Memo

To: Middle Santa Ana River TMDL Task Force

From: Richard Meyerhoff, GEI Consultants
Steven Wolosoff, CDM Smith

Date: October 15, 2021

Re: Middle Santa Ana River Watershed Studies for Task Force Consideration

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The Middle Santa Ana River (MSAR) Bacteria TMDL Task Force (Task Force) has had several discussions regarding new activities or studies for the Task Force to consider funding to support anticipated data needs to facilitate revisions to the TMDL or existing dry weather condition Comprehensive Bacteria Reduction Plans (CBRPs) or support development of a wet weather condition CBRPs. At the August 23, 2021 Task Force Meeting, Steven Wolosoff delivered a presentation, "Preparing for Wet Weather CBRPs" that identified five potential studies for the Task Force to consider:

1. Characterize channel hydraulics to determine flowrate (cfs) that causes unsafe swimming conditions in the impaired waters, which triggers the high flow suspension (HFS)
2. Quantify bacteria load removed via retention basins/Water Quality Management Plan (WQMP) implementation since 2005 TMDL development
3. Collect wet weather data to quantify non-MS4 bacteria loads from homeless encampments to potentially provide basis for an offset program
4. Conduct study to characterize loads of human markers at MS4 outfalls during wet weather, with emphasis on smaller storms that do not trigger HFS
5. Given that BMPs could increase stormwater capture and groundwater basin recharge in the upper Santa Ana River watershed, which supports bacteria TMDL compliance, evaluate how this strategy impacts the Santa Ana River watershed as a whole

Based on the discussions that occurred at the August and September Task Force meetings, there was general interest among Task Force members to consider three of the above studies (#1, #3, and #4). The purpose of this memorandum is to provide a description, scope of work and cost estimate to complete each of these three studies. To prepare this information, it was assumed that projects would be implemented by firms/staff already working on bacteria-related issues on behalf of the Task Force (CDM Smith, GEI Consultants, CWE and Essential Environmental and Engineering Systems).

Study No. 1: Characterize Channel Hydraulics to Determine Flowrate that Causes Unsafe Swimming Conditions in Impaired Waters, which Triggers the HFS

Study Description/Background

The Basin Plan describes high flow conditions that lead to a temporary suspension of REC1 objectives as follows:

> *Flow conditions in freshwater streams in the Santa Ana River watershed are presumptively unsafe if either of the following conditions occurs: (1) stream velocity is greater than 8 feet-per-second (fps); or (2) the product of stream depth (feet) and velocity (fps) (the depth-velocity product) is greater than 10 ft^2/sec. Where representative stream gauge data are not available, unsafe flows are presumed to exist in stream channels that have been engineered or heavily modified for flood control purposes when rainfall in the area tributary to the stream is greater than or equal to 0.5 inches in 24 hours.*

There is the potential that the flow conditions that would exceed the 8 fps or 10 ft^2/sec thresholds as a result of rainfall in the area tributary to the MSAR impaired waters is less than the default 0.5 inches in 24 hours. Collection of channel velocity measurements can provide information needed to understand the runoff event volume that would be sufficient to create unsafe flow conditions in each impaired water.

How Does the Proposed Study Support TMDL Revision and/or Wet Weather CBRP Development?

Findings would support development of a scientific basis for determining the size of rain event for which the water quality of the runoff must be controlled. Result would become the target for bacteria load reduction in any form of compliance demonstration. A targeted capture volume that is less than the runoff that would be generated form a 0.5 inch/24 hour storm event over the watershed could result in a significantly lower bacteria load to be controlled with BMPs or offsets (if allowed as an option) in the compliance demonstration that will need to be prepared for the wet weather CBRPs.

Proposed Tasks

- Task 1: Obtain and review field measurement data from USGS used to develop stage discharge rating curves for three gauges, one on each of the MSAR impaired waters.
- Task 2: Evaluate velocity and depth-velocity products of each field measurement against the HFS criteria and determine the peak flow rate (cfs) that is likely to generate unsafe conditions.
- Task 3: Compare the velocity or depth-velocity product flow rate with peak flows from discrete storm events representative of 0.5 inches in 24 hours over the tributary area.
- Task 4: Prepare technical memorandum summarizing findings and recommendation for application of HFS as part of the wet weather CBRP compliance demonstration.

Cost Estimate

The estimated cost to complete Study 1 is $34,200. **Table 1** provides the estimated cost to complete each of the tasks listed above. The majority of the work would be completed by CDM Smith.

Study No. 2: Collect Wet Weather Data to Quantify non-MS4 Bacteria Loads from Homeless Encampments to Potentially Provide Basis for an Offset Program

Study Description

Homeless encampments are suspected to be an important source of fecal bacteria arising from within MSAR impaired waters. Although not an MS4 source of bacteria, supporting efforts to mitigate this source of impairment may provide a number of watershed benefits:

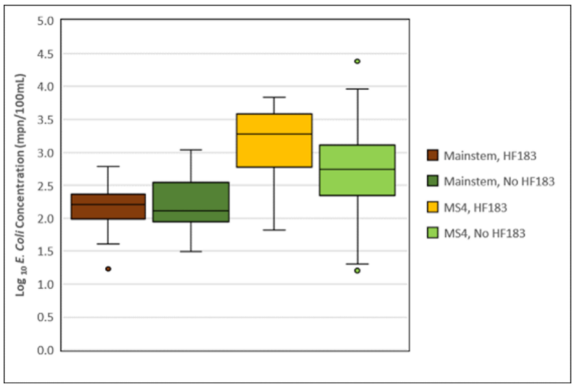
- Direct removal of this source could offset a portion of the fecal bacteria load reduction that might otherwise be required through implementation of watershed BMPs
- Supports local and regional programs focused on re-sheltering persons experiencing homelessness.
- Removing the fecal bacteria source rather than the stormwater BMPs (e.g., through distributed retention/infiltration basins), runoff upstream of Prado Basin would be preserved for downstream habitat and use of water downstream of the MSAR watershed.

Conceptually, development of a homeless encampment offset program could provide a "win-win-win" outcome, if done properly. However, critical to the establishment of such an offset program would be (a) determining what is scientifically defensible fecal bacteria load that would be eliminated under wet weather conditions if a homeless encampment is removed from the river bottom; (b) buy-in from regulators that such an offset program can be used as a tool to facilitate demonstrations of compliance with TMDL requirements.

Technical Considerations

A special study funded by SAWPA is currently underway to evaluate *E. coli* bacteria and trash impacts associated with presence of homeless encampments in Santa Ana River Reach 3. This special study focuses only on dry weather conditions, specifically, four dry weather sampling events will occur at three sites in fall 2021. Other than a recent study in the San Diego River watershed, we are not aware of any other studies that have been conducted to quantify the *E. coli* fecal bacteria load from homeless encampments during wet weather. We are also unaware of any efforts to implement a fecal bacteria offset program to support compliance with a bacteria TMDL. Site-specific data from MSAR impaired waters using appropriately selected source tracking tools is needed to develop a scientifically defensible approach to estimating offsets related to removal of a homeless encampment.

There are numerous confounding factors when reviewing general fecal bacteria loads in a receiving water such as contributions from leaking sewers, urbanized watersheds, and uncontrollable sources. Several methods exist to trace specific sources of fecal bacteria including microbial DNA markers, personal and pharmaceutical care products (PPCP), and bacteriophages. However, the relationship between these tracers and general *E. coli* load can be highly site-specific. The 2019 dry season MSAR Synoptic Study found no relationship between the presence of HF183 *Bacteroides* DNA marker and *E. coli* concentrations within the mainstem of the MSAR (see figure). Conversely, *E. coli* concentrations were 2-3 times greater at MS4 outfalls when HF183 was present. This finding could suggest the load of human derived bacteria in dry



weather is low relative to other sources in the mainstem of the river, but that important sources exist within MS4 drainage areas that could be identified and eliminated. Field observation along with interviews of persons experiencing homelessness suggest that most open defecation is not directly into the waterway; thus, it would be more likely to see greater fecal loads to the river from surrounding encampments as water levels rise during wet weather.

The MSAR TMDL Task Force has not conducted any bacteria source tracking during wet weather within the Santa Ana River mainstem; however, Dr. Phil Gedalanga (University California Fullerton) collected samples for the HF183 marker analysis during dry and wet weather in 2019-2020 and found increasing concentrations (as gene copies/100 mL) with wet weather. Given this finding, and the consistent patterns of higher *E.coli* concentrations during wet weather in the MSAR watershed, it is possible that a human source could be an important source contributing to the rise in general fecal bacteria in impaired waters.

There are multiple sources of human associated fecal bacteria with very different management strategies. A recent study from scientists at San Diego State University attempted to parse sources of human fecal bacteria during wet weather in the San Diego River between: (1) migration of untreated wastewater from leaking sewers; and (2) open defecation, the latter presumably prevalent within homeless encampments. The study found that use of ratio of caffeine/sucralose (Caf/Suc), two commonly used beverage/food items, served as a strong indicator of untreated wastewater (ratio > 2) or open defecation (ratio < 2). During large storm events, saturated soils were found to facilitate mobilization of untreated wastewater leaked from sewers to migrate to storm drains. Conversely, during smaller storms, low Caf/Suc ratios were observed indicating open defecation playing a greater role. Given that smaller storms will be the focus for development of a wet weather CBRP (after taking into account the HFS), open defecation such as may occur in homeless encampments, may be an important source of fecal bacteria the MSAR.

How Does the Proposed Study Support TMDL Revision and/or Wet Weather CBRP Development?

The proposed study will collect data needed to develop an estimation of the *E. coli* load reduction during wet weather conditions that could be associated with the implementation of homeless encampment cleanup activities. If load reduction benefits can be attributed to removal of homeless encampments and implementation of an offset program is an acceptable tool to support demonstration of compliance with the MSAR TMDL, the wet weather CBRP could then incorporate such a program for use by permittees.

Potential Ancillary Benefits

- Potential additional resources to augment existing multi-agency homeless re-sheltering and encampment cleanup programs.
- Rather than capture and infiltrate stormwater in the upper watershed to support MSAR TMDL compliance, stormwater can continue to be stored in Prado Basin and released to downstream spreading areas that sustain the Orange County groundwater basin.

Proposed Approach

- Task 1: Design and obtain approval for a study (including Monitoring Plan (MP)/Quality Assurance Project Plan (QAPP)) to collect data during wet weather (targeting small to moderate storms that are not anticipated to exceed HFS criteria) to estimate the *E. coli* load attributable to presence of homeless encampments in the MSAR impaired waters. The MP/QAPP prepared for the Regional Bacteria Monitoring Program will be used as the basis for development of an MP/QAPP for this study.

- Task 2: Implement approved wet weather sampling program (including pre- and post-sampling activities, laboratory coordination, data QA/QC and data management). Depending on the number of sample events needed to develop a scientifically defensible data set, this study could require multiple years of data collection; therefore, for the purposes of this study and before investing in a longer study, we recommend implementing a one-year pilot study that samples four wet weather events over one wet season (assumes that at least four wet weather events occur that meet storm criteria) at two encampment sites (samples would be collected upstream/downstream of the site).
- Task 3: Technical memorandum that provides: (a) estimate of *E. coli* load reduction that could be associated with removal of a homeless encampment; (b) framework for an offset program (assuming study findings are positive.

Cost Estimate

The estimated cost to complete Study 2 is $76,500. **Table 1** provides the estimated cost to complete each of the three tasks listed above. CWE would conduct the wet weather sampling; other team members would be responsible for development of study design (including MP/QAPP) and study's final Technical Memorandum.

Potential Study No. 3: Characterization of Bacteria Human Marker Loads at MS4 Outfalls during Wet Weather, with Emphasis on Smaller Storms that Do Not Trigger HFS

Study Description/Background

The Task Force has collected and analyzed dry weather samples for microbial DNA markers in Tier 1 (MS4 outfalls) source evaluation sampling programs in 2007, 2012, and 2019. The results of these Tier 1 evaluations resulted in the prioritization of MS4 drains and follow-up Tier 2 investigations within upstream MS4 networks with much success on finding and eliminating specific sources. In the 2019 MSAR Synoptic Study, concentrations of HF183 *Bacteroides* marker were below detection or relatively low at most sites. This finding, along with demonstrations that dry weather *E. coli* loads were reduced to below the targets set in the 2012 CBRPs, made a strong case for compliance with the MSAR TMDL MS4 dry weather condition wasteload allocations.

The MS4 permittees will need also need to reduce *E. coli* loads in wet weather conditions, in particular small to moderate storms that result in runoff that does not trigger the HFS criteria in impaired waters. Meeting required load reductions from controllable sources will be challenging given the typical increase in *E. coli* observed in stormwater runoff, especially during the period of the rising hydrograph. Regardless of the challenges, a key area where load reductions could be targeted would be focusing resources on reducing loads attributed to controllable human bacteria sources, e.g., homeless encampments or sanitary sewer leakage. To date there has not been a study conducted in the MSAR watershed to evaluate *E. coli* loads in wet weather runoff from MS4s that may be attributable to human sources of bacteria. Having that information will be very beneficial to the development of a wet weather condition CBRP for the MS4s.

How Does Proposed Study Support TMDL Revision and/or Wet Weather CBRP Development?

The wet weather CBRP will need to address controllable sources of fecal bacteria from MS4 outfalls during small to moderate storm events. Understanding what portion of the total *E. coli* load that comes from a human source will aid in the development of a wet weather CBRP designed to address controllable sources. In addition, the information generated by this study would support a TMDL revision by providing data to parse controllable and uncontrollable fractions of *E. coli* loading at MS4 outfall locations.

Potential Ancillary Benefits

- Focus on controlling human sources of bacteria will result in greater protection to swimmer health in downstream waters than might be realized by focusing on all fecal bacteria sources.
- Rather than capture and infiltrate stormwater in the upper watershed to support MSAR TMDL compliance, stormwater can continue to be stored in Prado Basin and released to downstream spreading areas that sustain the Orange County groundwater basin.

Proposed Approach

- Task 1: Perform a simple desktop spatial analysis to identify segments of MS4 systems in close proximity to sanitary sewer infrastructure.
- Task 2: Design and obtain approval for a study (including MP/QAPP) to collect the necessary data during wet weather (targeting small to moderate storms that are not anticipated to exceed HFS criteria) to estimate the signal of human associated fecal bacteria and other tracers to parse the source

of human waste between untreated sewage and watershed land based sources based on samples collected at downstream Tier 1 sites. The MP/QAPP prepared for the Regional Bacteria Monitoring Program will be used as the basis for development of an MP/QAPP for this study.

- Task 3: Implement approved wet weather sampling program (including pre- and post-sampling activities, laboratory coordination, data QA/QC and data management). Depending on the number of sample events needed to develop a scientifically defensible data set, this study could require multiple years of data collection; therefore, for the purposes of this study and before investing in a longer study, we recommend implementing a one-year pilot study that targets sampling two wet weather events over one wet season (assumes that at least two wet weather events occur that meet storm criteria) at ten sites. The cost estimate is based on this level of effort.
- Task 4: Technical memorandum that provides results from wet weather sample results.

Cost Estimate

The estimated cost to complete Study 3 is $77,900. **Table 1** provides the estimated cost to complete each of the four tasks listed above. CWE would conduct the wet weather sampling; other team members would be responsible for the MS4/sanitary sewer analysis, development of study design (including MP/QAPP) and the study's final Technical Memorandum.

Table 1. Cost Estimate for Proposed Studies

Study	Tasks	Hours	Labor	Expenses	Total
Study 1 – Flowrate that Triggers High Flow Suspension	Task 1 – Stage Discharge Rating Curves	40	$7,850	$0	$7,850
	Task 2 - Peak flow Rates (PFR) vs. HFS Criteria	40	$7,850	$0	$7,850
	Task 3 - Relationship between PFR and Rainfall Volume	40	$7,850	$0	$7,850
	Task 4 – Technical Memorandum	50	$10,650	$0	$10,650
	Study 1 Total	**170**	**$34,200**	**$0**	**$34,200**
Study 2 –Wet Weather Sampling/ Potential Bacteria Offset Program	Task 1 – Study Design (MP & QAPP)	50	$9,600	$0	$9,600
	Task 2 – Wet Weather Sampling (4 events, 4 locations)	182	$27,500	$20,000	$47,500
	Task 3 – Technical Memorandum/ Offset Framework	84	$19,400	$0	$18,400
	Study 2 Total	**316**	**$56,500**	**$20,000**	**$76,500**
Study 3 – MS4 Wet Weather Bacteria Sampling	Task 1 – MS4/Sanitary Sewer Analysis	40	$7,500	$0	$7,500
	Task 2 – Study Design (MP & QAPP)	50	$9,600	$0	$9,600
	Task 3 – Wet Weather Sampling (4 events, 4 locations)	182	$27,500	$20,000	$47,500
	Task 4 – Technical Memorandum	60	$13,300	$0	$13,300
	Study 3 Total	**332**	**$57,900**	**$20,000**	**$77,900**
	Total – All Three Studies	**818**	**$148,600**	**$40,000**	**$188,600**