# MSAR WATERSHED TMDL TASK FORCE

MSAR Bacteria Synoptic Study Project Update November 19, 2019

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# PRESENTATION OUTLINE

- Update to hydrologically disconnected area mapping
- Bacteroides Results
   POTWs, Mainstem, MS4
- Prioritization Analysis
- Approximation of human fecal contamination
- New directions for TMDL revision





## HYDROLOGICALLY DISCONNECTED AREAS



## HYDROLOGICALLY DISCONNECTED AREAS

- Map updated leveraging data collected since CBRP
- Changes since CBRP
  - City of Claremont entirely within disconnected area boundary
  - Other subareas adjusted
  - Fewer Tier 1 sites
    (n=14) than in 2012
    source evaluation
    (n=34)



## HYDROLOGICALLY DISCONNECTED AREAS

• Distribution of Acreage in the MSAR Watershed

Category	Acres	% of Watershed
Tier 1 MS4 Drainage Areas	68,768	14%
Temescal Creek	135,437	28%
Prado Park Lake	6,110	1%
Hydrologically Disconnected DA	223,098	47%
Other Areas with Minimal DWF	44,146	9%
Total MSAR Watershed	477,560	100%



## BACTEROIDES RESULTS

- POTWs
- Mainstem
- MS4



#### BACTEROIDES HF183 MARKER

- EPA approved qPCR method for quantification of DNA from human
- Most specific for human source based on EPA evaluation
- Human marker used in MSAR watershed: Riverside RWQCP effluent channel (2007); Tier 1 source evaluation (2012); Tier 2 source evaluation (2013-14); Gedalanga research (2018); and Synoptic Study (2019)
- Some other notable regional applications include
  - Regional Assessment of Human Fecal Contamination in Southern CA Coastal Drainages (2013 - 2015) (Cao et al. 2017)
  - Tracking Human Fecal Sources in an Urban Watershed during Wet Weather (2016-2017) (SCCWRP)
  - Terrestrial Sources Homogenize Bacterial Water Quality during Rainfall in Two Urbanized Watersheds in Santa Barbara, CA (2005) (published in Sercu et al. 2011)
  - UC Davis study evaluating treatment processes and surface water samples (2009)

#### BACTEROIDES HF183 MARKER – POTW SAMPLES

- Not a culture based method viable and non-viable genes detected
- In effluent-dominated waters, raw sewage, septage, and treated effluent are difficult to discriminate
- Task Force still opted to analyze 60 samples for *Bacteroides* directly in POTW effluent and within mainstem
- No amplification in any POTW samples was found
  - Agreement with RWQCP effluent channel research by Litton et al. (2010)
  - Differs from prior study by Gedalanga et al. (2019)
- Detections of HF183 were observed within the receiving waters interpreted as largely from human sources not treated at POTWs for sampled days in 2019 dry season

### BACTEROIDES IN MAINSTEM

- Amplification of human HF183 *Bacteroides* marker in 23 of 42 samples
- Generally low gene copies except for August 14 at Mission Avenue Bridge:
  - 100 gene copies (gc) / 200 mL
- Evidence of a significant human, non-MS4 source
  - Recall this site has zero MS4 inputs during dry weather
- Human source appears to be inconsequential to general fecal indicator concentration





## BACTEROIDES IN MS4

- Amplification of human HF183 *Bacteroides* marker in 25 of 91 samples
- Concentrations from all six samples at T1-MCSD exceed any other MS4 sample results
  - Persistent in 6 of 6 samples, geomean of 462 gc/200 mL
  - Peak result 1636 gc/200 mL (August 14)
  - MS4 drainage ~2700 acres in City of Riverside



#### HUMAN BACTEROIDES VERSUS GENERAL E. COLI

 Geomean of *E. coli* concentrations is greater in MS4 sites when HF183 amplification was found

MS4 Samples Only	Ν	E. coli Geomean (MPN/100 mL)	P-Value
HF183 Amplified	25	1,270	0.008
HF183 Not Amplified	61	509	

Mainstem Samples Only	N	E. coli Geomean (MPN/100 mL)	P-Value
HF183 Amplified	23	142	0.932
HF183 Not Amplified	19	157	



• Implication: Non-human sources more likely drive mainstem *E. coli* 



## HUMAN FECAL CONTAMINATION

Real World Measures for Source Evaluation



#### HF183 LOAD ESTIMATION

• Dry Weather Flow volume \* HF183 concentration = Human *Bacteroides* gc/day



#### HOW MUCH FECAL MATTER?

 Ahmed et al. (2016) synthesis of studies globally estimating concentration of human DNA markers in human feces (HF), raw sewage (RS), septic wastewater (SW) and effluent wastewater (EW)



Figure from Ahmed, W., Bridie Hughes, Valerie J. Harwood. 2016. *Current Status of Marker Genes of Bacteroides and Related Taxa for Identifying Sewage Pollution in Environmental Waters. Integrative Biology Faculty and Staff Publications*. 360.



## HOW MUCH FECAL MATTER?

- To put findings into perspective the mass of human feces or volume of raw sewage that would explain observations in MSAR watershed
- 1 tootsie roll = ~ 6 grams
- 1 pitcher = ~ 5 liters



## HOW MUCH FECAL MATTER

• Bad day at T1-MCSD outfall: ~ 8 billion gc/day ~ 1 gram HF ~ 5 liters RS



• Bay day in SAR at Mission: ~70 billion gc/day ~12 grams HF ~ 40 liters RS



### PERSPECTIVES ON HOW MUCH FECAL MATTER??

- Small amount of fecal matter is likely coming from multiple people
  - Amplification in 25 of 72 samples from MS4 and within 8 of 14 Tier 1 drainages
  - Sources from both urban areas with no surface drainage features and within river bottom









## PROTECTING REC1 USE

• Consider a Hierarchy of Impairment





# PRIORITIZATION

• 2019 Synoptic Study

# PRIORITIZATION CRITERIA (TIER 1 DATA ONLY)

- DWF generation per area (gallons/acre/day)
- E. coli loading (MPN/day)
- Frequency of HF183 *Bacteroides* marker amplification
- Recreation Risk of Exposure

Mean ~50 gal/acre/day → ~ 10 gallons/day of outdoor water waste per property for SFR five/acre land use



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## PRIORITIZATION RESULTS

- Composite score based on factor weighting as follows:
  - 0.3 for DWF rates
  - 0.3 for *E. coli* load
  - 0.3 for frequency of HF183 amplification
  - 0.1 for recreational exposure risk



## NEXT STEPS – PREPARATION OF TRIENNIAL REPORT

- Comments on current draft by Close of Business December 6, 2019
- Report in early January (all elements incorporated) for Task Force discussion
- Address any final comments prior to submittal of Triennial Report to Santa Ana Water Board – due by February 15, 2019

