Prima Deshecha Cañada Watershed: Poche Beach Bacterial Source Tracking Investigation

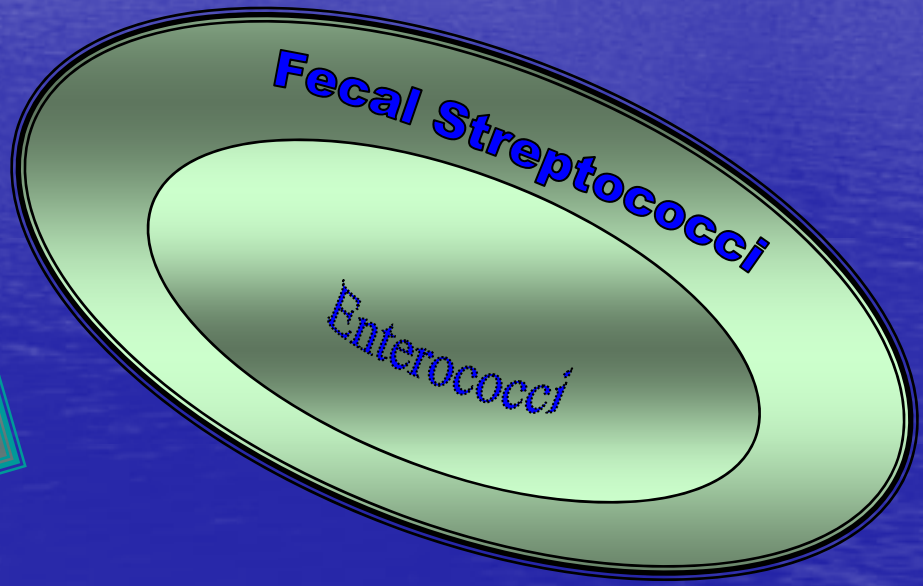
March 22, 2007

WESTON SOLUTIONS

Definitions

- Pathogen: A microorganism (bactera, viruses, protozoa/parasites) that causes illness or death.
- Indicator Bacteria: Bacteria used to identify potential pathogens in water.
  - Too difficult to test for every known pathogen
  - Present in all warm-blooded animals
  - Presence of these organisms = possibility of pathogens

Indicator Organism Families



Amount of Bacteria in Sewage

- Total Coliforms - 10^7 - 10^9 per 100mL
- Fecal Coliforms - 10^6 - 10^7 per 100mL
- Enterococci - 10^4 - 10^5 per 100mL

- Bacteroides (Q-PCR) 10^7-10^{10}

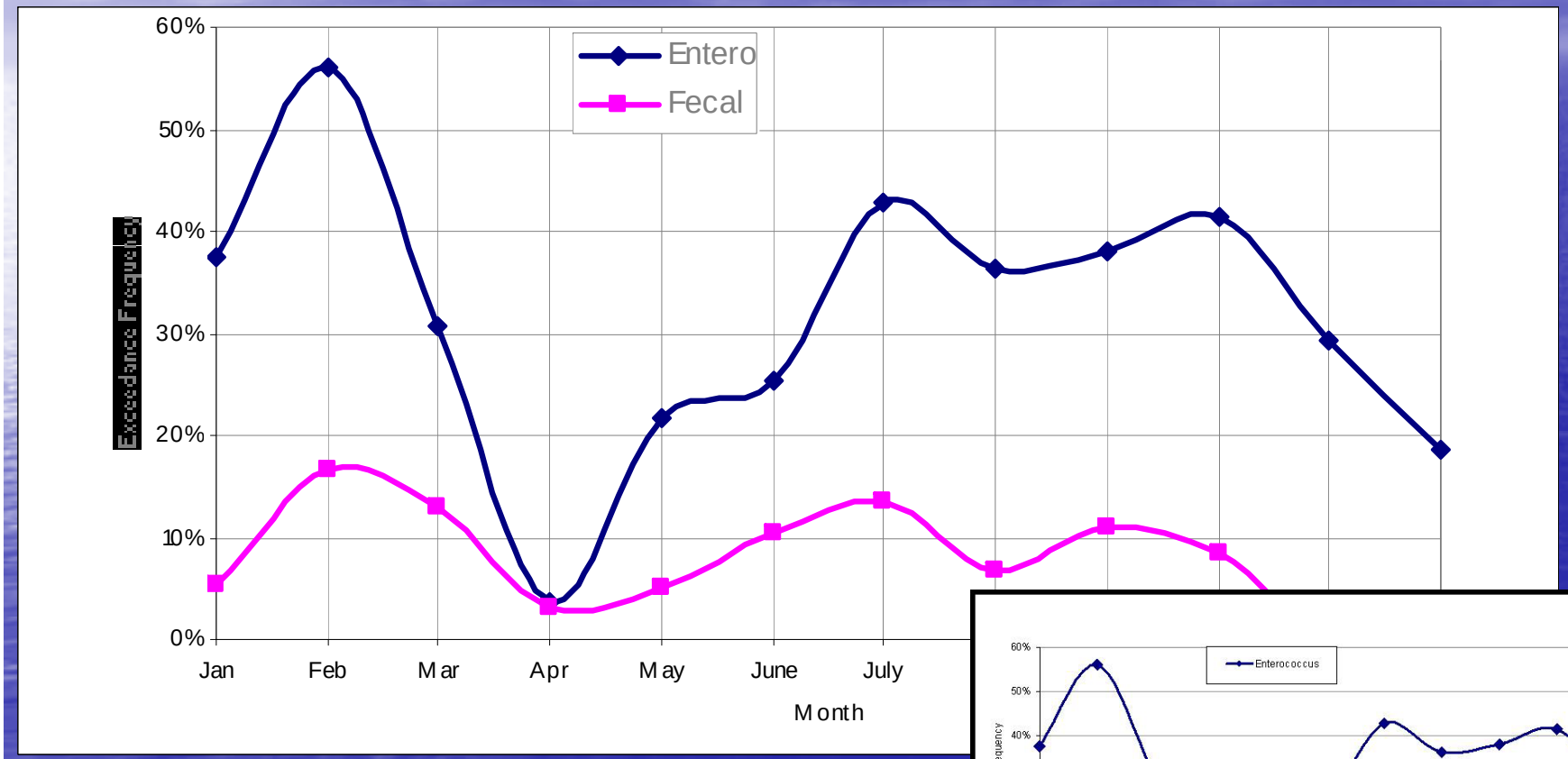
Project Design

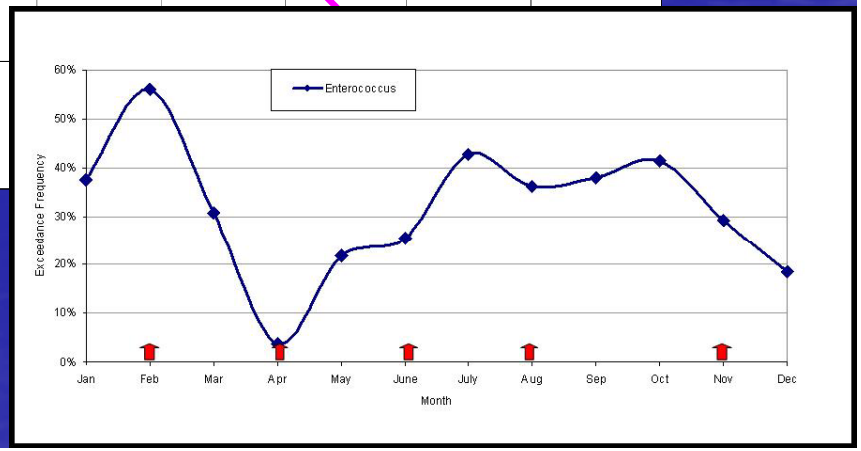
- Historical exceedances of indicator bacteria
- Primary source of indicator bacteria at Poche Beach is thought to be urban runoff delivered to the beach from the Prima Deshecha Cañada Watershed via the M01 channel.
- Investigate spatial and temporal patterns within the watershed
- Determine sources of bacteria, measure flow and assess loads
- Suggest BMPs for reduction of loading and contaminants

Map of Original Sampling Locations - Prima Deshecha Cañada Watershed


ARCO

Five, 24-hour Events to Account for Seasonal Patterns





Sampling

Phase I: Two 24-hour events:

August 1, 2005

November 1, 2005

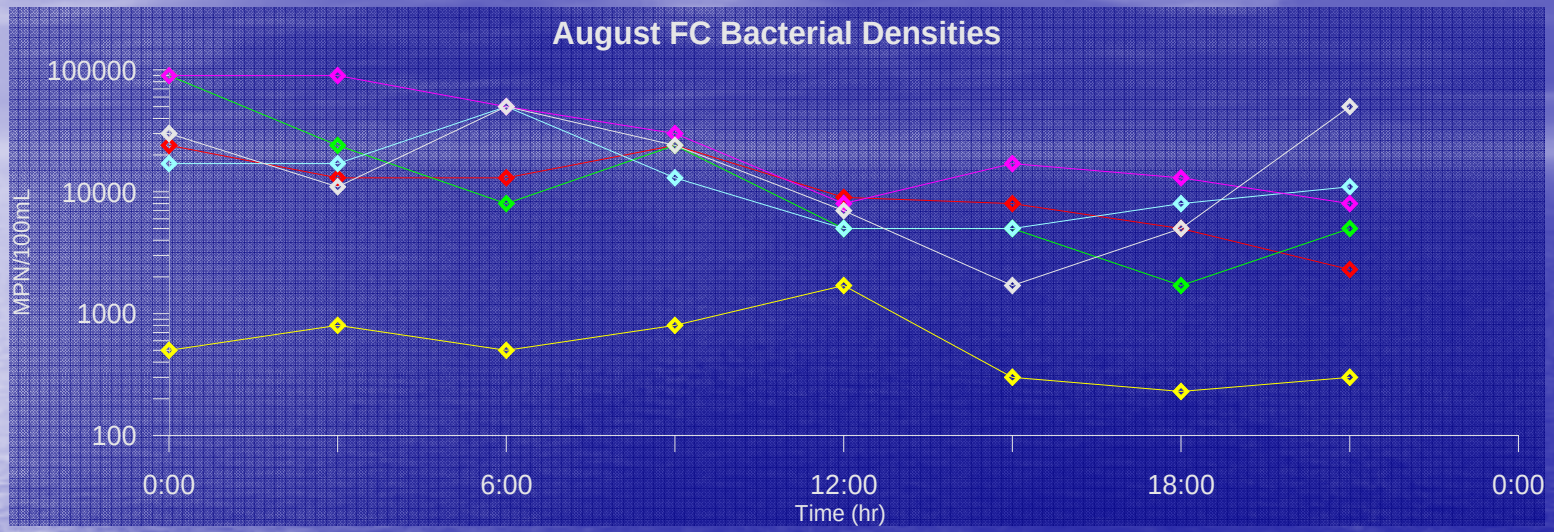
Phase II: Two adapted approach events:

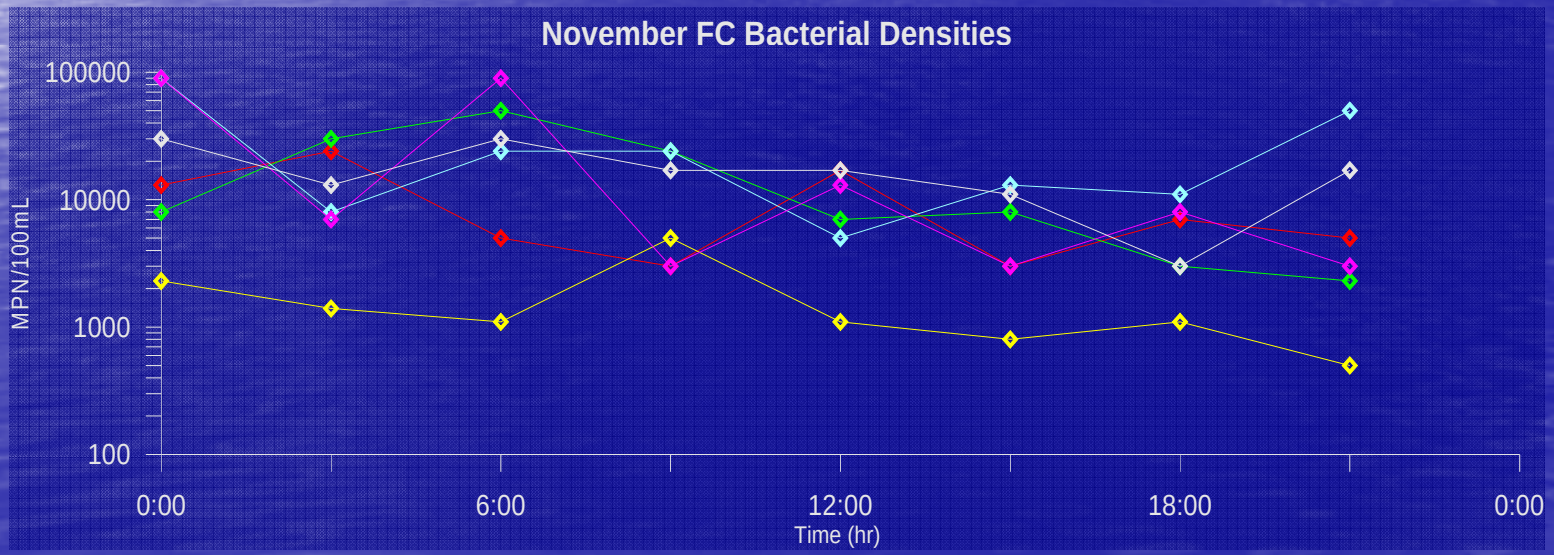
February 3, 2006

August 1, 2006

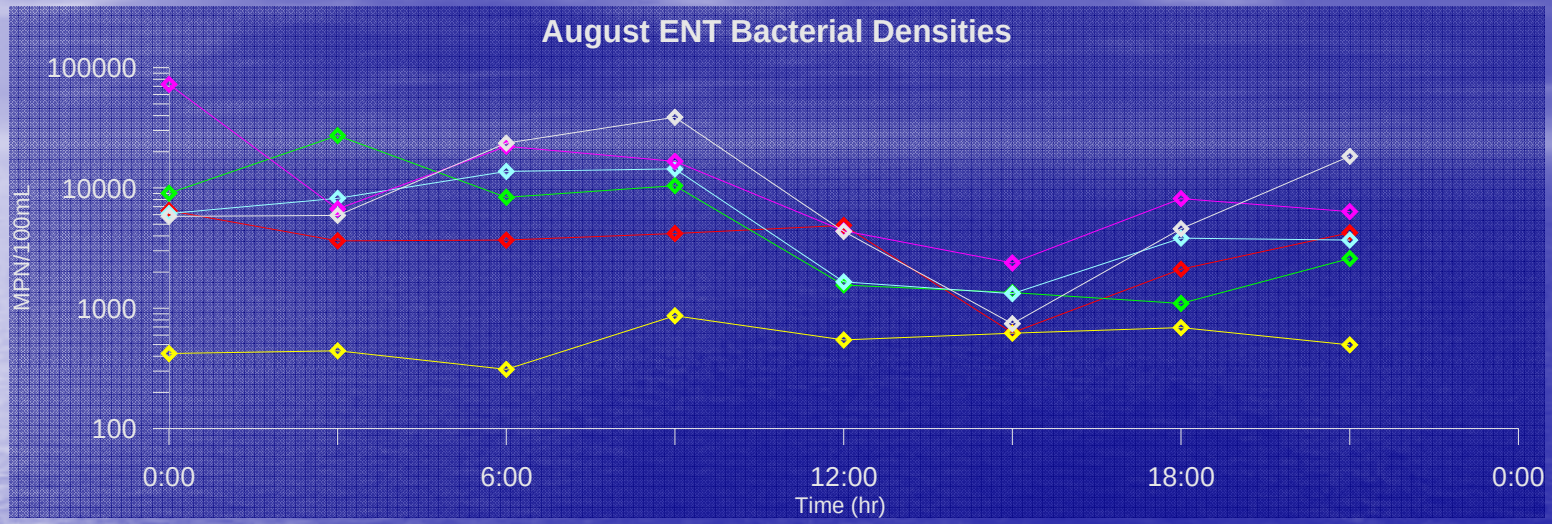
Spatial and Temporal Bacterial Densities (Concentration) from Phase I Events

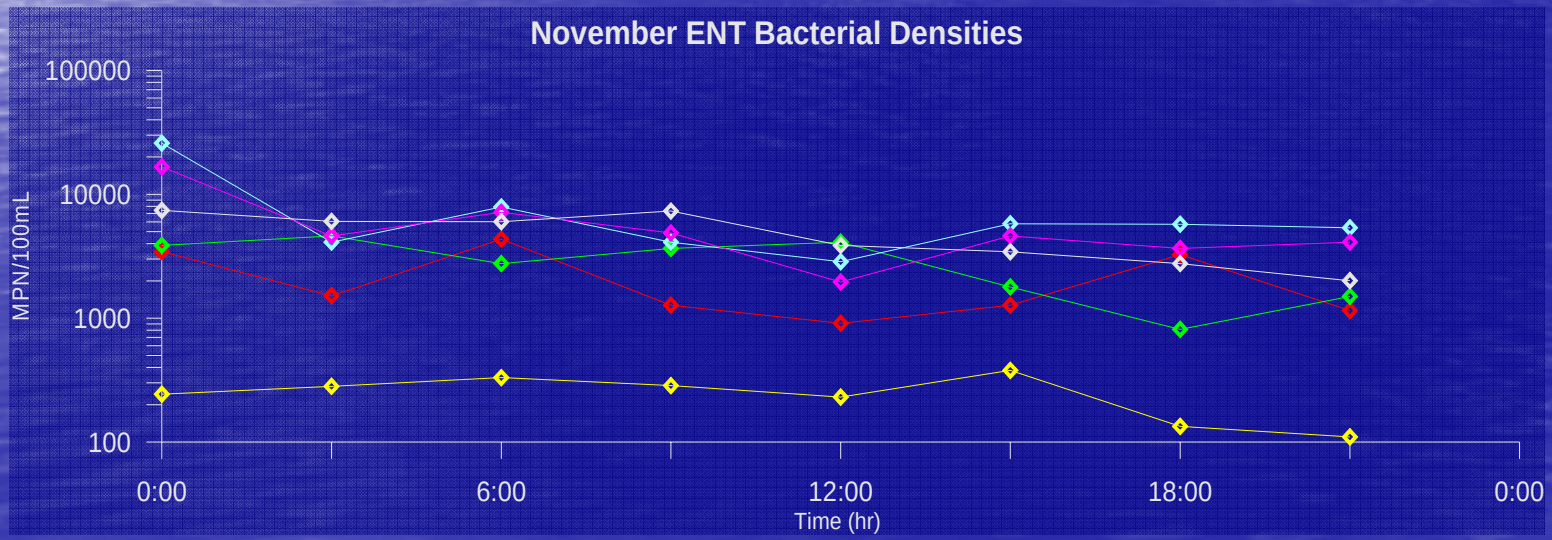
Fecal Coliform Bacterial Densities

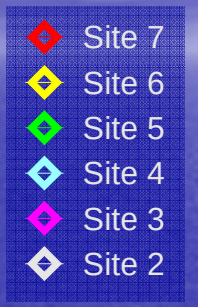




Enterococcus Bacterial Densities



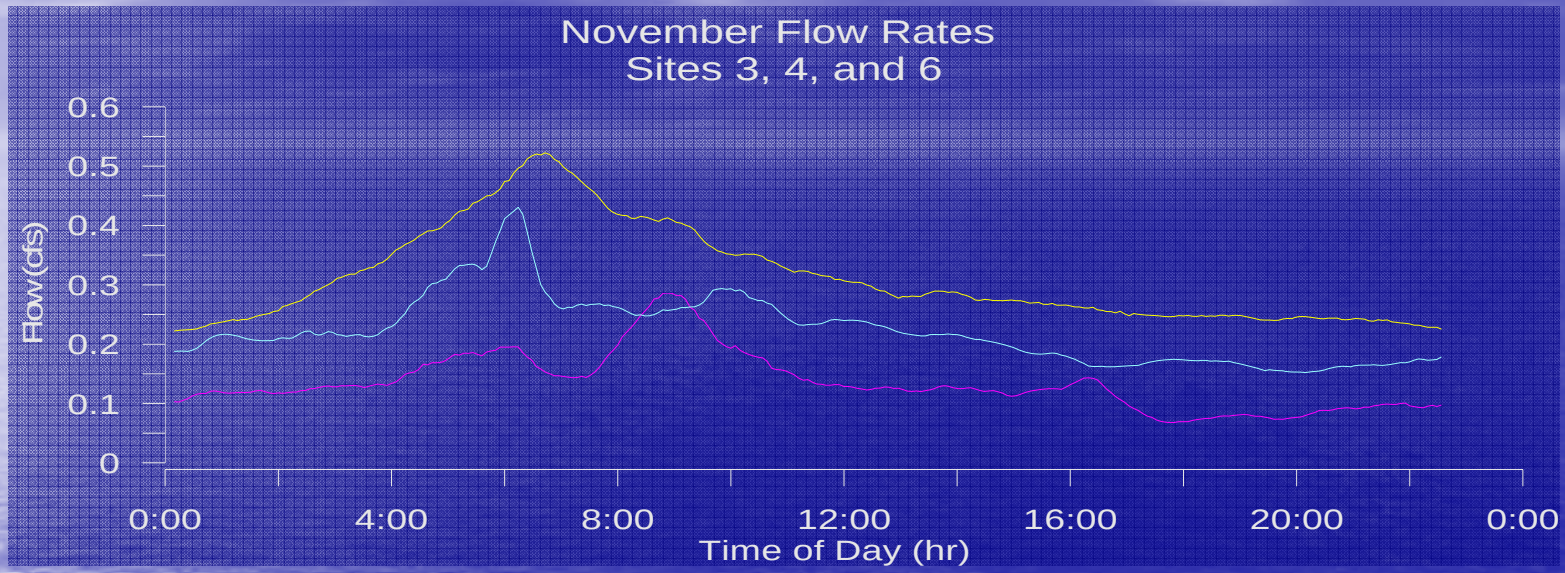


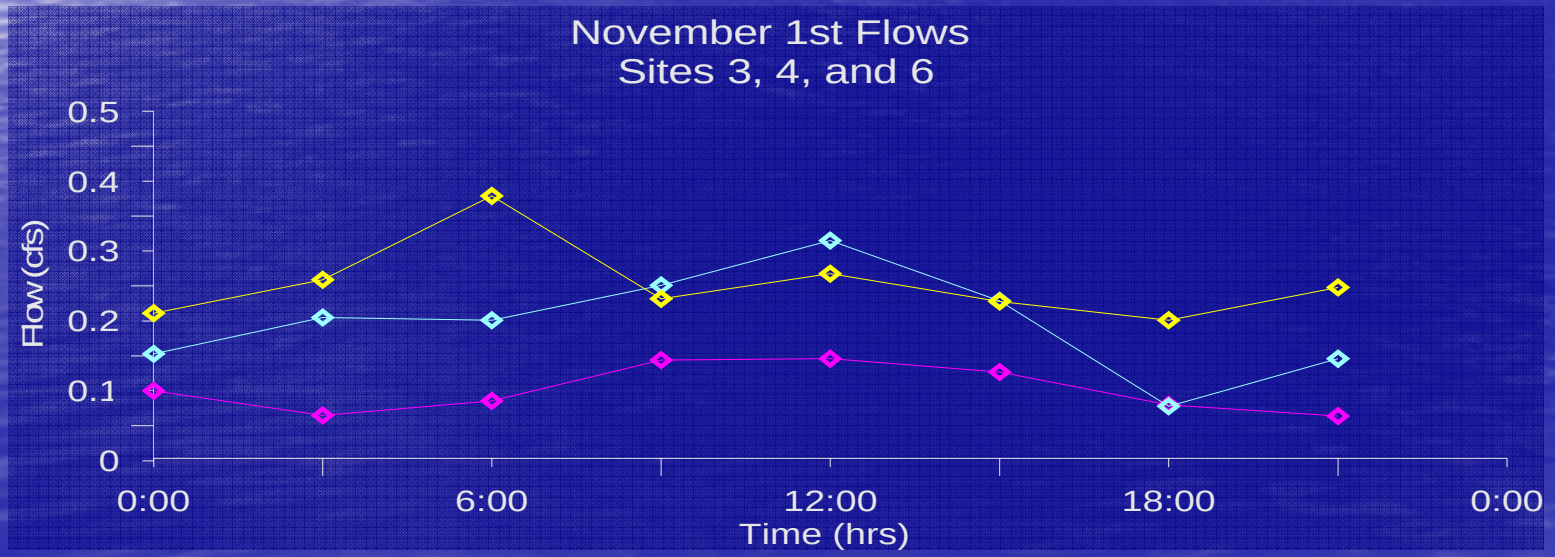


Flow Measurements and Loading

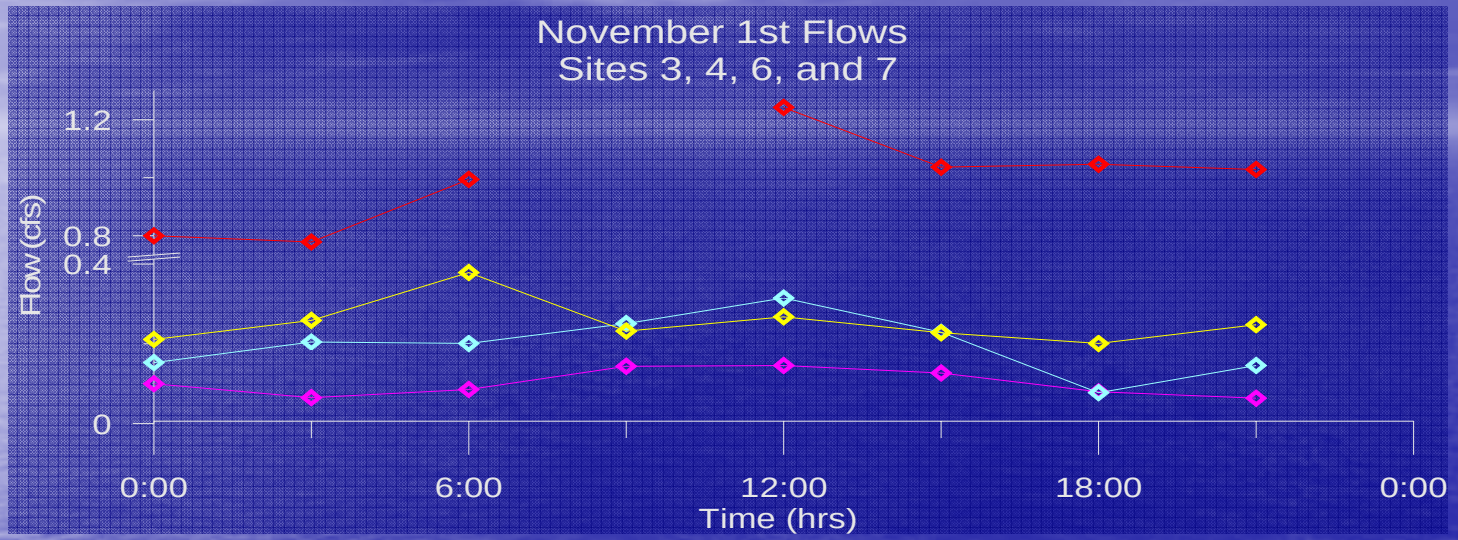
- Sites 3, 4, 6 and 7* for November 1, 2005
  - *Site 7 tidally influenced. Flow data taken only during ebbing tide.
  - Site 5 November 1 data questionable. Not included on graph.

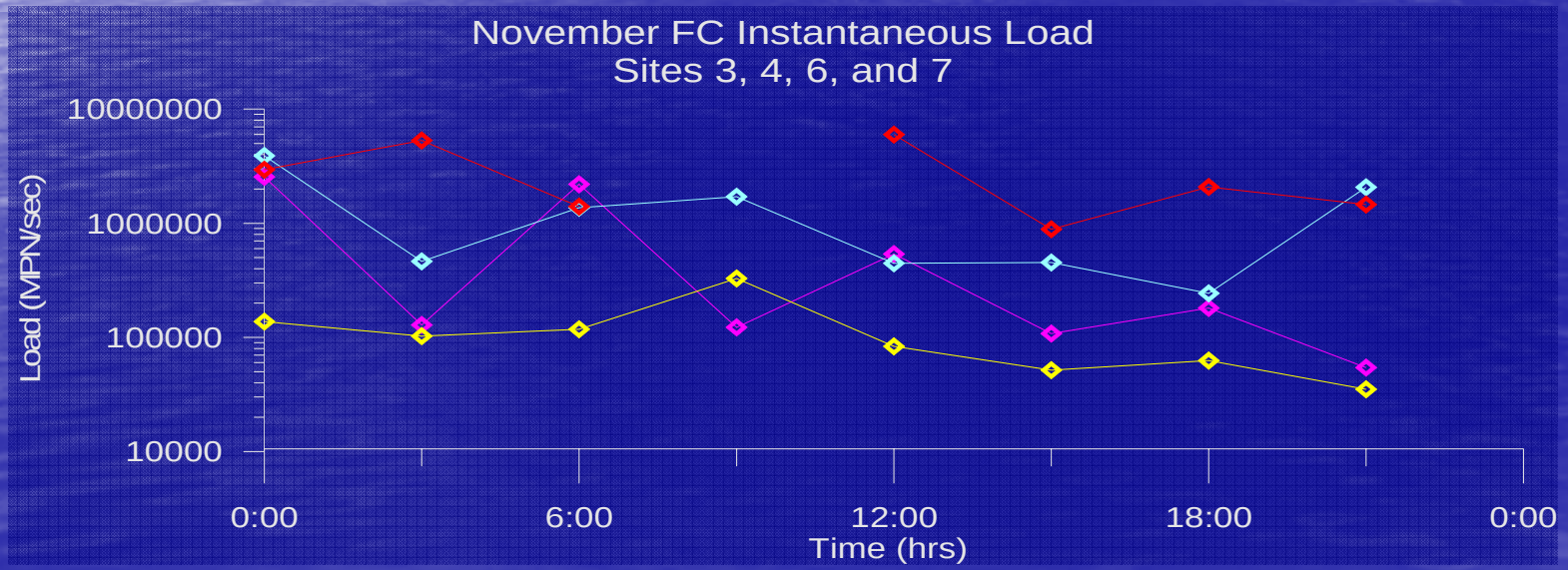
Average November and November 1st Flows



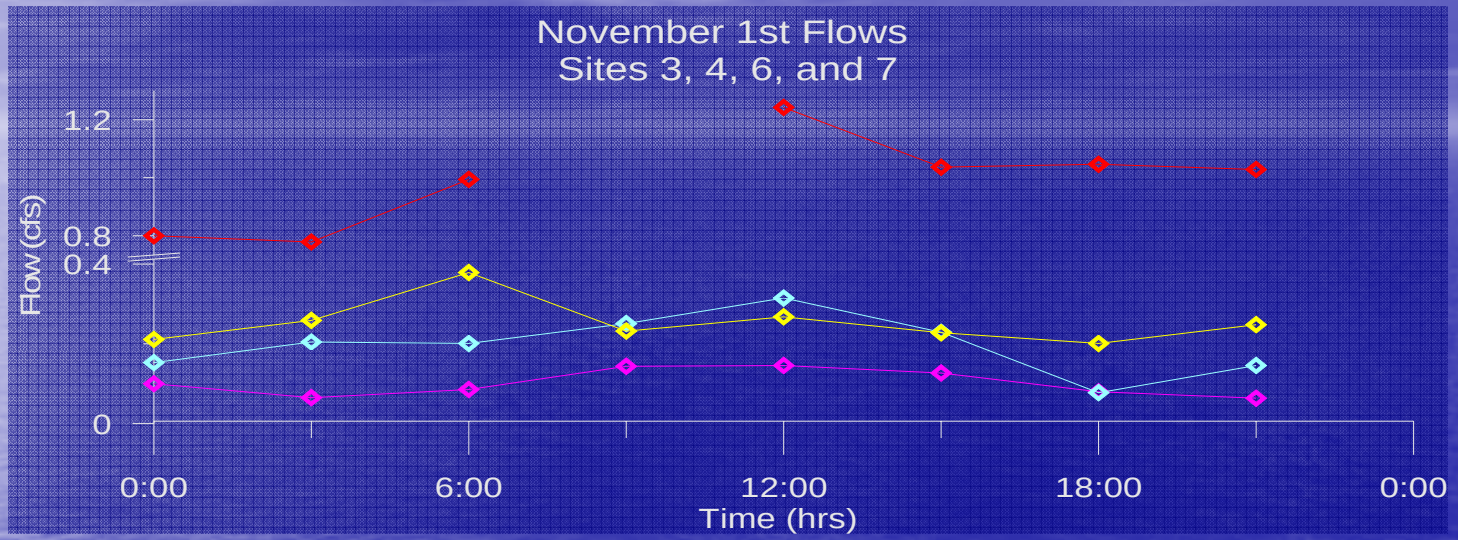


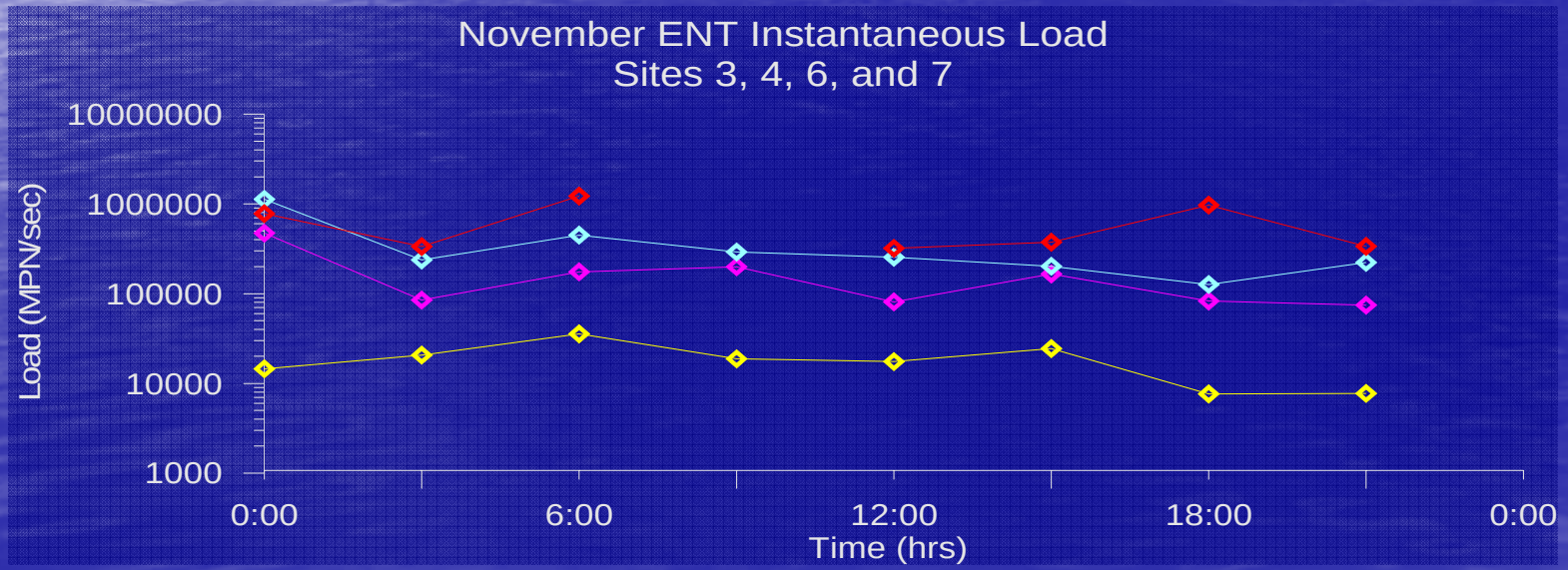
November 1st Flows and Fecal Coliform Loading





November 1st Flows and Enterococcus Loading





Findings: Phase I

- Main flow emanating from top half of channel
- Flow highest early morning
- Bacterial concentrations similar throughout channel
- No human contamination found

Phase II

Hypotheses

- Bacteria throughout the watershed is amplified by grass, fertilizers, and trash and is transported by irrigation and other runoff to drainage pipes.
- Outflow from drainage pipes contributes to high bacterial counts in the M01 channel.

Irrigation:
Sites 3 and 4

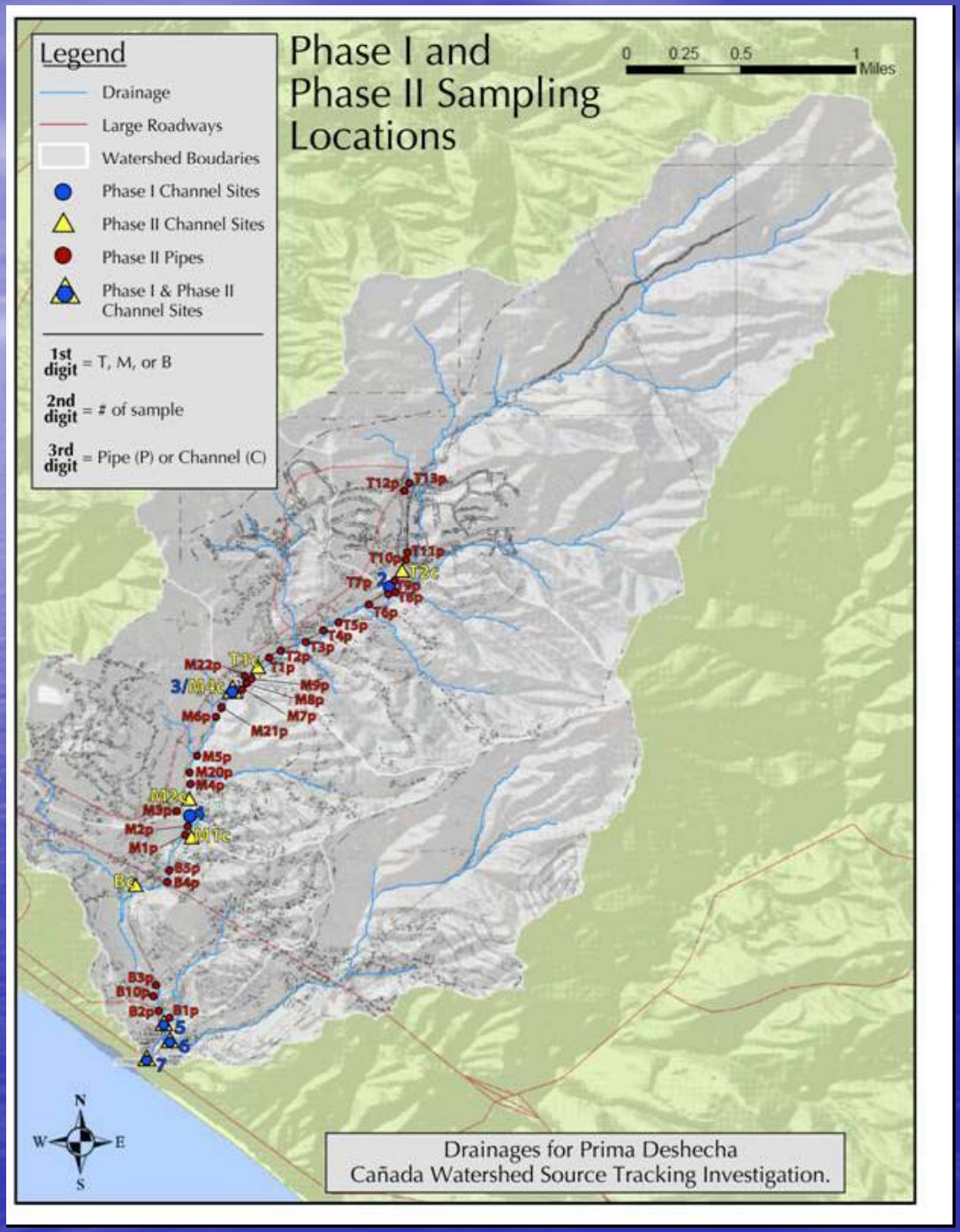
Adapted Approach

- Focus on early morning hours when flow is highest
- Focus monitoring efforts on secondary drainage pipes and weepholes entering the channel
- Characterize flows/loading throughout channel
- Sampling events:
  - February 3, 2006 and August 1, 2006

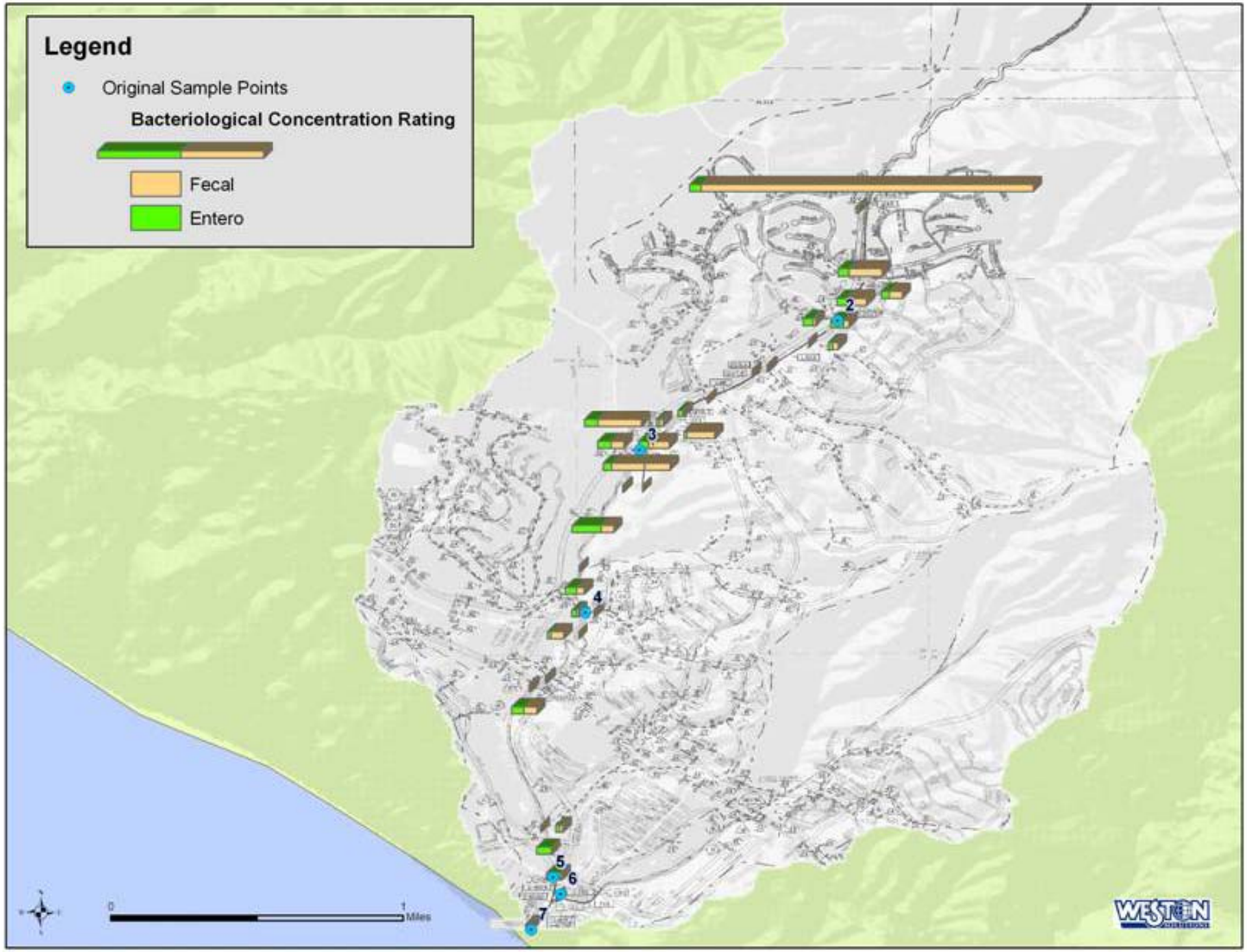

SMACK THEM

Monitoring Events

- Collect bacteria samples from flowing drainage pipes, weepholes and main channel
- Collect Q-PCR samples from all drainage pipes and main channel
- Monitor flows from pipes and in-channel downstream of flowing pipes
- Test algae and biofilm samples

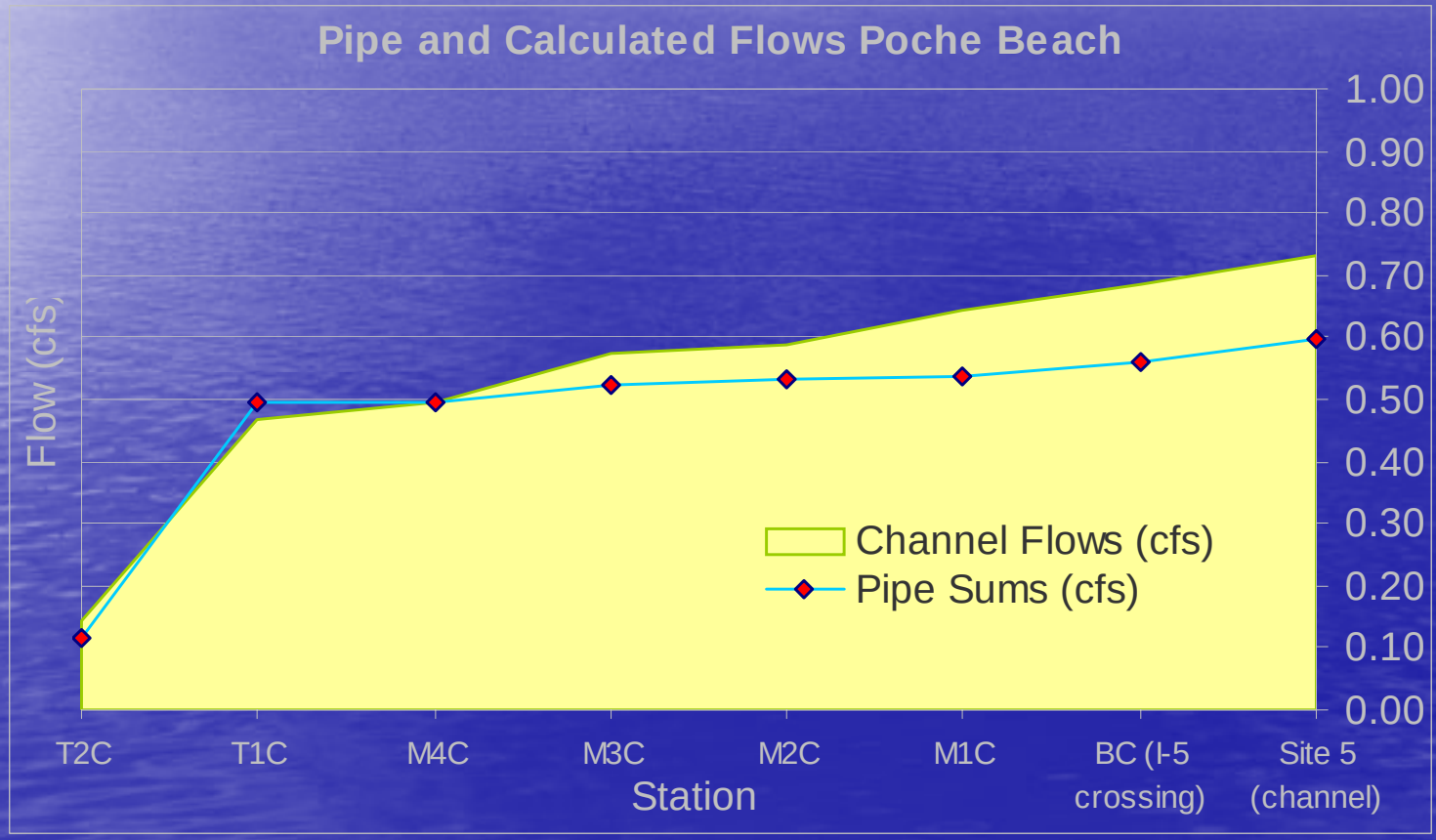

Legend
Drainage
Large Roadways
Watershed Boudaries
Phase I Channel Sites
Phase II Channel Sites
Phase II Pipes
Phase I & Phase II Channel Sites
1st digit = T, M, or B
2nd digit = # of sample
3rd digit = Pipe (P) or Channel (C)
Phase I and Phase II Sampling Locations
0 0.25 0.5 1 Miles
N
W
E
S
Drainages for Prima Deshecha
Cañada Watershed Source Tracking Investigation.

Bacterial Densities from February Sampling Event


Legend
Original Sample Points
Bacteriological Concentration Rating
Fecal
Entero
2
3
4
5
6
7
0
1
Miles
WESTON

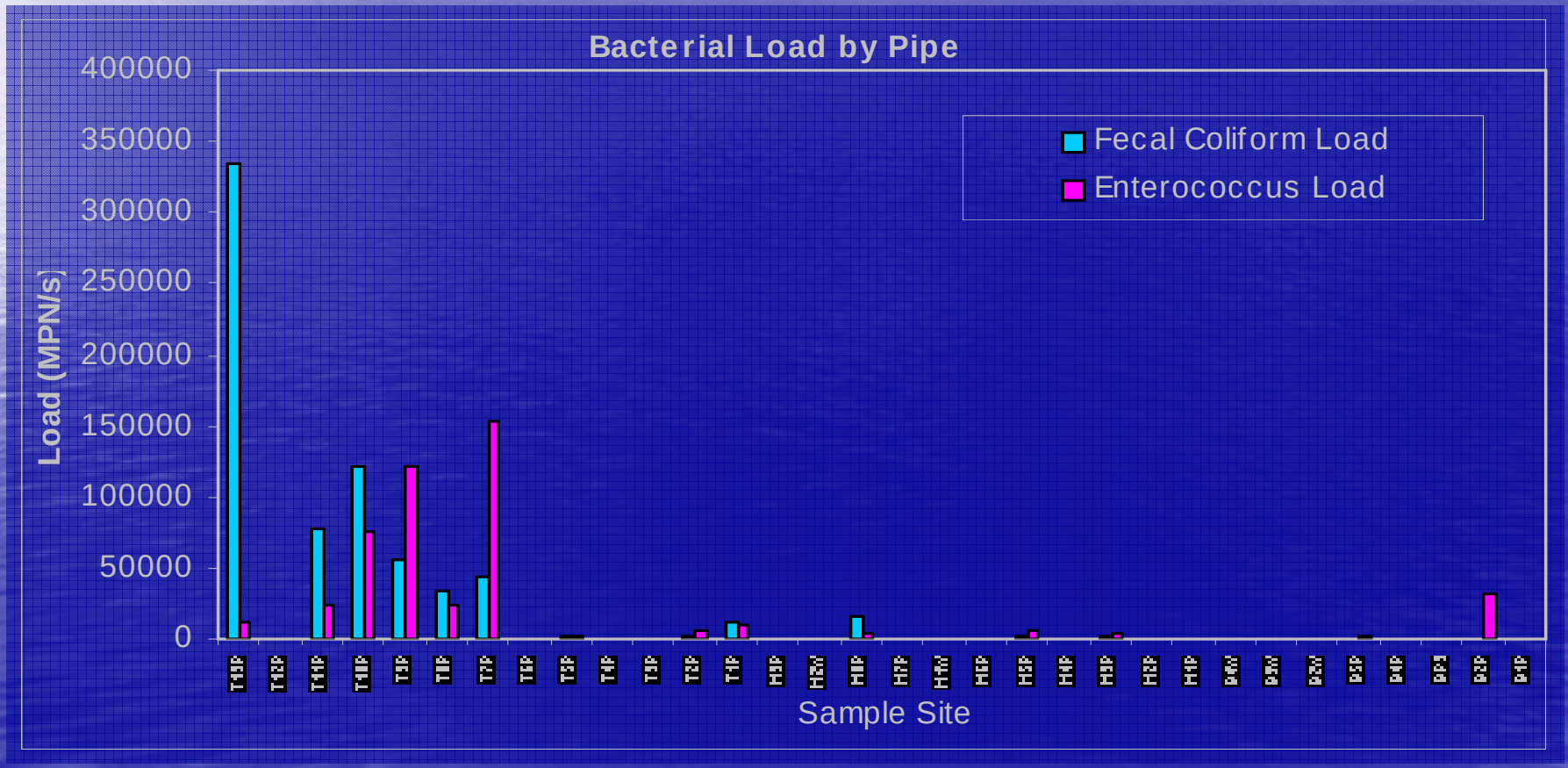
Main Channel and Pipe Flows

Drainage Pipe Flows and Main Channel Flows



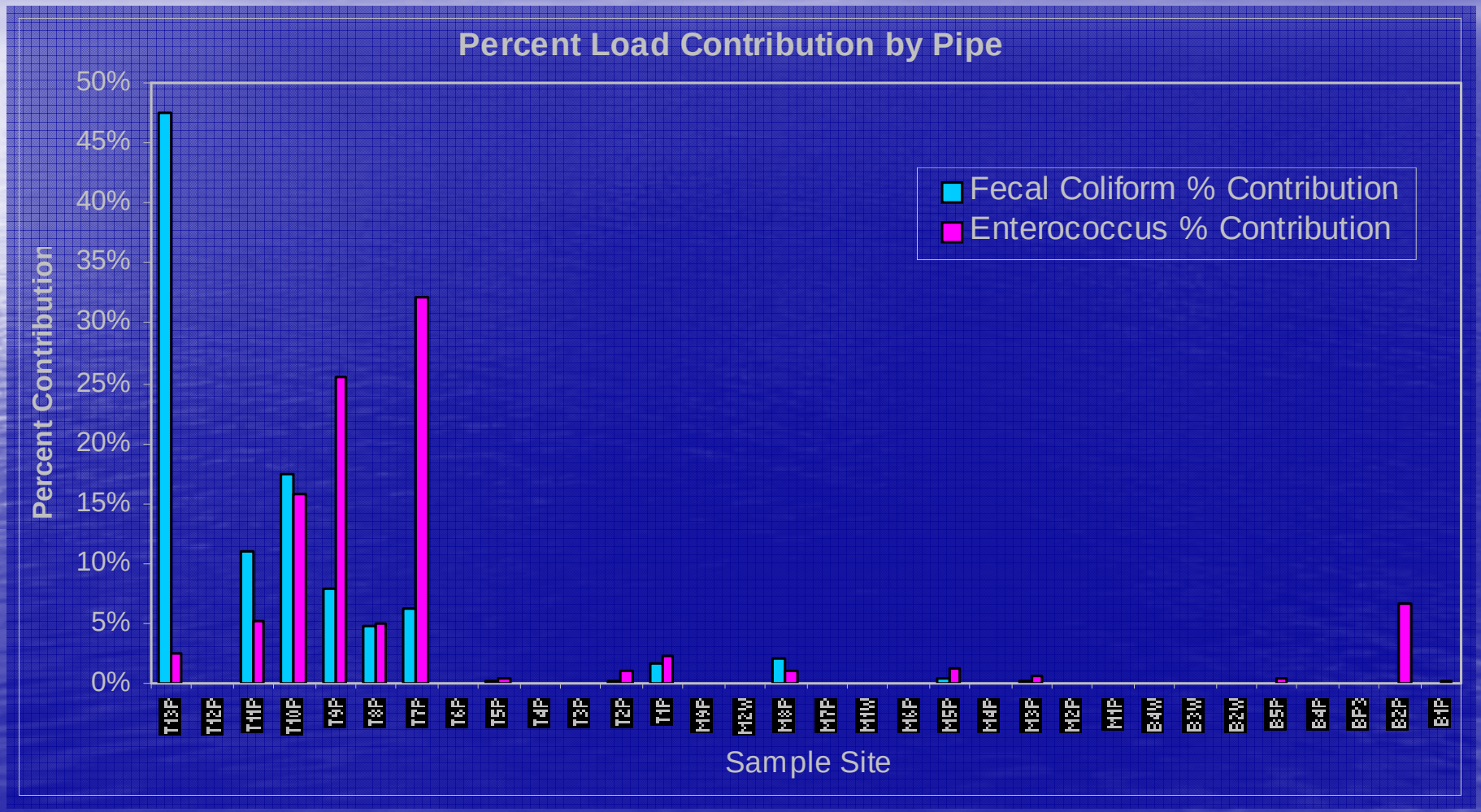
Phase II: February, 2006 Sampling Event

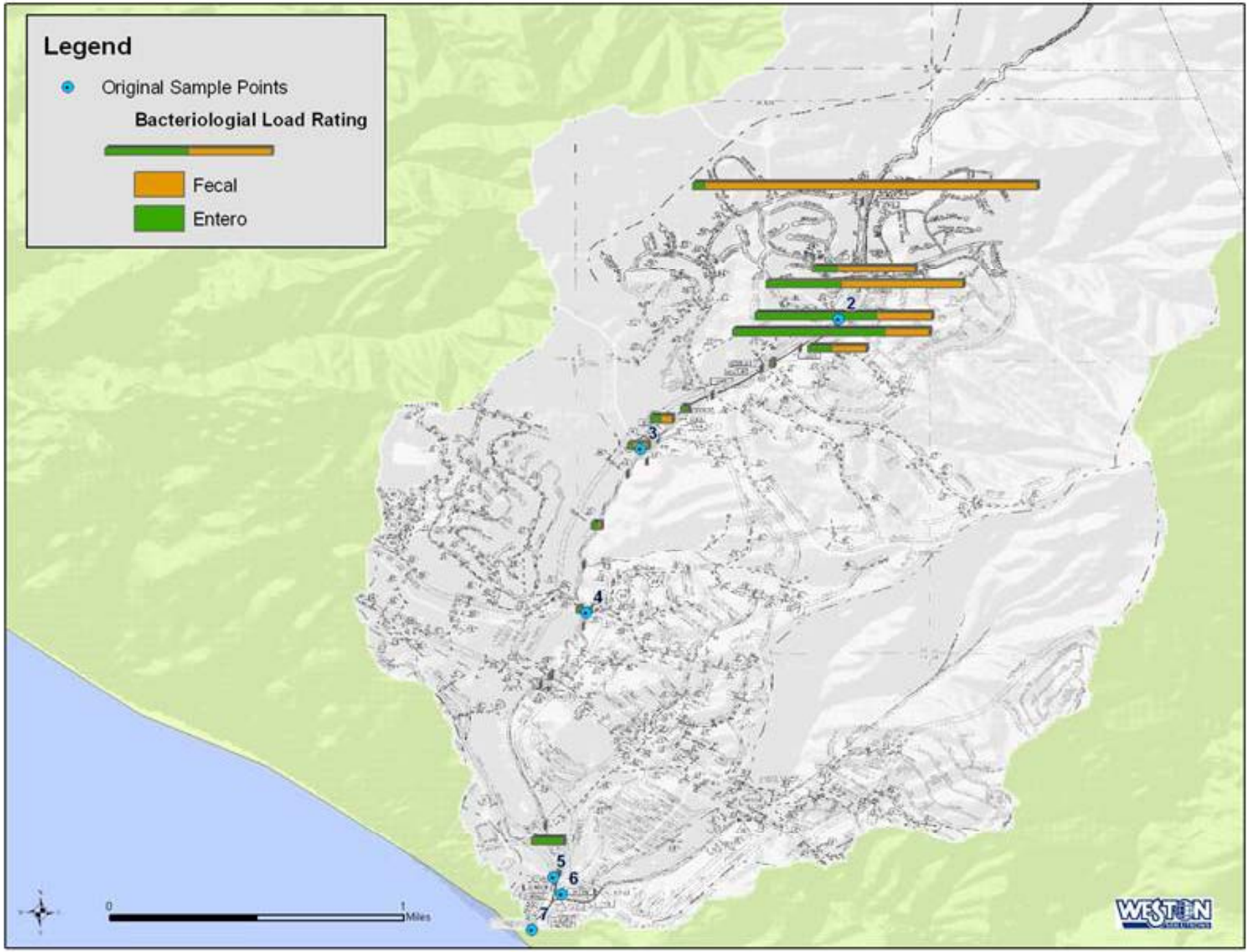
Bacterial Loading by Drainage Pipe

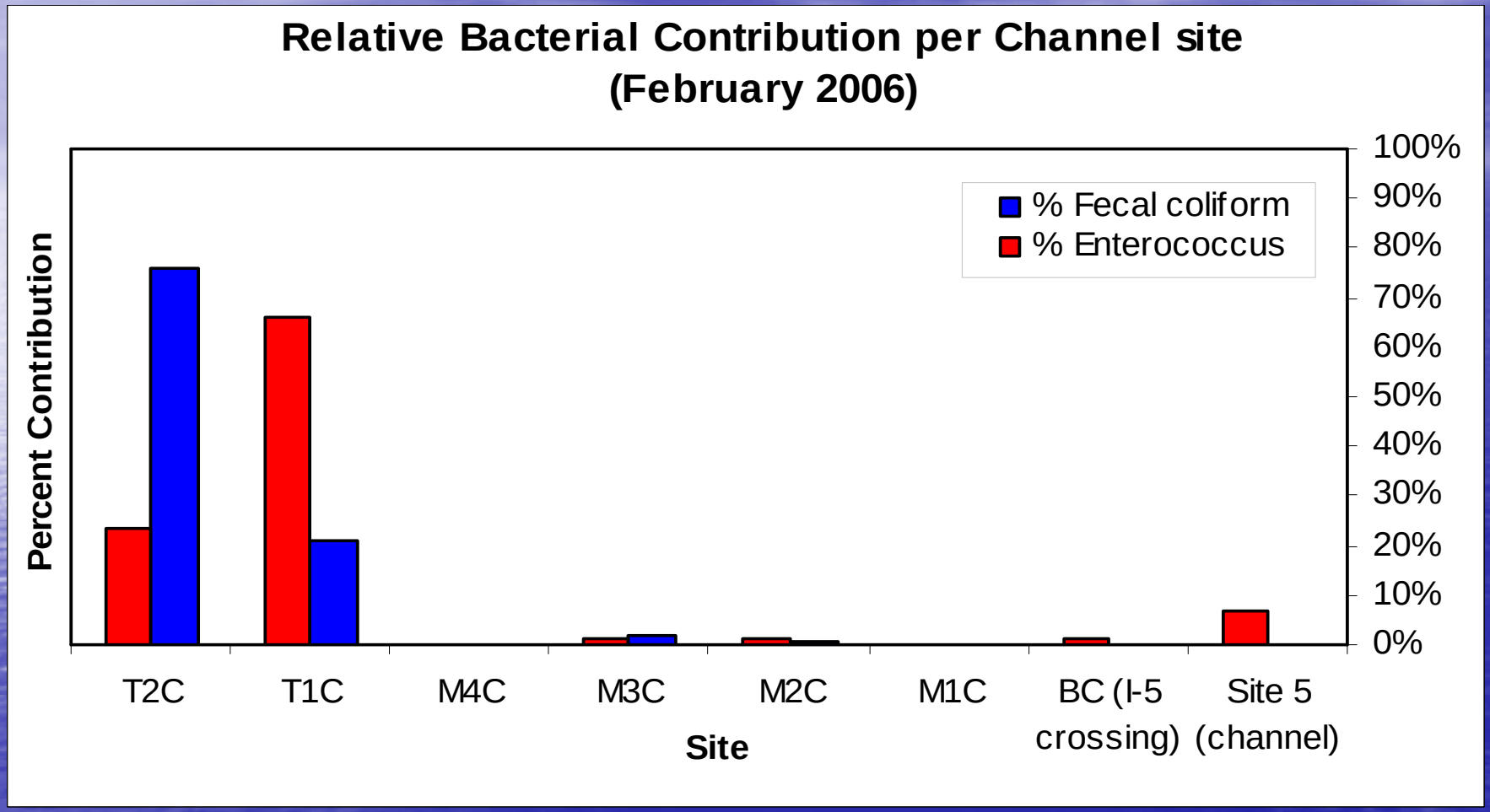


% Contribution of Bacterial Loading

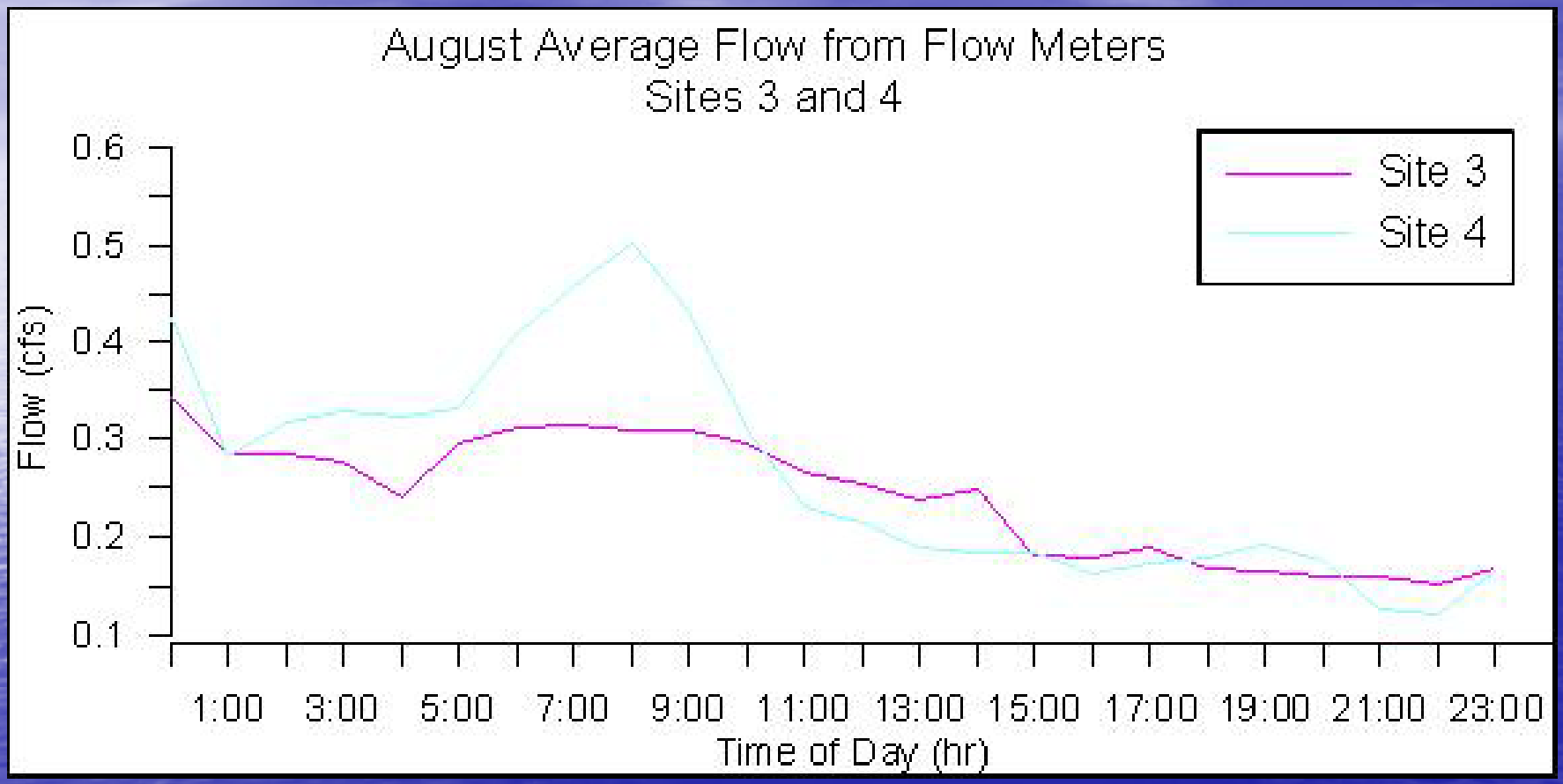
Top pipes contribute 97% of fecal, 90% of entero

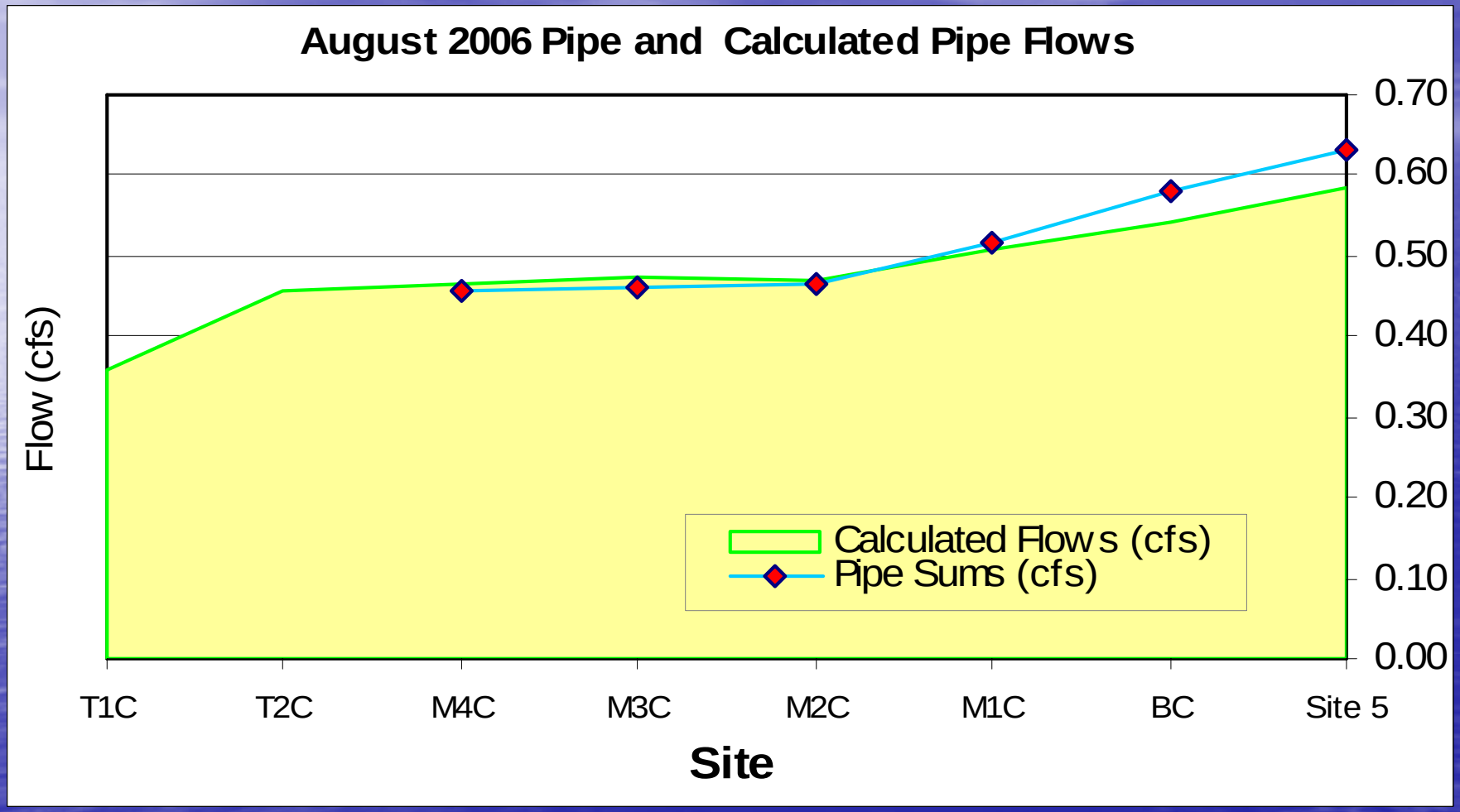


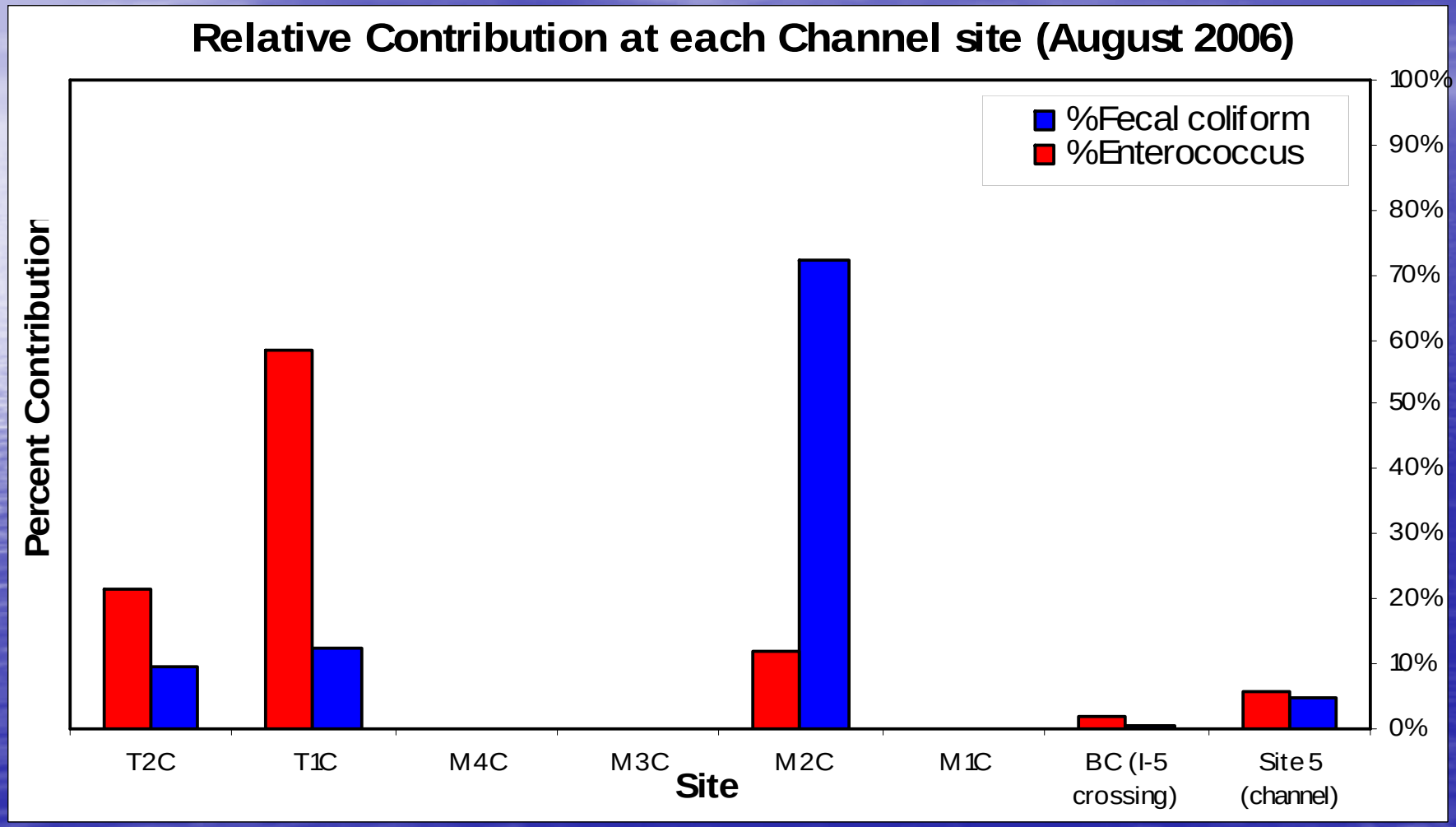

Legend
Original Sample Points
Bacteriologial Load Rating
Fecal
Entero
2
3
4
5
6
7
0
1
Miles
WESTON


Relative Bacterial Contribution per Channel site
(February 2006)
Percent Contribution
% Fecal coliform
% Enterococcus
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
T2C
T1C
M4C
M3C
M2C
M1C
BC (I-5 crossing)
Site 5 (channel)
Site

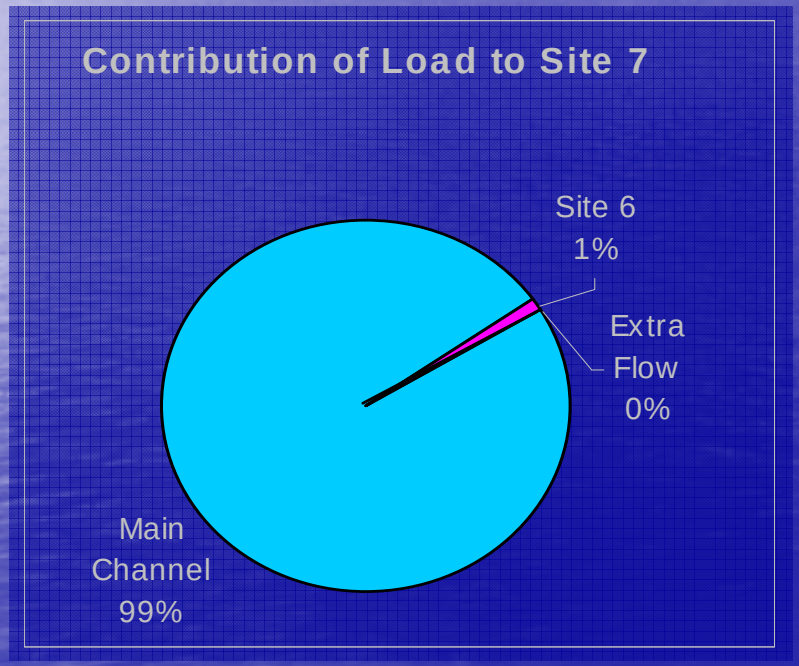
Phase II: August, 2006 Sampling Event


August Average Flow from Flow Meters
Sites 3 and 4
Site 3
Site 4
Flow (cfs)
0.6
0.5
0.4
0.3
0.2
0.1
1:00
3:00
5:00
7:00
9:00
11:00
13:00
15:00
17:00
19:00
21:00
23:00
Time of Day (hr)


August 2006 Pipe and Calculated Pipe Flows
Flow (cfs)
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Calculated Flows (cfs)
Pipe Sums (cfs)
T1C
T2C
M4C
M3C
M2C
M1C
BC
Site 5
Site


Relative Contribution at each Channel site (August 2006)
%Fecal coliform
%Enterococcus
Percent Contribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
T2C
T1C
M4C
M3C
M2C
M1C
BC (I-5 crossing)
Site 5 (channel)
Site

Contributions to Load at Site 7



Total Load Contribution **INTO** scour pond estimated at:

- Fecal Coliform 712,554 MPN/s
- Enterococcus 481,097 MPN/s

OUT OF the scour pond:

- Fecal Coliform 644,208 MPN/s
- Enterococcus 348,368 MPN/s

Conclusions

1	Using cutting-edge molecular source tracking techniques, the bacteria in the Prima Deshecha Watershed were not found to be human in origin.
2	Greater than 75% of the total bacterial loading in the M01 watershed originates from the top of the channel.
3	Biofilm on the concrete floor of the M01 main flood control channel does not appear to be a source of bacteria contamination at the M01 Channel. It is unknown if biofilm in the smaller diameter storm drains leading to the main channel may be a contributor of bacterial contamination.
4	Over-irrigation from the top of the channel appears to be the main contributor of bacterial loading.
5	The Cascadita Channel contributes less than 1% of the bacterial loading to the overall runoff.

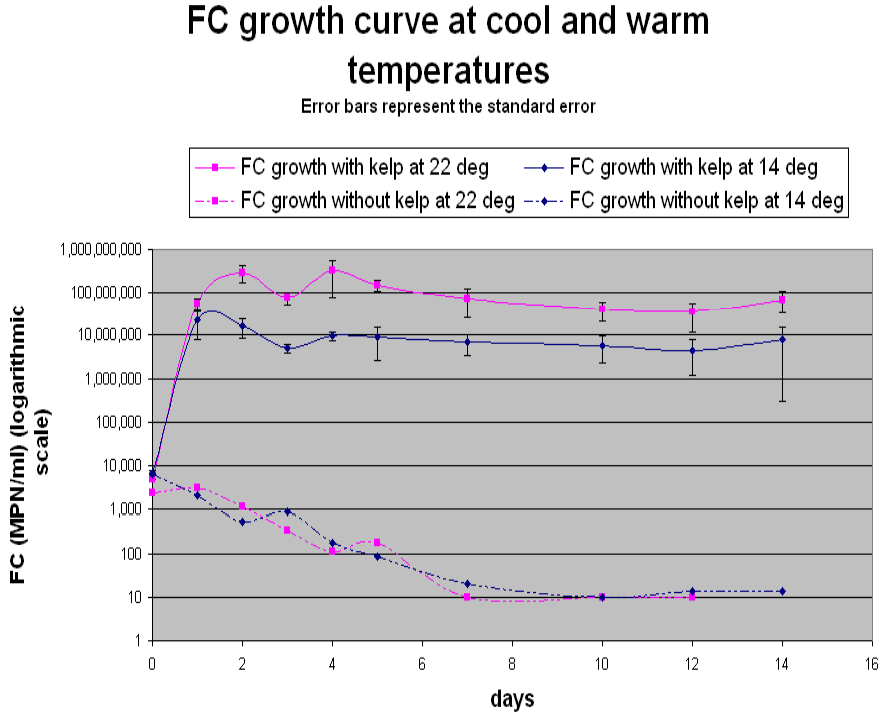
Questions?

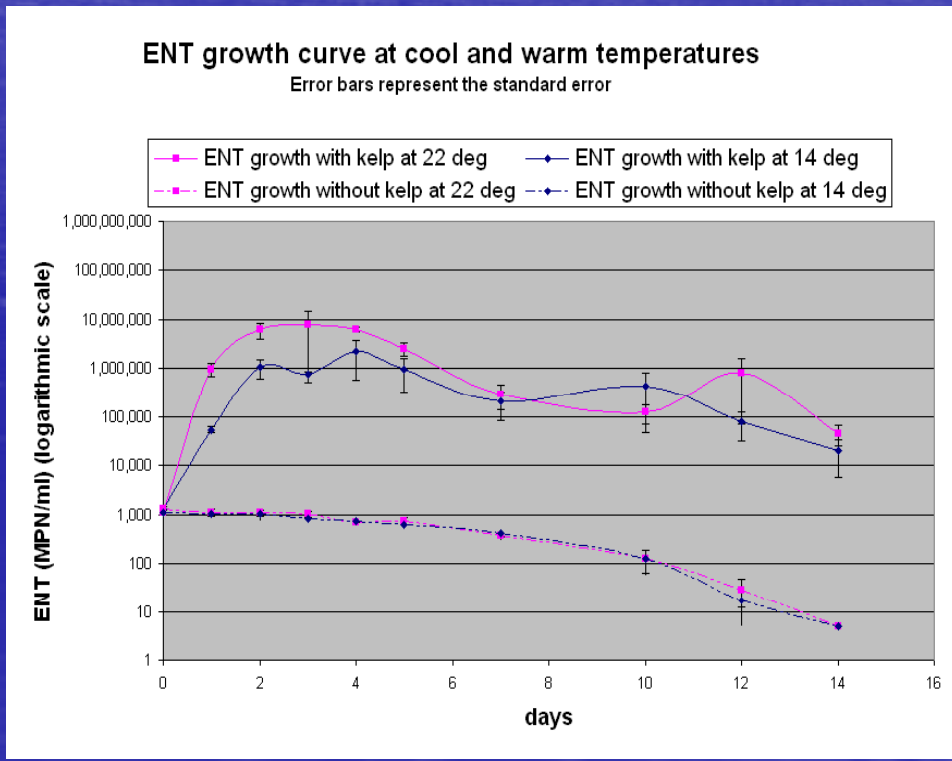
Larissa A. Aumand

760-497-3537

Larissa.Aumand@WestonSolutions.com

Regrowth Study Results





Q-PCR, Algae and Biofilm Results

- Q-PCR: No human signal detected at any drainage pipe or channel site
- Algae:
  - Fecal coliform = 23,000 MPN/100ml
  - Enterococcus = 6,690 and 154,060 MPN/100ml
- Biofilm:
  - Fecal coliform = 20 - 1,100 MPN/100ml
  - Enterococcus = ND - 1,259 MPN/100ml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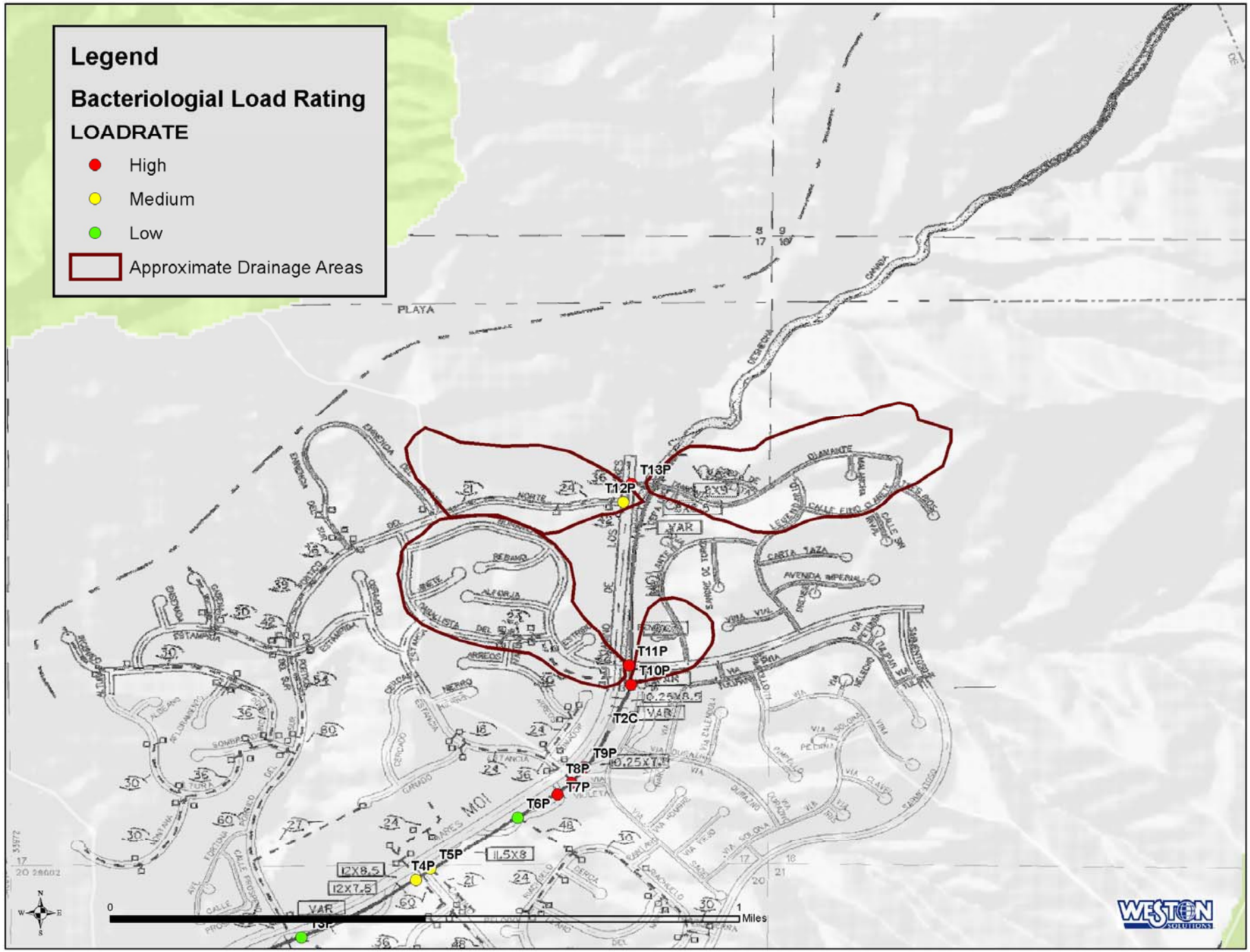
Legend
Bacteriologial Load Rating
LOADRATE
High
Medium
Low
Approximate Drainage Areas
T13P
T12P
T11P
T10P
T2C
T9P
T8P
T7P
T6P
T5P
T4P
T3P
PLAYA
0
1
Miles
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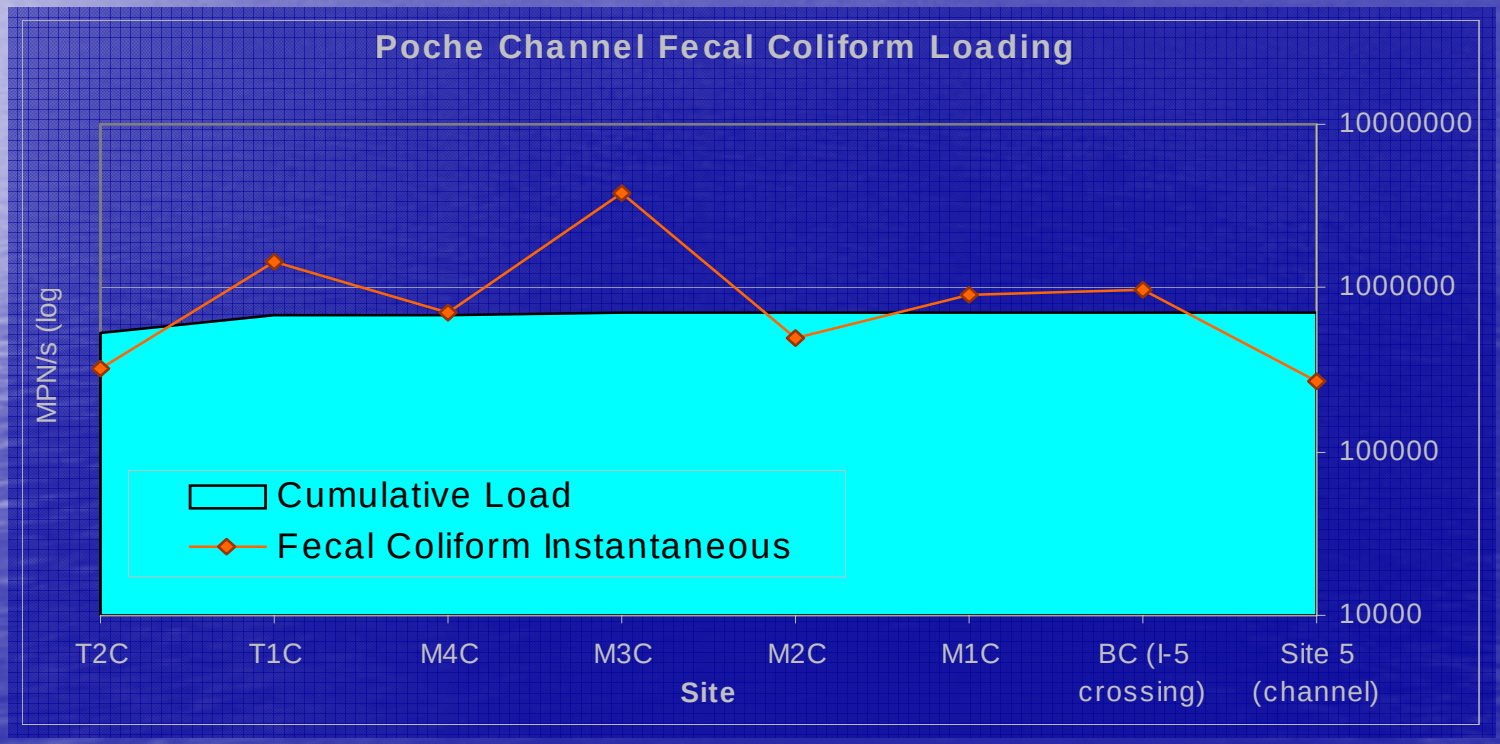
Source Matrix

	Potential Sources	Potential Solutions	Data Needs
1	Grass clippings	1-Gravel area prior to culvert 2-Bridge	Verify grass clippings as source. Verify load contributions.
2	Trash from access areas	1-Control access-fencing, landscaping 2- Litter control/cleanup	Verify trash contribution as source. Verify load contributions.
3	Fertilizer use	Reduce fertilizer use through educational tools	Verify fertilizer as source. Verify load contributions. Determine actual use and type of fertilizer.
4	Scour pond regrowth	1-Elminate pond 2-Reduce retention time in water	Verify habitat value. Verify environment as source of regrowth potential.
5	Algae mats	Algae control through nutrient reduction (see fertilizer solutions)	Investigate ecological and sustainable algae solutions.
6	Biofilm	1-Reduce flow during summer months 2-Power wash in selected areas 3-Treated geotextile lining in selected sections	Verify groundwater contribution. Investigate innovative technologies.

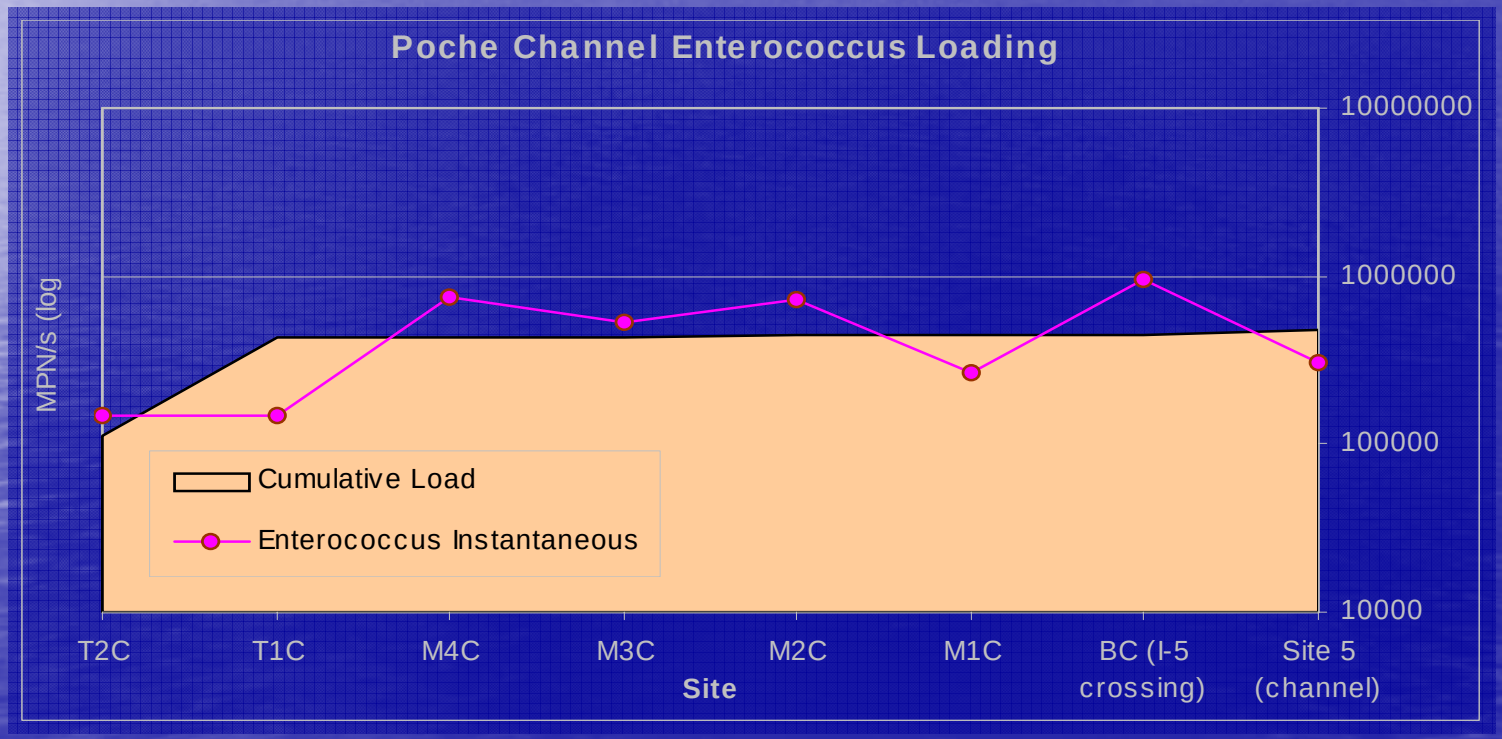
Migration Matrix

	Migration Pathways	Flow Controls
1	Urban Runoff - Summer Dry	1-Irrigation controls - timers/sensors 2-Education/incentives 3-Collection/retention/infiltration or reuse
2	Groundwater infiltration into channel	1-Lining of selected sections of channel 2-Groundwater diversion - interception trench 3-Reduce Irrigation - controls
3	Stormwater	1-Retention and infiltration 2-Redirect stormwater infiltration

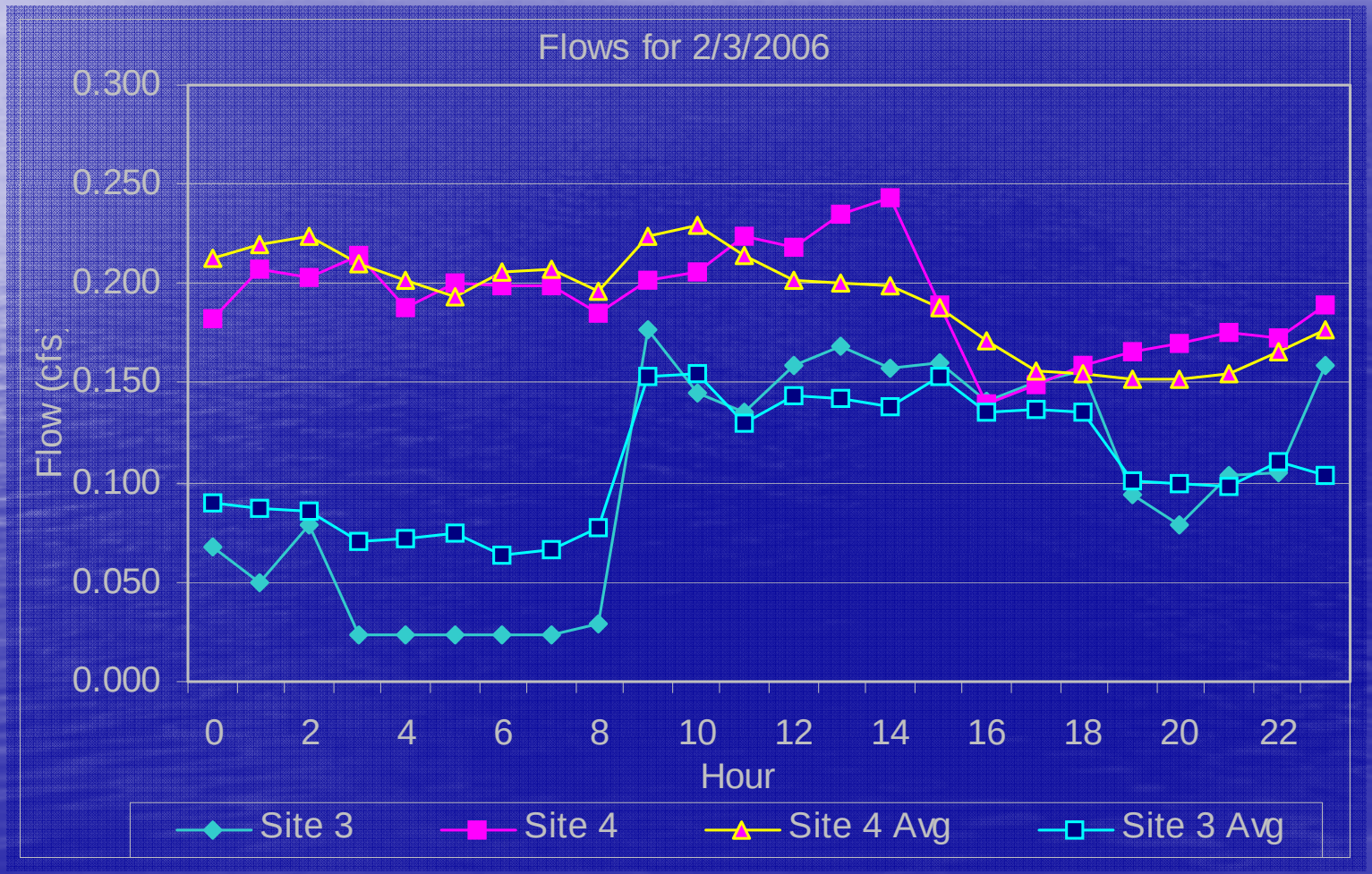
Fecal Coliform Loading in Main Channel



Enterococcus Loading in Main Channel



Site 3 and 4 Daily and Weekly Average Flows

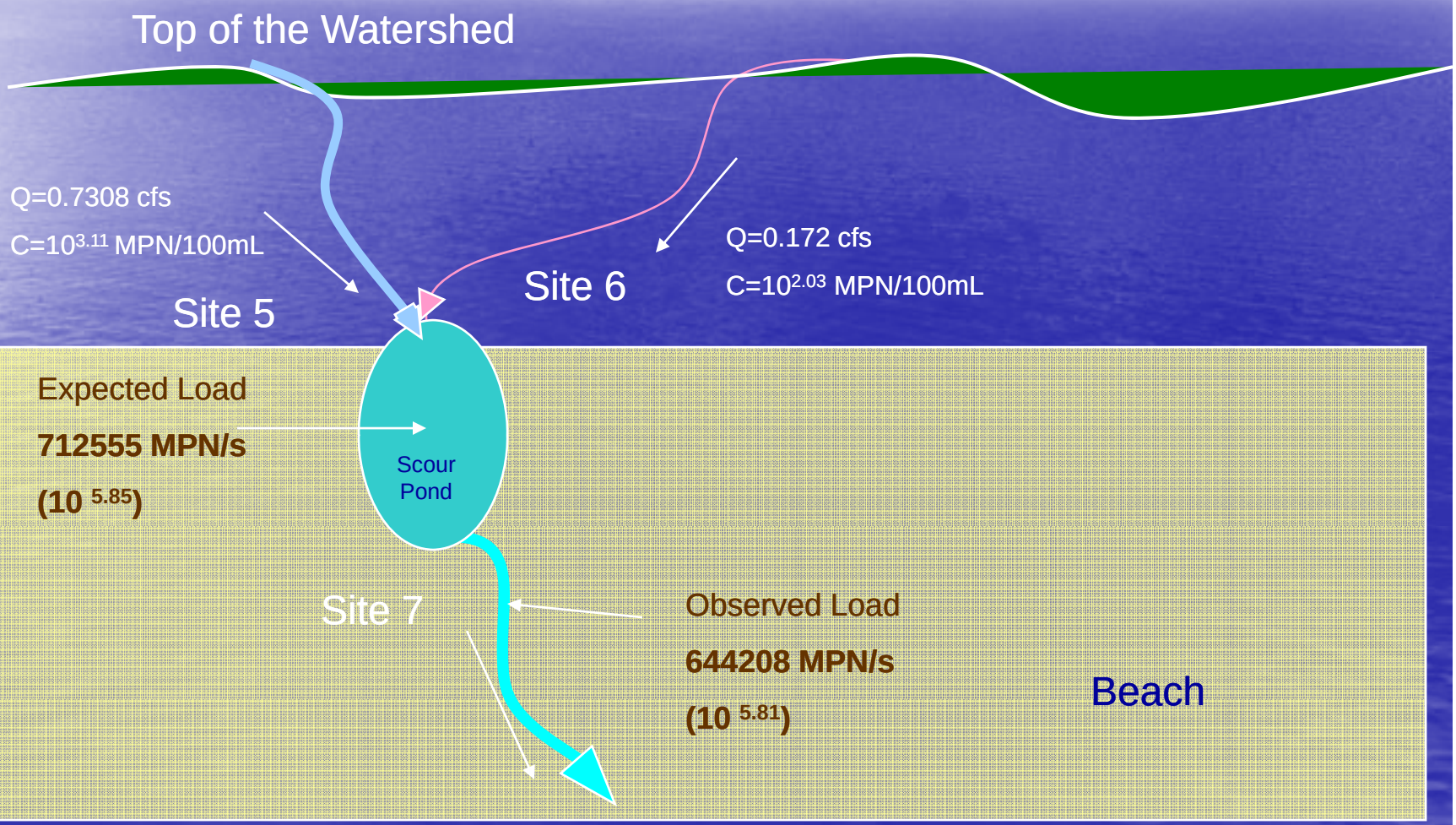


Poche Beach Flows and Loads

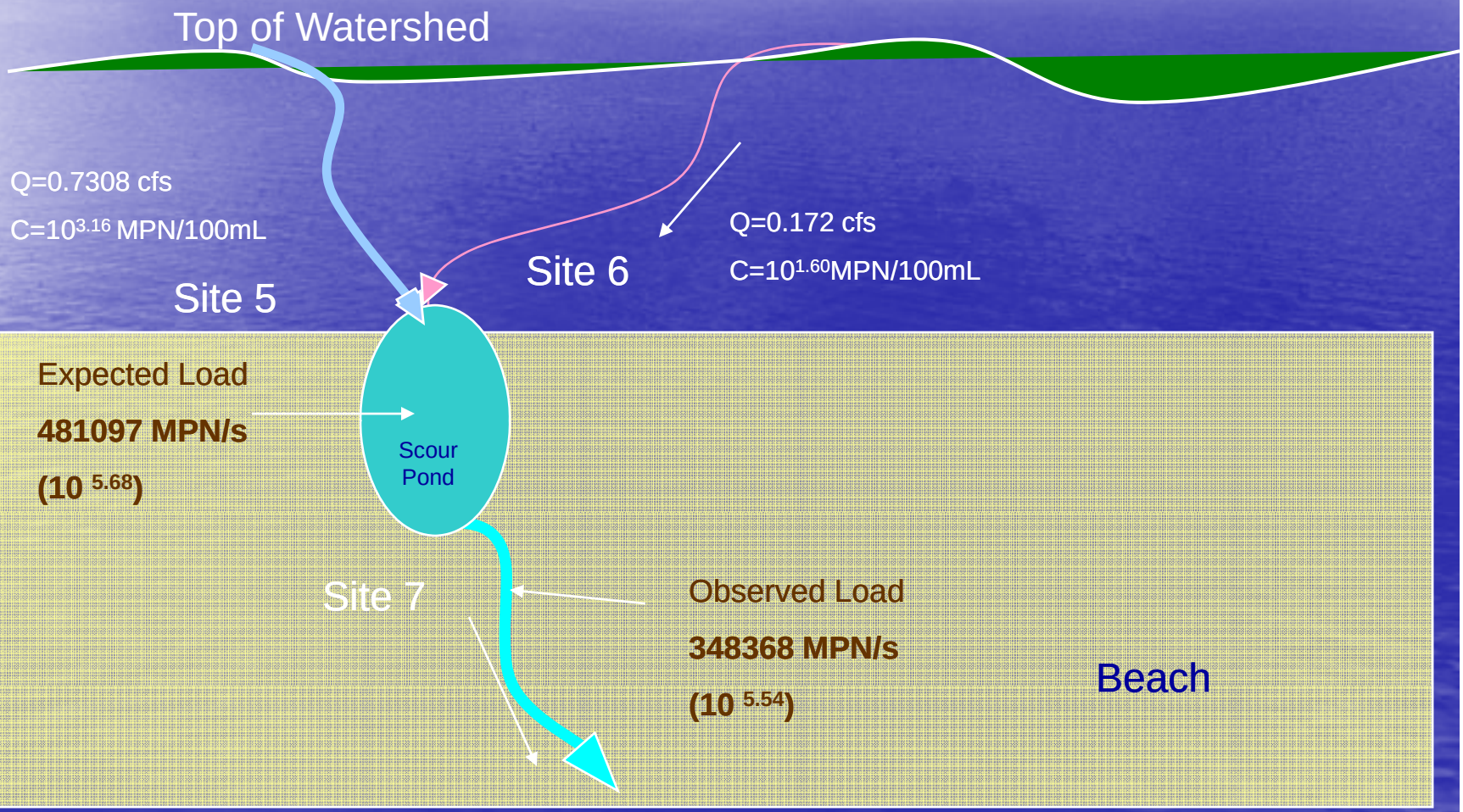
Poche Beach Flows and Loads				
Site	Pipe Sums (cfs)	Channel Flows (cfs)	Estimated Load (log MPN/s) Fecal Coliform	Enterococcus
Site 7	**NA**	**1.75**	**$10^{5.8}$**	**$10^{5.54}$**
Site 6	**NA**	**0.17**	**$10^{3.92}$**	**$10^{3.3}$**
Site 5 (channel)	**0.60**	**0.73**	**$10^{5.85}$**	**$10^{5.68}$**
BC (I-5 crossing)	**0.56**	**0.69**	**$10^{5.85}$**	**$10^{5.65}$**
M1C	**0.54**	**0.64**	**$10^{5.85}$**	**$10^{5.64}$**
M2C	**0.53**	**0.59**	**$10^{5.85}$**	**$10^{5.64}$**
M3C	**0.53**	**0.58**	**$10^{5.84}$**	**$10^{5.64}$**
M4C	**0.50**	**0.50**	**$10^{5.83}$**	**$10^{5.63}$**
T1C	**0.49**	**0.47**	**$10^{5.83}$**	**$10^{5.63}$**
T2C	**0.12**	**0.14**	**$10^{5.73}$**	**$10^{5.05}$**
Weep Holes	**NA**	**0.14****	**$10^{2.74}$**	**$10^{2.26}$**

** This value was calculated based on the difference between expected channel flow at site 5 and the sum of flows from all upstream pipes

Fecal Coliform Contributions



Enterococcus Contributions



Land Use in Watershed