, web page document download).

The following status and trend analyses of Clark County's stormwater characterization monitoring results focus on the cumulative period of monitoring since water year 2010.

Methods

Trend analyses were performed following a consistent process on fourteen stormwater constituents (including storm flow) common to both the commercial and high density residential monitoring sites. The first step involved compiling and manipulating finalized water quality and flow data in preparation for statistical analyses. Initially, water quality monitoring data were queried from the county's water quality data base. Average sampled flows from each monitored storm were also integrated to enhance analyses. The reconfigured data were imported into WQSTAT PLUS software (Sanitas Technologies, 1998) for statistical analyses.

Background information and descriptive statistics were summarized and calculated for each of the analyzed parameters. Thirteen water quality parameters were analyzed, including fecal coliform bacteria, total suspended solids, turbidity, and both the dissolved and total fractions of several metals (i.e. cadmium, copper, lead, mercury, and zinc). With the exception of grab-sampled fecal coliform, all of the water quality results are based on event mean concentrations (EMC) from flow-weighted composite samples. Most of the data spanned from the beginning of monitoring in water year 2010 through water year 2019. Mercury monitoring was discontinued after approximately three years at the commercial site (March 2010 - January 2013) due to consistently low concentrations, but ran for about seven years (February 2012 –June 2019) at the high density residential site based on updated permit requirements.

Statistical assumptions were next evaluated for their potential impact on trend analyses and the preferred statistical analyses utilized. This step included evaluating normality, histograms, serial correlation, differences across both annual and seasonal box and whisker plots, and seasonality.

Helsel and Hirsch (Statistical Methods in Water Resources, 1992, pp. 8-9) note

> "Summary tables which include the median and other percentiles have far greater applicability to skewed data. Skewed data also call into question the applicability of hypothesis tests which are based on assumptions that the data have a normal distribution. These tests, called parametric tests, may be of questionable value when applied to water resources data, as the data are often neither normal nor even symmetric. The interquartile range (IQR or range of central 50 percent of the data) is the most commonly-used resistant (to impacts of outliers) measure of spread."

Based on the characteristics of the data frequency distributions and trend assumption evaluations, subsequent analyses primarily utilized medians, IQRs, and nonparametric statistical tests.

Given the random timing of both the composite and grab sampled storms and the limited sample size over the monitoring period, there are few options to address potential serial correlation in the statistical analyses of the COM and HDR data. If points within a data series are not independent (that is, exhibit auto-correlation) the risk of falsely detecting a trend is increased (Jakowyna and Donohue, 2008). While there may be alternative analyses to address

serial correlation and possible information redundancy (such as subsampling, summary statistics on subgroups, or more sophisticated estimation methods) (Helsel and Hirsch, 1992, pp. 252-253), these analyses are beyond the scope of this project and likely not feasible given the characteristics of the data set.

Helsel and Hirsch (Helsel and Hirsch, 1992, p.329) summarized the potential impact of confounding variables on water quality trends.

> "Variables other than time (T) trend often have considerable influence on the random response variable of interest (Y). These 'exogenous' variables are usually natural, random phenomena such as rainfall, temperature or streamflow. By removing the variation in Y caused by these variables, the background variability or 'noise' is reduced so that any trend 'signal' present can be seen. The ability (power) of a trend test to discern changes in Y with T is then increased. The removal process involves modeling, and thus explaining, the effect of exogenous variables with regression or LOWESS (LOcally Weighted Scatterplot Smoothing)."

The manual for the WQStat Plus (Sanitas Technologies, 1998, p. 79) statistical package specifically describes using flow adjustment to address the confounding effects of flow.

> "Flow adjusting data allows the user to relate stream-flow to various constituents and to remove flow effects prior to further statistical analysis. The most common application of flow adjustment is trend analysis. For water quality constituents, which are closely related to flow, an apparent trend in quality could be caused by a change in flow. By flow adjusting before trend analysis, the user can remove flow effects and determine the magnitude and statistical significance of trends, which are not explained by flow. Often trend analyses will be performed both with and without flow adjustments to identify trends, which are related to flow as well as those which are not related to flow."

For each monitoring site, this project followed this dual approach of trend analyses on both non-flow-adjusted and flow-adjusted data. The exogenous variable flow was addressed using parameter-specific linear regression models based on average sampled flows for composite-sampling events. Average sampled flows are calculated by dividing each sampled storm volume by its sampling duration. The derived flow-adjusted concentration values were used for descriptive statistics and trend analyses to help evaluate possible confounding impacts of flow.

Helsel and Hirsch also discuss dealing with seasonality in water quality data (Helsel and Hirsch, 1992, pp.337-338).

> "There are many instances where changes between different seasons of the year are a major source of variation in the Y variable. As with other exogenous effects, seasonal variation must be compensated for or 'removed' in order to better discern the trend in Y over time. Seasonality often remains even after discharge affects have been removed."

Importantly, Helsel and Hirsch note:

> "When one is forced, by the sheer number of analyses that must be performed (say a many-station, many-variable trend study) to work without detailed case-by-case checking of assumptions, then nonparametric procedures are ideal. They are always nearly as powerful as regression, and the failure to edit out or correctly transform a small percentage of outlying data will not have a substantial effect on the results (Helsel and Hirsch, 1992, p.329)."

Due to the large number of water quality parameters and the statistical assumptions evaluated, this project utilized the nonparametric Mann-Kendall or Seasonal Kendall trend tests and slope estimators depending on presence of seasonality. Specifically, nonparametric trend analyses were selected because none of the analyzed parameters met the assumption for a normal distribution and only a minority of them might achieve normality through transformations.

Finally, each parameter's median values and trends were evaluated relative to regional or national medians and for statistical and practical significance. This step involved contextual evaluations of the following information: the latest applicable estimated trend values; annual changes based on estimated trend slopes; monitoring period means and medians; comparisons with recent land use specific water quality medians; subtractive differences between the regional and national medians versus the latest estimated trend values; and estimates of time for extending the trends either forward or backward to reach the regional or national medians. In summary, the practical significance of potential trends is presented relative to improving or degrading water quality within projected ten-year time periods.

Results and Discussion

This report focuses on trend analyses of flow-weighted composite stormwater samples using both non-flow-adjusted and flow-adjusted data. Trend analysis of average sampled flow is also evaluated for potential impact on other parameters. Grab samples for fecal coliform are excluded from flow-adjusted analyses. Only non-flow-adjusted regional and national medians are available for comparisons and context.

Consistent with this project's earlier findings, the vast majority of paired non-flow-adjusted and flow-adjusted trends had the same or similar values for significance, direction, and magnitude. Due to these similarities and the lack of comparable regional or national flow-adjusted descriptive statistics, this report's status and trend test evaluation tables only present results for non-flow-adjusted data. The only exceptions to this similarity between pre- and post- flow adjusted trend tests were:

- higher confidence in the decreasing trends for dissolved lead and total mercury at the COM site
- switching dissolved lead and mercury trends at the HDR site to non-significant
- switching total mercury trend at the HDR site to a slightly significant decreasing trend (80% confidence level).

Table 1 and Table 2 summarize parameter background information and descriptive statistics for the COM and HDR sites for the monitoring period from March 2010 through water year 2019. Monitoring periods for dissolved and total mercury covered March 2010 through January 2013 for the commercial site, and February 2012 through June 2019 for the high density residential site. With the exception of mercury, the vast majority of results for all water quality parameters were above detection limits.

Total composite sample counts for the COM site were 99 for all parameters except for mercury (34). There were 85 fecal coliform grab-sample results.

Total composite sample counts for the HDR site were 96 for all parameters except for mercury (64). There were 80 fecal coliform grab-sample results.

Medians were only calculated (as applicable) for non-flow-adjusted data sets since comparable regional and national flow-adjusted medians were not available for comparison. Median values tended to be higher at COM than HDR for all parameters except fecal coliform, dissolved copper, dissolved zinc, and total zinc. Differences between COM and HDR medians were not tested for statistical significance.

Table 1

Commercial Site WY2010-19 Stormwater Characterization Background and Descriptive Statistics												
Monitored Parameters Background							Descriptive Statistics					
Parameter	Flow Adjusted	Units	Data Range	Number of Nondetects	Percent Nondetects	Ecology MRL	Sample Size (n)	Maximum	Minimum	9-year Means	Std. Dev.	9-year Medians
Average Sampled Flow	No	gal/sec	3/29/10-6/7/19	0	0%	na	99	11.41	0.27	1.97	1.74	1.55
Fecal Coliform	No	MPN	3/29/10-6/6/19	0	0%	2	85	11000	14	976	1528	350
Dissolved Cadmium	No	ug/L	3/29/10-6/7/19	0	0%	0.1	99	0.142	0.01	0.03	0.02	0.02
Dissolved Cadmium	Yes	ug/L	3/29/10-6/7/19	0	0%	0.1	99	0.137	0.01	0.03	0.02	
Total Cadmium	No	ug/L	3/29/10-6/7/19	0	0%	0.2	99	0.976	0.026	0.188	0.173	0.139
Total Cadmium	Yes	ug/L	3/29/10-6/7/19	0	0%	0.2	99	0.994	0.027	0.188	0.173	
Dissolved Copper	No	ug/L	3/29/10-6/7/19	2	2%	0.1	99	22.2	1.48	4.9	3.0	4.1
Dissolved Copper	Yes	ug/L	3/29/10-6/7/19	2	2%	0.1	99	20.1	1.74	4.9	2.8	
Total Copper	No	ug/L	3/29/10-6/7/19	0	0%	0.5	99	70.2	5.08	19.9	11.6	17.1
Total Copper	Yes	ug/L	3/29/10-6/7/19	0	0%	0.5	99	72.4	5.11	19.9	11.7	
Dissolved Lead	No	ug/L	3/29/10-6/7/19	0	0%	0.1	99	0.744	0.014	0.120	0.120	0.083
Dissolved Lead	Yes	ug/L	3/29/10-6/7/19	0	0%	0.1	99	0.685	0.019	0.120	0.114	
Total Lead	No	ug/L	3/29/10-6/7/19	0	0%	0.1	99	101	1.38	15	15	10
Total Lead	Yes	ug/L	3/29/10-6/7/19	0	0%	0.1	99	106	1.36	15	16	
Dissolved Mercury	No	ug/L	3/29/10-1/23/13	30	88%	0.1	34	0.04	0.01	0.01	0.01	0.01
Dissolved Mercury	Yes	ug/L	3/29/10-1/23/13	30	88%	0.1	34	0.04	0.01	0.01	0.01	
Total Mercury	No	ug/L	3/29/10-1/23/13	23	68%	0.1	34	0.08	0.01	0.02	0.02	0.01
Total Mercury	Yes	ug/L	3/29/10-1/23/13	23	68%	0.1	34	0.09	0.01	0.02	0.02	
Total Suspended Solids	No	mg/L	3/29/10-6/7/19	0	0%	1	99	582	11.5	125	114	89
Total Suspended Solids	Yes	mg/L	3/29/10-6/7/19	0	0%	1	99	574	12.1	125	112	
Turbidity	No	NTU	3/29/10-6/7/19	0	0%	0.2	99	189	12.8	48	35	36
Turbidity	Yes	NTU	3/29/10-6/7/19	0	0%	0.2	99	183	13.1	48	35	
Dissolved Zinc	No	ug/L	3/29/10-6/7/19	0	0%	1	99	106	13.8	27	13	24
Dissolved Zinc	Yes	ug/L	3/29/10-6/7/19	0	0%	1	99	99	13.5	27	12	
Total Zinc	No	ug/L	3/29/10-6/7/19	0	0%	5	99	421	26.9	113	74	93
Total Zinc	Yes	ug/L	3/29/10-6/7/19	0	0%	5	99	418	27.2	113	74	

Table 2

High Density Residential Site WY2010-19 Stormwater Characterization Background and Descriptive Statistics												
Monitored Parameters Background							Descriptive Statistics					
Parameter	Flow Adjusted	Units	Data Range	Number of Nondetects	Percent Nondetects	Ecology MRL	Sample Size (n)	Maximum	Minimum	9-year Means	Std. Dev.	9-year Medians
Average Sampled Flow	No	gal/sec	3/28/10-6/27/19	0	0%	na	96	23.6	0.27	6.1	5.0	4.9
Fecal Coliform	No	MPN	4/15/10-6/26/19	0	0%	2	80	92000	17	6048	13865	1600
Dissolved Cadmium	No	ug/L	3/28/10-6/27/19	4	4%	0.1	96	0.106	0.0025	0.020	0.014	0.018
Dissolved Cadmium	Yes	ug/L	3/28/10-6/27/19	4	4%	0.1	96	0.057	0.004	0.020	0.011	
Total Cadmium	No	ug/L	3/28/10-6/27/19	1	1%	0.2	96	0.614	0.003	0.062	0.076	0.041
Total Cadmium	Yes	ug/L	3/28/10-6/27/19	1	1%	0.2	96	0.554	0.004	0.062	0.072	
Dissolved Copper	No	ug/L	3/28/10-6/27/19	2	2%	0.1	96	24.2	1.67	5.2	3.7	4.2
Dissolved Copper	Yes	ug/L	3/28/10-6/27/19	2	2%	0.1	96	24.1	1.41	5.2	3.5	
Total Copper	No	ug/L	3/28/10-6/27/19	0	0%	0.5	96	88.9	1.89	12.3	12.7	7.8
Total Copper	Yes	ug/L	3/28/10-6/27/19	0	0%	0.5	96	87.3	1.90	12.3	12.6	
Dissolved Lead	No	ug/L	3/28/10-6/27/19	0	0%	0.1	96	1.92	0.017	0.11	0.25	0.05
Dissolved Lead	Yes	ug/L	3/28/10-6/27/19	0	0%	0.1	96	1.62	0.028	0.11	0.19	
Total Lead	No	ug/L	3/28/10-6/27/19	0	0%	0.1	96	34.1	0.149	2.4	4.1	1.3
Total Lead	Yes	ug/L	3/28/10-6/27/19	0	0%	0.1	96	38.8	0.116	2.4	4.4	
Dissolved Mercury	No	ug/L	2/21/12-6/27/19	60	94%	0.1	64	0.1	0.01	0.01	0.01	0.01
Dissolved Mercury	Yes	ug/L	2/21/12-6/27/19	60	94%	0.1	64	0.08	0.008	0.01	0.01	
Total Mercury	No	ug/L	2/21/12-6/27/19	59	92%	0.1	64	0.14	0.01	0.01	0.02	0.01
Total Mercury	Yes	ug/L	2/21/12-6/27/19	59	92%	0.1	64	0.11	0.008	0.01	0.01	
Total Suspended Solids	No	mg/L	3/28/10-6/27/19	2	2%	1	96	509	2.5	48	75	24
Total Suspended Solids	Yes	mg/L	3/28/10-6/27/19	2	2%	1	96	678	2.1	48	85	
Turbidity	No	NTU	3/28/10-6/27/19	0	0%	0.2	96	114	4.67	15	14	11
Turbidity	Yes	NTU	3/28/10-6/27/19	0	0%	0.2	96	124	4.75	15	15	
Dissolved Zinc	No	ug/L	3/28/10-6/27/19	0	0%	1	96	1260	35.6	181	198	114
Dissolved Zinc	Yes	ug/L	3/28/10-6/27/19	0	0%	1	96	1347	39.2	181	194	
Total Zinc	No	ug/L	3/28/10-6/27/19	0	0%	5	96	1570	46.8	277	272	172
Total Zinc	Yes	ug/L	3/28/10-6/27/19	0	0%	5	96	1594	47.2	277	271	

Evaluations of statistical trend analyses assumptions are summarized in Table 3 and Table 4. Statistical tests of distributions for normality and evaluations of the histograms showed none of the results were normally distributed. Chronologically ordered results for most of the monitored parameters exhibited statistically significant serial correlation indicating potential redundancy in the information they depict. Interpretations of annual and seasonal box plots concisely illustrated inter-annual and seasonal variability.

Seasonality statistical tests were performed using a wet season of October through April versus a dry season of May through September (Kruskal-Wallis tests results shown in Table 3 and Table 4, where green shading highlights significant seasonality and blue the absence of significant seasonality). These tests indicated that significant seasonality often exists regardless of whether the parameters were flow-adjusted. In fact, seasonality was only absent for the following parameters: average sampled flow and mercury at both sites; dissolved lead at the COM site and; fecal coliform and flow adjusted dissolved cadmium at the HDR site.

Table 5 and Table 6 summarize the results of nonparametric trend tests on non-flow-adjusted and flow-adjusted data for the COM and HDR sites. At least half of the significant trends had changes over nine years that were greater than 25% of their mean.

The Mann-Kendall trend test and Sen's slope estimators were utilized for those parameters that showed no significant seasonality (blue shaded cells in tables 5 and 6). At the COM site, most (5 of 7) of the parameters not showing seasonality tested as having statistically significant Mann-Kendall trends at confidence levels of 80% (2), 95% (2), and 99% (1) (grey shaded cells in the trend evaluation column). At the HDR site, two thirds (4 of 6) of the parameters not showing seasonality also tested as having statistically significant Mann-Kendall trends at confidence levels of 80% (1), 90% (1), 99% (1), and 99.9% (1) (grey shaded cells).

The Seasonal Kendall trend test and slope estimators were utilized for those parameters that showed significant seasonality (light green shaded cells in tables 5 and 6). Most (15 of 19 parameters exhibiting seasonality at the COM site also had significant seasonal Kendall trends at confidence levels of 80% (2), 90% (1), and 95% (12) (grey shaded cells). Just over half (11 of 20) of the parameters exhibiting seasonality at the HDR site also had significant seasonal Kendall trends at confidence levels of 90% (1) and 95% (10) (grey shaded cells).

Table 3

Commercial Site WY2010-19 Stormwater Characterization Trend Assumptions Evaluation										
			Test If Normal Distribution (possible normality transformation)		Histogram of Frequency Distribution		Test for Serial Correlation:	Box & Whisker Plots		Seasonality Test:
					Skewness	Kurtosis	Rank Von Neumann	Annual (Based on Calendar Years)	Seasonal	Kruskal-Wallis Test (α of .05)
Parameter	Flow Adjusted	Units	Shapiro-Wilk: when n<50 (alpha = 0.05)	Shapiro-Francia: when n>=50, (alpha = 0.05)	(+=right, -=left)	(<-1: flatter peak/short tails, |value|<1 to 0: about normal, >1: more peaked/long tails)	(Smallest alpha if found significant)	IQR's Rel. Size, Similarity, Overlap	Seasonal IQRs Overlap	(Ho:same seasonal medians May-Sep vs. Oct-Apr)
Average Sampled Flow	No	gal/sec	na	No (ln)	2.61	9.93	Yes (0.025)	2013 IQR widest & highest but all full yrs still overlap	Yes	No Seasonality
Fecal Coliform	No	MPN	na	No (ln)	3.9	22.03	Yes (0.1)	2015/16 IQRs wider & higher, most yrs overlap except very high '19 (n=2)	Yes	Yes - Significant Seasonality
Dissolved Cadmium	No	ug/L	na	No (none)	4.01	24.58	Yes (0.01)	Most Yrs Similar / Overlap	Yes	Yes - Significant Seasonality
Dissolved Cadmium	Yes	ug/L	na	No (none)	3.89	23.68	Yes (0.01)	Most Yrs Similar / Overlap	Slight	Yes - Significant Seasonality
Total Cadmium	No	ug/L	na	No (ln)	2.35	6.62	Yes (0.005)	2010/13 IQRs wider & higher, most yrs overlap except very high '10 (n=9)	Yes	Yes - Significant Seasonality
Total Cadmium	Yes	ug/L	na	No (ln)	2.37	6.87	Yes (0.005)	2010/13 IQRs wider & higher, most yrs overlap except very high '10 (n=9)	Slight	Yes - Significant Seasonality
Dissolved Copper	No	ug/L	na	No (ln)	2.56	11.03	Yes (0.005)	Most Yrs Similar / Overlap except for high 2019 (n=2)	No	Yes - Significant Seasonality
Dissolved Copper	Yes	ug/L	na	No (none)	2.59	10.05	Yes (0.005)	Most Yrs Similar / Overlap except for high 2019 (n=2)	No	Yes - Significant Seasonality
Total Copper	No	ug/L	na	No (ln)	1.96	5.19	Yes (0.005)	2010/13 IQRs wider & higher, most full yrs overlap except very high '19 (n=2)	Slight	Yes - Significant Seasonality
Total Copper	Yes	ug/L	na	No (ln)	2.06	5.98	Yes (0.005)	2010/13 IQRs wider & higher, most full yrs overlap except very high '19 (n=2)	Very Slight	Yes - Significant Seasonality
Dissolved Lead	No	ug/L	na	No (ln)	2.91	10.98	Yes (0.005)	Most Yrs Similar / Overlap except wider and higher for 2010 (n=9)	Yes	No Seasonality
Dissolved Lead	Yes	ug/L	na	No (none)	2.7	9.47	Yes (0.005)	Most Yrs Similar / Overlap except wider and higher for 2010 (n=9)	Yes	No Seasonality
Total Lead	No	ug/L	na	No (ln)	3.07	12.8	Yes (0.005)	Most Yrs Similar / Overlap except wider and higher for 2010 (n=9)	Yes	Yes - Significant Seasonality
Total Lead	Yes	ug/L	na	No (ln)	3.25	14.43	Yes (0.005)	Most Yrs Similar / Overlap except wider and higher for 2010 (n=9)	Slight	Yes - Significant Seasonality
Dissolved Mercury	No	ug/L	No (none)	na	3.3	12.25	Yes (0.005)	Very limited range in IQRs due to most ND values	Slight	No Seasonality
Dissolved Mercury	Yes	ug/L	No (none)	na	3.2	11.26	Yes (0.005)	Very limited range in IQRs due to most ND values	Slight	No Seasonality
Total Mercury	No	ug/L	No (none)	na	2.41	6.46	Yes (0.005)	Early IQR's width larger & higher than latter IQR's	Yes	No Seasonality
Total Mercury	Yes	ug/L	No (none)	na	2.95	10.86	Yes (0.05)	Early IQR's width larger & higher than latter IQR's	Yes	No Seasonality
Total Suspended Solids	No	mg/L	na	No (ln)	2.21	5.54	Yes (0.005)	2010/13 IQRs wider & higher, most full yrs overlap except very high '19 (n=2)	Slight	Yes - Significant Seasonality
Total Suspended Solids	Yes	mg/L	na	No (ln)	2.11	4.9	Yes (0.005)	'10,'11&'13 IQRs wider & higher, most full yrs overlap except very high '19 (n=2)	Slight	Yes - Significant Seasonality
Turbidity	No	NTU	na	No (ln)	1.85	3.72	Yes (0.005)	Most Yrs Similar / Overlap except for high 2019 (n=2)	Partial	Yes - Significant Seasonality
Turbidity	Yes	NTU	na	No (ln)	1.89	4.02	No (at α of 0.005)	Most Yrs Similar / Overlap except for high 2019 (n=2)	Partial	Yes - Significant Seasonality
Dissolved Zinc	No	ug/L	na	No (none)	2.97	14.15	Yes (0.005)	Most Yrs Similar / Overlap except for high 2019 (n=2)	Slight	Yes - Significant Seasonality
Dissolved Zinc	Yes	ug/L	na	No (none)	2.96	13.24	Yes (0.005)	Most Yrs Similar / Overlap except for high 2019 (n=2)	No	Yes - Significant Seasonality
Total Zinc	No	ug/L	na	No (ln)	1.83	4.04	Yes (0.005)	Most Yrs Similar / Overlap except for high 2019 (n=2)	Slight	Yes - Significant Seasonality
Total Zinc	Yes	ug/L	na	No (ln)	1.9	4.56	Yes (0.005)	Most Yrs Similar / Overlap except for high 2019 (n=2)	Slight	Yes - Significant Seasonality

Table 4

High Density Residential Site WY2010-19 Stormwater Characterization Trend Assumptions Evaluation										
			Test If Normal Distribution (possible normality transformation)		Histogram of Frequency Distribution		Test for Serial Correlation:	Box & Whisker Plots		Seasonality Test:
					Skewness	Kurtosis	Rank Von Neumann	Annual (Based on Calendar Years)	Seasonal	Kruskal-Wallis Test (α of .05)
Parameter	Flow Adjusted	Units	Shapiro-Wilk: when n<50 (alpha = 0.05)	Shapiro-Francia: when n>=50, (alpha = 0.05)	(+=right, -=left)	(<-1: flatter peak/short tails, |value|<1 to 0: about normal, >1: more peaked/long tails)	(Smallest alpha if found significant)	IQR's Rel. Size, Similarity, Overlap	Seasonal IQRs Overlap	(Ho:same seasonal medians May-Sep vs. Oct-Apr)
Average Sampled Flow	No	gal/sec	na	No (ln/cube root)	1.65	3.05	Yes (0.01)	'13 (n=6) & '19 (n=2) higher than '11 & '12 narrow IQRs but most yrs overlap	Yes	No Seasonality
Fecal Coliform	No	MPN	na	No (ln)	4.06	20.44	Yes (0.005)	2015-18 IQRs wider & higher but most yrs overlap except higher '19 (n=2)	Slight	No Seasonality
Dissolved Cadmium	No	ug/L	na	No (none)	2.9	15.01	Yes (0.005)	Most Yrs Similar / Overlap except '15 narrower / lower, '19 higher (n=2)	Yes	Yes - Significant Seasonality
Dissolved Cadmium	Yes	ug/L	na	No (ln/cube root)	1.37	2.02	Yes (0.025)	Most Yrs Similar / Overlap except '10 (n=6) wider / higher, '19 higher (n=2)	Yes	No Seasonality
Total Cadmium	No	ug/L	na	No (none)	4.54	29.4	Yes (0.005)	Most Yrs Similar / Overlap except '13 (n=6) wider / higher, '19 higher (n=2)	No	Yes - Significant Seasonality
Total Cadmium	Yes	ug/L	na	No (none)	4.01	23.19	Yes (0.005)	Most Yrs Similar / Overlap except '13 (n=6) wider / higher, '19 higher (n=2)	No	Yes - Significant Seasonality
Dissolved Copper	No	ug/L	na	No (none)	2.86	10.7	Yes (0.005)	Most Yrs Similar / Overlap except '14 narrower and '19 much higher (n=2)	No	Yes - Significant Seasonality
Dissolved Copper	Yes	ug/L	na	No (none)	2.93	11.94	Yes (0.005)	Most Yrs Similar / Overlap except '14 narrower and '19 much higher (n=2)	No	Yes - Significant Seasonality
Total Copper	No	ug/L	na	No (none)	3.46	15.6	Yes (0.005)	Most Yrs Similar / Overlap except '13 (n=6) wider / higher, '19 much higher (n=2)	No	Yes - Significant Seasonality
Total Copper	Yes	ug/L	na	No (none)	3.41	14.96	Yes (0.005)	Most Yrs Similar / Overlap except '13 (n=6) wider / higher, '19 much higher (n=2)	No	Yes - Significant Seasonality
Dissolved Lead	No	ug/L	na	No (none)	5.97	39.02	Yes (0.05)	Most Yrs Similar / Overlap except '19 much higher (n=2)	Slight	Yes - Significant Seasonality
Dissolved Lead	Yes	ug/L	na	No (none)	5.83	40.65	Yes (0.1)	Most Yrs Similar / Overlap except '19 much higher (n=2)	Yes	Yes - Significant Seasonality
Total Lead	No	ug/L	na	No (none)	5.57	40.3	Yes (0.005)	Most Yrs Similar / Overlap except '13 (n=6) wider / higher, '19 much higher (n=2)	No	Yes - Significant Seasonality
Total Lead	Yes	ug/L	na	No (none)	6.2	48.54	Yes (0.01)	Most Yrs Similar / Overlap except '13 (n=6) wider / higher, '19 much higher (n=2)	No	Yes - Significant Seasonality
Dissolved Mercury	No	ug/L	na	No (none)	6.39	46.3	Yes (0.005)	Most Yrs Similar / Overlap except '18 much wider	Yes	Yes - Significant Seasonality
Dissolved Mercury	Yes	ug/L	na	No (none)	6.02	42.31	No (even at α of 0.1)	Most Yrs Similar / Overlap except lower for 2012 (n=1)	Yes	No Seasonality
Total Mercury	No	ug/L	na	No (none)	7.05	55.04	Yes (0.005)	Most Yrs Similar / Overlap except '13 & '18 much wider	No	No Seasonality
Total Mercury	Yes	ug/L	na	No (none)	6.66	50.28	No (even at α of 0.1)	Most Yrs Similar / Overlap except '12 (n=1) lower and '13 & '18 much wider	Slight	No Seasonality
Total Suspended Solids	No	mg/L	na	No (none)	3.78	17.61	Yes (0.05)	Most Yrs Similar / Overlap except '13 (n=6) wider / higher, '19 much higher (n=2)	Slight	Yes - Significant Seasonality
Total Suspended Solids	Yes	mg/L	na	No (none)	5.06	33.13	Yes (0.025)	Most Yrs Similar / Overlap except '13 (n=6) wider / higher, '19 much higher (n=2)	No	Yes - Significant Seasonality
Turbidity	No	NTU	na	No (none)	4.44	27.76	Yes (0.1)	Most Yrs Similar / Overlap except '19 much higher (n=2)	No	Yes - Significant Seasonality
Turbidity	Yes	NTU	na	No (none)	4.93	33.58	Yes (0.1)	Most Yrs Similar / Overlap except '19 much higher (n=2)	No	Yes - Significant Seasonality
Dissolved Zinc	No	ug/L	na	No (none)	3.27	13.24	Yes (0.005)	'10-'14 IQRs tend to overlap & be higher; '15-'19 (except '17) narrower & lower	Yes	Yes - Significant Seasonality
Dissolved Zinc	Yes	ug/L	na	No (none)	3.33	14.63	Yes (0.005)	'10-'14 IQRs tend to overlap & be higher; '15-'19 (except '17) narrower & lower	Yes	Yes - Significant Seasonality
Total Zinc	No	ug/L	na	No (none)	2.48	7.47	Yes (0.005)	Most Yrs Similar / Overlap except '13 (n=6) wider / higher, '19 narrower (n=2)	Yes	Yes - Significant Seasonality
Total Zinc	Yes	ug/L	na	No (none)	2.46	7.52	Yes (0.005)	Most Yrs Similar / Overlap except '13 (n=6) wider / higher, '19 narrower (n=2)	Yes	Yes - Significant Seasonality

Table 5

Commercial Site WY2010-19 Stormwater Characterization Trend Tests													
			Nonparametric Trend Tests (over time)										
			Mann-Kendall Trend Tests & Sen's Slope Estimators					Seasonal Kendall Trend Tests and Slope Estimators					
Parameter	**Flow Adjusted**	**Units**	Trend Evaluation: Direction & Highest Significant Confidence Level (Maximum tested 99.9% C.L.)	Slope (units/yr)	Estimated 9-yr Change	% Change of 9-yr Mean for M.K. Trends (bold: C.L. >= 80% & Change >Abs. 25%)	Est. Latest M.K. Trend Value	Trend Evaluation: Direction & Highest Significant Confidence Level (Maximum tested 95% C.L.)	Slope (units/yr)	Estimated 9-yr Change	% Change of 9-yr Mean for S.K. Trends (bold: C.L. >= 80% & Change > Abs. 25%)	Est. Latest S.K. Trend Value
Average Sampled Flow	No	gal/sec	Decreasing at 80% C.L.	-0.05	-0.45	-23%	1.3	Decreasing at 90% C.L.	-0.07	-0.63	**-32%**	1.2
Fecal Coliform	No	MPN	Increasing at 80% C.L.	16	146	15%	400	No significant trend even at 80% C.L.	0	0	0%	350
Dissolved Cadmium	No	ug/L	Decreasing at 99.9% C.L.	-0.001	-0.01	**-42%**	0.017	Decreasing at 95% C.L.	-0.001	-0.01	**-39%**	0.018
Dissolved Cadmium	Yes	ug/L	Decreasing at 99.9% C.L.	-0.001	-0.01	**-47%**	0.017	Decreasing at 95% C.L.	-0.001	-0.01	**-43%**	0.017
Total Cadmium	No	ug/L	Decreasing at 99.9% C.L.	-0.022	-0.20	**-105%**	0.038	Decreasing at 95% C.L.	-0.020	-0.18	**-96%**	0.045
Total Cadmium	Yes	ug/L	Decreasing at 99.9% C.L.	-0.022	-0.20	**-104%**	0.04	Decreasing at 95% C.L.	-0.020	-0.18	**-96%**	0.048
Dissolved Copper	No	ug/L	No significant trend even at 80% C.L.	0.004	0.04	1%	4.13	No significant trend even at 80% C.L.	0.03	0.2	5%	4.35
Dissolved Copper	Yes	ug/L	No significant trend even at 80% C.L.	-0.03	-0.2	-5%	3.98	No significant trend even at 80% C.L.	-0.001	-0.009	0%	4.05
Total Copper	No	ug/L	Decreasing at 99% C.L.	-1.0	-8.6	**-43%**	12.8	Decreasing at 95% C.L.	-0.8	-7.5	**-38%**	13.2
Total Copper	Yes	ug/L	Decreasing at 99% C.L.	-1.0	-8.6	**-43%**	12.0	Decreasing at 95% C.L.	-0.9	-7.7	**-38%**	12.8
Dissolved Lead	No	ug/L	Decreasing at 80% C.L.	-0.004	-0.036	**-30%**	0.064	No significant trend even at 80% C.L.	-0.003	-0.025	-21%	0.070
Dissolved Lead	Yes	ug/L	Decreasing at 95% C.L.	-0.005	-0.043	**-36%**	0.061	Decreasing at 90% C.L.	-0.004	-0.036	**-30%**	0.065
Total Lead	No	ug/L	Decreasing at 99.9% C.L.	-2	-16	**-112%**	2	Decreasing at 95% C.L.	-1.5	-14	**-95%**	3.0
Total Lead	Yes	ug/L	Decreasing at 99.9% C.L.	-2	-16	**-111%**	2	Decreasing at 95% C.L.	-1.5	-14	**-94%**	3.0
Dissolved Mercury	No	ug/L	No significant trend even at 80% C.L.	0	0	0%	0.01	No significant trend even at 80% C.L.	0	0	0%	0.01
Dissolved Mercury	Yes	ug/L	No significant trend even at 80% C.L.	0	0	0%	0.01	No significant trend even at 80% C.L.	0	0	0%	0.01
Total Mercury	No	ug/L	Decreasing at 95% C.L.	0	0	0%	0.01	Not increasing or decreasing at 90% C.L.	0	0	0%	0.01
Total Mercury	Yes	ug/L	Decreasing at 99% C.L.	-0.002	-0.02	**-107%**	0.007	Decreasing at 90% C.L.	-0.001	-0.01	**-53%**	0.009
Total Suspended Solids	No	mg/L	Decreasing at 99.9% C.L.	-10	-88	**-70%**	42	Decreasing at 95% C.L.	-9	-83	**-66%**	45
Total Suspended Solids	Yes	mg/L	Decreasing at 99.9% C.L.	-10	-86	**-69%**	47	Decreasing at 95% C.L.	-9	-78	**-63%**	51
Turbidity	No	NTU	Decreasing at 95% C.L.	-2	-14	**-30%**	28.5	Decreasing at 80% C.L.	-1	-11	-23%	30
Turbidity	Yes	NTU	Decreasing at 95% C.L.	-2	-14	**-30%**	27	Decreasing at 90% C.L.	-1	-12	-24%	28.5
Dissolved Zinc	No	ug/L	No significant trend even at 80% C.L.	0.2	2	7%	24.5	Increasing at 80% C.L.	0.4	4	14%	25
Dissolved Zinc	Yes	ug/L	No significant trend even at 80% C.L.	-0.04	-0.3	-1%	23	No significant trend even at 80% C.L.	0.1	1	3%	24
Total Zinc	No	ug/L	Decreasing at 99% C.L.	-6	-54	**-48%**	65	Decreasing at 95% C.L.	-5	-46	**-41%**	70
Total Zinc	Yes	ug/L	Decreasing at 99% C.L.	-6	-56	**-50%**	62.5	Decreasing at 95% C.L.	-5	-48	**-43%**	65

Table 6

High Density Residential Site WY2010-19 Stormwater Characterization Trend Tests												
			Nonparametric Trend Tests (over time)									
			Mann-Kendall Trend Tests & Sen's Slope Estimators					Seasonal Kendall Trend Tests and Slope Estimators				
Parameter	**Flow Adjusted**	**Units**	Trend Evaluation: Direction & Highest Significant Confidence Level (Maximum tested 99.9% C.L.)	Slope (units/yr)	Estimated 9-yr Change	% Change of 9-yr Mean for M.K. Trends (bold: C.L. >= 80% & Change > Abs. 25%)	Est. Latest M.K. Trend Value	Trend Evaluation: Direction & Highest Significant Confidence Level (Maximum tested 95% C.L.)	Slope (units/yr)	Estimated 9-yr Change	% Change of 9-yr Mean for S.K. Trends (bold: C.L. >= 80% & Change > Abs. 25%)	Est. Latest S.K. Trend Value
Average Sampled Flow	No	gal/sec	Increasing at 90% C.L.	0.2	2.2	**36%**	6.1	Increasing at 80% C.L.	0.2	1.8	**29%**	5.9
Fecal Coliform	No	MPN	Increasing at 99% C.L.	168	1514	**25%**	2250	Increasing at 95% C.L.	136	1226	20%	2250
Dissolved Cadmium	No	ug/L	Decreasing at 99.9% C.L.	-0.002	-0.01	**-69%**	0.01	Decreasing at 95% C.L.	-0.002	-0.02	**-76%**	0.010
Dissolved Cadmium	Yes	ug/L	Decreasing at 99.9% C.L.	-0.001	-0.01	**-58%**	0.006	Decreasing at 95% C.L.	-0.001	-0.01	**-64%**	0.012
Total Cadmium	No	ug/L	Decreasing at 99% C.L.	-0.003	-0.03	**-45%**	0.026	Decreasing at 95% C.L.	-0.003	-0.03	**-42%**	0.026
Total Cadmium	Yes	ug/L	Decreasing at 99% C.L.	-0.003	-0.03	**-43%**	0.027	Decreasing at 95% C.L.	-0.003	-0.02	**-39%**	0.029
Dissolved Copper	No	ug/L	No significant trend even at 80% C.L.	-0.1	-0.7	-13%	3.83	No significant trend even at 80% C.L.	-0.1	-0.7	-14%	3.825
Dissolved Copper	Yes	ug/L	No significant trend even at 80% C.L.	-0.04	-0.4	-7%	4.28	No significant trend even at 80% C.L.	-0.1	-0.5	-9%	4.275
Total Copper	No	ug/L	No significant trend even at 80% C.L.	0.1	1.3	10%	8.55	No significant trend even at 80% C.L.	0.1	1.3	10%	8.33
Total Copper	Yes	ug/L	No significant trend even at 80% C.L.	0.1	1.3	11%	8.55	No significant trend even at 80% C.L.	0.1	1.3	10%	8.55
Dissolved Lead	No	ug/L	Decreasing at 90% C.L.	-0.002	-0.02	-17%	0.04	Decreasing at 90% C.L.	-0.002	-0.02	-19%	0.04
Dissolved Lead	Yes	ug/L	No significant trend even at 80% C.L.	-0.001	-0.01	-12%	0.055	No significant trend even at 80% C.L.	-0.002	-0.01	-13%	0.055
Total Lead	No	ug/L	Decreasing at 90% C.L.	-0.07	-0.6	**-27%**	0.9	Decreasing at 95% C.L.	-0.06	-0.5	-22%	1
Total Lead	Yes	ug/L	Decreasing at 95% C.L.	-0.08	-0.7	**-29%**	0.8	Decreasing at 95% C.L.	-0.06	-0.6	-24%	0.9
Dissolved Mercury	No	ug/L	Increasing at 95% C.L.	0	0.00	0%	0.01	Signif. trend at 95% C.L. but zero slope	0	0	0%	0.01
Dissolved Mercury	Yes	ug/L	No significant trend even at 80% C.L.	-0.0001	0.00	-7%	0.010	No significant trend even at 80% C.L.	-0.0001	-0.0007	-7%	0.010
Total Mercury	No	ug/L	No significant trend even at 80% C.L.	0	0.00	0%	0.01	Signif. trend at 80% C.L. but zero slope	0	0	0%	0.01
Total Mercury	Yes	ug/L	Decreasing at 80% C.L.	-0.0001	0.00	-10%	0.01	No significant trend even at 80% C.L.	-0.0001	-0.0007	-5%	0.01
Total Suspended Solids	No	mg/L	No significant trend even at 80% C.L.	-0.5	-4	-9%	21	No significant trend even at 80% C.L.	-0.4	-3	-7%	21
Total Suspended Solids	Yes	mg/L	No significant trend even at 80% C.L.	-0.7	-6	-13%	21	No significant trend even at 80% C.L.	-0.5	-4	-9%	21
Turbidity	No	NTU	No significant trend even at 80% C.L.	0	0	0%	11	No significant trend even at 80% C.L.	0.1	0.5	3%	11
Turbidity	Yes	NTU	No significant trend even at 80% C.L.	-0.05	-0.4	-3%	11	No significant trend even at 80% C.L.	0.01	0.1	1%	11.5
Dissolved Zinc	No	ug/L	Decreasing at 99.9% C.L.	-12	-109	**-60%**	55	Decreasing at 95% C.L.	-13	-113	**-62%**	50
Dissolved Zinc	Yes	ug/L	Decreasing at 99.9% C.L.	-10	-93	**-51%**	70	Decreasing at 95% C.L.	-11	-98	**-54%**	65
Total Zinc	No	ug/L	Decreasing at 99.9% C.L.	-15	-132	**-48%**	100	Decreasing at 95% C.L.	-14	-129	**-46%**	100
Total Zinc	Yes	ug/L	Decreasing at 99.9% C.L.	-14	-126	**-46%**	105	Decreasing at 95% C.L.	-14	-122	**-44%**	105

Table 7 and Table 8 summarize evaluations of the COM and HDR stormwater quality status and trends. These evaluations are primarily based on nine-year medians and the latest trend values relative to available regional and national medians. The COM and HDR parameter medians are presented as a percentage of both regional and national stormwater medians and the amount of time since or until their projected trend values approach these medians.

Several considerations apply to these evaluations. Differences between medians and relative to criteria were not tested for statistical significance. Trend evaluations are limited to non-flow adjusted results. Some of the latest estimated trend values were so low that they were below their Ecology designated method reporting limits; including dissolved cadmium, lead and mercury as well as total cadmium and mercury. Red numerical values in Table 7 and Table 8 indicate degrading water quality trends.

Commercial Site Status (COM)

Table 7 shows only a few of the medians at the COM site were substantially higher than the regional Western Washington or national (NSQD) medians. In fact, medians for half of the parameters were substantially lower than (<75% of) their regional medians, including fecal coliform, total lead, and the dissolved fractions of cadmium, copper, lead, and zinc. Medians for total cadmium, copper, mercury, and zinc were similar to (between 75% and 125% of) their regional values. The only two parameters with medians substantially higher than (>125% of) their regional medians were total suspended solids (216%) and turbidity (187%). Of the eleven medians compared to NSQD medians, nine were substantially less, ranging from 2 to 62% of their NSQD medians. Only total copper was similar to (101%) and total suspended solids was substantially higher than (206%) their NSQD medians.

Showing some consistency, the multi-year median for total suspended solids was slightly more than twice the regional and national medians while the turbidity median was slightly less than twice the regional median.

High Density Residential Site Status (HDR)

Similar to the COM site results, Table 8 shows only a few of the medians at the HDR site were substantially higher than the regional Western Washington or national (NSQD) medians. Medians for five of the eleven parameters were substantially lower than (<75% of) their regional medians, including turbidity and both dissolved and total cadmium and lead. Medians for total copper and total suspended solids were similar to (between 75% and 125% of) their regional medians. Four parameters had medians substantially larger than (>125% of) the regional medians including fecal coliform (457%), dissolved copper (138%), dissolved zinc (755%) and total zinc (416%). Of the ten medians compared to NSQD medians, eight were substantially lower ranging from 2 to 65% of their NSQD medians. Dissolved (362%) and

Table 7

Commercial Site WY2010-19 Stormwater Characterization Trend Evaluations										
Non-Flow-Adjusted Parameter	**Units**	Latest Applicable Estimated Trend Value	Applicable Estimated Annual Change (Slope = units/yr)	Clark County COM Site 9-year Medians	Clark County's 9-Yr. Median as % of DOE WWA Median	Clark County's 9-Yr. Median as % of NSQD Median	Years Est. County Concs. (+/-) Reach W. WA. Median	Years Est. County Concs. (+/-) Reach NSQD Median	**Overall Assessment** **Status**: Clark County COM Medians Relative to Regional & National Medians/ **Applicable Trend**: Statistical Significance Over 9-Year Monitoring Period	**Statistically AND Practically Significant Trend - Improving / Degrading (Within approx. + or - Projected 10 yrs of W. WA. or NSQD Medians)**
Average Sampled Flow	gal/sec	1.3	-0.05	1.55	na	na	na	na	No West. WA or NSQD compar. / Significant (80% CL) downward M.K. trend of -0.05 units/yr	NA
Fecal Coliform	MPN	350	0	350	68%	8%	na	na	68% of Western WA & 8% of NSQD / Non-significant (even at 80% CL) up or down S.K. trend	No
Dissolved Cadmium	ug/L	0.018	-0.001	0.02	46%	8%	-28	-244	46% of W WA & 8% of NSQD / Significant (95% CL) downward S.K. trend of -0.001 units/yr	No
Total Cadmium	ug/L	**0.045**	-0.020	0.139	82%	14%	-6	-46	82% of W WA & 14% of NSQD / Significant (95% CL) downward S.K. trend of -0.02 units/yr	Yes - improving away from W.WA. (-6 yrs)
Dissolved Copper	ug/L	4.35	0.03	4.1	66%	54%	73	124	66% of Western WA & 54% of NSQD / Non-significant (even at 80% CL) upward S.K. trend	No
Total Copper	ug/L	**13.2**	-0.8	17.1	87%	101%	-8	-5	87% of W WA & 101% of NSQD / Significant (95% CL) downward S.K. trend of -0.8 units/yr	Yes - improving away from W.WA. & NSQD (-8 & -5 yrs)
Dissolved Lead	ug/L	0.064	-0.004	0.083	26%	2%	-64	-1234	26% of W WA & 2% of NSQD / Significant (80% CL) downward M.K. trend of -0.004 units/yr	No
Total Lead	ug/L	**3.0**	-1.5	10	71%	57%	-7	-10	71% of W WA & 57% of NSQD / Significant (95% CL) downward S.K. trend of -1.5 units/yr	Yes - improving away from W.WA. & NSQD (-7 & -10 yrs)
Dissolved Mercury	ug/L	0.01	0	0.01	na	na	na	na	Comparisons nonapplicalbe / Non-significant (even at 80% CL) up or down M. K. trend	No
Total Mercury	ug/L	0.01	0	0.01	83%	5%	na	na	83% of W WA & 5% of NSQD / Signif. (95% CL) downward M.K. trend but slope of zero units/yr	No
Total Suspended Solids	mg/L	**45**	-9	89	216%	206%	0.4	0.2	216% of W WA & 206% of NSQD / Significant (95% CL) downward S.K. trend of -9 units/yr	Yes - improving toward W.WA. & NSQD (0.4 & 0.2 yrs)
Turbidity	NTU	**30**	-1	36	187%	na	9	na	187% of West. WA & no NSQD compar. / Signif. (80% CL) downward S.K. trend of -1 units/yr	Yes - improving toward W.WA. (9 yrs)
Dissolved Zinc	ug/L	25	0.4	24	63%	40%	29	80	63% of Western WA & 40% of NSQD / Significant (80% CL) upward S.K. trend of 0.4 units/yr	No
Total Zinc	ug/L	**70**	-5	93	91%	62%	-6	-16	91% of W WA & 62% of NSQD / Significant (95% CL) downward S.K. trend of -5 units/yr	Yes - improving away from W.WA. (-6 yrs)

Table 8

High Density Residential Site WY2010-19 Stormwater Characterization Trend Evaluations										
Non-Flow-Adjusted Parameter	**Units**	Latest Applicable Estimated Trend Value	Applicable Estimated Annual Change (Slope = units/yr)	Clark County HDR Site 9-year Medians	Clark County's 9-Yr. Median as % of DOE WWA Median	Clark County's 9-Yr. Median as % of NSQD Median	Years Est. County Concs. (+/-) Reach W. WA. Median	Years Est. County Concs. (+/-) Reach NSQD Median	**Overall Assessment** **Status**: Clark County COM Medians Relative to Regional & National Medians/ **Applicable Trend**: Statistical Significance Over 9-Year Monitoring Period	**Statistically AND Practically Significant Trend - Improving / Degrading (Within approx. + or - Projected 10 yrs of W. WA. or NSQD Medians)**
Average Sampled Flow	gal/sec	6.1	0.2	4.9	na	na	na	na	No Western WA or NSQD compar. / Significant (90% CL) upward M.K. trend of 0.2 units/yr	No
Fecal Coliform	MPN	2250	168	1600	457%	23%	-11	28	457% of W. WA & 23% of NSQD / Significant (99% CL) upward M.K. trend of 168 units/yr	No
Dissolved Cadmium	ug/L	0.010	-0.002	0.018	53%	na	-14	na	53% of W. WA & na NSQD / Significant (95% CL) downward S.K. trend of -0.002 units/yr	No
Total Cadmium	ug/L	0.026	-0.003	0.041	46%	8%	-22	-163	46% of W. WA & 8% of NSQD / Significant (95% CL) downward S.K. trend of -0.003 units/yr	No
Dissolved Copper	ug/L	3.825	-0.1	4.2	138%	60%	10	-39	138% of W. WA & 60% of NSQD / Non-significant (even at 80% CL) downward S.K. trend	No
Total Copper	ug/L	8.33	0.1	7.8	101%	65%	-4	26	101% of W. WA & 65% of NSQD / Non-significant (even at 80% CL) upward trend	No
Dissolved Lead	ug/L	0.04	-0.002	0.05	31%	2%	-57	-1287	31% of W. WA & 2% of NSQD / Significant (90% CL) downward S.K. trend of -0.002 units/yr	No
Total Lead	ug/L	1	-0.06	1.3	31%	10%	-52	-187	31% of W. WA & 10% of NSQD / Significant (95% CL) downward S.K. trend of -0.06 units/yr	No
Dissolved Mercury	ug/L	0.01	0	0.01	na	na	na	na	Compar. nonapplicalbe / Signif. (95% CL) S.K. trend but slope of zero units/yr	No
Total Mercury	ug/L	0.01	0	0.01	na	5%	na	na	na for W. WA & 5% of NSQD / Non-significant (even at 80% CL) up or down M. K. trend	No
Total Suspended Solids	mg/L	21	-0.4	24	84%	48%	-18	-74	84% of W. WA & 48% of NSQD / Non-significant (even at 80% CL) downward S.K. trend	No
Turbidity	NTU	11	0.1	11	74%	na	74	na	74% of W. WA & na for NSQD / Non-significant (even at 80% CL) upward S.K. trend	No
Dissolved Zinc	ug/L	**50**	-13	114	755%	362%	3	1	755% of W. WA & 362% of NSQD / Significant (95% CL) downward S.K. trend of -13 units/yr	Yes - improving toward W.WA. & NSQD (3 & 1 yrs)
Total Zinc	ug/L	**100**	-14	172	416%	235%	4	2	416% of W. WA & 235% of NSQD / Significant (95% CL) downward S.K. trend of -14 units/yr	Yes - improving toward W.WA. & NSQD (4 & 2 yrs)

total (235%) zinc were substantially higher than their NSQD medians. The medians for dissolved and total zinc were approximately 2.4 to 7.6 times as much as than regional and national medians, by far the most pronounced difference among measured parameters. Higher zinc levels within the drainage area could potentially be due to extensive galvanized metal surfaces, roofing materials, and use of zinc-based products to control moss.

Overall Status Evaluation (COM and HDR)

In comparisons with the regional western Washington and national NSQD medians, at least half (>45%) of the medians for both the COM and HDR sites were substantially lower.

Two of twelve COM medians (dissolved cadmium and dissolved lead) and three of eleven HDR medians (total cadmium, dissolved lead, and total lead) were less than 50% of their respective regional medians. Relative to NSQD medians, six of eleven COM parameter medians (fecal coliform, dissolved cadmium, total cadmium, dissolved lead, total mercury and dissolved zinc) and six of ten HDR medians (fecal coliform, total cadmium, dissolved lead, total lead, total mercury and total suspended solids) were less than 50% of their respective NSQD medians.

Trends and Practical Significance (COM and HDR)

Table 7 and Table 8 summarize the statistical significance, direction, and annual rate of change for trend tests on non-flow-adjusted results for the fourteen COM and HDR stormwater parameters.

Over the nine year monitoring period, both sites had significant, albeit slight trends in average sampled flow. However, these trends were in different directions and at different confidence levels (COM downward annual trend of -0.05 gal. / sec. at 80% C.L. and HDR upward annual trend of 0.2 gal. / sec. at 90% C.L.) and no objective criteria exist for their evaluation. Further evaluation of potential flow trend impacts on the other parameters is beyond the scope of this project.

Of the thirteen COM and HDR water quality parameters evaluated for trends, most of those with significant trends had negative slopes indicating potential improvement in water quality. Ten of thirteen COM water quality parameters had statistically significant trends, and eight of those had decreasing trends. Only dissolved zinc showed an increasing trend. The significance of the total mercury trend at the COM site is questionable given the slope is very close to zero and the majority of results were non-detects.

Eight of thirteen HDR water quality parameters had statistically significant trends. Of these eight, six were decreasing, dissolved mercury had a slope of approximately zero, and only fecal coliform had an increasing trend. The significance of the dissolved mercury trend at the HDR site is also not statistically meaningful given the predominance of non-detect values and its slope close to zero.

To help interpret the practical significance of identified trends, the COM and HDR trends were projected from their latest estimated values toward an arbitrary criterion set at the level of the associated regional or NSQD median.

In Table 7 and Table 8, the third and fourth columns from the right show the projected number of years either into the future or back in time until the trend line approaches the regional or NSQD medians. These projected periods are for relative comparison purposes only.

Figure 1 is a schematic of the four possible combinations of trend projections. Whether a trend is projected backward or forward in time depends on the latest estimated value relative to the regional or NSQD median, and whether the slope of the trend is negative or positive.

The four possible projections are described below:

1) (Upper left quadrant) Where the latest estimated value is higher than the regional or national median and the trend has a negative slope (improving water quality), the number of years is projected forward in time (black positive numbers) to when the criterion will be met in the future.
2) (Lower left quadrant) Where the latest estimated value is already lower than the regional or national median and the trend has a negative slope (improving water quality), the number of years is projected backward in time (black negative numbers) to how long ago the criterion was first met.
3) (Upper right quadrant) Where the latest estimated value is higher than the regional or national median and the trend has a positive slope (degrading water quality), the number of years is projected backward in time (red negative numbers) to how long ago the criterion was last met.
4) (Lower right quadrant) Where the latest estimated value is lower than the regional or national median and the trend has a positive slope (degrading water quality), the number of years is projected forward in time (red positive number) to when the criterion will no longer be met in the future.

Often, trends can be statistically significant (especially for large data sets) but not practically significant because the changes over time are not large enough to make much difference given realistic time scales and inherent measurement errors. For this report, practical significance is defined as those trends having both statistical significance and meaningful slope magnitudes. The practical significance of a trend's slope is based on whether the projected trend approaches a criterion within approximately ten years under the assumption of no changes in the trend.

By these measures, only six of COM's ten and two of HDR's eight statistically significant water quality trends were also practically significant. Parameters with practically significant trends and their interpretation are summarized in Table 7 and Table 8 (highlighted dark green in first and last columns.

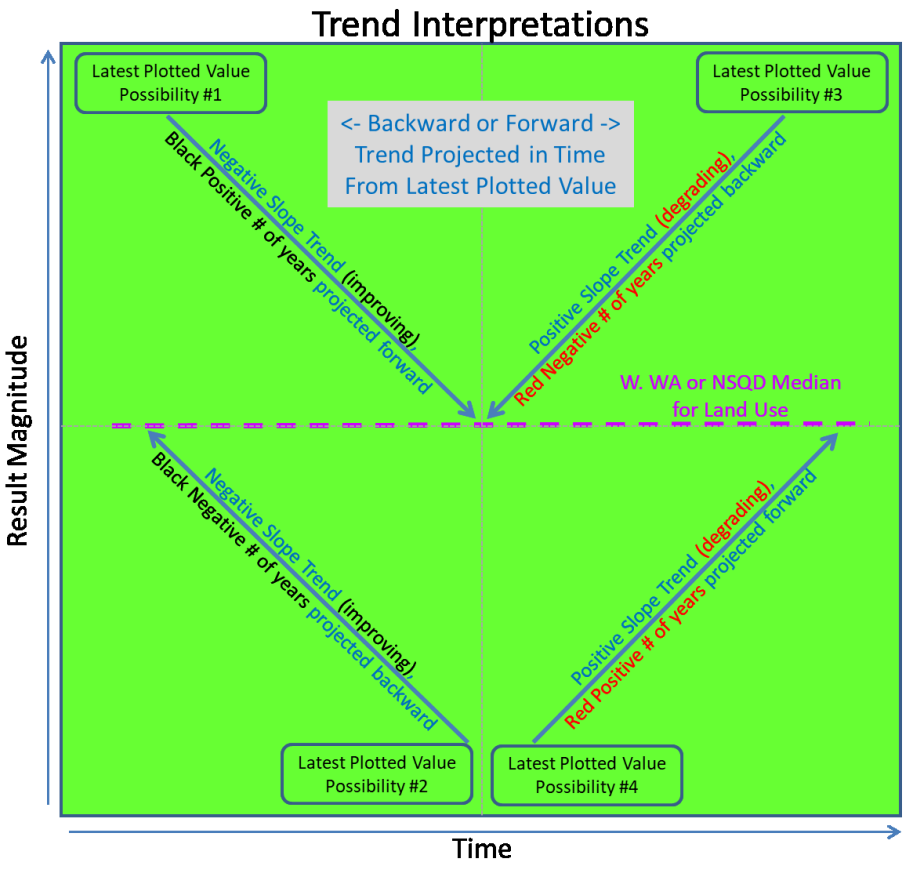

Figure 1 Interpreting practical significance of trends by projecting years from latest plotted trend value toward regional western Washington or National Stormwater Quality Database (NSQD) criterion medians

The six practically significant COM trends are all improving (negative trend slope) but the direction of their projected time to reach regional or national medians depends on their latest estimated trend value. COM's latest estimated trend values for total copper and lead are already below their respective regional and NSQD medians (lower left quadrant of Figure 1). Their backward projected trends toward the regional medians are -8 and -7 years and the NSQD medians are -5 and -10 years. COM's latest estimated total cadmium and zinc are below just their regional medians and are projected backwards to both reach their regional medians in -6 years. In contrast, COM's latest estimated total suspended solids trend value is higher than both its regional and NSQD medians (upper left quadrant of Figure 1). Its projected times are 0.4 and 0.2 years forward to reach the respective medians. Similarly, COM's latest turbidity is above its regional median. It is projected forward to reach this criterion in 9 years.

The two practically significant HDR water quality trends for dissolved and total zinc are also both improving with their latest estimated trend values higher than their respective regional and NSQD medians (upper left quadrant of Figure 1). The forward projected time for dissolved and total zinc trends to approach their regional medians are 3 and 4 years and the NSQD medians are 1 and 2 years, respectively.

Practically significant trends for water years 2010-2019 at COM and HDR are shown as graphs in Figure 2 through Figure 9 beginning on page 22. Table 9 and Table 10 at the end of this report contain the full status and trend evaluations for the COM and HDR sites.

Conclusion

Results from nine years of extensive stormwater characterization monitoring at one commercial and one high-density residential site in Clark County indicate median concentrations for most important stormwater pollutants are lower than those found regionally and nationally for similar land uses. Several statistically significant trends were discovered; however, many of those trends do not appear to have practical significance in terms of changing water quality.

Stormwater quality status and trend evaluations were based on nearly 100 composite storm samples and focused on thirteen typically important parameters at both the commercial land use site (COM) and the high-density residential land use site (HDR).

Status evaluations:

Notable findings related to the status of stormwater quality included:

- Median concentrations of most water quality parameters were lower than regional or national medians for areas with similar land use
- At the COM site, total suspended solids (216%) and turbidity (187%) were substantially higher than their corresponding western Washington medians, and total suspended solids (206%) was substantially higher than the national median.
- At the HDR site, fecal coliform (457%), dissolved copper (138%), dissolved zinc (755%) and total zinc (416%) were substantially higher than their corresponding western Washington medians; dissolved zinc (362%) and total zinc (235%) were substantially higher than the national medians.

Trend evaluations:

Notable findings related to trends in stormwater quality included:

- Statistically significant trends were found at an 80% or higher confidence level for 10 of 13 parameters at the COM site and 8 of 13 parameters at the HDR site.
- Only eight of these trends appear to have practical significance based on the magnitude of their slopes. In all eight cases, the trends indicate improving water quality (total cadmium, total copper, total lead, total zinc, total suspended solids, and turbidity at the COM site; dissolved and total zinc at the HDR site)
- At the COM site, total suspended solids and turbidity are the only parameters with practically significant trends where the latest estimated value is higher than their regional medians. If current trends continue they are projected to decrease to near regional medians in approximately 0.4 and 9 years, respectively,.
- At the HDR site, the latest estimated values for its two practically significant trends for dissolved and total zinc are substantially higher than their regional medians. In both cases, medians are projected to decrease to near regional medians in approximately 4 years if current trends continue.

Differences between Clark County and regional or national results were not tested for statistical significance and may be due to a variety of land use, hydrologic, monitoring, or stormwater management factors.

References Used for Status and Trend Analyses

Helsel, D.R., and R.M. Hirsch. 1992. *Statistical Methods in Water Resources.* Elsevier Science B.V., Amsterdam, Netherlands. 529 p.

Jakowyna, Brad and Rob Donohue. 2008. Government of Western Australia Water and Rivers Commission, Department of the Environment Aquatic Science Branch, *Statewide Assessment of River Water Quality Methods.* Web page document download.

Minton, G. 2002. *Stormwater Treatment Biological, Chemical, and Engineering Principles*. Resource Planning Associates, Seattle, WA. 416 p.

Pitt, R., Maestre, A., and Morquecho, R. February 2004. *National Stormwater Quality Database, version 1.1*. Department of Civil and Environmental Engineering, University of Alabama, Tuscaloosa, AL.

New York City Department of Environmental Protection. December 2001. *New York City's 2001 Watershed Protection Program Summary, Assessment and Long-term Plan, Appendix C Trend Analysis Methodology*. 611 p.

Sanitas Technologies / Intelligent Decision Technologies, LTD. 1998. *WQStat Plus statistical software, Ver. 1.56 and User's Guide*. 124 p.

Washington State Department of Ecology. February 2015. *Western Washington NPDES Phase I Stormwater Permit Final S8.D Data Characterization 2009-2013 (Publication No. 15-03-001)*. Olympia, WA 152 p.

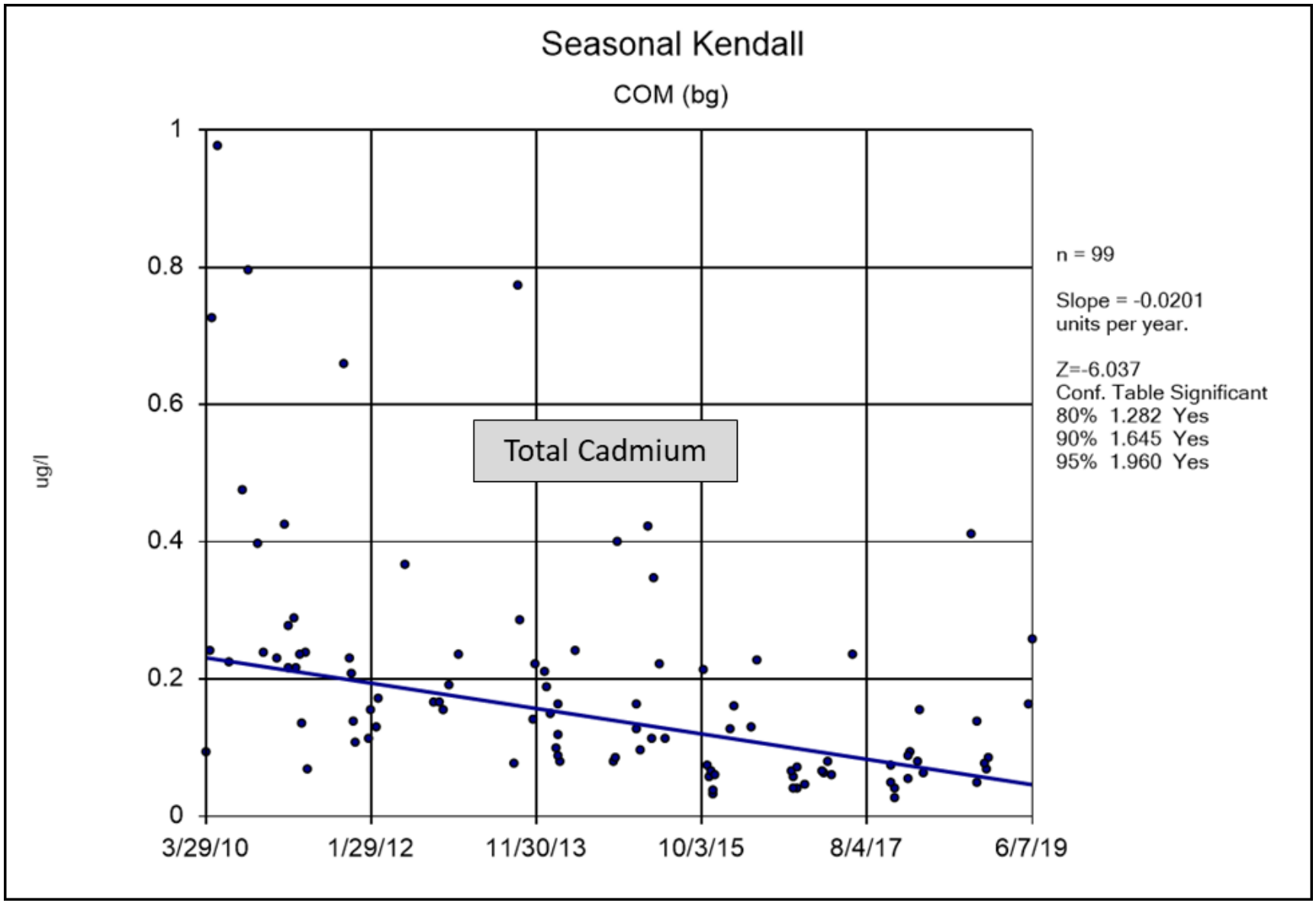

Figure 2 Commercial site WY2010-19 non-flow adjusted total cadmium data Seasonal Kendall trend test

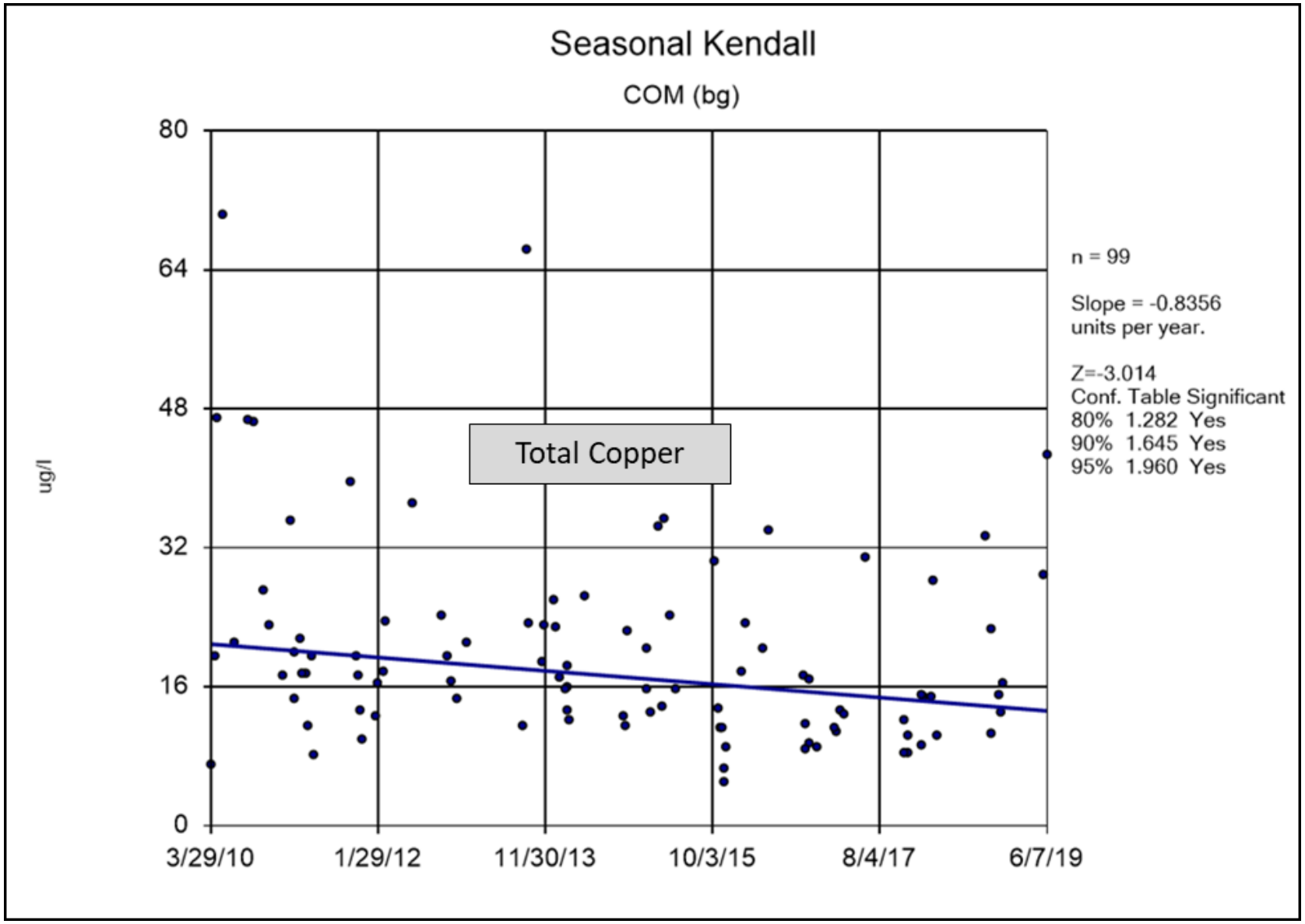

Figure 3 Commercial site WY2010-19 non-flow adjusted total copper data Seasonal Kendall trend test

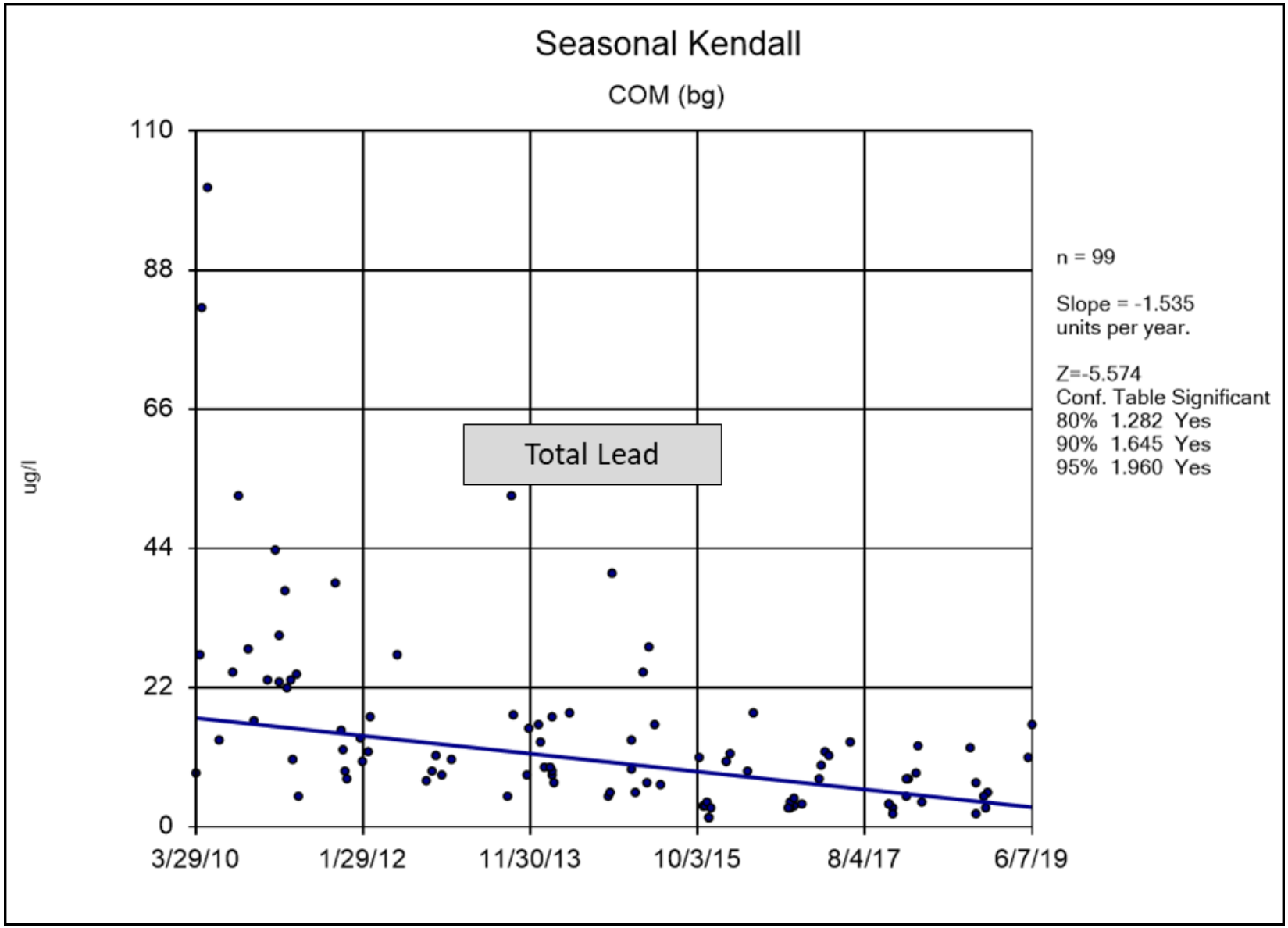

Figure 4 Commercial site WY2010-19 non-flow adjusted total lead data Seasonal Kendall trend test

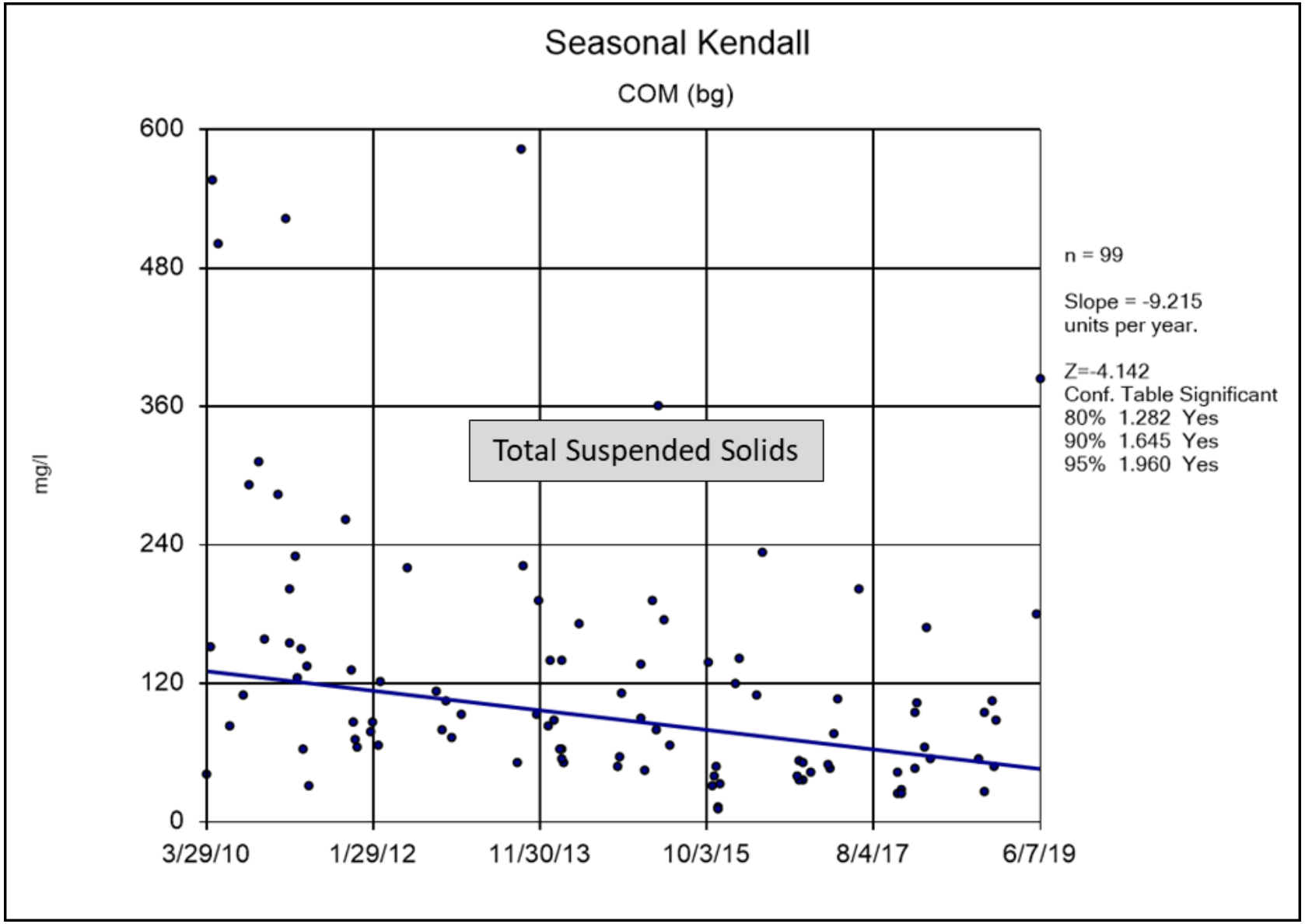

Figure 5 Commercial site WY2010-19 non-flow adjusted total suspended solids data Seasonal Kendall trend test

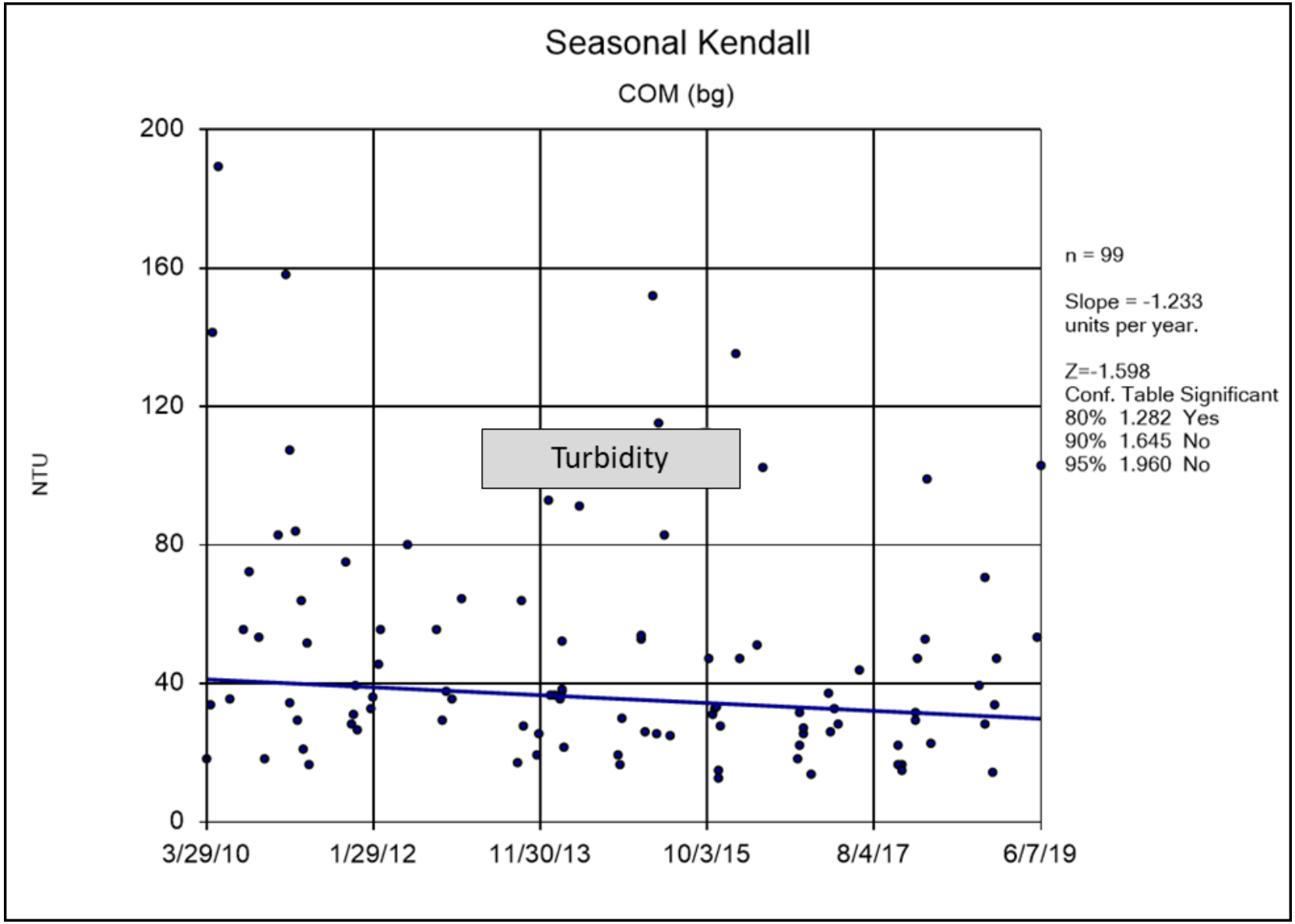

Figure 6 Commercial site WY2010-19 non-flow adjusted turbidity data Seasonal Kendall trend test

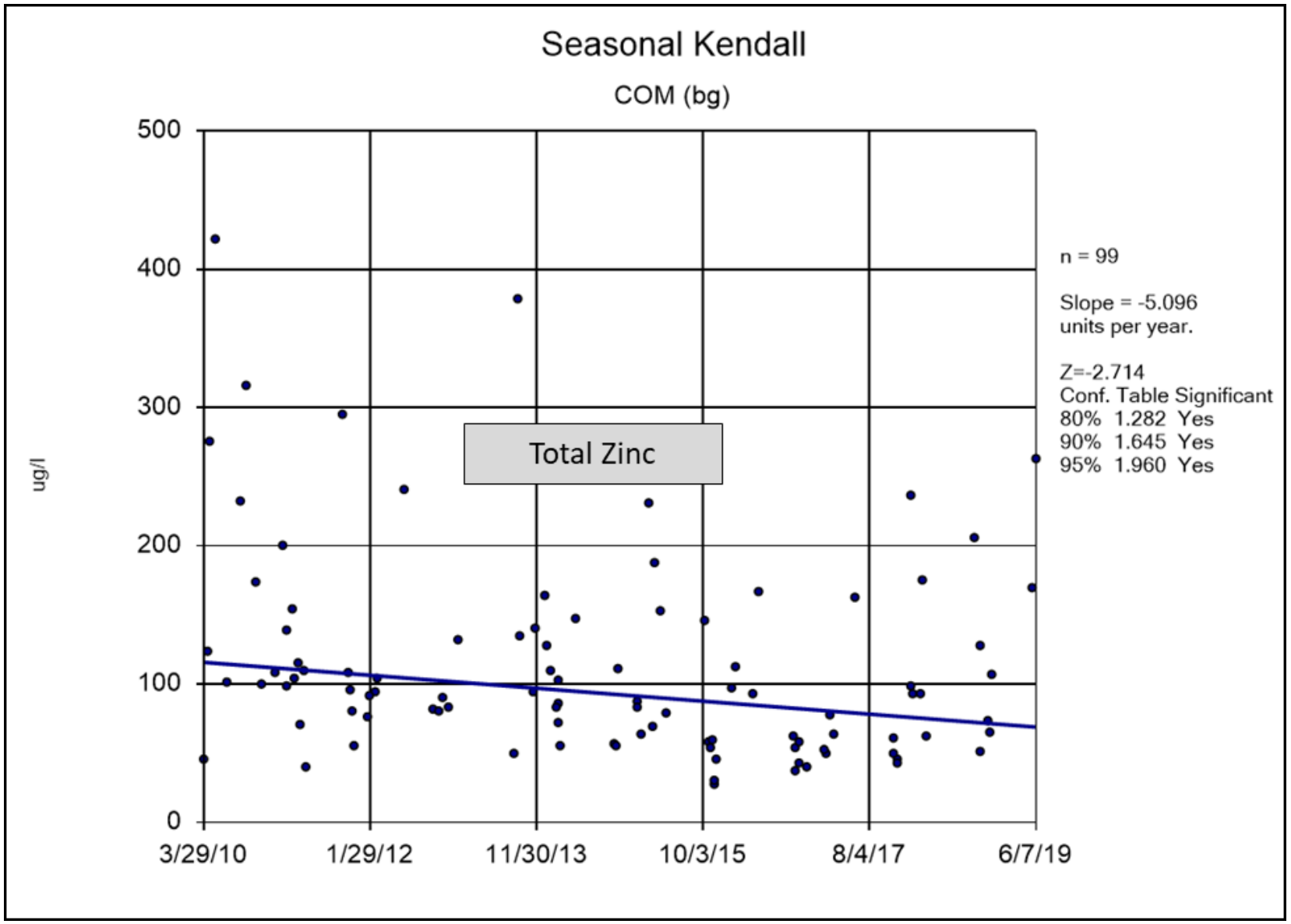

Figure 7 Commercial site WY2010-19 non-flow adjusted total zinc data Seasonal Kendall trend test

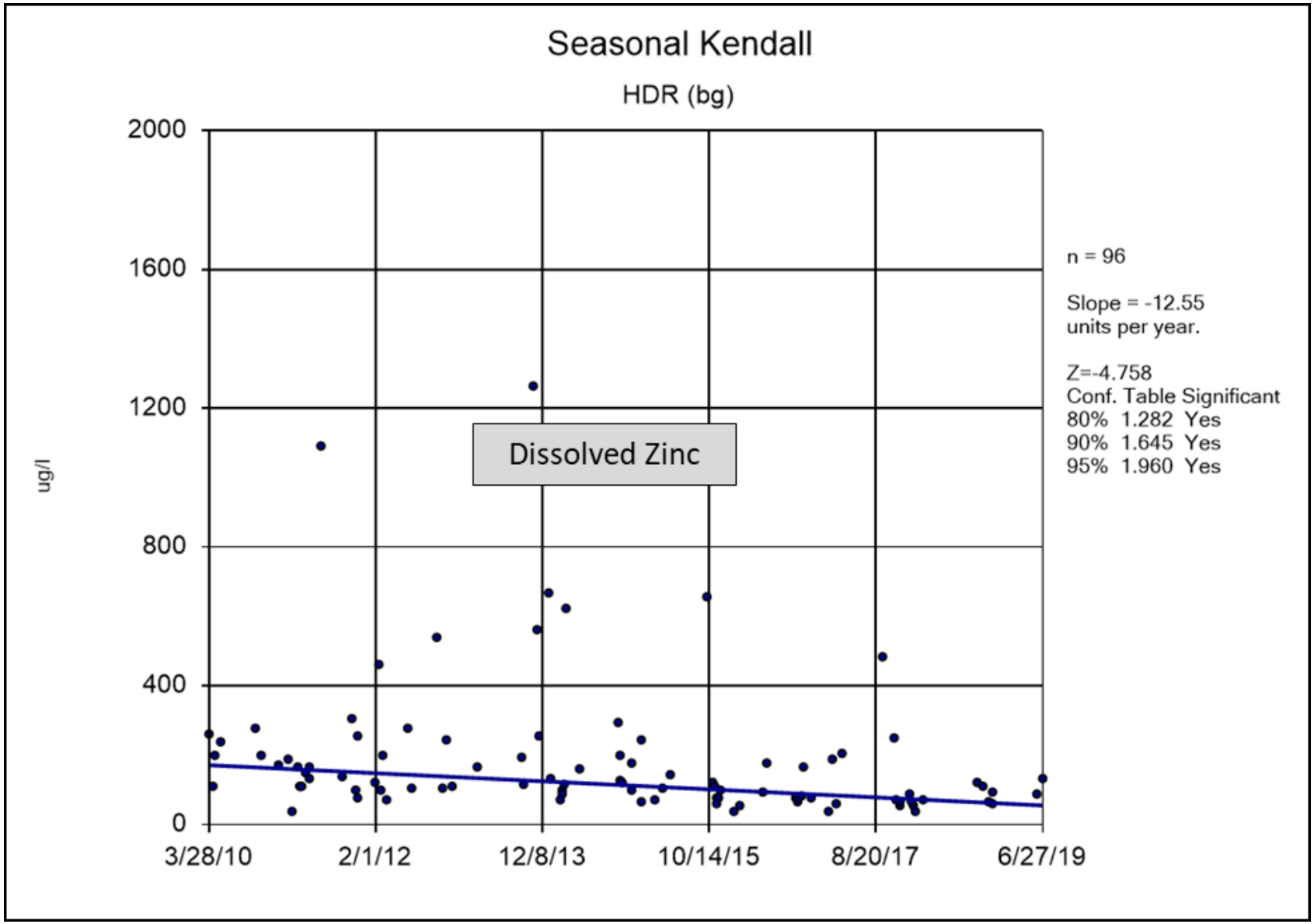

Figure 8 High Density Residential site WY2010-19 non-flow adjusted dissolved zinc data Seasonal Kendall trend test

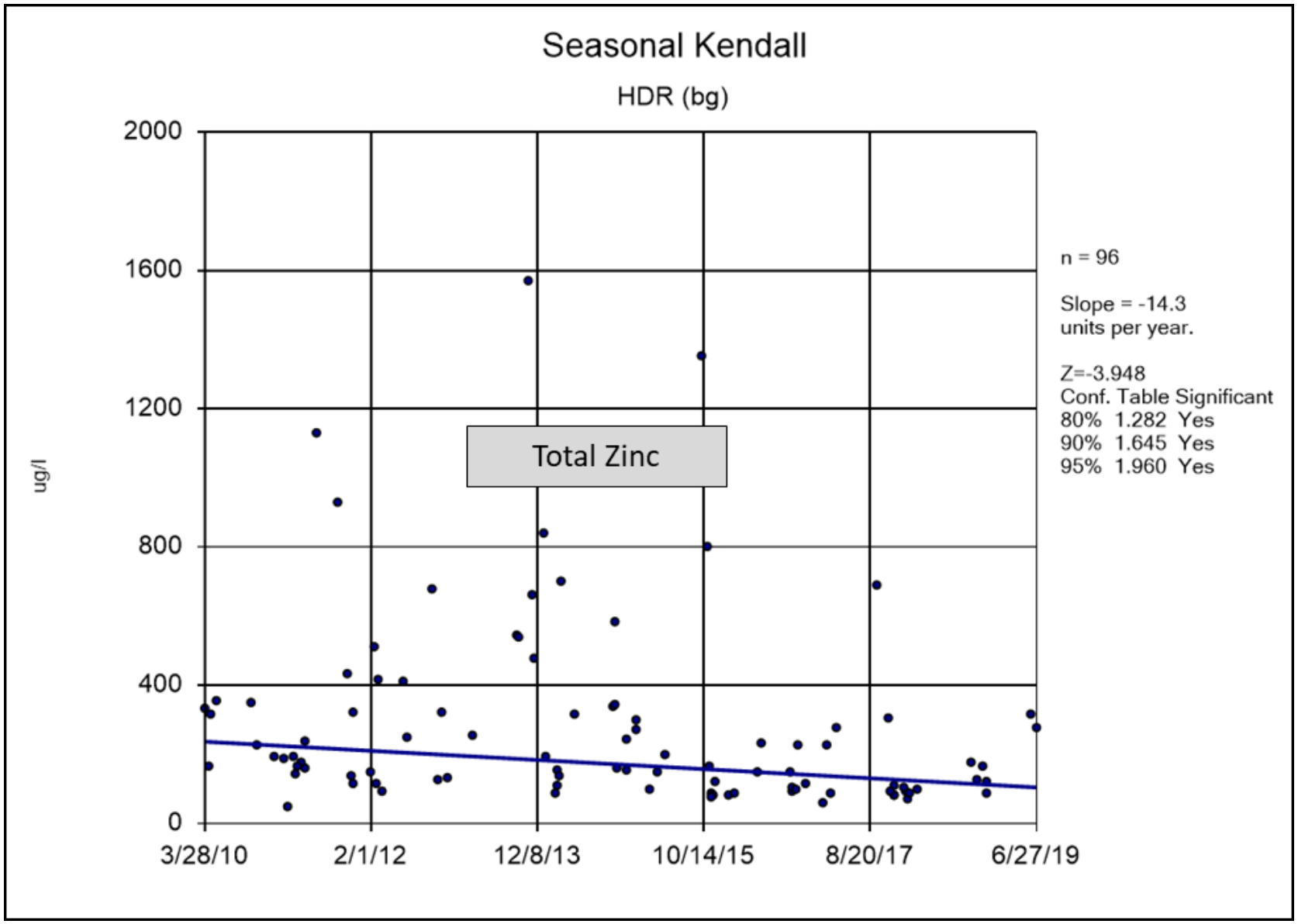

Figure 9 High Density Residential site WY2010-19 non-flow adjusted total zinc data Seasonal Kendall trend test

Table 9

Commercial Site WY2010-19 Stormwater Characterization Status and Trend Evaluations

Parameter	Flow Adjusted	Units	Latest Applicable Estimated Trend Value	Applicable Estimated Annual Change (Slope = units/yr)	Clark County COM Site 9-year Means	Clark County COM Site 9-year Medians	D.O.E. W.WA. NPDES Phase I Permit 2009-13 Commercial Land Use K-M Medians	Clark County's 9-Yr. Median as % of DOE WWA Median	NSQD Median Commercial L.U. Concs. (Total Metals Fraction)	Clark County's 9-Yr. Median as % of NSQD Median	Difference between W. WA. Median and Lateset Trend Value	Years Est. County Concs. (+/-) Within W. WA. Median	Difference between NSQD Median and Lateset Trend Value	Years Est. County Concs. (+/-) Within NSQD Median	Latest Trend Value as Multiple of Ecology MRL	**Status**: Clark County COM Medians Relative to Regional & National Medians (>75%) / **Applicable Trend**: Statistical Significance Over 9-Yr. Monitoring Period (>80% Confid. Level) with Trend Direction and Magnitude	**Statistically AND Practically Significant Trend - Improving / Degrading (Within approx. + or - Projected 10 yrs of W. WA. or NSQD Medians)**
Average Sampled Flow	No	gal / sec	1.3	-0.05	1.97	1.55	na	na	na	na	na	na	na	na	na	No West. WA or NSQD compar. / Signif. (80% CL) downward M.K. trend of -0.05 units/yr	NA
Fecal Coliform	No	MPN	350	0	976	350	515	68%	4600	8%	165	na	4250	na	175	68% of Western WA & 8% of NSQD / Non-significant (even at 80% CL) up or down S.K. trend	No
Dissolved Cadmium	No	ug/L	0.018	-0.001	0.03	0.02	0.05	46%	0.3	8%	0.03	-28	0.28	-244	0.2	46% of W WA & 8% of NSQD / Significant (95% CL) downward S.K. trend of -0.001 units/yr	No
	Yes	ug/L	0.017	-0.001	0.03										0.2		
Total Cadmium	No	ug/L	**0.045**	-0.020	0.188	0.139	**0.17**	82%	0.96	14%	0.13	**-6**	0.92	-46	0.2	82% of W WA & 14% of NSQD / Significant (95% CL) downward S.K. trend of -0.02 units/yr	Yes - **improving** away from W.WA. (-6 yrs)
	Yes	ug/L	0.048	-0.020	0.188										0.2		
Dissolved Copper	No	ug/L	4.35	0.03	4.9	4.1	6.25	66%	7.57	54%	1.90	73	3.22	124	44	66% of Western WA & 54% of NSQD / Non-significant (even at 80% CL) upward S.K. trend	No
	Yes	ug/L	4.05	-0.001	4.9										41		
Total Copper	No	ug/L	**13.2**	-0.8	19.9	17.1	**19.6**	87%	**17**	101%	6.4	**-8**	4	**-5**	26	87% of W WA & 101% of NSQD / Significant (95% CL) downward S.K. trend of -0.8 units/yr	Yes - **improving** away from W.WA. & NSQD (-8 & -5 yrs)
	Yes	ug/L	12.8	-0.9	19.9										26		
Dissolved Lead	No	ug/L	0.064	-0.004	0.120	0.083	0.32	26%	5	2%	0.26	-64	4.9	-1234	0.6	26% of W WA & 2% of NSQD / Significant (80% CL) downward M.K. trend of -0.004 units/yr	No
	Yes	ug/L	0.061	-0.005	0.120										0.6		
Total Lead	No	ug/L	**3.0**	-1.5	15	10	**14.4**	71%	**18**	57%	11.4	**-7**	15	**-10**	30	71% of W WA & 57% of NSQD / Significant (95% CL) downward S.K. trend of -1.5 units/yr	Yes - **improving** away from W.WA. & NSQD (-7 & -10 yrs)
	Yes	ug/L	3.0	-1.5	15										30		
Dissolved Mercury	No	ug/L	0.01	0	0.01	0.01	na	na	na	na	na	na	na	na	0.1	Comparisons nonapplicalbe / Non-significant (even at 80% CL) up or down M. K. trend	No
	Yes	ug/L	0.01	0	0.01										0.1		
Total Mercury	No	ug/L	0.01	0	0.02	0.01	0.012	83%	0.2	5%	0.002	na	0.19	na	0.1	83% of W WA & 5% of NSQD / Significant (95% CL) downward M.K. trend but slope of zero units/yr	No
	Yes	ug/L	0.007	-0.002	0.02										0.1		
Total Suspended Solids	No	mg/L	**45**	-9	125	89	**41**	216%	**43**	206%	-4	**0.4**	-2	**0.2**	45	216% of W WA & 206% of NSQD / Significant (95% CL) downward S.K. trend of -9 units/yr	Yes - **improving** toward W.WA. & NSQD (0.4 & 0.2 yrs)
	Yes	mg/L	51	-9	125										51		
Turbidity	No	NTU	**30**	-1	48	36	**19**	187%	na	na	-11	**9**	na	na	150	187% of West. WA & no NSQD compar. / Significant (80% CL) downward S.K. trend of -1 units/yr	Yes - **improving** toward W.WA. (9 yrs)
	Yes	NTU	28.5	-1	48										143		
Dissolved Zinc	No	ug/L	25	0.4	27	24	37.4	63%	59	40%	12	29	34	80	25	63% of Western WA & 40% of NSQD / Significant (80% CL) upward S.K. trend of 0.4 units/yr	No
	Yes	ug/L	24	0.1	27										24		
Total Zinc	No	ug/L	**70**	-5	113	93	**102**	91%	150	62%	32	**-6**	80	-16	14	91% of W WA & 62% of NSQD / Significant (95% CL) downward S.K. trend of -5 units/yr	Yes - **improving** away from W.WA. (-6 yrs)
	Yes	ug/L	65	-5	113										13		

Table 10

High Density Residential Site WY2010-19 Stormwater Characterization Status and Trend Evaluations

Parameter	Flow Adjusted	Units	Latest Applicable Estimated Trend Value	Applicable Estimated Annual Change (Slope = units/yr)	Clark County HDR Site 9-year Means	Clark County HDR Site 9-year Medians	D.O.E. W.WA. NPDES Phase I Permit 2009-13 Hi. Den. Res. Land Use K-M Medians	Clark County's 9-Yr. Median as % of DOE WWA Median	NSQD Median Residential L.U. Concs. (Total Metals Fraction)	Clark County's 9-Yr. Median as % of NSQD Median	Difference between W. WA. Median and Lateset Trend Value	Years Est. County Concs. (+/-) Within W. WA. Median	Difference between NSQD Median and Lateset Trend Value	Years Est. County Concs. (+/-) Within NSQD Median	Latest Trend Value as Multiple of Ecology MRL	**Status**: Clark County HDR Medians Relative to Regional & National Medians (>75%) / **Applicable Trend**: Statistical Significance Over 9-Yr. Monitoring Period (>80% Confid. Level) with Trend Direction and Magnitude	**Statistically AND Practically Significant Trend - Improving / Degrading (Within approx. + or - Projected 10 yrs of W. WA. or NSQD Medians)**
Average Sampled Flow	No	gal / sec	6.1	0.2	6.1	4.9	na	na	na	na	na	na	na	na	na	No Western WA or NSQD compar. / Significant (90% CL) upward M.K. trend of 0.2 units/yr	No
Fecal Coliform	No	MPN	2250	168	6048	1600	350	457%	7000	23%	-1900	-11	4750	28	1125.0	457% of W. WA & 23% of NSQD / Significant (99% CL) upward M.K. trend of 168 units/yr	No
Dissolved Cadmium	No	ug/L	0.010	-0.002	0.020	0.018	0.033	53%	na	na	0.024	-14	na	na	0.1	53% of W. WA & na NSQD / Significant (95% CL) downward S.K. trend of -0.002 units/yr	No
	Yes	ug/L	0.006	-0.001	0.020										0.1		
Total Cadmium	No	ug/L	0.026	-0.003	0.062	0.041	0.09	46%	0.5	8%	0.06	-22	0.4737	-163	0.1	46% of W. WA & 8% of NSQD / Significant (95% CL) downward S.K. trend of -0.003 units/yr	No
	Yes	ug/L	0.029	-0.003	0.06236										0.1		
Dissolved Copper	No	ug/L	3.825	-0.1	5.2	4.2	3.05	138%	7	60%	-0.78	**10**	3.175	-39	38.3	138% of W. WA & 60% of NSQD / Non-significant (even at 80% CL) downward S.K. trend	No
	Yes	ug/L	4.275	-0.1	5.2										42.8		
Total Copper	No	ug/L	8.33	0.1	12.3	7.8	7.73	101%	12	65%	-0.59	**-4**	3.675	26	16.7	101% of W. WA & 65% of NSQD / Non-significant (even at 80% CL) upward trend	No
	Yes	ug/L	8.55	0.1	12.3										17.1		
Dissolved Lead	No	ug/L	0.04	-0.002	0.11	0.05	0.17	31%	3	2%	0.13	-57	2.96	-1287	0.4	31% of W. WA & 2% of NSQD / Significant (90% CL) downward S.K. trend of -0.002 units/yr	No
	Yes	ug/L	0.055	-0.002	0.11										0.6		
Total Lead	No	ug/L	1	-0.06	2.4	1.3	4.05	31%	12	10%	3	-52	11	-187	10.0	31% of W. WA & 10% of NSQD / Significant (95% CL) downward S.K. trend of -0.06 units/yr	No
	Yes	ug/L	0.9	-0.06	2.4										9.0		
Dissolved Mercury	No	ug/L	0.01	0	0.01	0.01	na	na	na	na	na	na	na	na	0.1	Compar. nonapplicalbe / Signif. (95% CL) S.K. trend but slope of zero units/yr	No
	Yes	ug/L	0.010	-0.0001	0.01										0.1		
Total Mercury	No	ug/L	0.01	0	0.01	0.01	na	na	0.2	5%	na	na	0.19	na	0.1	na for W. WA & 5% of NSQD / Non-significant (even at 80% CL) up or down M. K. trend	No
	Yes	ug/L	0.01	-0.0001	0.01										0.1		
Total Suspended Solids	No	mg/L	21	-0.4	48	24	28	84%	49	48%	7	-18	28	-74	21.0	84% of W. WA & 48% of NSQD / Non-significant (even at 80% CL) downward S.K. trend	No
	Yes	mg/L	21	-0.5	48										21.0		
Turbidity	No	NTU	11	0.1	15	11	15	74%	na	na	4	74	na	na	55.0	74% of W. WA & na for NSQD / Non-significant (even at 80% CL) upward S.K. trend	No
	Yes	NTU	11.5	0.01	15										57.5		
Dissolved Zinc	No	ug/L	**50**	-13	181	114	**15.1**	755%	**31.5**	362%	-35	**3**	-18.5	**1**	50.0	755% of W. WA & 362% of NSQD / Significant (95% CL) downward S.K. trend of -13 units/yr	Yes - **improving** toward W.WA. & NSQD (3 & 1 yrs)
	Yes	ug/L	65	-11	181										65.0		
Total Zinc	No	ug/L	**100**	-14	277	172	**41.2**	416%	**73**	235%	-59	**4**	-27	**2**	20.0	416% of W. WA & 235% of NSQD / Significant (95% CL) downward S.K. trend of -14 units/yr	Yes - **improving** toward W.WA. & NSQD (4 & 2 yrs)
	Yes	ug/L	105	-14	277										21.0		