MEMORANDUM

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SUBJECT: **REPORT OF WASTE DISCHARGE EXECUTIVE SUMMARY – DISCHARGE AND RECEIVING WATER CHARACTERIZATION**

The purpose of this technical memorandum is to summarize the assumptions and methods for calculation of summary statistics, loads, and trend analysis and present the results in a format that can be transmitted to the Water Board as part of the Report of Waste Discharge (ROWD) to be submitted in June 2007. Additionally, this memorandum will be used in the June 2007 Stormwater Quality Improvement Plans (SQIP) prepared by the Sacramento Stormwater Permittees.

Methods

DATA TEMPORAL RANGE

For the purposes of characterizing the ROWD data period, data since the end of 2002 are used as this coincides with the third Permit period. This limits the available urban runoff data to three years (six dry weather events and twelve wet weather events) because every third year monitoring is not performed at the urban runoff sites. Wet weather data through February 2007 are included as a fourth year of data. This is adequate to reasonably calculate summary statistics. For the purpose of the trend analysis, additional data will be used to look at changes between the Permit-period data and previous periods as discussed later in this report.

CONSTITUENT SELECTION

The Permit does not specify which of the more than one hundred constituents monitored should be included in the required trend and loading analyses. The Permit does include an "evaluation of any correlation between target pollutants identified by the Permittees (including but not limited

to metals and PAHs) and TSS loadings..." (page 3 of the 2002 Monitoring and Reporting Program Requirements section of the Permit). The DC2005 analysis selected constituents that were identified as Program target pollutants in the most recent (2002) target pollutants prioritization and those constituents that were reported in Reports of Water Quality Exceedance (RWQE) through the 2003-04 reporting year. It is recommended that this same list be used with the addition of methyl mercury and other "new" RWQE constituents. The "short" list, based on the above criteria, is shown in Table 1.

Table 1. Short List Constituents for Detailed Analysis

Cadmium, dissolved
Copper, dissolved
Lead, dissolved
Mercury, total
Mercury, total methyl
Zinc, dissolved
Total Dissolved Solids
Total Suspended Solids
Escherichia coli
Diazinon
Chlorpyrifos
DDT
Chrysene and Total PAHs
Pentachlorophenol
Lindane

LOAD ANALYSIS

There is also no specific guidance in the Sacramento Stormwater Permit (Permit) or from other sources on how the loading analyses should be performed. The loading analysis report in the Discharge Characterization 2005 Report (DC 2005) shows the load calculations performed on the 1999-2004 data period. The results of these data were considered in addition to the "simple" loading calculations performed for the ROWD for the short list of constituents. Loads were broken into dry season, wet weather, and inter-storm wet season 'regimes'. Median concentration and average flows for each period were used to calculate loads.

TREND ANALYSIS

There is no specific guidance in the Sacramento Stormwater Permit (Permit) or from other sources on how the trend analyses should be performed. The trend analysis performed for the ROWD includes visual inspection, distributional comparisons, and summary statistic comparisons. A graphical representation of the historical data was prepared for the short list of constituents. Time series plots were prepared that show detected (shaded points), not detected (unshaded at the MDL or RL), and the applicable lowest WQOs for urban runoff and receiving water sites.

Summary statistics and distributional comparisons were used to assess how urban runoff and receiving water quality have changed over the course of the Monitoring Program (status and trend monitoring). The following comparisons were performed:

- Summary statistics for all constituents using Regression on Order Statistics (ROS) to estimate when non-detects are present for discharge characterization, urban tributary, and river sampling for the Permit period.
- Comparison to WQOs and exceedance rates for urban runoff and receiving waters for short list constituents for December 2002 through February 2007 Permit period. Results are compared against all WQOs, and the resulting "probability" of meeting the WQO is based on all comparisons, not just the comparison to the lowest WQO.
- Probability plots for entire urban runoff data set (1990-2007).
- A summary of monitoring event parameters (rainfall, last rainfall date, etc) and monthly rainfall for the 1999-2007 period.
- Comparison of summary statistics between the 1990-2002 and 2002-2007 data periods for the short list of constituents, when available (urban tributaries have only been monitored during the 2002-2007 Permit period).
- Time series plots 1990-2007 for the short list of constituents, where available
- Box-plots comparing 1990-2002 and 2002-2007 data periods by sites for the short list of constituents, where available.

These data summaries, along with the DC 2005 report that was submitted in the 2004-05 Annual Monitoring Report, satisfy several ROWD data requirements from 40 CFR 122.6 (122.26.1.iv.A – rainfall data, 122.26.1.iv.B - discharge data, and 122.26.2.iii – characterization data).

A more comprehensive regression-based statistical analysis will be performed in the next Permit term as part of the Long Term Effectiveness (LTE) Study and was in part performed as part of DC 2005 for the urban runoff. In addition, because there is currently insufficient bioassessment data to perform a regression-based analysis and no promulgated reference stream for Central Valley low gradient streams, the Permittees are planning future monitoring activities to combine bioassessment monitoring with sediment, water column chemistry, and water column toxicity sampling in a *multiple lines of investigation* approach. This approach will provide a means to assess the overall water body health without relying on a simple *threshold* comparison whereby a water column concentration is compared against a presumed WQO.

Results

Key Results and findings for the data analyses included in the June 2007 ROWD are summarized in this report, especially as the findings pertain to the Stormwater Program's effectiveness in measuring changes in urban runoff and receiving water quality.

URBAN RUNOFF

Complete summary statistics by sites (Sump 104, Sump 111, and Strong Ranch Slough) and a description of the monitored events are included in Part I of the ROWD data submittal. In general, urban runoff data indicate significant reductions in nearly every constituent of interest. Table 2 compares the central value (median) and variability (interquartile range) for the short list constituents of interest and unfiltered metals (i.e., total metals) at all three sites combined.

It is not possible to ascertain all of the factors contributing to the changes observed in urban discharge quality. In addition to actual differences in urban runoff concentrations over time, changes could also be the result of sample collection or data quality differences. For example, early 1990's data include multiple samples per storm which are all included in the analysis and could possibly bias the 1990-2002 median higher if that particular storm had higher concentrations of the constituent of interest. Figure 1 is a time series plot for TSS that illustrates a decreasing trend in concentration. Isolated high values can sometimes be attributed to long antecedent dry periods.

Table 2. Comparison of Urban Runoff Median and Interquartile Range Between Monitoring Periods

Constituent	Units	1990-2002				2002-2007				RPD	
		n	Percent Detected	Median	IQR	n	Percent Detected	Median	IQR	Median	IQR
Cd - DIS	µg/L	115	59.1%	0.087	0.13	54	92.6%	0.035	0.04	-85.8%	-104.9%
Cd - TR	µg/L	109	83.5%	0.31	0.44	54	100.0%	0.16	0.24	-63.8%	-58.9%
Cu - DIS	µg/L	119	100.0%	5.37	5.15	54	100.0%	4.21	3.07	-24.3%	-50.5%
Cu - TR	µg/L	109	100.0%	13.57	15.67	54	100.0%	10.71	13.12	-23.6%	-17.7%
Pb - DIS	µg/L	119	71.4%	0.75	1.50	54	98.1%	0.44	0.61	-52.6%	-84.6%
Pb - TR	µg/L	109	98.2%	12.27	24.53	54	100.0%	5.74	12.80	-72.6%	-62.8%
Hg, Total	µg/L	79	65.8%	0.032	0.084	56	100.0%	0.015	0.025	-75.1%	-106.7%
Hg, Methyl	µg/L	0	id	id	id	54	100.0%	0.00024	0.00027	id	id
Zinc, DIS	µg/L	119	98.3%	45.74	64.09	54	100.0%	23.06	30.30	-65.9%	-71.6%
Zinc, Total	µg/L	109	100.0%	122.37	223.98	54	100.0%	62.02	102.19	-65.5%	-74.7%
TDS	µg/L	108	100.0%	82.24	94.55	53	98.1%	88.57	116.44	7.4%	20.8%
TSS	µg/L	123	95.9%	43.03	87.93	46	93.5%	25.79	59.75	-50.1%	-38.2%
E. coli	MPN/100 mL	12	91.7%	6,023	14,474	55	100.0%	4,769	16,255	-23.2%	11.6%
Diazinon	µg/L	196	82.1%	0.21	0.32	54	53.7%	0.034	0.091	-144.9%	-110.8%
Chlorpyrifos	µg/L	171	44.4%	0.032	0.038	54	3.7%	id	id	id	id
DDT and By- Products	µg/L	186	0.0%	id	id	180	6.1%	id	id	id	id
Chrysene	µg/L	32	6.3%	id	id	53	71.7%	0.029	0.077	id	id
PAHs	µg/L	24	87.5%	0.16	0.69	52	82.7%	0.22	0.83	30.8%	18.8%
Pentachlorphenol	µg/L	94	21.3%	0.071	0.12	53	50.9%	0.077	0.13	7.4%	8.5%
Lindane and By-Products	µg/L	248	0.8%	id	id	302	4.0%	id	id	id	id

Notes:
n = number of observations (samples)
Median = 50th percentile as estimate of median calculated using regression of order statistics
IQR = estimated inter quartile range (75th percentile - 25th percentile) calculated using regression of order statistics
RPD = relative percent difference calculated as the difference divided by the average of two values
id = insufficient detected data

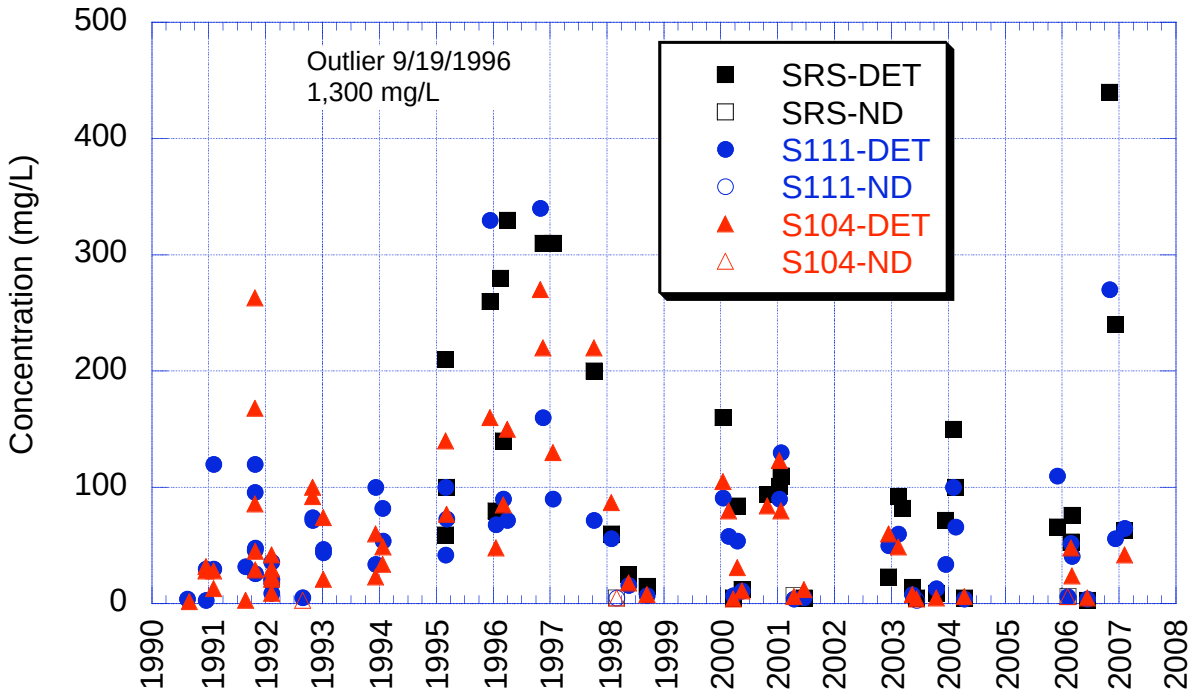

Figure 1. TSS at Urban Runoff Sites 1990-2007

URBAN TRIBUTARY

Summary statistics and WQO comparisons for the urban tributaries and additional (urban tributary) pesticide monitoring sites are provided in Part II of the ROWD data submittal. Because the urban tributary data are limited to the third Permit term (2002-2007), it is not possible to draw conclusions on trends. Moreover, only a limited set of constituents are monitored at these sites (Arcade Creek at Watt Ave., Morrison Creek at Brookfield Dr., and Willow Creek at Blue Ravine Road) more than once per year. However, there are two exceptions where decreases are evident. Pesticide registration changes (i.e., residential bans) for chlorpyrifos and diazinon and public outreach efforts have clearly led to significant decreases in observed concentrations as shown in Figure 2 and Figure 3.

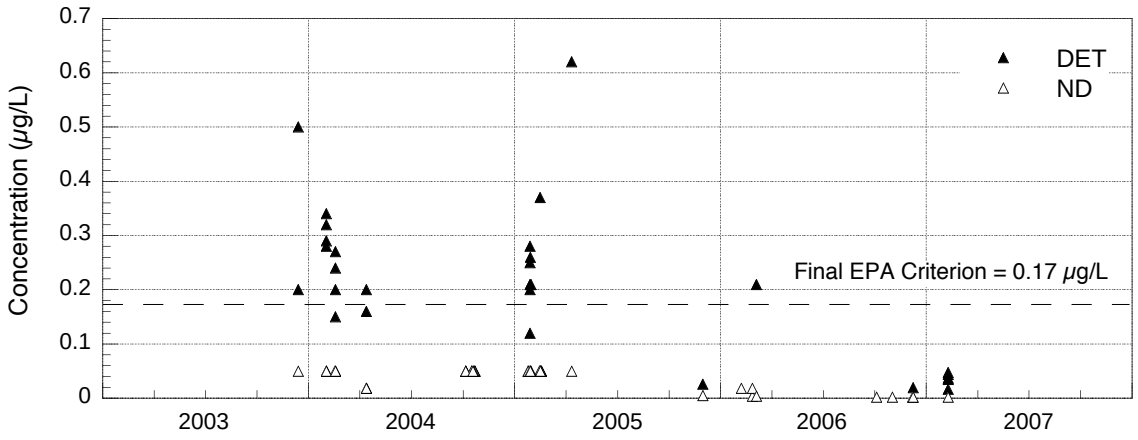

Figure 2. Diazinon Concentrations (µg/L) in Sacramento Urban Tributaries 2003-2007

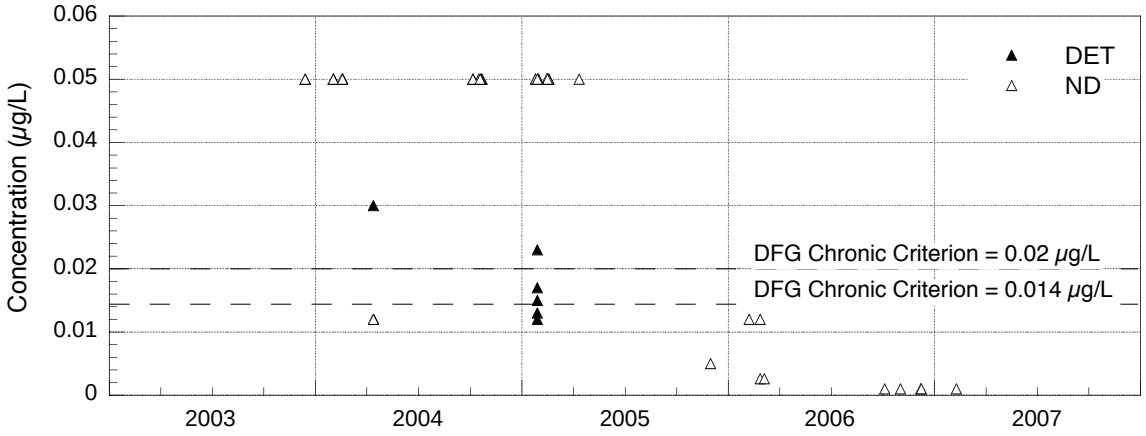

Figure 3. Chlorpyrifos Concentration (µg/L) in Sacramento Urban Tributaries 2003-2007

A detailed analysis of the urban tributary data was also completed to compare/characterize pesticide concentrations in the different tributaries. Based on this analysis of the additional

pesticide data[1] it is apparent that diazinon and chlorpyrifos monitoring of the six additional pesticide locations and the Morrison Creek at Brookfield location is not necessary as these sites are sufficiently characterized by the Arcade Creek at Watt Ave. and Willow Creek at Blue Ravine Rd. locations.

Following some exceedances California Toxics Rule (CTR) WQOs of copper and zinc in urban tributaries, the Permittees performed extensive metals monitoring including input parameters for the Biotic Ligand Model (BLM)[2]. The BLM is a toxicity model that is most refined for and is promulgated for an EPA criterion. Results of the monitoring and modeling effort demonstrate that the noted WQO exceedances would not pose toxic concentrations to sensitive freshwater fish that may be present in the urban tributaries.

RIVER

Both the American and Sacramento Rivers include drainage from large, mostly un-urbanized areas. Trends in water quality can be difficult to detect without more sophisticated techniques or unless a significant change occurs (i.e., a major source is removed). Because the flow rates in these rivers is high relative to urban runoff, changes in concentrations between monitoring locations upstream and downstream of urban runoff outfalls are difficult to detect. The downstream monitoring locations on the Sacramento River (Freeport Marina and River Mile 44) generally have *lower* concentrations than the monitoring location upstream of the urban area (Veterans Bridge). This is in great part due to the input from the American River as the confluence of the two rivers is downstream from Veterans Bridge. In some cases the American River at Highway 80 site is observed to have higher concentrations than both the site upstream (Nimbus) and downstream (Discovery Park). This effect is most likely due to site specific sampling conditions. The Permit requires monitoring downstream of the Strong Ranch/Chicken Ranch Slough outfall, but upstream of Highway 80. During lower flow conditions, this reach of the River is not accessible from a boat and is generally shallow. During higher flow conditions (i.e., storm events) sediments are more easily disturbed into the water column.

Figure 4 and Figure 5 are box-plots for TSS in the Sacramento and American Rivers, respectively. Box-plots provide distributional information (inter-quartile range, data range, distribution type, etc.) and are presented to compare changes in these characteristics between upstream and downstream sites, as well as between data periods (1990-2002 vs. 2002-2007). TSS was used only as a general indicator of typical patterns. The complete set of box-plots is included in Part III of the ROWD data submittal.

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[1] Brian Laurenson, Larry Walker Associates. *Evaluation of Additional Pesticide Monitoring Data – 2007 Update.* Memorandum prepared for Sacramento Stormwater Quality Partnership. May 2007

[2] Iain Clark, Larry Walker Associates. *Results of Biotic Ligand Model Analysis of Sacramento Urban Tributary Data for Copper, Cadmium and Zinc*. Memorandum prepared for Sacramento Stormwater Quality Partnership. May 2007

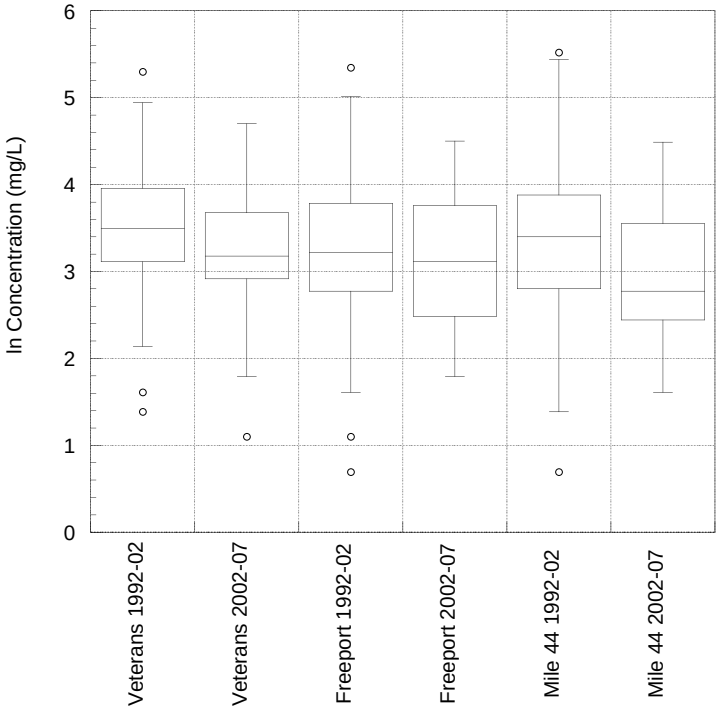

Figure 4. TSS in Sacramento River 1990-2007

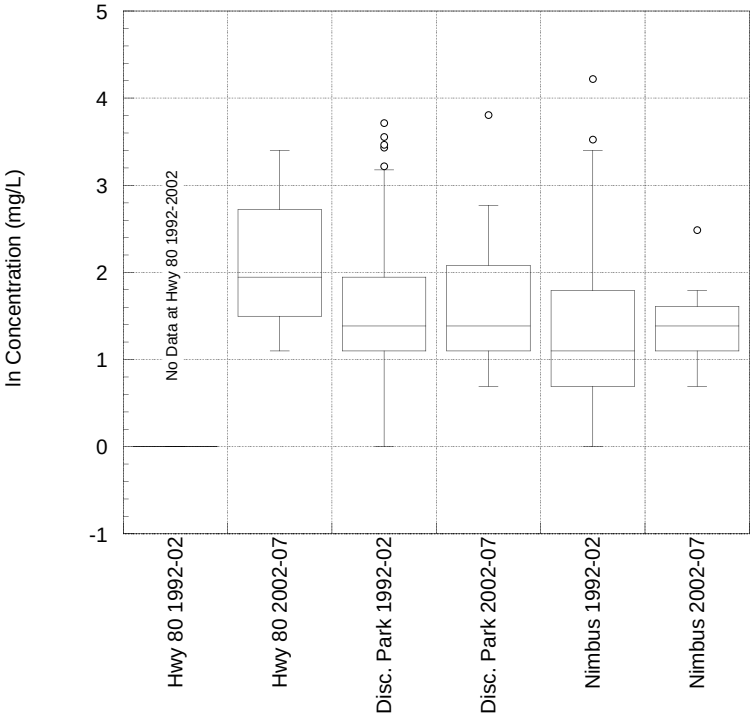

Figure 5. TSS in American River 1990-2007

Conclusions

Based on a review of the results presented in the 2007 ROWD data submittal, the following conclusions can be made with regard to status and trend monitoring:

URBAN RUNOFF

- Median concentrations for the 2002-2007 monitoring period are consistently lower than the previous monitoring period (1990-2002) for the 'short list' of key constituents selected (see Table 1). This may be attributable to better sampling techniques or other management program activities (e.g., street sweeping, public outreach, etc.). This pattern is evident in box plot comparisons, time series plots, in addition to comparisons of period median concentrations.
- Since pesticide registration changes went into effect in 2006, chlorpyrifos has not been detected and diazinon concentrations have been detected consistently below the (EPA revised) WQO (0.17 µg/L).
- Sump 104 and Strong Ranch Slough distributions are more similar to each other than to Sump 111. Sump 104 and Strong Ranch Slough drainage areas land uses are residential with some commercial and Sump 111 is light industrial and much smaller in area.
- Data collected to date are insufficient to characterize trends in new development urban runoff quality.

URBAN TRIBUTARY

- Data collected to date are insufficient to characterize trends except in the case of chlorpyrifos and diazinon where pesticide registration changes have clearly reduced concentrations of these pesticides below WQO concentrations.
- When adjusted to consider site specific conditions using the BLM, copper, zinc, and cadmium observed concentrations generally do not exceed WQOs or site specific LC50s, even in cases where the observed concentrations exceeded the CTR WQO.
- The Arcade Creek at Watt Ave. and Willow Creek at Blue Ravine Rd. monitoring locations are representative of the other "additional pesticide" locations and the Morrison Creek at Brookfield location in terms of chlorpyrifos and diazinon concentrations. Continued monitoring of the additional sites does not provide useful information, especially in light of the registration changes.
- Arcade Creek and Morrison Creek are distributionally similar for most constituents; Willow Creek tends to have lower concentrations of most constituents.

RIVER

- Differences between the upstream and downstream Sacramento River sites are explained by the confluence and influence of the American River, and site comparison are generally not useful.
- The American River at Highway 80 site location has been problematic because of the shallow depth in the reach where sample collection is required. It is not usually possible,

especially in dry weather, to navigate a boat upstream, and it has been necessary to move the site location frequently in order to safely access the river between the Chicken/Strong Ranch Slough discharge point and the Highway 80 Bridge. Collecting the transect composite without disturbing the sediments can also be difficult in this shallow reach. Finally, the Sump 10 urban runoff location is near to the upstream location during wet weather. Sampling in this location may be subject to localized discharge plume issues and may not be representative of river at that location.