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Memorandum

To: Santa Ana Stormwater Quality Standards Task Force

From: CDM

Date: March 3, 2010

Subject: Preliminary Draft - Flow Analysis – Channel Response to Specific Precipitation Events

This technical memorandum describes how flow conditions resulting from storms with approximately 0.5 inches in total rainfall depth correlate with proposed high flow use suspension triggers for implementation of high flow recreational use suspensions for waterbodies within the Santa Ana River Basin.

As proposed, the 0.5 inches of total rainfall would be a default threshold that could be applied anywhere in the watershed, subject to selection of an appropriate rain gage(s) to represent a particular water body. This is the only threshold that is currently used in the Los Angeles Regional Board area to trigger a temporary suspension of REC-1 uses. Under the draft proposed Basin Plan amendment staff report for the Santa Ana Watershed, additional threshold criteria are being proposed that could be used in lieu of rainfall data where flow gage data is available.

Alternative Suspension Trigger Thresholds

The proposed alternative suspension triggers include:

- Stream velocity greater than or equal to 8 ft/s; or
- Stream depth-velocity product greater than or equal to 10 ft²/s.

The threshold criteria of stream velocity >8 ft/s was derived from _____.¹

The USGS uses the depth-velocity product criteria (stream depth * velocity), which takes into account both flow rate and channel morphology, to assess whether flow conditions are safe for wading in order to obtain samples and/or other measurements. For trained field water sampling staff, USGS sets this criteria at 10 ft²/s maximum.

¹ ADD CITATION

Flow Data Analysis

For the Santa Ana Delhi Channel, Mill-Cucamonga Creek, and Temescal Wash watersheds and channels, rainfall events with depths ranging from less than 0.1 inch to more than 8 inches were evaluated using approximately 400 storm event hydrographs for each location from 1988 to 2008. Storm events were isolated from the long term record to more accurately assess flow conditions during wet weather. Using the channel geometry and peak flow associated with each of the storms, the channel velocity and depth-velocity product were calculated for each storm event and location. Each storm has a unique hydrograph which results in a range of channel flow responses. For example, a 0.5 inch 24-hour storm in the Santa Ana Delhi Channel watershed can result in a peak flow anywhere from 20 cfs to more than 1,700 cfs, resulting in velocities ranging from 0.9 to 4.1 ft/s, and depth-velocity products ranging from 1.2 to 35.7 ft²/s. Table 1 shows a summary of the range of peak flows, velocities, and depth-velocity products for all storms with total rainfall between 0.4" to 0.59" at representative gages for Santa Ana Delhi, Temescal Wash, and Mill-Cucamonga Creek over the period of 1988 to 2008.

Table 1

	Peak Flow		Velocity at Peak Flow Rate			Depth-Velocity Product		
	Range (cfs)	Average (cfs)	Range (ft/s)	Average (ft/s)	% storms greater than 8 ft/s	Range (ft ² /s)	Average (ft ² /s)	% storms greater than 10 ft ² /s
Santa Ana Delhi	23 to 1,765	557.2	0.9 to 4.1	2.6	0%	1.2 to 35.7	12.4	50%
Temescal Wash	77 to 908	459.0	3.1 to 10.6	8.6	71%	3.5 to 25.7	18.3	75%
Mill-Cucamonga Creek	403 to 5,150	1474.7	5.7 to 24.5	12	80%	4.8 to 62	17.9	60%

* storm sizes ranged from 0.4" to 0.59"

By plotting rainfall depth versus peak depth-velocity product and plotting a best fit line from the available data, it is possible to estimate the peak depth-velocity product for specific storm event sizes. Similarly, by plotting rainfall depth versus peak velocity, we can estimate how the data correlates with the 8 ft/s threshold. The plots are provided in Appendix A and summarized in Table 2.

Table 2

	Best fit peak velocity for 0.5" storm (ft/s)	Best fit peak depth-velocity product for 0.5" storm (ft²/s)
Santa Ana Delhi	2.3	12
Temescal Wash	7.3	15
Mill-Cucamonga Creek	12	17

The figures in Appendix A show the number of events that will reach or exceed increasing intervals of depth velocity products for each of the study sections. The results of this analysis showed that 84 of 249 events in the Santa Ana Delhi Channel, 156 of 316 events in Temescal Wash, and 128 of 681 events in Mill-Cucamonga Creek, exceeded the USGS 10 ft²/sec guideline. The results also suggest that using a 0.5 inch storm event as a default for these three different watersheds would be “conservative” in the sense that this would typically result in a depth-velocity product that would exceed the trigger depth-velocity product and for two of the three watersheds would result in velocities near or greater than the 8 ft/s trigger criteria.

Frequency distributions of flow in the study sections showed that for more than 90% of the time, flowrates, depths, and velocities are characteristic of low flow conditions. Low flow conditions differed in each study section due to differences in drainage area characteristics. The incorporation of a low flow channel in Temescal Wash and the Santa Ana Delhi Channel alters the characteristics of dry weather conditions in the analyzed study sections. While flowrates remain constant, dry weather flow within the low flow channel is deeper and moving quicker than it would if spread across the bottom of the entire channel.

Conclusions

Proposed high flow use suspension triggers of stream velocity greater than or equal to 8 ft/s and stream depth-velocity product greater than or equal to 10 ft²/s fall well within the range of flow responses resulting from 0.5” rainfall events in three study reaches within the Santa Ana River watershed.

In one reach (Santa Ana Delhi Channel) the depth-velocity product trigger was a better fit for a 0.5” storm event, while the velocity trigger was a better fit for 0.5” storms within the other two study reaches.