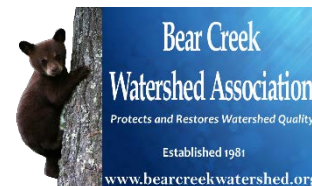


Technical Memorandum BCWA



Date: February 8, 2017
To: Bear Creek Watershed Association
From: Russell N. Clayshulte, Manager
Re: BCWA TM 2016.03 Coyote Gulch

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The Association coordinates with the City of Lakewood a sampling program on Coyote Gulch in the Bear Creek Park (Figure 1). The monitoring is done at two sampling sites: above the restoration project (Upper Coyote), and at the discharge into the reservoir (Lower Coyote). Beginning in 2013, the Association incorporated the nutrient sampling into the Association monitoring program as part of the P2 Supplemental Monitoring Program. The Association reduced the monitoring frequency to bi-monthly. Nutrient analyses are done at the Association’s contract laboratory GEI Consultants Inc. The Association collects the chemistry data for total phosphorus, total nitrogen, ammonia-nitrogen and nitrate-nitrogen (Table 1). The Association takes bi- monthly flow measurements to determine nutrient loading. The Association also collects data for temperature, pH, specific conductance and Dissolved Oxygen. Data results are incorporated into the Association annual data summaries. The Association has pre-construction and post-construction loading data. This monitoring project has established a total phosphorus trade credit for use of the Association membership. Data maintained in the BCWA *MSD11 Coyote Gulch Data Master spreadsheet*.



Figure 1 Coyote Gulch Project and Sample Sites

Table 1 Field Data

Segment	Site	Location	Date	Time	pH	Water Temp °C	Air Temp °C	DO (mg/l)	SC (us/cm)	Flow (cfs)	Est Periphyton Coverage %	Water Clarity
Segment 4a	Site 47a	Upper Coyote	2/22/2016	9:48	7.58	0.10		10.55	1584	0.69	5%	c
			4/25/2016	11:42	7.81	11.20		12.35	1333	2.30	20%	c
			6/20/2016	10:55	7.22	18.30		5.71	1370	0.46	15%	c
			8/22/2016	11:10	7.97	16.10	31.4	6.65	1203	0.74	5%	c
			10/17/2016	11:36	8.16	8.60	21	10.26	1449	0.55	10%	c
			12/5/2016	11:25	8.14	0.10	11	12.82	1522	0.32	2%	c
	Site 47b	Lower Coyote	2/22/2016	9:57	7.53	1.00		12.26	1534	0.69	25%	c
			4/25/2016	11:55	7.82	11.80		13.09	1317	1.90	20%	c
			6/20/2016	11:10	7.54	19.00		7.47	1353	0.40	80%	c
			8/22/2016	11:15	8.31	17.40	31.2	8.07	1093	0.56	40%	c
			10/17/2016	11:45	8.27	10.10	21	11.43	1422	0.43	10%	c
			12/5/2016	11:35	8.26	0.50	11	15.69	1474	0.27	10%	c

Table 2 Nutrient Data

Segment	Site	Location	Date	Total Nitrogen	Total Phosphorus
Segment 4a	Site 47a	Upper Coyote	2/22/2016	3256	14
			4/25/2016	1947	21
			6/20/2016	1162	189
			8/22/2016	1057	98
			10/17/2016	1936	27
			12/5/2016	3892	18
	Site 47b	Lower Coyote	2/22/2016	3201	9
			4/25/2016	1950	31
			6/20/2016	972	156
			8/22/2016	940	77
			10/17/2016	1705	14
			12/5/2016	3810	23

Table 3 Flow Data

	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec
	cfs					
Upper Coyote	0.69	2.30	0.46	0.74	0.55	0.32
Lower Coyote	0.69	1.90	0.40	0.56	0.43	0.27
	Ac-Ft/day					
Upper Coyote	1.366	4.561	0.912	1.467	1.091	0.625
Lower Coyote	1.370	3.768	0.793	1.110	0.853	0.535
	Ac-ft/month					
Upper Coyote	82.0	273.7	54.7	88.0	65.4	37.5
Lower Coyote	82.2	229.8	48.4	68.8	52.0	32.7

Table 4 Nutrient Loads

Location	Date	Flow Estimate	Loading Pounds/Period	
			Total Nitrogen	Total Phosphorus
Upper Coyote	Jan-Feb	82.0	726.8	3.1
	Mar-Apr	273.7	1450.8	15.6
	May-Jun	54.7	173.2	28.2
	Jul-Aug	88.0	253.4	23.5
	Sep-Oct	65.4	693.5	3.2
	Nov-Dec	37.5	326.7	0.9
Lower Coyote	Jan-Feb	82.2	716.6	2.0
	Mar-Apr	229.8	1220.4	19.4
	May-Jun	48.4	128.1	20.6
	Jul-Aug	68.8	176.2	14.4
	Sep-Oct	52.0	241.5	2.0
	Nov-Dec	32.7	338.8	2.0

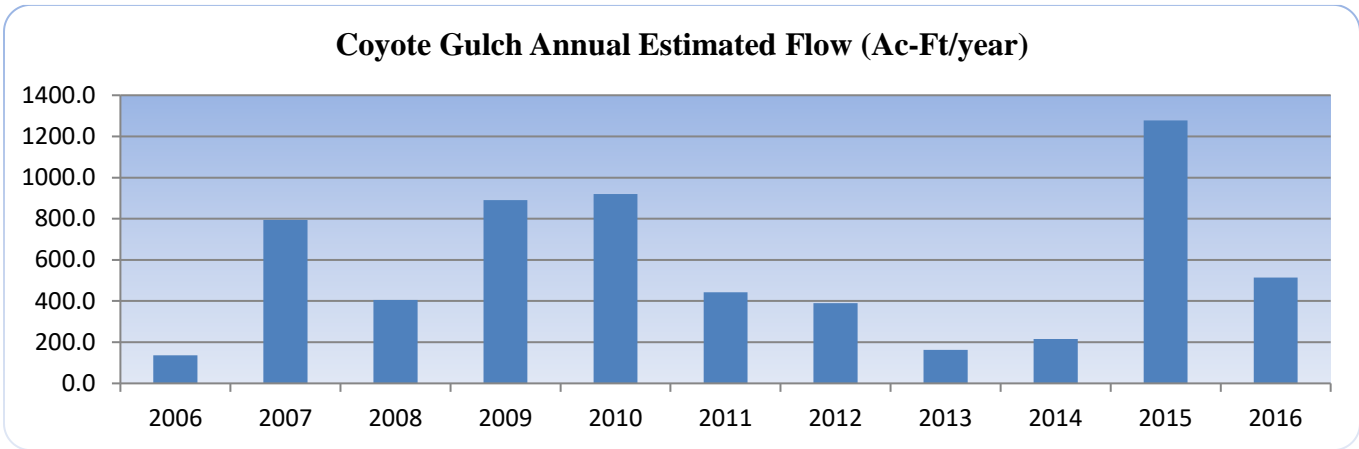


Figure 2 Estimated Annual Flows

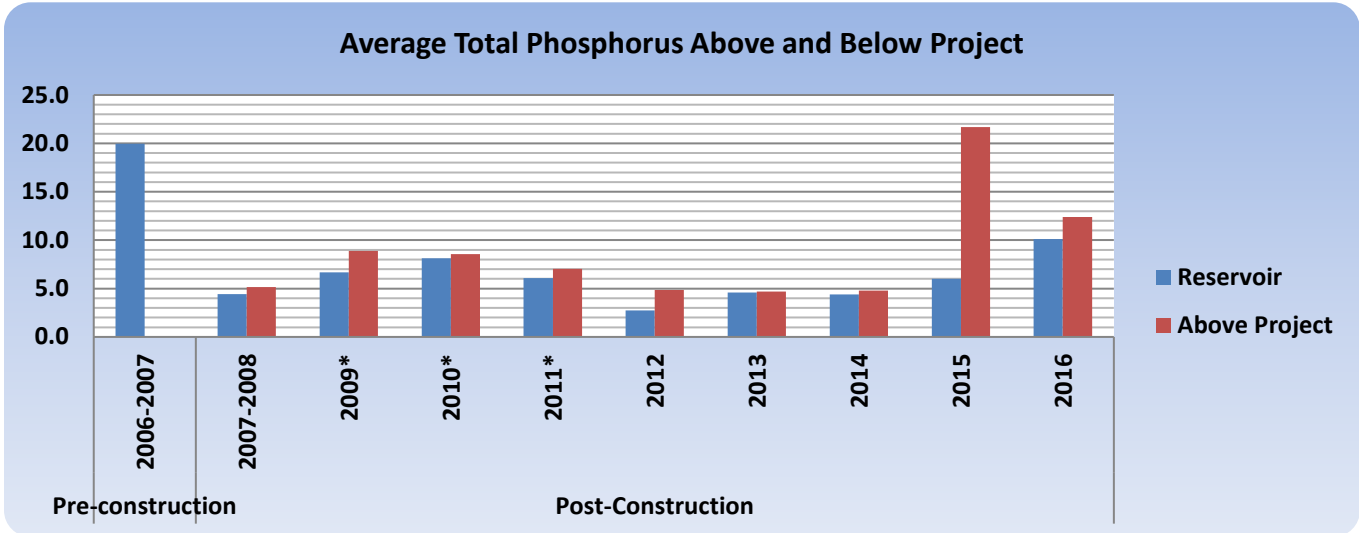


Figure 3 Total Phosphorus Removal by Project

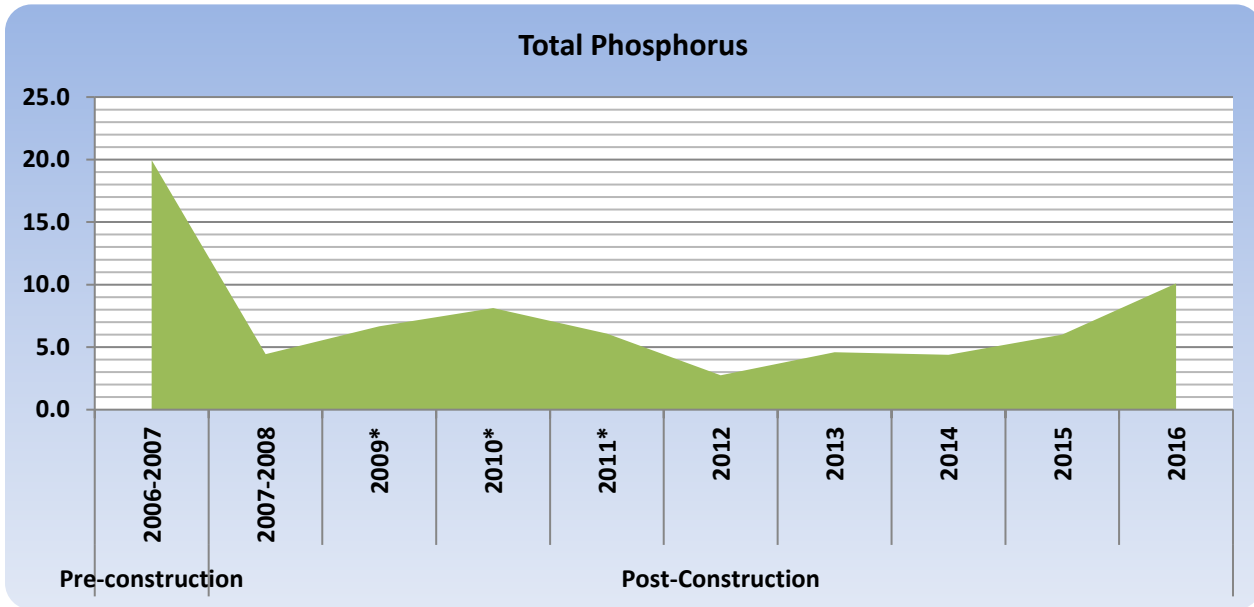


Figure 4 Total Phosphorus Baseload Estimates

Table 5 Project Average Loading for Trade Estimates

		Average Loading Pounds By Year			
		Reservoir		Above Project	
		Nitrate	T Phos	Nitrate	T Phos
Pre-construction	2006-2007	200.7	20.0		
Post-Construction	2007-2008	128.7	4.4	160.9	5.2
	2009*	142.0	6.7	185.9	8.9
	2010*	203.7	8.1	222.3	8.5
	2011*	103.0	6.1	163.9	7.0
	2012	106.6	2.7	104.4	4.8
	2013	80.6	4.6	78.8	4.7
	2014	90.3	4.4	131.4	4.8
	2015		6		21.7
	2016		10.1		12.4
		T Nitrogen		T Nitrogen	
	2015	260		500	
	2016	470.3		604.1	
		Loading Pounds After Stable			
		Reservoir		Above Project	
		Nitrate	T. Phos	Nitrate	T Phos
	Total Pounds	11,167	676	14,463	888
	Average	186	11	241	15
	Median	91	4	128	5
		T Nitrogen		T Nitrogen	
	Total Pounds	730.3		1104.1	
	Average	365		552	

2009*/2010*/2011/2015 average loadings per year excludes April storm loadings

Table 6 2016 Annual Nutrient Loads

	Annual Pounds		
	Flow Estimate ac-yr	Total Nitrogen	Total Phosphorus
Upper Coyote	601.3	3624.4	74.6
Lower Coyote	514.0	2821.6	60.4
Average Loading			
Upper Coyote		604.1	12.4
Lower Coyote		470.3	10.1

Table 7 2016 Trade Pound Estimates

Total Phosphorus Trade Pounds				
	Total Base Flow		Trade Ration Pounds	
	Monthly	Annual	Monthly	Annual
Average	5.9	70.9	7.0	84.3
Median	6.0	72.0	7.0	83.8
Monthly TRP=PC Base Load-TBF Monthly Pounds/2				
The base trade ratio is 2:1 for Association Trade Projects				
Base Flows Exclude April Storm Loadings				
Annual Trade Pounds Available = 84 pounds Total Phosphorus				