Appendix F Hydrology and Water Quality Technical Appendix

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The Hydrology and Water Quality Technical Appendix details calculations and methods used in determining potential water quality impacts occurring with implementation of the Tesoro Viejo Project.

Water Quality

Potential effects of the Proposed Project on water quality were evaluated qualitatively based on the Simple Method,[1] which was developed by the Center for Watershed Protection (2004) to estimate annual pollutant loads for chemical constituents as a product of annual runoff volume and typical values for pollutant concentrations in stormwater, depending on land use. The Simple Method estimates the mean annual pollutant load based on the mean annual rainfall, the runoff coefficient, the pollutant concentration in runoff, and the land area. This calculation of pollutant load provides an estimate of the total amount (e.g., pounds) of pollutant that would enter the receiving water during an average year.

Simple Method:

$$L = R * C * A * UCF \qquad [1]$$

Where: L = Annual load (lbs)

R = Annual runoff (inches)

C = Pollutant concentration (mg/l)

A = Area (acres)

UCF = 0.226 = Unit conversion factor

Or for bacteria:

Where: L = Annual load (Billion Colonies)

R = Annual runoff (inches)

C = Bacteria concentration (#/100 ml)

A = Area (acres)

[1] The Simple Method estimates stormwater runoff pollutant loads for urban areas. The technique requires a modest amount of information, including the sub watershed drainage area and impervious cover, stormwater runoff pollutant concentrations, and annual precipitation. With the Simple Method, the investigator can either break up land use into specific areas such as residential, commercial, industrial, and roadways and calculate annual pollutant loads for each type of land, or use more generalized pollutant values for land uses such as new suburban areas, older urban areas, central business districts, and highways. For the Tesoro Viejo development, we used specific areas with stormwater pollutant concentrations from the NSQD data as described in subsequent paragraphs.

UCF = 1.03 * 10-3 = Unit conversion factor for bacteria

Annual runoff is determined by:

R = P * Pj * Rv [2]

Where: R = Annual runoff (inches)

P = Annual rainfall (inches) (11.6 inches for the Proposed Project area)

Pj = Fraction of annual rainfall events that produce runoff (usually 0.9)

Rv = Runoff coefficient (unitless)

Runoff coefficients are estimated based on the Caltrans methods (2007). Numbers factored into the final runoff coefficient for each catchment basin are determined based on relief, soil infiltration, vegetal cover, and surface storage factors listed in Figure 819.2A, Attachment D, of the SWPPP/WPCP Preparation Manual (Caltrans 2007). Table 1 and Table 2, below, show the runoff coefficient calculations for the Project Site given pre- and post-development conditions.

Table 1 Existing Conditions Runoff Coefficient Calculations

Catchment	*Area (acres)*	*Relief*	*Soil Infiltration*	*Vegetal Cover*	*Surface Storage*	*Existing Runoff Coefficient*
A	488	0.08	0.12	0.1	0.1	0.4
B	416	0.1	0.12	0.08	0.1	0.4
C	361	0.08	0.12	0.1	0.1	0.4
D	122	0.08	0.12	0.1	0.1	0.4
E	482	0.1	0.12	0.1	0.1	0.42
F	68	0.1	0.12	0.1	0.04	0.36

Table 2 Post-Project Conditions Runoff Coefficient Calculations

Catchment	*Area (acres)*	*Pervious Coefficient*	*Impervious Fraction*	*Impervious Coefficient*	*Proposed Project Runoff Coefficient*
A	488	.4	0.90	0.95	0.88
B	416	.4	0.45	0.95	0.57
C	361	.4	0.45	0.95	0.57
D	122	.4	0.45	0.95	0.57
E	482	.42	0.45	0.95	0.57
F	68	.36	0.30	0.95	0.46

Mean annual pollutant load is a function of both the concentration of pollutants in stormwater runoff and the total amount of runoff from an area. Thus, even if land use changes such that the concentration of a pollutant in stormwater is lower than existing conditions, the load might be higher if the amount of runoff is higher. The converse is also true; if the concentration of pollutants is higher, but the runoff is lower, the total load may be lower. The pollutant concentrations used in the analysis are listed in

Table 4.3 (Typical Pollutant Concentrations in Stormwater) and described below. The runoff coefficients for determining pollutant loads are described above. The mean annual rainfall was described in the Section 4.8.1 (Environmental Setting) and is 11.6 inches per year.

Table 3 Typical Pollutant Concentrations in Stormwater

Pollutant	Units	Land Use Category		
		Vacant	Commercial	Residential
Suspended Solids	mg/L	48.5	42.0	49.0
Total Phosphorous	mg/L	0.31	0.22	0.30
Filtered phosphorous	mg/L	0.13	0.11	0.17
Total Nitrogen	mg/L	0.74	1.6	1.4
Inorganic-Nitrogen	mg/L	0.18	0.50	0.32
Total Copper	μg/L	10.0	17.0	12.0
Total Lead	μg/L	10.0	18.0	12.0
Total Zinc	μg/L	40.0	150	73.0
Oil and Grease	mg/L	1.30	4.70	3.9
Fecal Coliforms	MPN/100mL	7.2 E+03	4.3 E+03	8.3 E+03

SOURCE: Pitt et al. 2005

Stormwater pollutant concentrations are estimated using data from the National Stormwater Quality Database (NSQD), Version 1.1. (Pitt and Maestre 2005). This data was used because it includes measured pollutant concentrations in stormwater for various land uses compiled on a national basis. The NSQD is a national database with stormwater data from the National Urban Runoff Program at locations around the United States. No stormwater pollutant concentration data by land use was available for Madera County.

Pollutant loads estimated using the Simple Method are listed in Table 4 (Estimated Pollutant Loads without BMPs). The Required Reduction column is the percent of load reduction from the developed areas that is required for developed condition loads to be the same as existing conditions loads.

Using Catchment A, developed condition, as an example:

Annual runoff is calculated from equation 2 as:

R = 11.6 inches * 0.9 * .88

R= 9.19 inches of annual runoff

And for total suspended solids, annual load would be:

L = 9.19 inches * 42 mg/L * 488 acres * 0.226

L = 42, 569 pounds per year

Table 4	Estimated Pollutant Loads without BMPs			
	Pollutant Load (lbs)			Required Removal (percent)
Pollutant	***Existing***	***Proposed Project***[a]	***Increase***	
Total Suspended Solids	77,242	121,227	43,984	36
Total Phosphorous	95	734	639	87
Filtered phosphorous	207	388	181	47
Total Nitrogen	11,79	3,301	2,123	64
Inorganic-Nitrogen	287	812	526	65
Total Copper	16	31	15	49
Total Lead	16	32	16	50
Total Zinc	64	199	135	68
Oil and Grease	2,070	8,916	6,846	77
	Billions of colonies			
Fecal Coliforms	52,261	231,700	179,440	77

SOURCE: PBS&J 2007

[a] Proposed Project loads used an area weighted average runoff coefficient and area weighted average concentrations in stormwater. Developed areas corresponding land use for stormwater concentrations were either residential, vacant, or commercial for all nonresidential and nonvacant land uses.

Estimated Storm Event Runoff

Total runoff for the first half inch of rainfall and for a 10-year 24-hour storm event (2.05 inches of precipitation), Section 4.8.4 (Project Impacts and Mitigation) was also calculated and are listed in Table 5 (Estimated Proposed Project Stormwater Runoff).

Using Catchment A, developed condition, as an example, the maximum potential runoff is calculated from equation 3 for the first half inch of rainfall is:

$$VR = P * Rv * A \qquad [3]$$

VR= 0.40 inches of runoff

Where: VR = Volume of runoff (acre-feet)

P = Amount of precipitation (feet)

Rv = Runoff coefficient (unitless)

A = Area (acres)

VR = 0.5 inches/12 inches per foot * *0.88* 488 acres

VR = 17.9 acre-feet

Table 5	Estimated Proposed Project Stormwater Runoff	
IMP Catchment	*First Flush; 0.5 inch (acre-feet)*	*10-year, 24-hour Storm Event (acre-feet)*
A	17.9	73.4
B	9.8	40.2
C	8.5	34.8
D	2.9	11.8
E	11.3	46.5
F	1.3	5.3

SOURCE: PBS&J 2007

Total runoff for the 10-year 24-hour storm event (2.05 inches of precipitation), Section 4.8.4 (Project Impacts and Mitigation) was also calculated for existing conditions and are listed in Table 6 (Estimated Existing Stormwater Runoff) using equation 3 and runoff coefficients from Table 1.

Using Catchment A, as an example, the maximum potential runoff is calculated from equation 3 for the 10-year 24-hour storm event as:

VR = 2.05/12 inches per foot * *0.40* 488 acres

VR = 35.1 acre-feet

Table 6	Estimated Existing Stormwater Runoff
IMP Catchment	*10-year 24-hour Storm Event (acre-feet)*
A	35.1
B	30.0
C	26.0
D	8.8
E	36.4
F	4.4

SOURCE: PBS&J 2007

The IMP detention ponds would be designed to detain the stormwater runoff from the Proposed Project in excess of existing conditions runoff for the 100-year 10-day storm event, or 6 inches of rainfall. Using equation 3, the total volume of runoff from each catchment for this design storm was calculated and is listed in Table 7 (Estimated Required Stormwater Detention). The estimated amount of detention is simply the difference between the Proposed Project runoff and the existing conditions runoff.

Table 7 Estimated Required Stormwater Detention			
Catchment	Existing 100-year 10-day Runoff (acre-feet)	Proposed Project 100-year 10-day Runoff (acre-feet)	Estimated Required Stormwater Detention (acre-feet)
A	97.6	214.7	117.1
B	83.2	117.5	34.3
C	72.2	102.0	29.8
D	24.4	34.5	10.1
E	101.2	136.2	34.9
F	12.2	15.6	3.4

This estimated required stormwater detention is likely a 'worst-case' condition because the runoff coefficient for existing conditions would likely be higher during this storm event. As pervious surfaces get saturated, they behave more like impervious surfaces and runoff is greater. While the Proposed Project runoff coefficients would also increase, they would not likely increase to as large an extent because more of the area would already be impervious surfaces. However, using the Caltrans estimated runoff coefficients provides for a 'worst-case' scenario. When the detention ponds are designed, more detailed analysis and modeling would be require to more accurately size the basins.

References

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