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Preliminary Report of Discharge Characterization Studies

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SECTION 1
INTRODUCTION

1.1 PURPOSE OF THE DOCUMENT

The purpose of this preliminary report is to provide a summary of the available water quality data collected through Caltrans various discharge characterization monitoring studies, conducted under the Caltrans Storm Water Monitoring and Research Program. Under Provision K 1 of the Statewide Storm Water Permit (NPDES Permit # CAS000003), Caltrans is required to provide "Characterization of Discharges". This preliminary report covers study data collected through the 2001-02 wet season. The final "Report of Discharge Characterization Studies", which will include all of the data collected through the 2002-03 wet season, will be completed in mid-late 2003.

This preliminary report presents an overview summary of the studies used to generate the data, a brief description of the methods used to conduct monitoring and statistical analyses, and a summary of the results through the 2001-02 wet season.

Caltrans has taken a multi-faceted approach to addressing their storm water requirements. The approach results in data that can be placed into four categories that encompass storm water quality issues:

1. Chemical water quality data
2. Particle/sediment quality data
3. Litter data
4. Toxicity data

The preliminary data presented in this report covers chemical water quality data. These data were gathered from two categories of studies conducted over the past five years:

- the Statewide Storm Water Runoff Characterization Study and
- additional studies.

The Statewide Storm Water Runoff Characterization Study is a multi-year study designed to characterize, through collection and analysis of representative samples, the quality of storm water runoff from specific types of Caltrans facilities. Furthermore, this study is conducted so as to generate sufficient water quality data to satisfy permit requirements, support research and development needs, provide inputs for load assessment and modeling efforts, provide useful information for watershed planning, and allow for scientifically-sound statistical data quantification. Storm water runoff from over 50 sites, representing seven different types of Caltrans facilities (highways, maintenance stations, park and ride lots, rest areas, acceleration/deceleration zones, toll plazas, and weigh stations), have been monitored since the 2000-01 wet season. The study is designed to produce data for each facility type over a three-

year period, during several storm events annually. This phase of the study is concluding at the end of the 2002-03 wet season (April 2003).

The "additional studies" generally include studies that were commenced prior to the initiation of the Statewide Storm Water Runoff Characterization Study, but also include studies that are designed to address specialized research or other programmatic needs under the Storm Water Monitoring and Applied Research Program. These additional studies provide complementary data to further characterize Caltrans storm water quality. These studies focus on a variety of issues typically involving regionally-localized monitoring sites.

The additional storm water characterization studies include:

- Construction Site Runoff Characterization Study
- Tahoe Basin Water Quality Characterization Study
- Specialized Characterization Studies
    - Statewide Toxicity Testing Study
    - North Coast River Loading Study
    - Small Stream Crossing Study
    - Herbicide Runoff Study
    - California Toxics Rule (CTR) Characterization Study
    - Pathogens Characterization Study
    - First Flush Characterization Study
    - Litter Monitoring Study
    - District 7 Drain Inlet Cleaning Efficacy Study
- Storm Water Treatment Technology Research Studies
- Erosion Control Characterization Studies

SECTION 2
METHODS

2.1 PURPOSE

This section presents a brief description of the methods used to conduct monitoring and statistical analyses.

2.2 MONITORING PROTOCOLS

Monitoring for the aforementioned studies was conducted in accordance with the Caltrans Guidance Manual: Storm Water Monitoring Protocols (July 2000, as updated). Table 2-1 presents the minimum constituents list used for Caltrans storm water monitoring projects.

Table 2-1. Minimum Constituent List for Characterization[1]

Constituent/Parameter name	*Units*	*RL*
Conventional		
Conductivity	mmhos/cm	1
Hardness as CaCO3	mg/L	2
pH[2]	pH Units	+/- 0.1
Temperature[2]	°C	+/- 0.1
Total Dissolved Solids (TDS)	mg/L	1
Total Suspended Solids (TSS)	mg/L	1
Dissolved Organic Carbon (DOC)	mg/L	1
Total Organic Carbon (TOC)	mg/L	1
Nutrient		
Nitrate as Nitrogen (NO3-N)	mg/L	0.1
Total Kjeldahl Nitrogen (TKN)	mg/L	0.1
Total Phosphorous	mg/L	0.03
Dissolved Ortho-Phosphate	mg/L	0.03
Metals (total recoverable and dissolved)		
Arsenic (As)	*u*g/L	1
Cadmium (Cd)	*u*g/L	0.2
Chromium (Cr)	*u*g/L	1
Copper (Cu)	*u*g/L	1
Lead (Pb)	*u*g/L	1
Nickel (Ni)	*u*g/L	2
Zinc (Zn)	*u*g/L	5
Organic Compounds[3]		
Diuron	*u*g/L	1
Glyphosate	*u*g/L	5
Oryzalin	*u*g/L	1
Oxadiazon	*u*g/L	0.05
Triclopyr	*u*g/L	0.1

[1] For analytical methods and other specifications, see *Table 12-1* in *Section 12* of the *Guidance Manual: Stormwater Monitoring Protocols*.
[2] Report to +/- 0.1 of the nearest standard measurement unit
[3] Analysis for the listed herbicides applies to Caltrans statewide characterization monitoring only; this analysis may not be appropriate or necessary for other types of projects.

2.3 DATA ANALYSIS

Testing for Normality - An underlying assumption of many statistical tests is that the data in question conform to a "normal" probability distribution. A normally-distributed population of values has a preponderance of data points around the mean, with progressively fewer observations toward the lower and upper extremes (this is generally shown graphically as the "bell-shaped curve"). Environmental data generally tend to conform better to a normal probability distribution when the data are transformed into their natural logarithms (i.e., when the data are "log-transformed"). This has also been found to be true in previous analyses of Caltrans storm water quality data (Kayhanian et al., in press).

Handling of Non-Detected Data - For some constituents, concentrations were below the minimum detection limits and were reported as not detected or "non-detect". When detected data are sufficiently numerous (including three or more detected data points in this instance), statistical techniques may be employed in calculating values for non-detect data. For this analysis, values were estimated for non-detects using the Caltrans data analysis software tool ("DAT"). This tool uses the detected values and a combination of regression and probability analysis to determine a "fill-in" concentration value to assign to all data points below the reporting limit (non-detects), based upon an assumed log-normal probability distribution The filled-in values are then used in statistical analysis.

Descriptive Statistics – Basic statistical summaries were derived for each facility type for each year, including non-detect data where feasible according to the methods described above. The number of data points ("n"), mean, and standard deviation are provided for each constituent for which adequate data are available. Note that statistical summaries for herbicide data are not presented in this preliminary report as data for only one year of characterization is available.

Temporal Trends in Discharge Concentrations – A very preliminary assessment of temporal trends in runoff quality was performed by plotting annual mean concentrations for each of the four major facility types for which multi-year data are available: highways, construction sites, maintenance facilities, and park and ride lots.

SECTION 3
RESULTS

3.1 PURPOSE

This section presents the preliminary statistical summaries of data collected through the 2001-02 wet season in tabular and graphical formats. Tables 3-1 through 3-4 present data collected at four major types of facilities. These facilities include highways, construction sites, maintenance yards, and park and ride stations. Figures 1 through 22 present a comparison of annual mean concentrations for these four facility types for each of the composite-sampled constituents on the minimum constituents list. Data sets characterizing these four facility types comprise a relatively large number of samples, and generally involve a comparatively long sampling record of up to four years.

Tables 3-5 through 3-9 present preliminary statistical summaries of data collected through the 2001-02 wet season at five additional types of facilities. These facilities include congested highways, free flowing highways, rest areas, toll plazas, and weigh station. Data sets collected for these studies typically consist of one to two years of data for the majority of the minimum constituents list, with comparatively fewer samples than the four major facility types. For these tables a dash (-) indicates that data were not available or that samples collected for the available storm events were collected as discrete ("grab") samples and not as composite samples; as such, these samples do not characterize a whole storm event. The letters "ID" in these tables indicate insufficient detected data. In such cases samples were collected as composite samples; however, there were not enough samples with detectable levels of a constituent to perform statistical analyses.

Note: for all statistical summary tables, the "Monitoring Year" indicates the year at the start of the wet season. So "1998" refers to the 1998-99 wet season, and "2001" refers to the 2001-02 wet season.

Table 3-1. Summary of Caltrans Monitoring Data for Construction Site Runoff (1998 - 2001)

Pollutant Category	Parameter	Data	Monitoring Year				
			1998	1999	2000	2001	All Years Combined
Conventionals	Dissolved Organic Carbon (DOC) (mg/L)	n	-	-	-	19	19
		Mean	-	-	-	9.0	9.0
		SD	-	-	-	10.2	10.2
	Total Organic Carbon (TOC) (mg/L)	N	-	-	-	19	19
		Mean	-	-	-	11.1	11.1
		SD	-	-	-	11.4	11.4
	Total Dissolved Solids (TDS) (mg/L)	n	40	30	-	19	89
		Mean	397.9	319.8	-	200.5	329.4
		SD	2668.2	240.2	-	118.0	1682.1
	Total Suspended Solids (TSS) (mg/L)	n	41	30	-	19	90
		Mean	450.1	828.0	-	355.6	556.1
		SD	1549.6	951.3	-	680.6	1117.3
Nutrients	Nitrate as Nitrogen (NO3-N) (mg/L)	n	40	30	-	19	89
		Mean	0.93	0.8	-	0.8	0.87
		SD	0.75	0.9	-	0.7	0.76
	Dissolved Ortho-Phosphate (mg/L)	n	40	-	-	19	59
		Mean	0.08	-	-	0.2	0.13
		SD	0.09	-	-	0.2	0.13
	Total Kjeldahl Nitrogen (TKN) (mg/L)	n	39	30	-	19	88
		Mean	2.7	2.1	-	1.3	2.2
		SD	3.8	2.5	-	1.1	2.8
	Total Phosphorous (mg/L)	n	38	30	-	19	87
		Mean	0.66	5.6	-	0.3	2.28
		SD	2.16	26.6	-	0.2	15.66
Metals	Arsenic (dis) (ug/L)	n	-	-	-	19	19
		Mean	-	-	-	1.76	1.76
		SD	-	-	-	1.76	1.76
	Arsenic (tot) (ug/L)	n	-	-	-	19	19
		Mean	-	-	-	4.12	4.12
		SD	-	-	-	3.54	3.54
	Cadmium (dis) (ug/L)	n	41	30	-	19	90
		Mean	ID	ID	-	ID	ID
		SD	ID	ID	-	ID	ID
	Cadmium (tot) (ug/L)	n	41	30	-	19	90
		Mean	0.54	0.91	-	0.44	0.66
		SD	2.03	0.99	-	0.46	1.33
	Chromium (dis) (ug/L)	n	41	30	-	19	90
		Mean	6.1	4.0	-	6.6	5.5
		SD	7.9	3.2	-	7.8	6.6

Table 3-1, continued.

Pollutant Category	Parameter	Data	Monitoring Year				
			1998	1999	2000	2001	All Years Combined
Metals	Chromium (tot) (ug/L)	n	41	30	-	19	90
		Mean	41.9	54.2	-	21.9	41.8
		SD	124.8	53.2	-	16.8	80.0
	Copper (dis) (ug/L)	n	40	30	-	19	89
		Mean	7.7	5.6	-	7.4	6.9
		SD	5.7	5.2	-	6.7	5.7
	Copper (tot) (ug/L)	n	41	30	-	19	90
		Mean	45.2	40.1	-	25.6	39.3
		SD	165.9	29.1	-	20.3	107.4
	Nickel (dis) (ug/L)	n	41	30	-	19	90
		Mean	ID	3.5	-	4.2	3.1
		SD	ID	3.9	-	2.6	2.8
	Nickel (tot) (ug/L)	n	41	30	-	19	90
		Mean	96.1	59.8	-	17.9	67.6
		SD	481.6	72.3	-	13.5	323.7
	Lead (dis) (ug/L)	n	41	30	-	19	90
		Mean	ID	ID	-	2.6	0.9
		SD	ID	ID	-	3.4	2.4
	Lead (tot) (ug/L)	n	41	30	-	19	90
		Mean	89.0	58.5	-	32.1	66.8
		SD	484.7	63.9	-	29.0	317.8
	Zinc (dis) (ug/L)	n	41	30	-	19	90
		Mean	92.6	15.3	-	31.0	54.1
		SD	757.2	19.7	-	56.5	497.6
	Zinc (tot) (ug/L)	n	41	30	-	19	90
		Mean	284.5	200.1	-	91.0	215.6
		SD	926.1	155.8	-	69.7	632.9

Table Notes:
"n" Number of samples
"SD" Standard deviation
"-" Indicates no whole storm event data for this combination of parameter, year, and facility
"ID" Indicates insufficient detected data
"dis" Dissolved fraction
"tot" Total recoverable

Table 3-2. Summary of Caltrans Monitoring Data for Highway Runoff (1998-2001)

Pollutant Category	Parameter	Data	Monitoring Year				
			1998	1999	2000	2001	All Years Combined
Conventionals	Dissolved Organic Carbon (DOC) (mg/L)	n	-	-	372	381	753
		Mean	-	-	15.8	23.7	19.8
		SD	-	-	31.7	28.2	29.0
	Total Organic Carbon (TOC) (mg/L)	n	111	121	365	369	966
		Mean	21.0	16.0	18.8	24.8	21.0
		SD	40.9	11.1	35.0	24.4	28.0
	Total Dissolved Solids (TDS) (mg/L)	n	21	-	356	369	746
		Mean	117.1	-	194.9	164.3	177.6
		SD	69.1	-	742.8	348.0	563.0
	Total Suspended Solids (TSS) (mg/L)	n	136	166	372	383	1057
		Mean	140.6	111.7	149.5	163.0	147.3
		SD	164.2	128.2	406.1	310.5	310.7
Nutrients	Nitrate as Nitrogen (NO3-N) (mg/L)	n	137	155	369	381	1042
		Mean	1.3	1.2	1.0	1.0	1.1
		SD	0.8	1.1	3.2	1.4	2.0
	Dissolved Ortho-Phosphate (mg/L)	n	72	57	370	381	880
		Mean	0.1	0.2	0.1	0.1	0.1
		SD	0.1	0.1	0.1	0.2	0.2
	Total Kjeldahl Nitrogen (TKN) (mg/L)	n	134	164	367	382	1047
		Mean	2.9	2.2	1.9	2.7	2.3
		SD	2.7	1.6	1.8	3.0	2.4
	Total Phosphorous (mg/L)	n	138	99	372	383	992
		Mean	0.3	0.7	0.4	0.3	0.4
		SD	0.2	1.5	0.7	0.5	0.7
Metals	Arsenic (dis) (ug/L)	n	18	-	365	369	752
		Mean	2.01	-	1.06	1.02	1.06
		SD	1.95	-	1.65	1.41	1.53
	Arsenic (tot) (ug/L)	n	18	-	373	383	774
		Mean	4.39	-	1.91	1.96	1.99
		SD	4.73	-	2.33	2.34	2.43
	Cadmium (dis) (ug/L)	n	127	123	373	382	1005
		Mean	0.22	0.14	0.26	0.23	0.24
		SD	0.32	0.12	0.42	0.39	0.37
	Cadmium (tot) (ug/L)	n	127	58	373	383	941
		Mean	1.24	1.14	0.74	0.76	0.84
		SD	1.08	1.08	0.79	1.94	1.37
	Chromium (dis) (ug/L)	n	127	123	373	383	1006
		Mean	2.9	2.3	2.5	3.6	2.9
		SD	2.0	0.8	2.4	5.6	3.8

Table 3-2, continued.

Pollutant Category	Parameter	Data	Monitoring Years				
			1998	1999	2000	2001	All Years Combined
Metals	Chromium (tot) (ug/L)	n	127	58	373	383	941
		Mean	13.1	9.0	8.3	9.0	9.3
		SD	10.4	8.5	12.2	9.2	10.6
	Copper (dis) (ug/L)	n	141	166	373	382	1062
		Mean	16.8	14.7	13.8	16.1	15.2
		SD	9.9	11.9	12.6	22.4	16.4
	Copper (tot) (ug/L)	n	141	101	373	383	998
		Mean	53.9	151.8	32.6	33.8	48.1
		SD	51.0	1329.0	30.2	35.7	412.5
	Nickel (dis) (ug/L)	n	127	123	373	383	1006
		Mean	4.2	3.3	4.0	5.5	4.5
		SD	2.9	4.3	4.7	7.2	5.6
	Nickel (tot) (ug/L)	n	127	58	373	383	941
		Mean	15.9	9.3	10.1	11.5	11.4
		SD	34.9	8.0	15.8	12.4	17.3
	Lead (dis) (ug/L)	n	141	166	373	382	1062
		Mean	4.2	5.1	5.7	5.4	5.4
		SD	16.0	6.9	28.2	33.9	25.7
	Lead (tot) (ug/L)	n	141	101	373	383	998
		Mean	131.1	135.1	50.4	30.0	62.6
		SD	226.8	294.1	139.8	112.0	164.5
	Zinc (dis) (ug/L)	n	141	166	373	382	1062
		Mean	56.8	55.8	74.8	82.6	72.2
		SD	67.1	67.7	109.9	148.8	115.3
	Zinc (tot) (ug/L)	n	141	101	373	383	998
		Mean	224.7	277.6	202.7	189.4	208.3
		SD	175.0	340.9	210.6	213.3	223.4

Table Notes:
"n" Number of samples
"SD" Standard deviation
"-" Indicates no whole storm event data for this combination of parameter, year, and facility
"ID" Indicates insufficient detected data
"dis" Dissolved fraction
"tot" Total recoverable

Table 3-3. Summary of Caltrans Monitoring Data for Maintenance Yard Runoff (1998 - 2001)

Pollutant Category	Parameter	Data	Monitoring Year				
			1998	1999	2000	2001	All Years Combined
Conventionals	Dissolved Organic Carbon (DOC) (mg/L)	n	-	-	82	32	114
		Mean	-	-	17.2	19.2	17.8
		SD	-	-	17.9	29.6	21.4
	Total Organic Carbon (TOC) (mg/L)	n	-	-	82	32	114
		Mean	-	-	20.2	20.8	20.4
		SD	-	-	20.1	30.7	23.1
	Total Dissolved Solids (TDS) (mg/L)	n	46	62	81	32	221
		Mean	60.0	67.2	63.4	79.9	66.2
		SD	28.5	48.9	61.3	113.7	62.1
	Total Suspended Solids (TSS) (mg/L)	n	55	86	81	32	254
		Mean	120.0	83.9	110.3	73.7	98.8
		SD	117.8	66.6	95.8	91.1	92.2
Nutrients	Nitrate as Nitrogen (NO3-N) (mg/L)	n	56	85	82	32	255
		Mean	0.7	0.7	0.8	0.6	0.7
		SD	0.6	0.4	1.0	1.1	0.7
	Dissolved Ortho-Phosphate (mg/L)	n	46	62	82	32	222
		Mean	0.4	0.2	0.1	0.1	0.2
		SD	2.2	0.1	0.2	0.8	0.9
	Total Kjeldahl Nitrogen (TKN) (mg/L)	n	53	85	81	32	251
		Mean	1.7	1.8	2.0	1.8	1.8
		SD	1.0	1.2	1.7	2.4	1.5
	Total Phosphorous (mg/L)	n	54	85	81	32	252
		Mean	0.4	0.4	0.3	0.2	0.3
		SD	0.3	0.3	0.3	0.2	0.3
Metals	Arsenic (dis) (ug/L)	n	-	-	81	32	113
		Mean	-	-	12.72	1.95	9.65
		SD	-	-	18.86	1.82	16.72
	Arsenic (tot) (ug/L)	n	-	-	82	32	114
		Mean	-	-	17.02	2.65	12.98
		SD	-	-	25.11	2.04	22.29
	Cadmium (dis) (ug/L)	n	46	62	81	32	221
		Mean	0.34	0.34	0.33	0.21	0.32
		SD	0.33	0.41	0.36	0.14	0.34
	Cadmium (tot) (ug/L)	n	47	63	82	32	224
		Mean	0.8	0.8	0.9	0.5	0.8
		SD	0.5	0.7	0.7	0.5	0.7
	Chromium (dis) (ug/L)	n	46	62	81	32	221
		Mean	1.2	1.2	1.6	1.4	1.4
		SD	1.3	0.7	1.8	0.9	1.4

Table 3-3, continued.

Pollutant Category	Parameter	Data	Monitoring Year				
			1998	1999	2000	2001	All Years Combined
Metals	Chromium (tot) (ug/L)	n	47	63	82	32	224
		Mean	12.0	6.8	5.5	6.2	7.3
		SD	15.4	8.0	4.8	6.1	9.2
	Copper (dis) (ug/L)	n	55	86	81	32	254
		Mean	8.9	13.1	18.2	9.1	13.3
		SD	6.9	17.6	21.3	8.8	16.6
	Copper (tot) (ug/L)	n	56	86	82	32	256
		Mean	23.1	46.7	38.0	16.3	34.9
		SD	17.7	190.8	45.0	13.9	110.3
	Nickel (dis) (ug/L)	n	46	63	81	32	222
		Mean	2.0	3.3	3.8	3.4	3.3
		SD	1.9	5.4	4.4	4.7	4.3
	Nickel (tot) (ug/L)	n	47	63	82	32	224
		Mean	10.7	7.6	7.4	8.9	8.4
		SD	13.3	6.7	7.3	10.2	9.0
	Lead (dis) (ug/L)	n	55	86	81	32	254
		Mean	1.6	2.7	3.4	1.0	2.5
		SD	1.8	3.7	7.4	1.1	4.8
	Lead (tot) (ug/L)	n	56	86	82	32	256
		Mean	43.8	36.3	34.1	13.3	34.3
		SD	66.3	49.8	48.6	11.1	50.2
	Zinc (dis) (ug/L)	n	55	86	81	32	254
		Mean	90.0	109.4	143.0	65.8	110.4
		SD	68.2	134.1	121.5	40.5	110.9
	Zinc (tot) (ug/L)	n	56	86	82	32	256
		Mean	210.2	236.1	307.6	131.0	240.2
		SD	226.3	297.4	297.2	82.6	264.7

Table Notes:
"n" Number of samples
"SD" Standard deviation
"-" Indicates no whole storm event data for this combination of parameter, year, and facility
"ID" Indicates insufficient detected data
"dis" Dissolved fraction
"tot" Total recoverable

Table 3-4. Summary of Caltrans Monitoring Data for Park and Ride Lot Runoff (1998 – 2001)

Pollutant Category	Parameter	Data	Monitoring Year				
			1998	1999	2000	2001	All Years Combined
Conventionals	Dissolved Organic Carbon (DOC) (mg/L)	n	-	-	92	60	152
		Mean	-	-	16.1	25.4	19.8
		SD	-	-	15.1	45.1	30.5
	Total Organic Carbon (TOC) (mg/L)	n	-	-	92	60	152
		Mean	-	-	19.7	22.8	20.9
		SD	-	-	16.9	27.2	21.3
	Total Dissolved Solids (TDS) (mg/L)	n	-	-	92	60	152
		Mean	-	-	59.6	71.6	64.4
		SD	-	-	57.9	111.8	80.7
	Total Suspended Solids (TSS) (mg/L)	n	5	22	92	60	179
		Mean	54.8	76.1	64.6	52.8	61.8
		SD	26.1	100.4	63.9	41.9	61.1
Nutrients	Nitrate as Nitrogen (NO3-N) (mg/L)	n	5	23	92	60	180
		Mean	0.3	0.6	0.7	0.6	0.7
		SD	0.2	0.6	1.0	0.9	0.9
	Dissolved Ortho-Phosphate (mg/L)	n	-	-	92	60	152
		Mean	-	-	0.2	0.1	0.2
		SD	-	-	0.2	0.2	0.2
	Total Kjeldahl Nitrogen (TKN) (mg/L)	n	5	22	92	60	179
		Mean	1.7	2.9	2.6	2.4	2.6
		SD	0.7	3.4	2.1	2.5	2.4
	Total Phosphorous (mg/L)	n	5	22	92	60	179
		Mean	0.3	0.5	0.4	0.3	0.4
		SD	0.1	0.6	0.6	0.2	0.5
Metals	Arsenic (dis) (ug/L)	n	-	-	92	60	152
		Mean	-	-	0.70	0.67	0.66
		SD	-	-	0.71	0.53	0.65
	Arsenic (tot) (ug/L)	n	-	-	92	60	152
		Mean	-	-	1.20	0.94	1.10
		SD	-	-	1.18	0.89	1.07
	Cadmium (dis) (ug/L)	n	-	-	92	60	152
		Mean	-	-	0.13	0.15	0.14
		SD	-	-	0.30	0.17	0.24
	Cadmium (tot) (ug/L)	n	-	-	92	60	152
		Mean	-	-	0.34	0.26	0.31
		SD	-	-	0.47	0.22	0.39
	Chromium (dis) (ug/L)	n	-	-	92	60	152
		Mean	-	-	0.9	0.9	0.9
		SD	-	-	0.6	0.7	0.6

Table 3-4, continued.

Pollutant Category	Parameter	Data	Monitoring Year				
			1998	1999	2000	2001	All Years Combined
Metals	Chromium (tot) (ug/L)	n	-	-	92	60	152
		Mean	-	-	2.5	3.3	2.8
		SD	-	-	2.2	2.7	2.4
	Copper (dis) (ug/L)	n	5	22	92	60	179
		Mean	6.2	8.2	8.5	10.3	9.0
		SD	2.8	7.8	7.1	12.0	8.9
	Copper (tot) (ug/L)	n	5	22	92	60	179
		Mean	14.4	18.7	16.8	16.0	16.7
		SD	4.0	17.4	16.7	14.1	15.3
	Nickel (dis) (ug/L)	n	-	-	92	60	152
		Mean	-	-	3.4	4.0	3.7
		SD	-	-	3.6	5.1	4.2
	Nickel (tot) (ug/L)	n	-	-	92	60	152
		Mean	-	-	5.7	6.4	6.0
		SD	-	-	4.3	5.4	4.7
	Lead (dis) (ug/L)	n	5	22	92	60	179
		Mean	ID	0.9	1.3	1.2	1.2
		SD	ID	1.5	1.7	1.5	1.5
	Lead (tot) (ug/L)	n	5	22	92	60	179
		Mean	10.2	14.0	9.1	7.6	9.2
		SD	10.6	11.2	9.6	10.4	9.9
	Zinc (dis) (ug/L)	n	5	22	92	60	179
		Mean	60.2	71.5	77.4	86.8	79.3
		SD	34.5	66.5	95.8	125.8	101.4
	Zinc (tot) (ug/L)	n	5	22	92	60	179
		Mean	114.2	189.1	165.4	141.2	158.8
		SD	61.0	177.0	177.2	143.8	162.9

Table Notes:
"n" Number of samples
"SD" Standard deviation
"-" Indicates no whole storm event data for this combination of parameter, year, and facility
"ID" Indicates insufficient detected data
"dis" Dissolved fraction
"tot" Total recoverable

Table 3-5. Summary of Caltrans Monitoring Data for Congested Highway Runoff (1998 - 2001)

Pollutant Category	Parameter	Data	Monitoring Year				
			1998	1999	2000	2001	All Years Combined
Conventionals	Dissolved Organic Carbon (DOC) (mg/L)	n	-	-	12	14	26
		Mean	-	-	15.8	36.2	26.8
		SD	-	-	11.1	12.6	15.5
	Total Organic Carbon (TOC) (mg/L)	n	-	-	12	14	26
		Mean	-	-	21.4	42.7	32.9
		SD	-	-	12.0	13.5	16.5
	Total Dissolved Solids (TDS) (mg/L)	n	-	-	12	14	26
		Mean	-	-	85.8	121.9	105.2
		SD	-	-	65.8	37.1	52.4
	Total Suspended Solids (TSS) (mg/L)	n	-	-	12	14	26
		Mean	-	-	67.2	103.3	86.6
		SD	-	-	128.9	58.6	81.3
Nutrients	Nitrate as Nitrogen (NO3-N) (mg/L)	n	-	-	12	14	26
		Mean	-	-	0.88	1.99	1.48
		SD	-	-	1.37	1.06	1.19
	Dissolved Ortho-Phosphate (mg/L)	n	-	-	12	14	26
		Mean	-	-	0.07	0.12	0.09
		SD	-	-	0.05	0.05	0.05
	Total Kjeldahl Nitrogen (TKN) (mg/L)	n	-	-	12	14	26
		Mean	-	-	1.9	4.5	3.3
		SD	-	-	2.3	4.8	3.8
	Total Phosphorous (mg/L)	n	-	-	12	14	26
		Mean	-	-	0.1	0.3	0.2
		SD	-	-	0.0	0.1	0.1
Metals	Arsenic (dis) (ug/L)	n	-	-	12	14	26
		Mean	-	-	0.76	1.31	1.14
		SD	-	-	1.13	0.52	0.63
	Arsenic (tot) (ug/L)	n	-	-	12	14	26
		Mean	-	-	1.21	1.97	1.73
		SD	-	-	1.77	1.06	1.20
	Cadmium (dis) (ug/L)	n	-	-	12	14	26
		Mean	-	-	0.20	0.78	0.51
		SD	-	-	0.19	1.21	0.92
	Cadmium (tot) (ug/L)	n	-	-	12	14	26
		Mean	-	-	0.55	1.16	0.88
		SD	-	-	0.79	1.05	0.87
	Chromium (dis) (ug/L)	n	-	-	12	14	26
		Mean	-	-	3.3	6.9	5.2
		SD	-	-	2.8	3.2	3.5

Table 3-5, continued.

Pollutant Category	Parameter	Data	Monitoring Year				
			1998	1999	2000	2001	All Years Combined
Metals	Chromium (tot) (ug/L)	n	-	-	12	14	26
		Mean	-	-	5.7	10.9	8.5
		SD	-	-	6.2	5.4	6.1
	Copper (dis) (ug/L)	n	-	-	12	14	26
		Mean	-	-	12.4	38.2	25.7
		SD	-	-	18.4	13.3	19.2
	Copper (tot) (ug/L)	n	-	-	12	14	26
		Mean	-	-	21.9	62.8	43.9
		SD	-	-	38.3	21.0	32.1
	Nickel (dis) (ug/L)	n	-	-	12	14	26
		Mean	-	-	3.6	9.3	6.8
		SD	-	-	7.5	3.6	5.5
	Nickel (tot) (ug/L)	n	-	-	12	14	26
		Mean	-	-	6.0	12.3	9.4
		SD	-	-	11.2	4.7	7.6
	Lead (dis) (ug/L)	n	-	-	12	14	26
		Mean	-	-	2.0	10.2	6.4
		SD	-	-	2.8	10.5	8.9
	Lead (tot) (ug/L)	n	-	-	12	14	26
		Mean	-	-	22.6	38.5	31.2
		SD	-	-	45.2	39.6	38.8
	Zinc (dis) (ug/L)	n	-	-	12	14	26
		Mean	-	-	106.0	170.7	139.0
		SD	-	-	326.2	89.6	189.7
	Zinc (tot) (ug/L)	n	-	-	12	14	26
		Mean	-	-	209.1	274.6	244.3
		SD	-	-	653.6	103.8	374.4

Table Notes:
"n" Number of samples
"SD" Standard deviation
"-" Indicates no whole storm event data for this combination of parameter, year, and facility
"ID" Indicates insufficient detected data
"dis" Dissolved fraction
"tot" Total recoverable

Table 3-6. Summary of Caltrans Monitoring Data for Free-Flowing Highway Runoff (1998 - 2001)

Pollutant Category	Parameter	Data	Monitoring Year				
			1998	1999	2000	2001	All Years Combined
Conventionals	Dissolved Organic Carbon (DOC) (mg/L)	n	-	-	15	15	30
		Mean	-	-	13.4	38.5	26.0
		SD	-	-	6.0	23.1	20.8
	Total Organic Carbon (TOC) (mg/L)	n	-	-	15	15	30
		Mean	-	-	16.7	45.0	30.8
		SD	-	-	8.1	29.9	25.4
	Total Dissolved Solids (TDS) (mg/L)	n	-	-	15	15	30
		Mean	-	-	92.7	122.9	107.7
		SD	-	-	41.7	76.7	62.5
	Total Suspended Solids (TSS) (mg/L)	n	-	-	15	15	30
		Mean	-	-	122.6	105.1	113.9
		SD	-	-	99.2	51.7	76.0
Nutrients	Nitrate as Nitrogen (NO3-N) (mg/L)	n	-	-	15	15	30
		Mean	-	-	0.8	1.8	1.3
		SD	-	-	0.4	1.1	1.0
	Dissolved Ortho-Phosphate (mg/L)	n	-	-	15	15	30
		Mean	-	-	0.1	0.1	0.1
		SD	-	-	0.1	0.1	0.1
	Total Kjeldahl Nitrogen (TKN) (mg/L)	n	-	-	15	15	30
		Mean	-	-	1.8	3.2	2.5
		SD	-	-	0.9	1.6	1.4
	Total Phosphorous (mg/L)	n	-	-	15	15	30
		Mean	-	-	0.3	0.3	0.3
		SD	-	-	0.1	0.2	0.1
Metals	Arsenic (dis) (ug/L)	n	-	-	15	15	30
		Mean	-	-	0.8	1.5	1.2
		SD	-	-	0.4	0.4	0.5
	Arsenic (tot) (ug/L)	n	-	-	15	15	30
		Mean	-	-	1.25	2.10	1.70
		SD	-	-	0.58	0.75	0.76
	Cadmium (dis) (ug/L)	n	-	-	15	15	30
		Mean	-	-	0.22	0.38	0.31
		SD	-	-	0.25	0.26	0.25
	Cadmium (tot) (ug/L)	n	-	-	15	15	30
		Mean	-	-	0.61	0.86	0.73
		SD	-	-	0.37	0.57	0.48
	Chromium (dis) (ug/L)	n	-	-	15	15	30
		Mean	-	-	2.8	5.9	4.3
		SD	-	-	1.3	4.1	3.4

Table 3-6, continued.

Pollutant Category	Parameter	Data	Monitoring Year				
			1998	1999	2000	2001	All Years Combined
Metals	Chromium (tot) (ug/L)	n	-	-	15	15	30
		Mean	-	-	6.5	9.9	8.2
		SD	-	-	4.2	4.4	4.5
	Copper (dis) (ug/L)	n	-	-	15	15	30
		Mean	-	-	11.2	32.3	21.7
		SD	-	-	7.4	12.2	14.6
	Copper (tot) (ug/L)	n	-	-	15	15	30
		Mean	-	-	24.6	52.0	38.3
		SD	-	-	18.9	22.9	24.6
	Nickel (dis) (ug/L)	n	-	-	15	15	30
		Mean	-	-	3.1	7.9	5.5
		SD	-	-	2.1	3.9	3.9
	Nickel (tot) (ug/L)	n	-	-	15	15	30
		Mean	-	-	6.0	11.3	8.7
		SD	-	-	4.8	5.9	5.8
	Lead (dis) (ug/L)	n	-	-	15	15	30
		Mean	-	-	11.6	27.9	19.7
		SD	-	-	15.6	36.2	28.5
	Lead (tot) (ug/L)	n	-	-	15	15	30
		Mean	-	-	63.3	81.7	72.5
		SD	-	-	74.6	89.0	80.2
	Zinc (dis) (ug/L)	n	-	-	15	15	30
		Mean	-	-	60.8	115.9	88.4
		SD	-	-	61.4	52.8	61.6
	Zinc (tot) (ug/L)	n	-	-	15	15	30
		Mean	-	-	169.5	274.7	222.1
		SD	-	-	109.0	142.6	134.2

Table Notes:
"n" Number of samples
"SD" Standard deviation
"-" Indicates no whole storm event data for this combination of parameter, year, and facility
"ID" Indicates insufficient detected data
"dis" Dissolved fraction
"tot" Total recoverable

Table 3-7. Summary of Caltrans Monitoring Data for Rest Area Runoff (1998 - 2001)

Pollutant Category	Parameter	Data	Monitoring Year				
			1998	1999	2000	2001	All Years Combined
Conventionals	Dissolved Organic Carbon (DOC) (mg/L)	n	-	-	22	17	39
		Mean	-	-	12.0	34.7	21.9
		SD	-	-	9.4	68.6	46.1
	Total Organic Carbon (TOC) (mg/L)	n	-	-	22	17	39
		Mean	-	-	15.0	36.9	24.5
		SD	-	-	11.2	70.3	47.1
	Total Dissolved Solids (TDS) (mg/L)	n	-	-	22	17	39
		Mean	-	-	37.7	105.9	67.4
		SD	-	-	23.8	226.0	151.6
	Total Suspended Solids (TSS) (mg/L)	n	-	-	22	17	39
		Mean	-	-	58.9	68.4	63.0
		SD	-	-	58.0	50.7	53.2
Nutrients	Nitrate as Nitrogen (NO3-N) (mg/L)	n	-	-	22	17	39
		Mean	-	-	0.9	0.9	0.9
		SD	-	-	0.9	0.9	0.9
	Dissolved Ortho-Phosphate (mg/L)	n	-	-	22	17	39
		Mean	-	-	0.2	0.9	0.5
		SD	-	-	0.2	2.9	1.9
	Total Kjeldahl Nitrogen (TKN) (mg/L)	n	-	-	22	17	39
		Mean	-	-	2.5	8.6	5.2
		SD	-	-	1.8	24.4	16.3
	Total Phosphorous (mg/L)	n	-	-	22	17	39
		Mean	-	-	0.4	0.6	0.5
		SD	-	-	0.4	0.7	0.5
Metals	Arsenic (dis) (ug/L)	n	-	-	22	17	39
		Mean	-	-	1.35	1.24	1.27
		SD	-	-	1.71	1.10	1.45
	Arsenic (tot) (ug/L)	n	-	-	22	17	39
		Mean	-	-	1.79	1.69	1.76
		SD	-	-	2.08	1.63	1.85
	Cadmium (dis) (ug/L)	n	-	-	22	17	39
		Mean	-	-	ID	ID	0.11
		SD	-	-	ID	ID	0.29
	Cadmium (tot) (ug/L)	n	-	-	22	17	39
		Mean	-	-	0.30	0.44	0.37
		SD	-	-	0.57	0.78	0.61
	Chromium (dis) (ug/L)	n	-	-	22	17	39
		Mean	-	-	1.3	2.9	2.0
		SD	-	-	1.5	4.0	2.9

Table 3-7, continued.

Pollutant Category	Parameter	Data	Monitoring Year				
			1998	1999	2000	2001	All Years Combined
Metals	Chromium (tot) (ug/L)	n	-	-	22	17	39
		Mean	-	-	4.1	6.5	5.2
		SD	-	-	4.3	4.1	4.2
	Copper (dis) (ug/L)	n	-	-	22	17	39
		Mean	-	-	7.5	14.2	10.4
		SD	-	-	5.1	20.4	13.8
	Copper (tot) (ug/L)	n	-	-	22	17	39
		Mean	-	-	12.5	22.5	16.9
		SD	-	-	9.9	22.0	16.3
	Nickel (dis) (ug/L)	n	-	-	22	17	39
		Mean	-	-	2.5	4.6	3.3
		SD	-	-	1.5	10.0	6.7
	Nickel (tot) (ug/L)	n	-	-	22	17	39
		Mean	-	-	6.7	9.8	8.0
		SD	-	-	8.8	11.0	9.5
	Lead (dis) (ug/L)	n	-	-	22	17	39
		Mean	-	-	0.9	2.0	1.3
		SD	-	-	0.6	2.6	1.9
	Lead (tot) (ug/L)	n	-	-	22	17	39
		Mean	-	-	6.0	11.2	8.3
		SD	-	-	7.4	10.4	9.0
	Zinc (dis) (ug/L)	n	-	-	22	17	39
		Mean	-	-	49.2	153.8	94.8
		SD	-	-	37.3	465.0	307.9
	Zinc (tot) (ug/L)	n	-	-	22	17	39
		Mean	-	-	96.9	232.1	155.8
		SD	-	-	86.5	526.1	348.6

Table Notes:
"n" Number of samples
"SD" Standard deviation
"-" Indicates no whole storm event data for this combination of parameter, year, and facility
"ID" Indicates insufficient detected data
"dis" Dissolved fraction
"tot" Total recoverable

Table 3-8. Summary of Caltrans Monitoring Data for Toll Plaza Runoff (1998 - 2001)

Pollutant Category	Parameter	Data	Monitoring Year				
			1998	1999	2000	2001	All Years Combined
Conventionals	Dissolved Organic Carbon (DOC) (mg/L)	n	-	-	-	16	16
		Mean	-	-	-	31.9	31.9
		SD	-	-	-	20.6	20.6
	Total Organic Carbon (TOC) (mg/L)	n	-	-	-	16	16
		Mean	-	-	-	37.5	37.5
		SD	-	-	-	20.7	20.7
	Total Dissolved Solids (TDS) (mg/L)	n	-	-	-	16	16
		Mean	-	-	-	96.9	96.9
		SD	-	-	-	84.2	84.2
	Total Suspended Solids (TSS) (mg/L)	n	-	-	-	16	16
		Mean	-	-	-	96.2	96.2
		SD	-	-	-	67.2	67.2
Nutrients	Nitrate as Nitrogen (NO3-N) (mg/L)	n	-	-	-	16	16
		Mean	-	-	-	1.0	1.0
		SD	-	-	-	0.9	0.9
	Dissolved Ortho-Phosphate (mg/L)	n	-	-	-	16	16
		Mean	-	-	-	0.1	0.1
		SD	-	-	-	0.1	0.1
	Total Kjeldahl Nitrogen (TKN) (mg/L)	n	-	-	-	16	16
		Mean	-	-	-	2.8	2.8
		SD	-	-	-	1.6	1.6
	Total Phosphorous (mg/L)	n	-	-	-	16	16
		Mean	-	-	-	0.3	0.3
		SD	-	-	-	0.1	0.1
Metals	Arsenic (dis) (ug/L)	n	-	-	-	16	16
		Mean	-	-	-	0.79	0.79
		SD	-	-	-	0.58	0.58
	Arsenic (tot) (ug/L)	n	-	-	-	16	16
		Mean	-	-	-	1.46	1.46
		SD	-	-	-	0.49	0.49
	Cadmium (dis) (ug/L)	n	-	-	-	16	16
		Mean	-	-	-	0.46	0.46
		SD	-	-	-	0.34	0.34
	Cadmium (tot) (ug/L)	n	-	-	-	16	16
		Mean	-	-	-	1.11	1.11
		SD	-	-	-	0.48	0.48
	Chromium (dis) (ug/L)	n	-	-	-	16	16
		Mean	-	-	-	4.8	4.8
		SD	-	-	-	2.9	2.9

Table 3-8, continued.

Pollutant Category	Parameter	Data	Monitoring Year				
			1998	1999	2000	2001	All Years Combined
Metals	Chromium (tot) (ug/L)	n	-	-	-	16	16
		Mean	-	-	-	11.4	11.4
		SD	-	-	-	8.3	8.3
	Copper (dis) (ug/L)	n	-	-	-	16	16
		Mean	-	-	-	31.3	31.3
		SD	-	-	-	23.4	23.4
	Copper (tot) (ug/L)	n	-	-	-	16	16
		Mean	-	-	-	60.1	60.1
		SD	-	-	-	22.8	22.8
	Nickel (dis) (ug/L)	n	-	-	-	16	16
		Mean	-	-	-	6.8	6.8
		SD	-	-	-	5.1	5.1
	Nickel (tot) (ug/L)	n	-	-	-	16	16
		Mean	-	-	-	13.4	13.4
		SD	-	-	-	5.9	5.9
	Lead (dis) (ug/L)	n	-	-	-	16	16
		Mean	-	-	-	4.0	4.0
		SD	-	-	-	4.8	4.8
	Lead (tot) (ug/L)	n	-	-	-	16	16
		Mean	-	-	-	23.9	23.9
		SD	-	-	-	9.4	9.4
	Zinc (dis) (ug/L)	n	-	-	-	16	16
		Mean	-	-	-	136.3	136.3
		SD	-	-	-	100.2	100.2
	Zinc (tot) (ug/L)	n	-	-	-	16	16
		Mean	-	-	-	280.0	280.0
		SD	-	-	-	109.1	109.1

Table Notes:
"n" Number of samples
"SD" Standard deviation
"-" Indicates no whole storm event data for this combination of parameter, year, and facility
"ID" Indicates insufficient detected data
"dis" Dissolved fraction
"tot" Total recoverable

Table 3-9. Summary of Caltrans Monitoring Data for Weigh Station Runoff (1998 - 2001)

Pollutant Category	Parameter	Data	Monitoring Year				
			1998	1999	2000	2001	All Years Combined
Conventionals	Dissolved Organic Carbon (DOC) (mg/L)	n	-	-	-	15	15
		Mean	-	-	-	26.3	26.3
		SD	-	-	-	18.2	18.2
	Total Organic Carbon (TOC) (mg/L)	n	-	-	-	15	15
		Mean	-	-	-	28.8	28.8
		SD	-	-	-	18.9	18.9
	Total Dissolved Solids (TDS) (mg/L)	n	-	-	-	15	15
		Mean	-	-	-	109.3	109.3
		SD	-	-	-	127.4	127.4
	Total Suspended Solids (TSS) (mg/L)	n	-	-	-	15	15
		Mean	-	-	-	67.4	67.4
		SD	-	-	-	48.2	48.2
Nutrients	Nitrate as Nitrogen (NO3-N) (mg/L)	n	-	-	-	15	15
		Mean	-	-	-	1.1	1.1
		SD	-	-	-	1.1	1.1
	Dissolved Ortho-Phosphate (mg/L)	n	-	-	-	15	15
		Mean	-	-	-	0.2	0.2
		SD	-	-	-	0.1	0.1
	Total Kjeldahl Nitrogen (TKN) (mg/L)	n	-	-	-	15	15
		Mean	-	-	-	3.2	3.2
		SD	-	-	-	3.4	3.4
	Total Phosphorous (mg/L)	n	-	-	-	15	15
		Mean	-	-	-	0.3	0.3
		SD	-	-	-	0.2	0.2
Metals	Arsenic (dis) (ug/L)	n	-	-	-	15	15
		Mean	-	-	-	1.26	1.26
		SD	-	-	-	0.42	0.42
	Arsenic (tot) (ug/L)	n	-	-	-	15	15
		Mean	-	-	-	1.57	1.57
		SD	-	-	-	0.80	0.80
	Cadmium (dis) (ug/L)	n	-	-	-	15	15
		Mean	-	-	-	0.24	0.24
		SD	-	-	-	0.19	0.19
	Cadmium (tot) (ug/L)	n	-	-	-	15	15
		Mean	-	-	-	0.51	0.51
		SD	-	-	-	0.44	0.44
	Chromium (dis) (ug/L)	n	-	-	-	15	15
		Mean	-	-	-	2.0	2.0
		SD	-	-	-	0.8	0.8

Table 3-9, continued.

Pollutant Category	Parameter	Data	Monitoring Year				
			1998	1999	2000	2001	All Years Combined
Metals	Chromium (tot) (ug/L)	n	-	-	-	15	15
		Mean	-	-	-	8.1	8.1
		SD	-	-	-	5.5	5.5
	Copper (dis) (ug/L)	n	-	-	-	15	15
		Mean	-	-	-	20.8	20.8
		SD	-	-	-	16.1	16.1
	Copper (tot) (ug/L)	n	-	-	-	15	15
		Mean	-	-	-	33.3	33.3
		SD	-	-	-	24.7	24.7
	Nickel (dis) (ug/L)	n	-	-	-	15	15
		Mean	-	-	-	4.2	4.2
		SD	-	-	-	2.3	2.3
	Nickel (tot) (ug/L)	n	-	-	-	15	15
		Mean	-	-	-	9.1	9.1
		SD	-	-	-	5.3	5.3
	Lead (dis) (ug/L)	n	-	-	-	15	15
		Mean	-	-	-	3.7	3.7
		SD	-	-	-	4.3	4.3
	Lead (tot) (ug/L)	n	-	-	-	15	15
		Mean	-	-	-	14.2	14.2
		SD	-	-	-	14.9	14.9
	Zinc (dis) (ug/L)	n	-	-	-	15	15
		Mean	-	-	-	119	119
		SD	-	-	-	96.5	96.5
	Zinc (tot) (ug/L)	n	-	-	-	15	15
		Mean	-	-	-	221.6	221.6
		SD	-	-	-	176.6	176.6

Table Notes:
"n" Number of samples
"SD" Standard deviation
"-" Indicates no whole storm event data for this combination of parameter, year, and facility
"ID" Indicates insufficient detected data
"dis" Dissolved fraction
"tot" Total recoverable

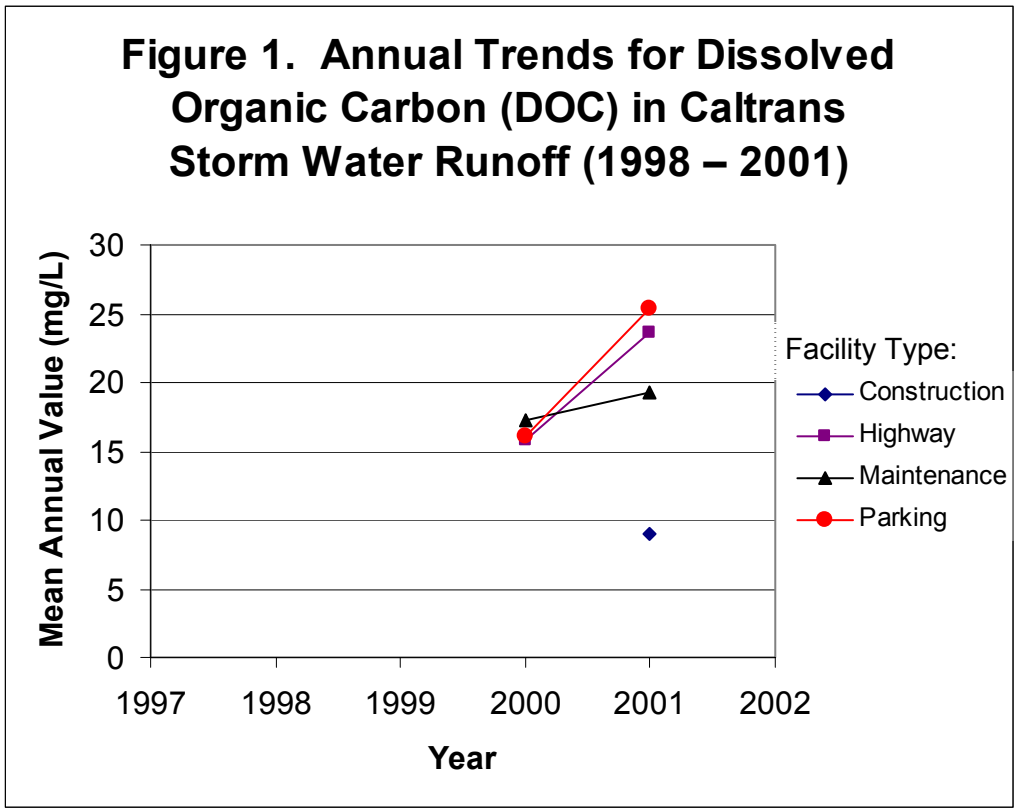


Figure 1. Annual Trends for Dissolved Organic Carbon (DOC) in Caltrans Storm Water Runoff (1998 – 2001)
Mean Annual Value (mg/L)
30
25
20
15
10
5
0
1997
1998
1999
2000
2001
2002
Year
Facility Type:
Construction
Highway
Maintenance
Parking

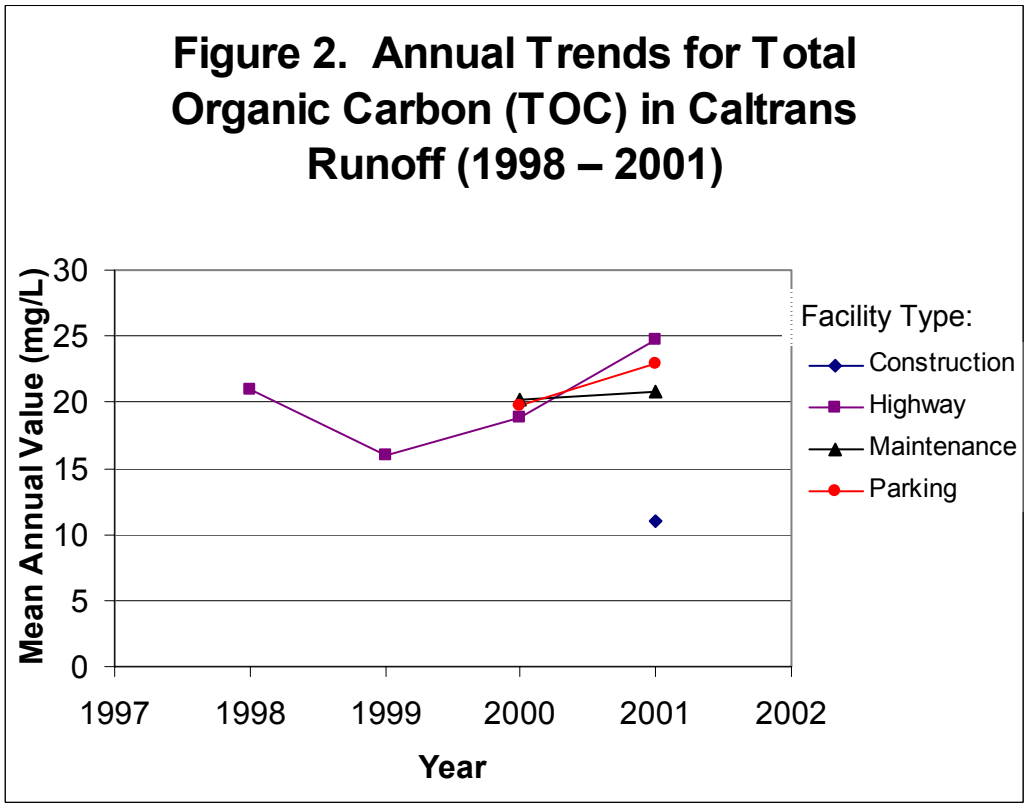


Figure 2. Annual Trends for Total Organic Carbon (TOC) in Caltrans Runoff (1998 – 2001)
Mean Annual Value (mg/L)
30
25
20
15
10
5
0
1997
1998
1999
2000
2001
2002
Year
Facility Type:
Construction
Highway
Maintenance
Parking

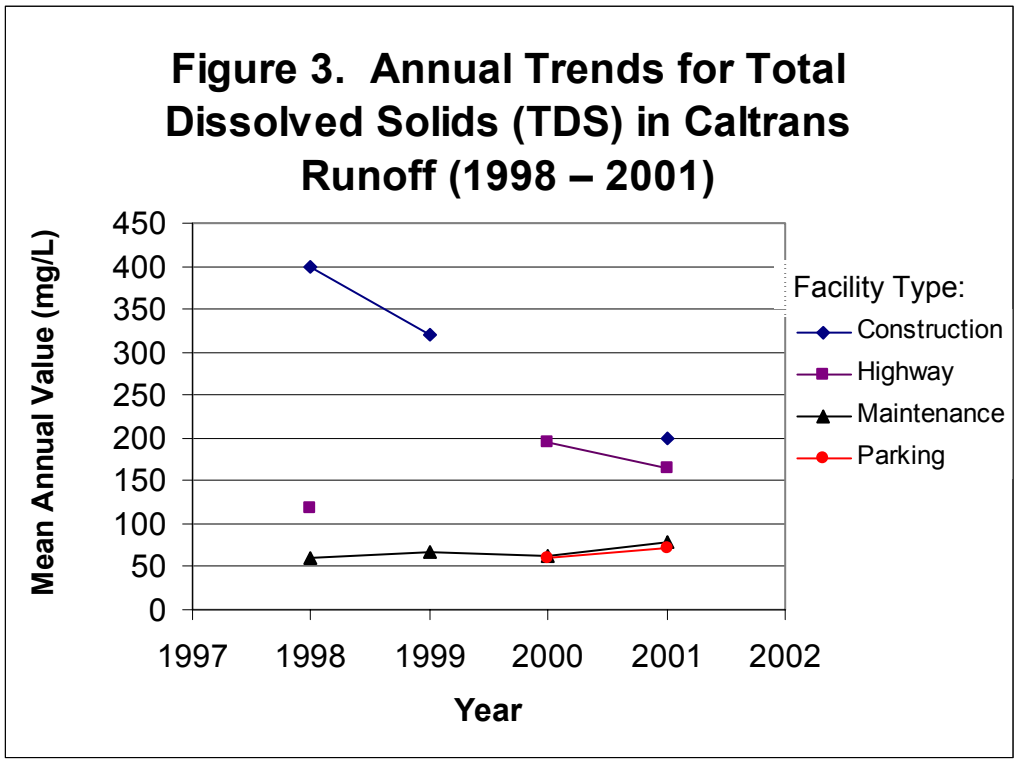


Figure 3. Annual Trends for Total Dissolved Solids (TDS) in Caltrans Runoff (1998 – 2001)
Mean Annual Value (mg/L)
450
400
350
300
250
200
150
100
50
0
1997
1998
1999
2000
2001
2002
Year
Facility Type:
Construction
Highway
Maintenance
Parking

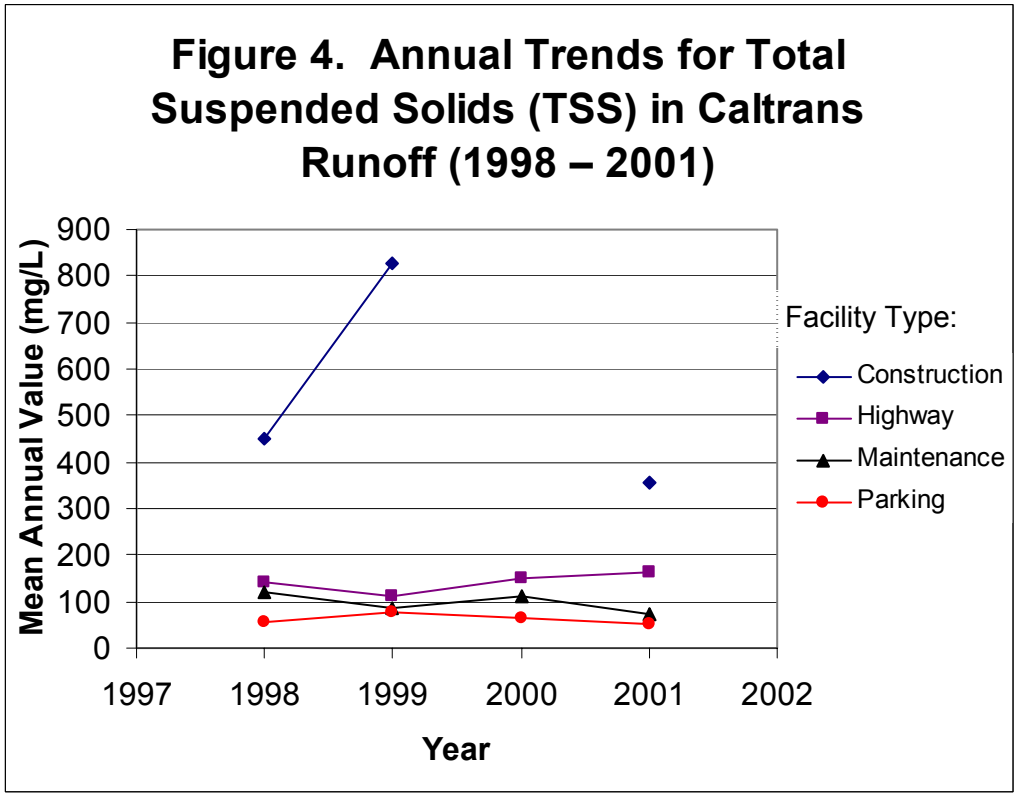


Figure 4. Annual Trends for Total Suspended Solids (TSS) in Caltrans Runoff (1998 – 2001)
Mean Annual Value (mg/L)
900
800
700
600
500
400
300
200
100
0
1997
1998
1999
2000
2001
2002
Year
Facility Type:
Construction
Highway
Maintenance
Parking

Figure 5. Annual Trends for Nitrate as Nitrogen (NO3-N) in Caltrans Runoff (1998 – 2001)

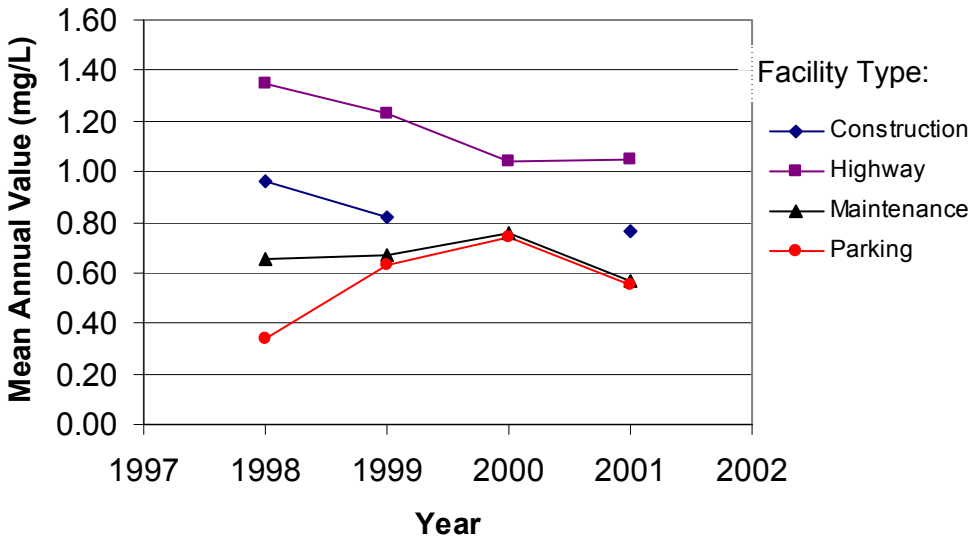
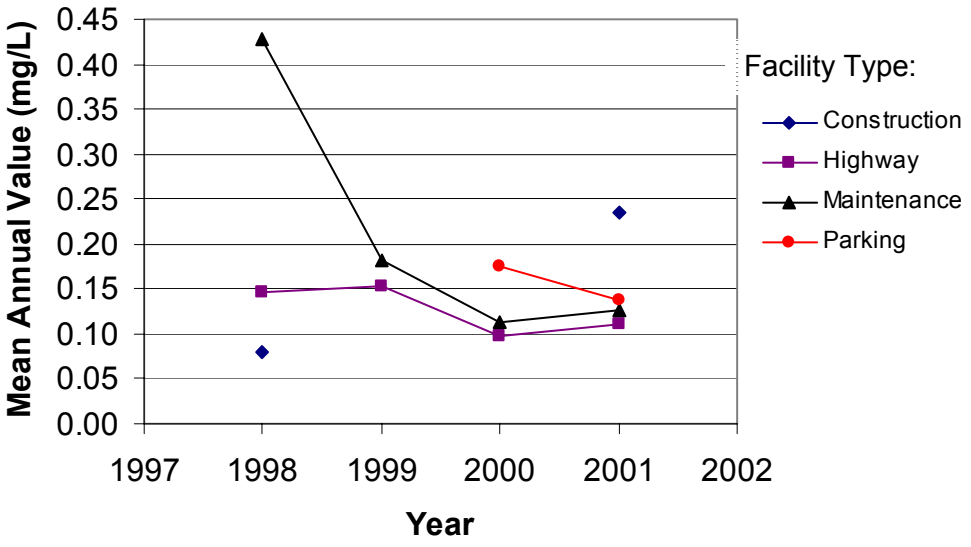


Figure 6. Annual Trends for Dissolved Ortho-Phosphate in Caltrans Runoff (1998 – 2001)



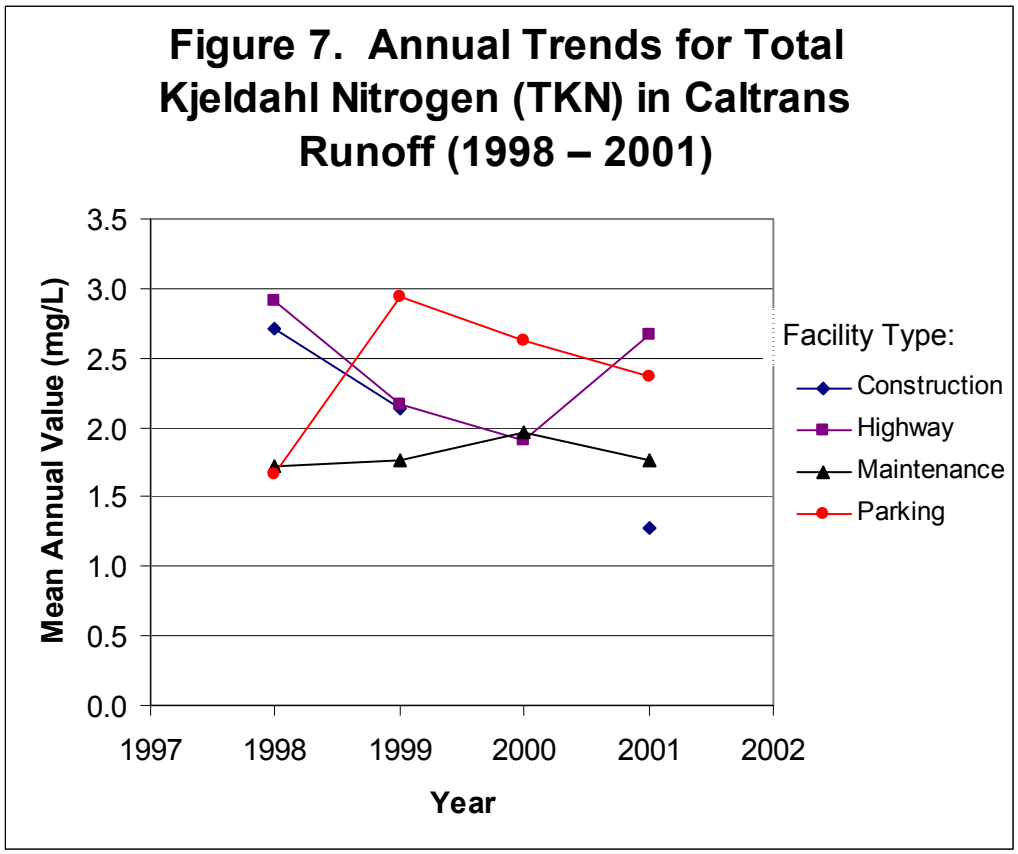


Figure 7. Annual Trends for Total Kjeldahl Nitrogen (TKN) in Caltrans Runoff (1998 – 2001)
Mean Annual Value (mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1997
1998
1999
2000
2001
2002
Year
Facility Type:
Construction
Highway
Maintenance
Parking

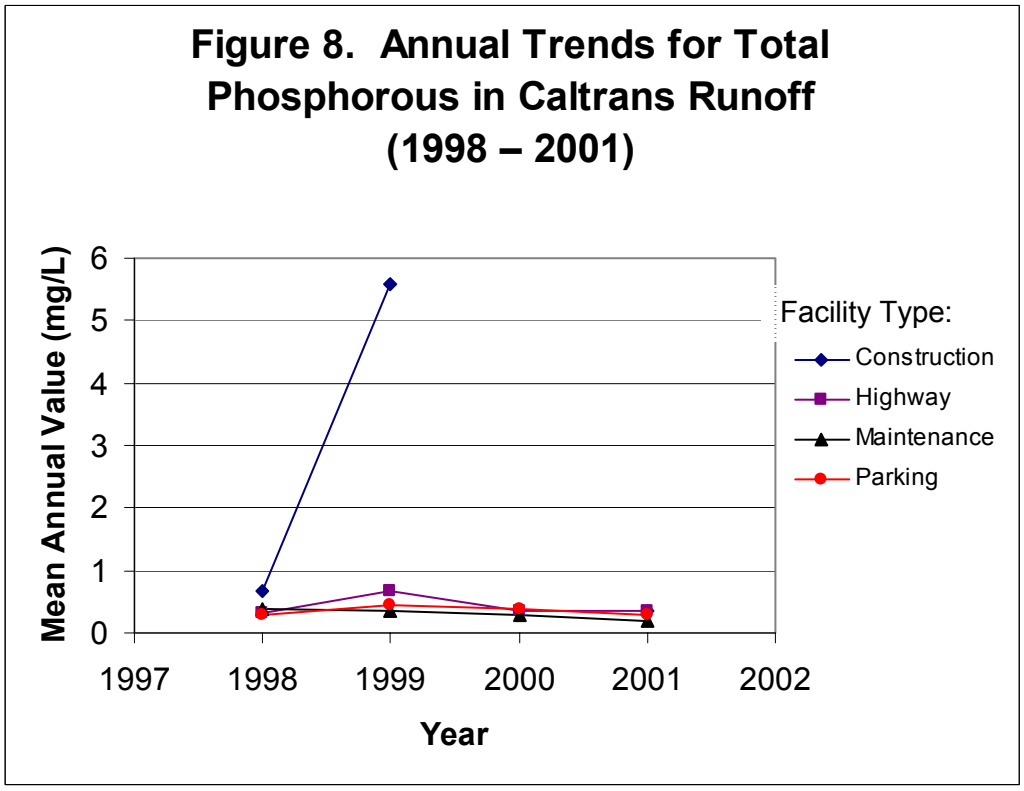


Figure 8. Annual Trends for Total Phosphorous in Caltrans Runoff (1998 – 2001)
Mean Annual Value (mg/L)
6
5
4
3
2
1
0
1997
1998
1999
2000
2001
2002
Year
Facility Type:
Construction
Highway
Maintenance
Parking

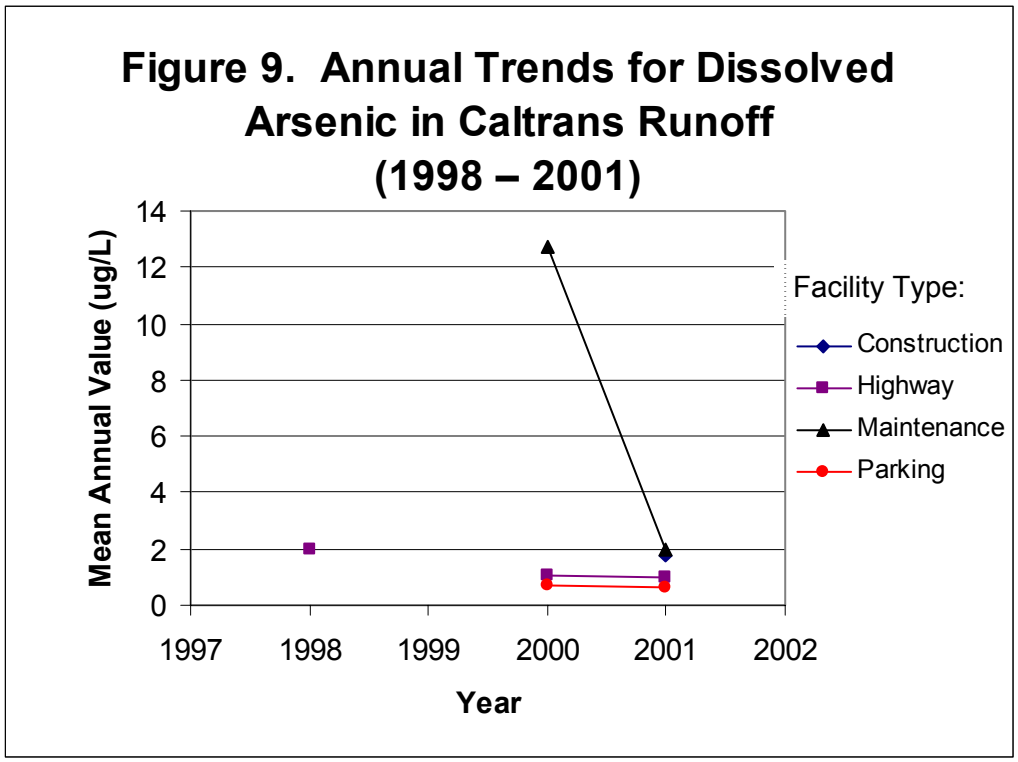


Figure 9. Annual Trends for Dissolved Arsenic in Caltrans Runoff (1998 – 2001)
Mean Annual Value (ug/L)
14
12
10
8
6
4
2
0
1997
1998
1999
2000
2001
2002
Year
Facility Type:
Construction
Highway
Maintenance
Parking

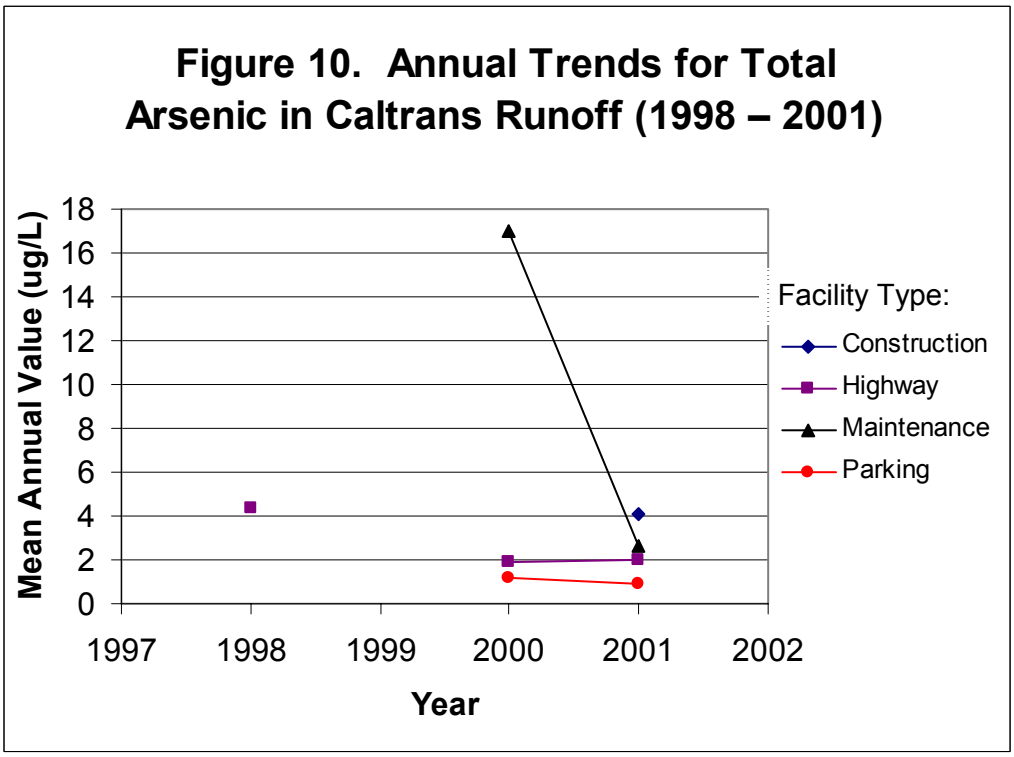
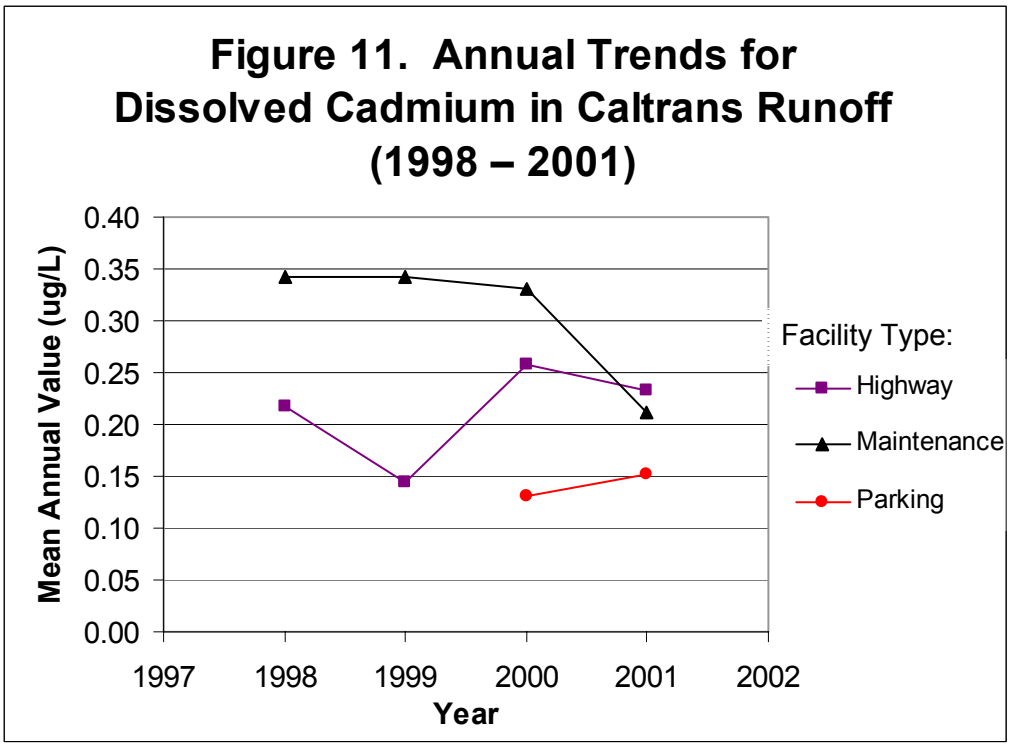
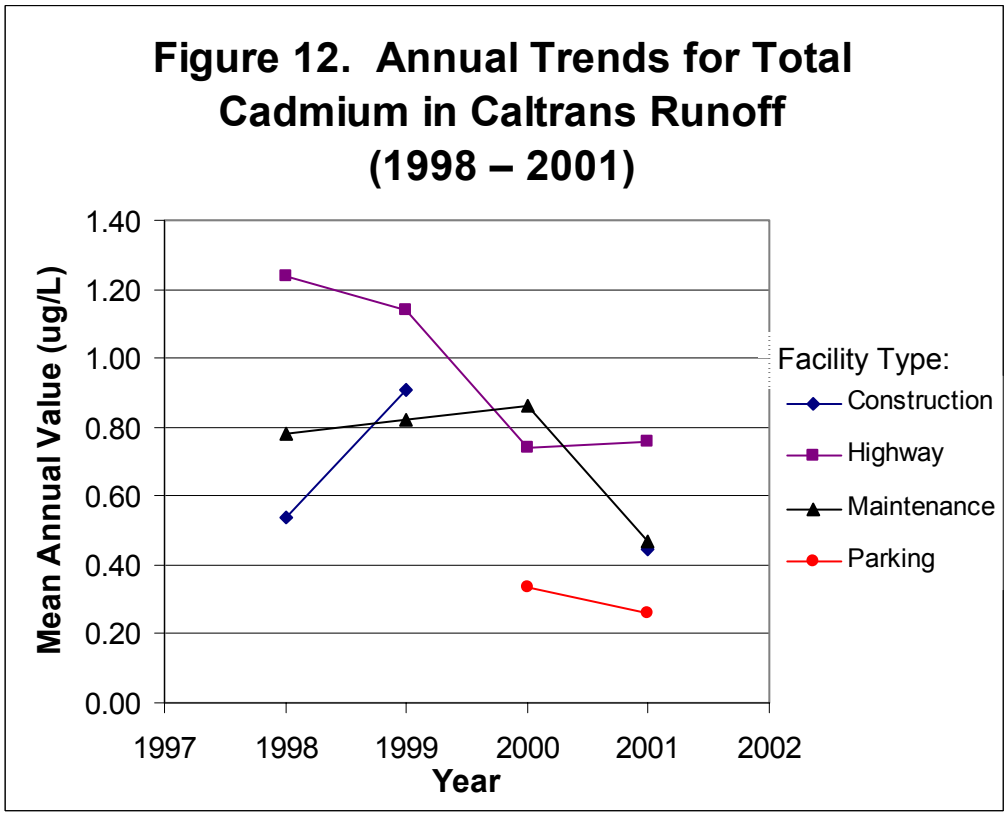


Figure 10. Annual Trends for Total Arsenic in Caltrans Runoff (1998 – 2001)
Mean Annual Value (ug/L)
18
16
14
12
10
8
6
4
2
0
1997
1998
1999
2000
2001
2002
Year
Facility Type:
Construction
Highway
Maintenance
Parking



Note: There was insufficient detected data to run statistics for construction sites.



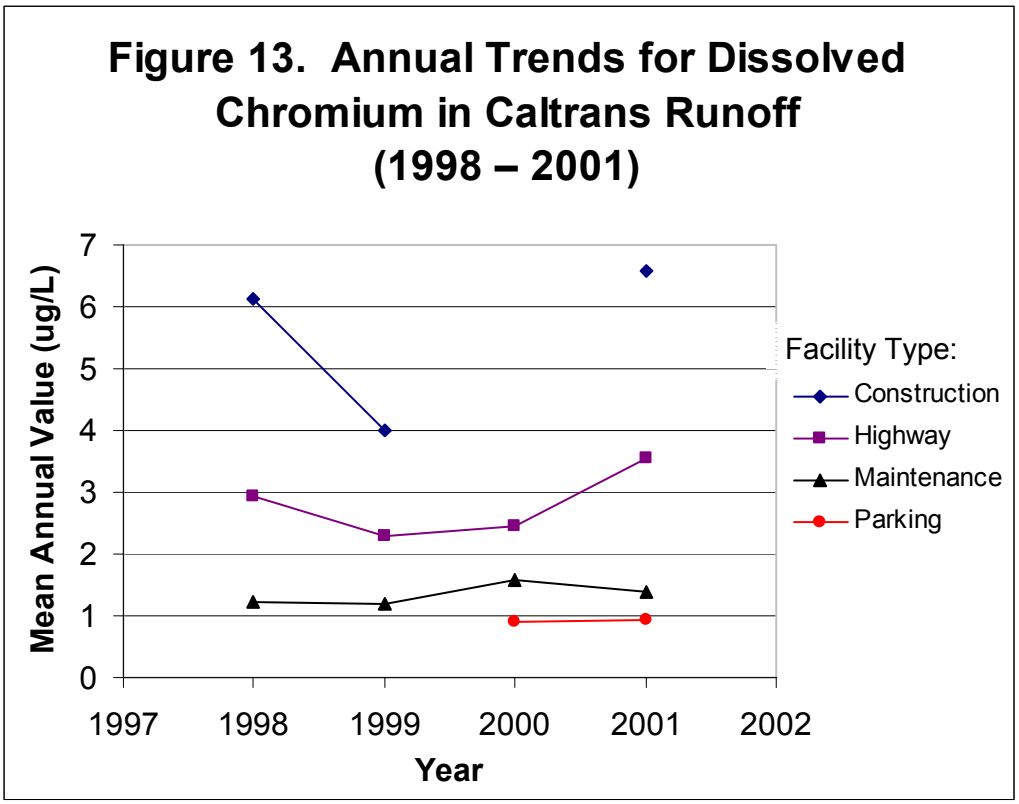


Figure 13. Annual Trends for Dissolved Chromium in Caltrans Runoff (1998 – 2001)
Mean Annual Value (ug/L)
0
1
2
3
4
5
6
7
1997
1998
1999
2000
2001
2002
Year
Facility Type:
Construction
Highway
Maintenance
Parking

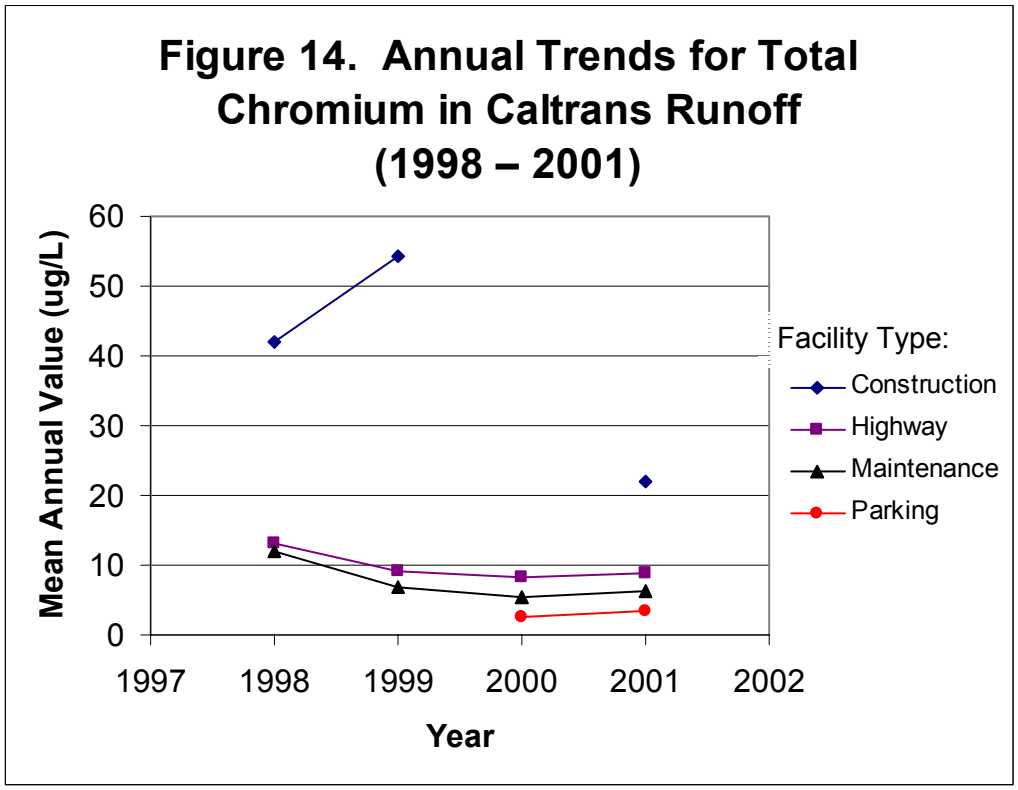


Figure 14. Annual Trends for Total Chromium in Caltrans Runoff (1998 – 2001)
Mean Annual Value (ug/L)
0
10
20
30
40
50
60
1997
1998
1999
2000
2001
2002
Year
Facility Type:
Construction
Highway
Maintenance
Parking

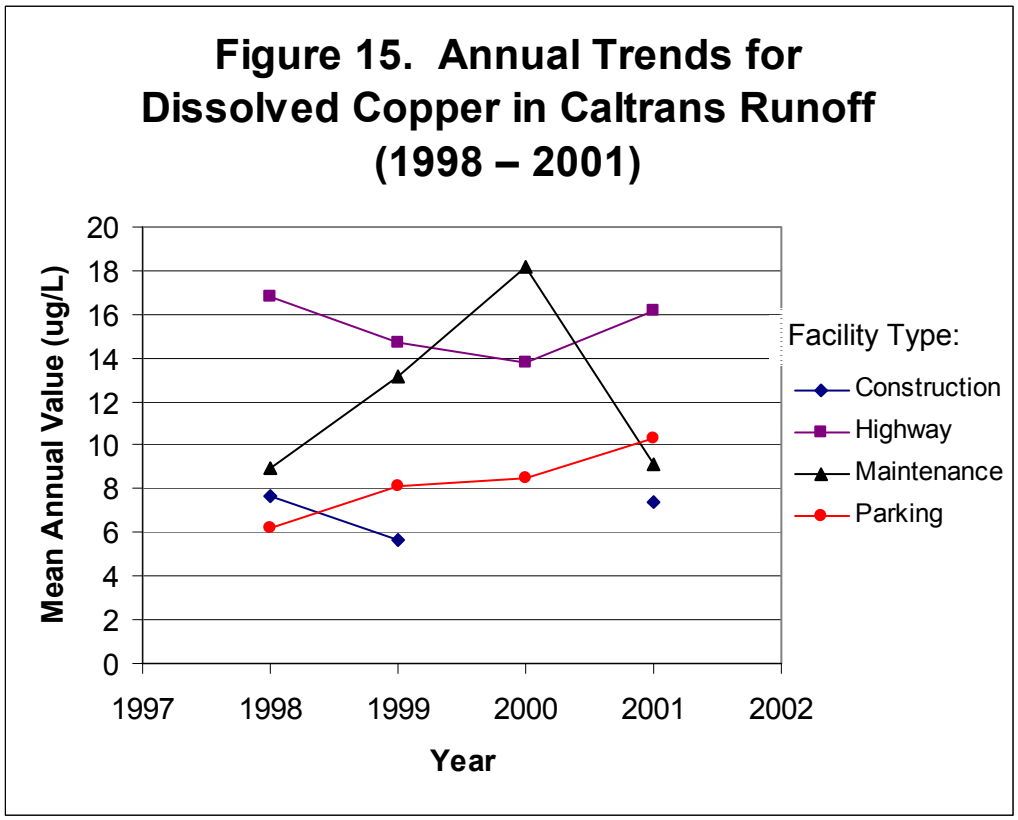


Figure 15. Annual Trends for Dissolved Copper in Caltrans Runoff (1998 – 2001)
Mean Annual Value (ug/L)
20
18
16
14
12
10
8
6
4
2
0
1997
1998
1999
2000
2001
2002
Year
Facility Type:
Construction
Highway
Maintenance
Parking

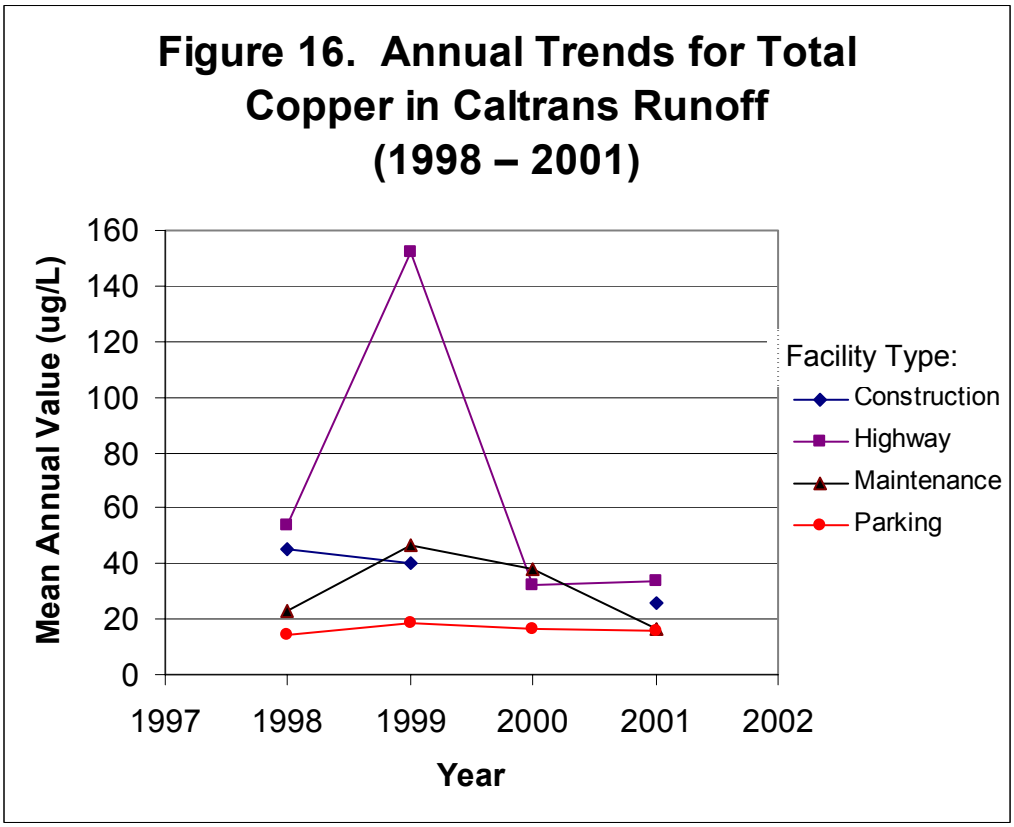


Figure 16. Annual Trends for Total Copper in Caltrans Runoff (1998 – 2001)
Mean Annual Value (ug/L)
160
140
120
100
80
60
40
20
0
1997
1998
1999
2000
2001
2002
Year
Facility Type:
Construction
Highway
Maintenance
Parking

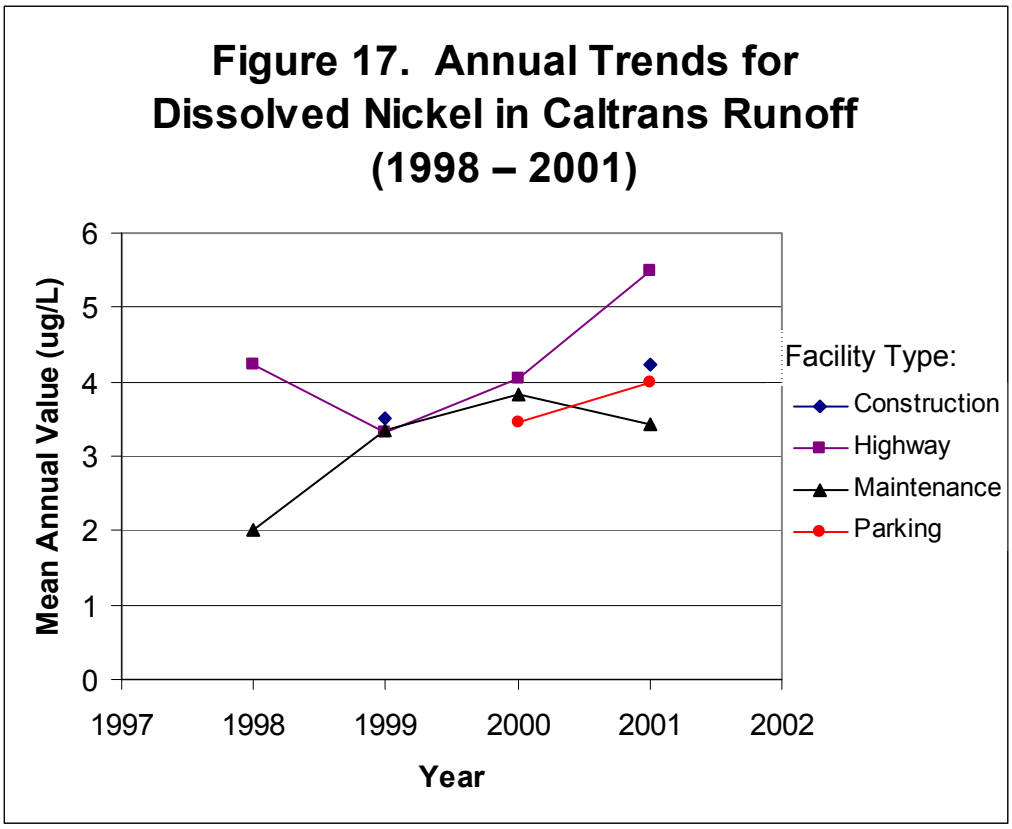


Figure 17. Annual Trends for Dissolved Nickel in Caltrans Runoff (1998 – 2001)
Mean Annual Value (ug/L)
0
1
2
3
4
5
6
1997
1998
1999
2000
2001
2002
Year
Facility Type:
Construction
Highway
Maintenance
Parking

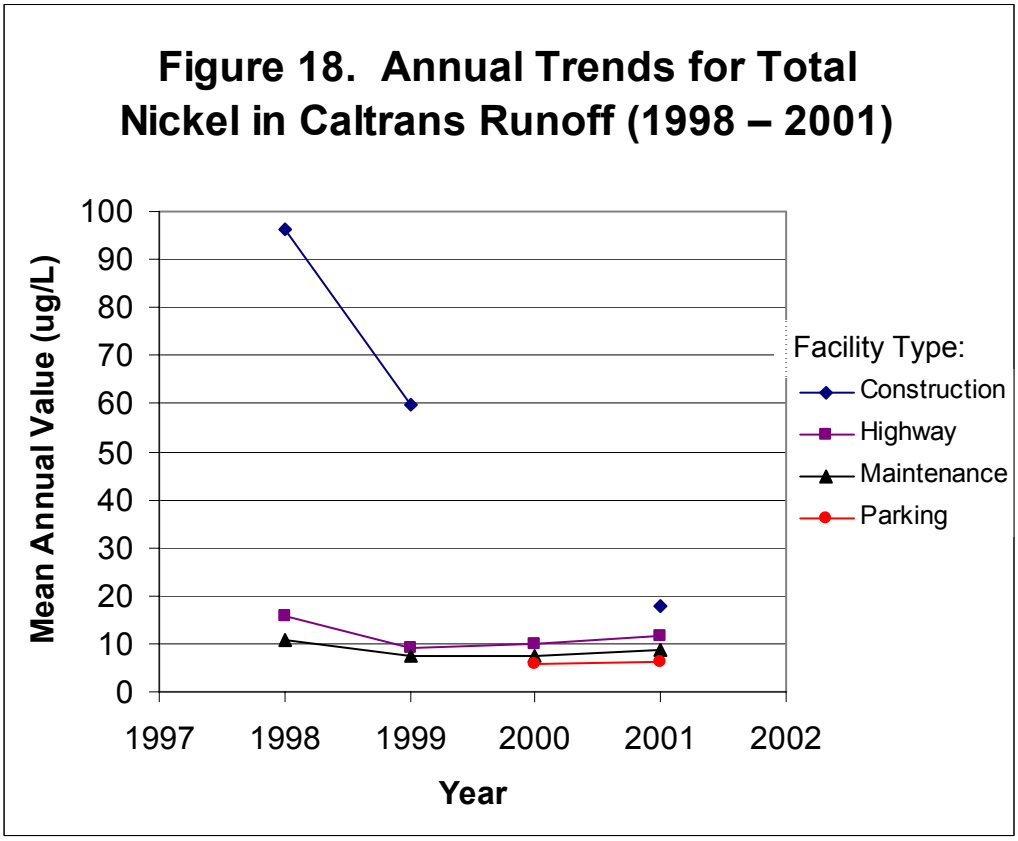


Figure 18. Annual Trends for Total Nickel in Caltrans Runoff (1998 – 2001)
Mean Annual Value (ug/L)
0
10
20
30
40
50
60
70
80
90
100
1997
1998
1999
2000
2001
2002
Year
Facility Type:
Construction
Highway
Maintenance
Parking

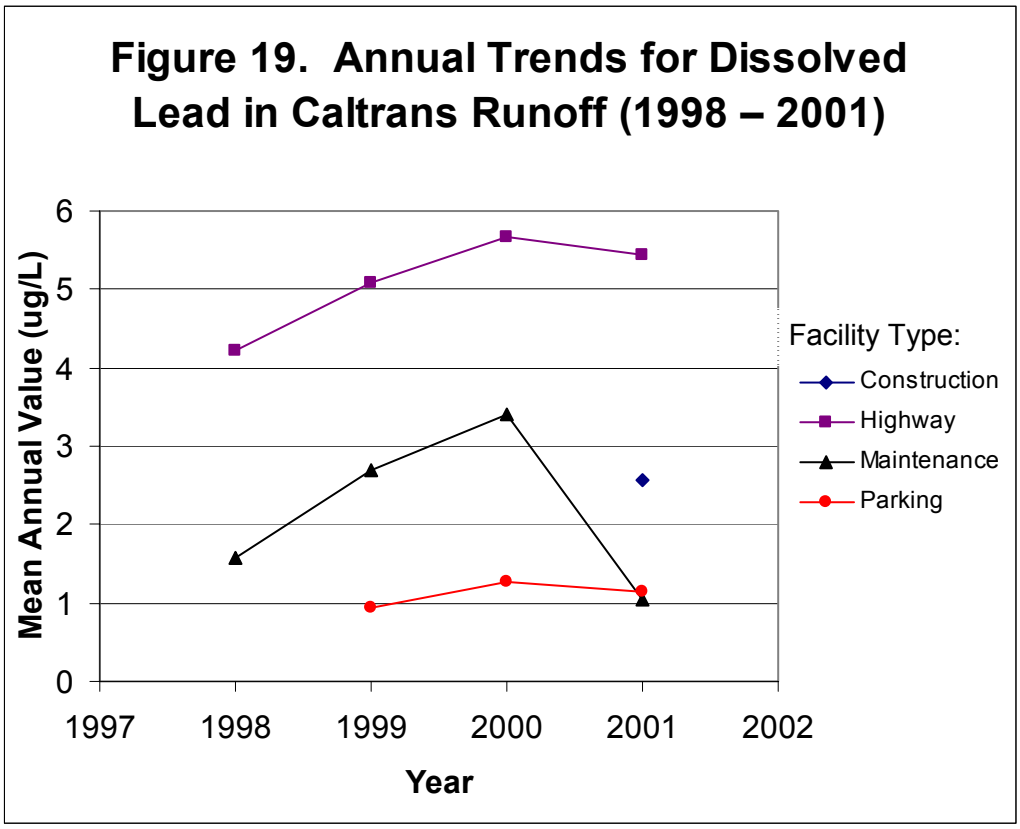


Figure 19. Annual Trends for Dissolved Lead in Caltrans Runoff (1998 – 2001)
Mean Annual Value (ug/L)
0
1
2
3
4
5
6
1997
1998
1999
2000
2001
2002
Year
Facility Type:
Construction
Highway
Maintenance
Parking

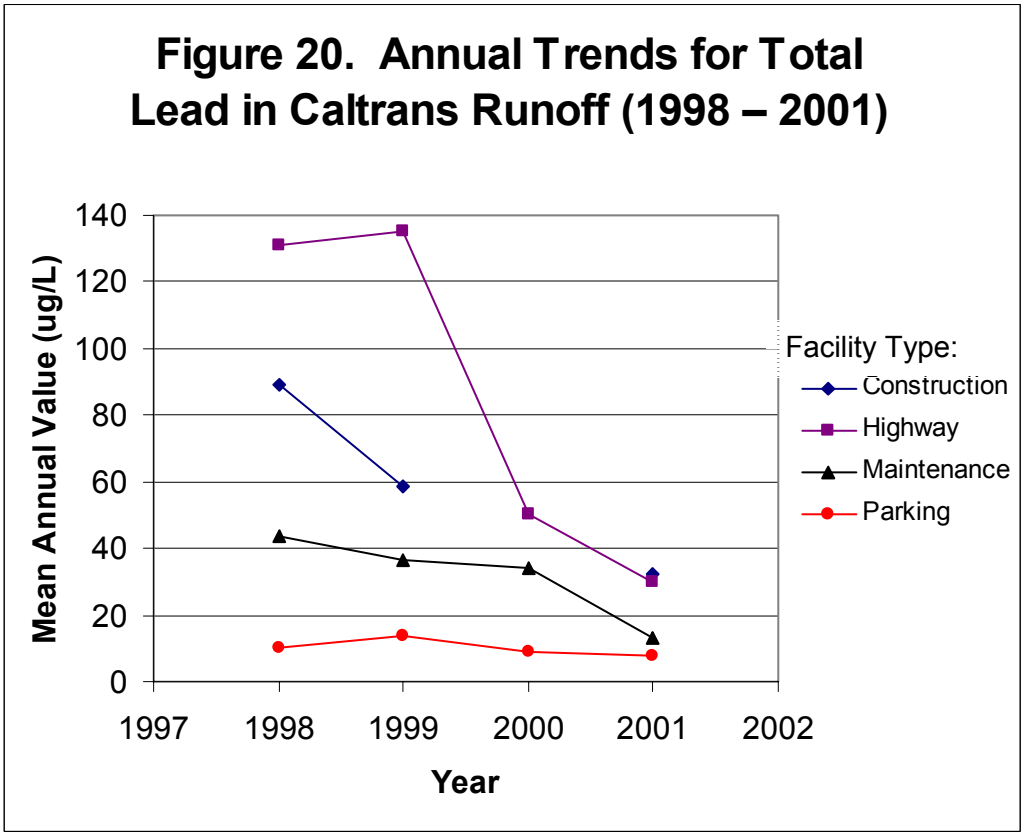


Figure 20. Annual Trends for Total Lead in Caltrans Runoff (1998 – 2001)
Mean Annual Value (ug/L)
0
20
40
60
80
100
120
140
1997
1998
1999
2000
2001
2002
Year
Facility Type:
Construction
Highway
Maintenance
Parking

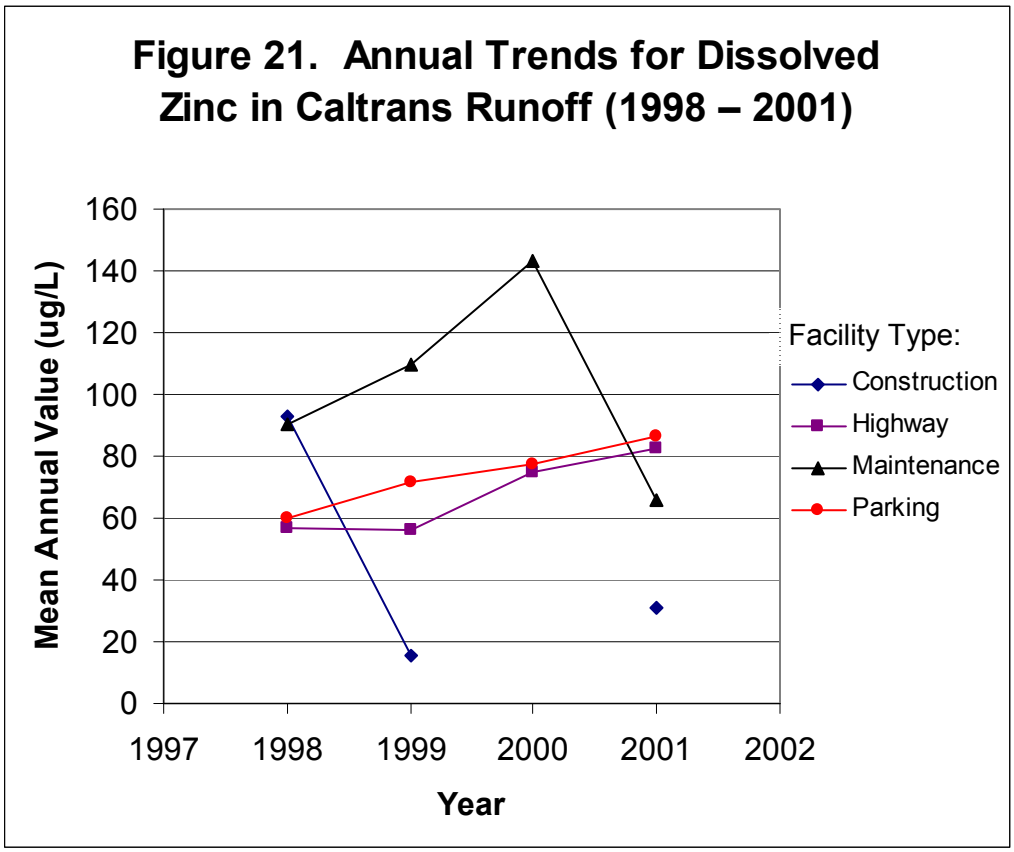


Figure 21. Annual Trends for Dissolved Zinc in Caltrans Runoff (1998 – 2001)
Mean Annual Value (ug/L)
160
140
120
100
80
60
40
20
0
1997
1998
1999
2000
2001
2002
Year
Facility Type:
Construction
Highway
Maintenance
Parking

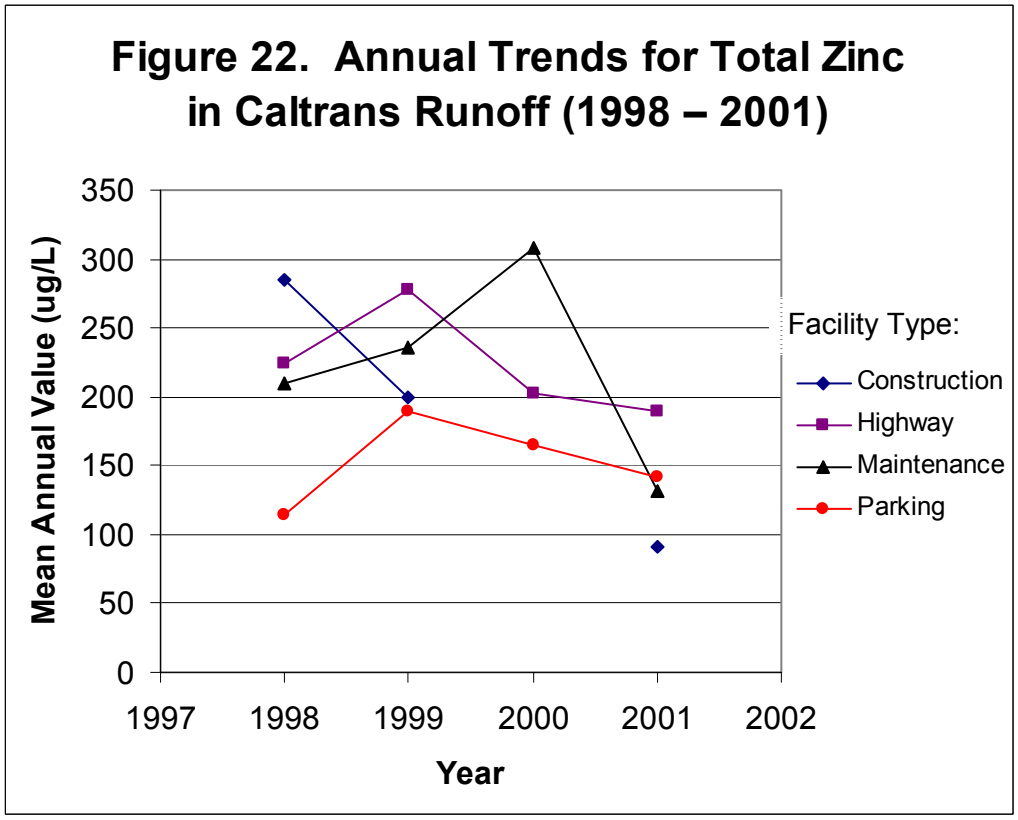


Figure 22. Annual Trends for Total Zinc in Caltrans Runoff (1998 – 2001)
Mean Annual Value (ug/L)
350
300
250
200
150
100
50
0
1997
1998
1999
2000
2001
2002
Year
Facility Type:
Construction
Highway
Maintenance
Parking

SECTION 4
REFERENCES

Caltrans (2000). Caltrans Guidance Manual: Storm Water Monitoring Protocols. July 2000.

Caltrans (2001). Storm Water Monitoring Program: Characterization Monitoring Plan FY 2001-2002. April 2000. CTSW-RT-01-007.

Caltrans (2001). Storm Water Monitoring Program: 3-Year Action Plan FY 01/02 - 03/04 April 2001. CTSW-RT-01-006.

Caltrans (2001). Caltrans Tahoe Basin Stormwater Monitoring Program *Monitoring Season 2000-2001* August 2001. CTSW-RT-01-038.

Caltrans (2001). Caltrans Statewide Stormwater Runoff Characterization Study *Monitoring Season 2000-2001* July 2001. CTSW-RT-01-015.

Caltrans (2001). Caltrans Construction Sites Runoff Characterization Study *Monitoring Season 2000-2001* August 2001. CTSW-RT-01-023.

Caltrans (2001). Caltrans Gross Solids Removal Device (GSRD) Pilot Study 2000-2001 *Interim Report* August 2001. CTSW-RT-01-047.

Caltrans (2001). Caltrans Public Education Litter Monitoring Study 2000-2001 July 2001. CTSW-RT-01-018.

Caltrans (2001). Technical Memorandum: Drain Inlet Cleaning Efficacy Study Water Quality and Litter Monitoring Program *Monitoring Season 2000-2001* July 2001. CTSW-TM-01-006.

Caltrans (2001). Caltrans First Flush Characterization Study *2000-2001 Storm Season* July 2001. CTSW-RT-01-037.

Caltrans (2001). Temporary Non-Vegetative Soil Stabilization Evaluation Study for 2000-2001 Season October 2001. CTSW-RT-01-066.

Caltrans (2001). UCLA First Flush Characterization Study: Year 2 December 2001. Draft report.

Caltrans (2002). Storm Water Monitoring and Research Program: Characterization Monitoring Plan FY 2002-03, Jan. 2002, CTSW-RT-02-004.

Caltrans (2002). Storm Water Monitoring and Research Program: 3-Year Action Plan FY 02/03-04/05, Jan. 2002 CTSW-RT-02-001.

Caltrans (2002). Sampling and Analysis Plan, Caltrans Tahoe Basin Water Quality.

Characterization and Sediment Trap Effectiveness Studies, Monitoring Season 2002-2003, Oct. 2002, CTSW-RT-02-061.

Caltrans (2002). Caltrans Statewide Storm Water Runoff Characterization Study Monitoring Season 2001-2002, July 2002 CTSW-RT-02-022.

Caltrans (2002). Caltrans Construction Sites Runoff Characterization Study, Sept . 2002 CTSW-RT-02-055.

Caltrans (2002). Phase 2 and 3 Gross Solids Removal Devices Operations and Maintenance Plan, Monitoring Season 2002/03, Nov. 2002 CTSW-RT-02-071.

Caltrans (2002). Caltrans Public Education Litter Monitoring Study 2001-2002, Jun 2002 CTSW-RT-02-021.

Caltrans (2002). Caltrans First Flush Characterization Study 2001-2002, Jun 2002 CTSW-RT-02-033d.

Kayhanian, M., Singh, S., Suverkropp, C., Borroum, S. (in press). The Impact of Annual Average Daily Traffic on Highway Runoff Pollutant Concentrations.