

Natural Source Exclusion: a Case Study at Santa Monica Pier



Mark Gold

UCLA Institute of the Environment and
Sustainability

Beach Grades

[Documents](#)

[FAQ](#)

Select Grades

Grade Type: ☒ Dry ☐ Wet [\[?\]](#)

By County

Search Beach [Go](#)

Predefined Searches

Sort List By

County	Number of Grades
Alameda:	7
Contra Costa:	3
Del Norte:	0
Humboldt:	5
Los Angeles:	101
Marin:	27
Mendocino:	7
Monterey:	8
Orange:	105
San Diego:	97
San Francisco:	17
San Luis Obispo:	20
San Mateo:	25
Santa Barbara:	21
Santa Cruz:	21
Sonoma:	7
Ventura:	54

Beaches Key:

● A or B Grade

● C Grade

● D or F Grade

⊘ Beach Closed

● ns - no sample [\[?\]](#)

☐ All Beaches

☐ Traffic

☐ Terrain

☐ Satellite

☐ Map

California Beach Report Card

Welcome to the only comprehensive analysis of coastline water quality in California. Each week, over 350 beaches are graded A to F based on bacteria analysis. Check back often for the latest grades...know before you go!

Dry: 309

Wet: 210



● A or B ● C ● D or F

Last updated: 11/5/2008

State Alerts

⊘ 0 Closures

☁ 2 Rain Advisories

[Learn More](#)

State Summary

Heal the Bay analyzed data for 316 locations this grading period. Grades updated on Fridays.

What's New

10/12/2008

[Feedback Survey - Tell us what you think about the new Beach Report Card](#)

9/30/2008

[Action Alert: Beach Monitoring Funds Eliminated - Your Help is Needed!](#)

9/25/2008

[2008 End of Summer Report Released](#)

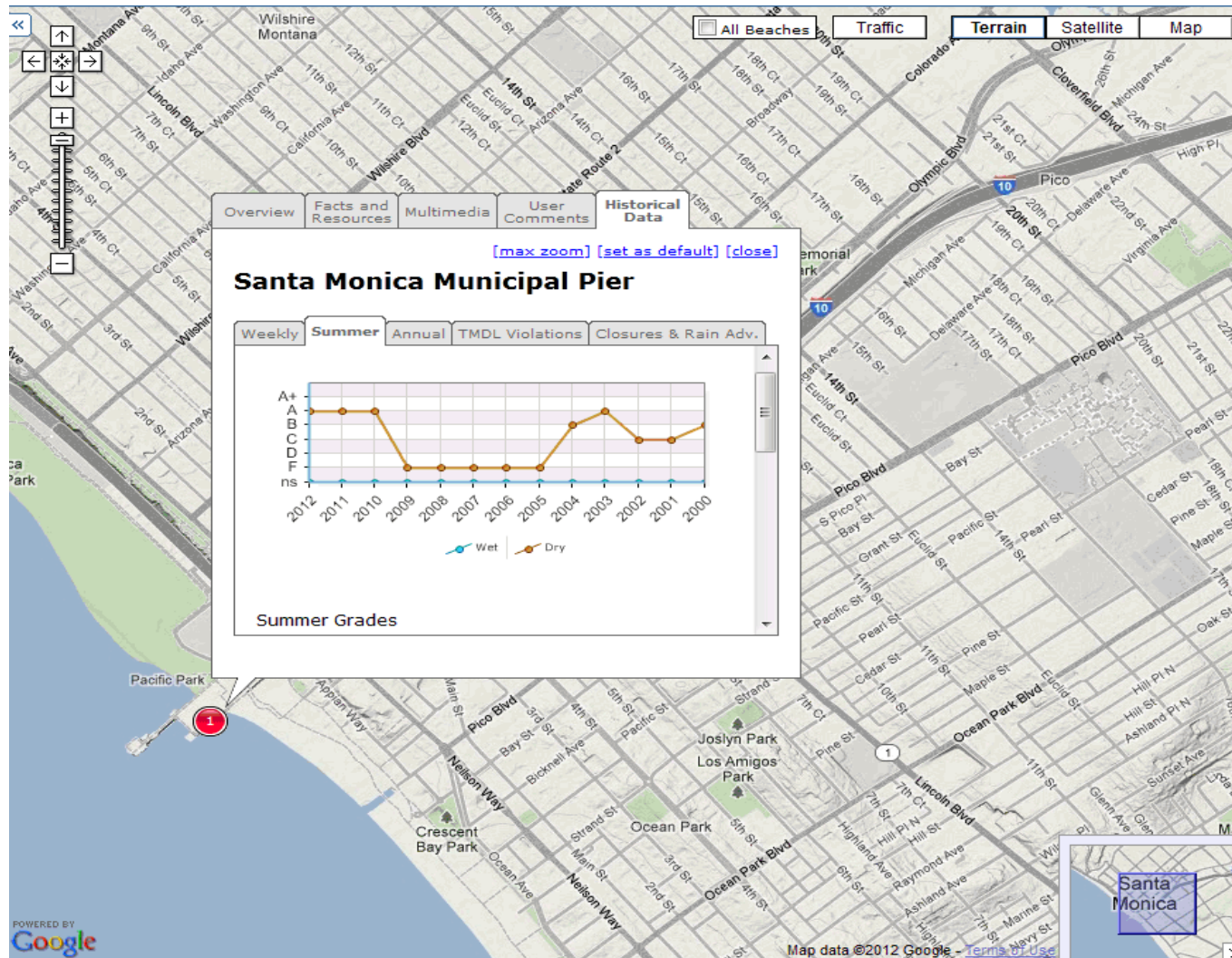
Feedback Survey

Tell us what you think about the new Beach Report Card.

Be Safe at the Beach

How Can I Help?

Santa Monica Pier Water Quality



Ponding Underneath Santa Monica Pier



Broken Stormdrain Under Pier



High Tide – Where the Pond and the Surf Meet



Basin Leak



Basin Leak Pond Under the Pier



Sequence of events

- 2006 HtB simple sanitary survey
- 2007-2008 – SM Pier trash cans are covered. Fish cleaning facilities are tied into sewer. Enforcement against illegal hosing off of pier
- 2009 – Stormdrain and diversion structure are replaced.
- Winter 2010 – Bird netting installed
- After netting installation -2010 – UCLA source tracking study

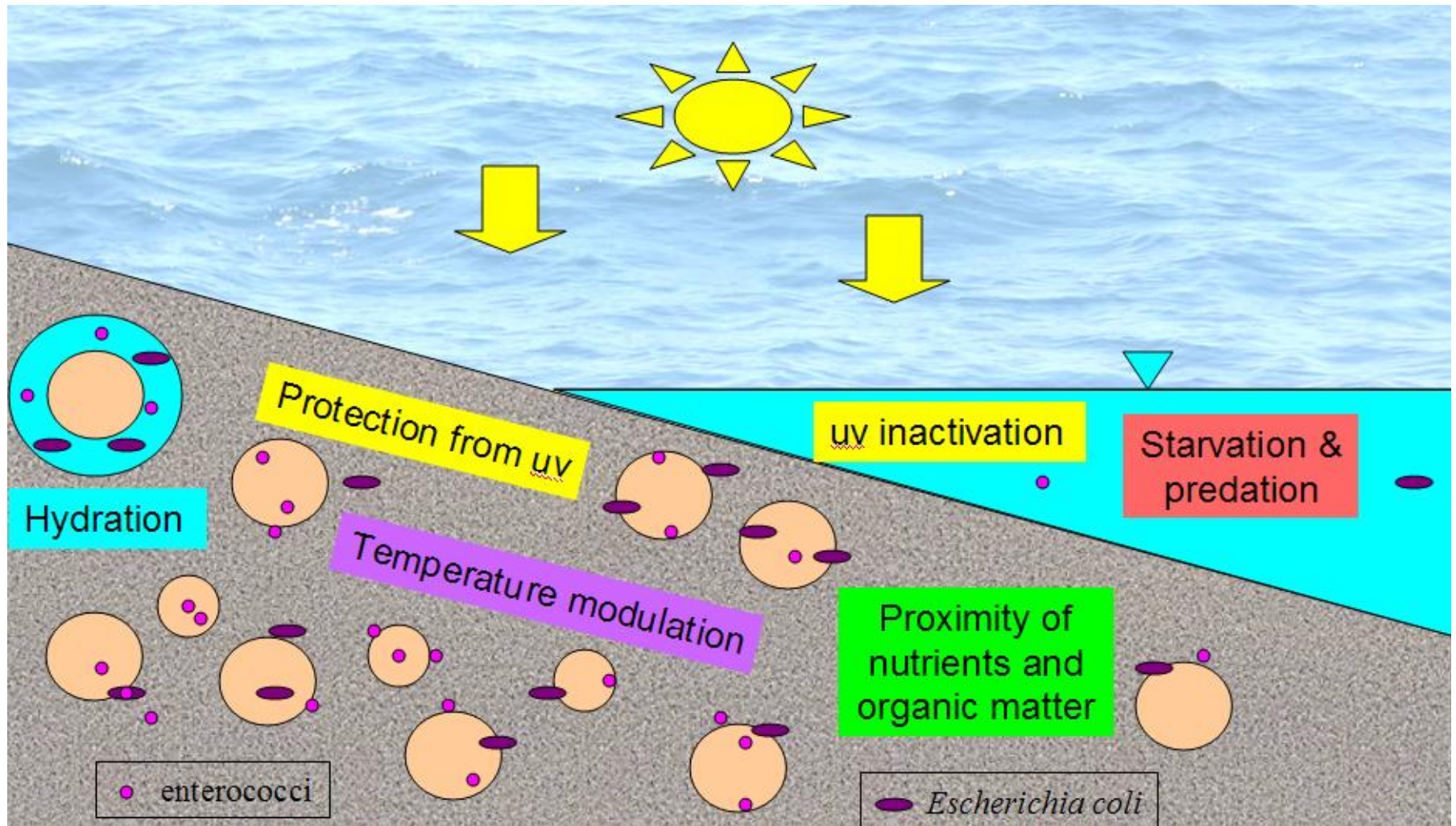
Appendix 1 Map



Outline – UCLA Sanitary survey – Jenny Jay

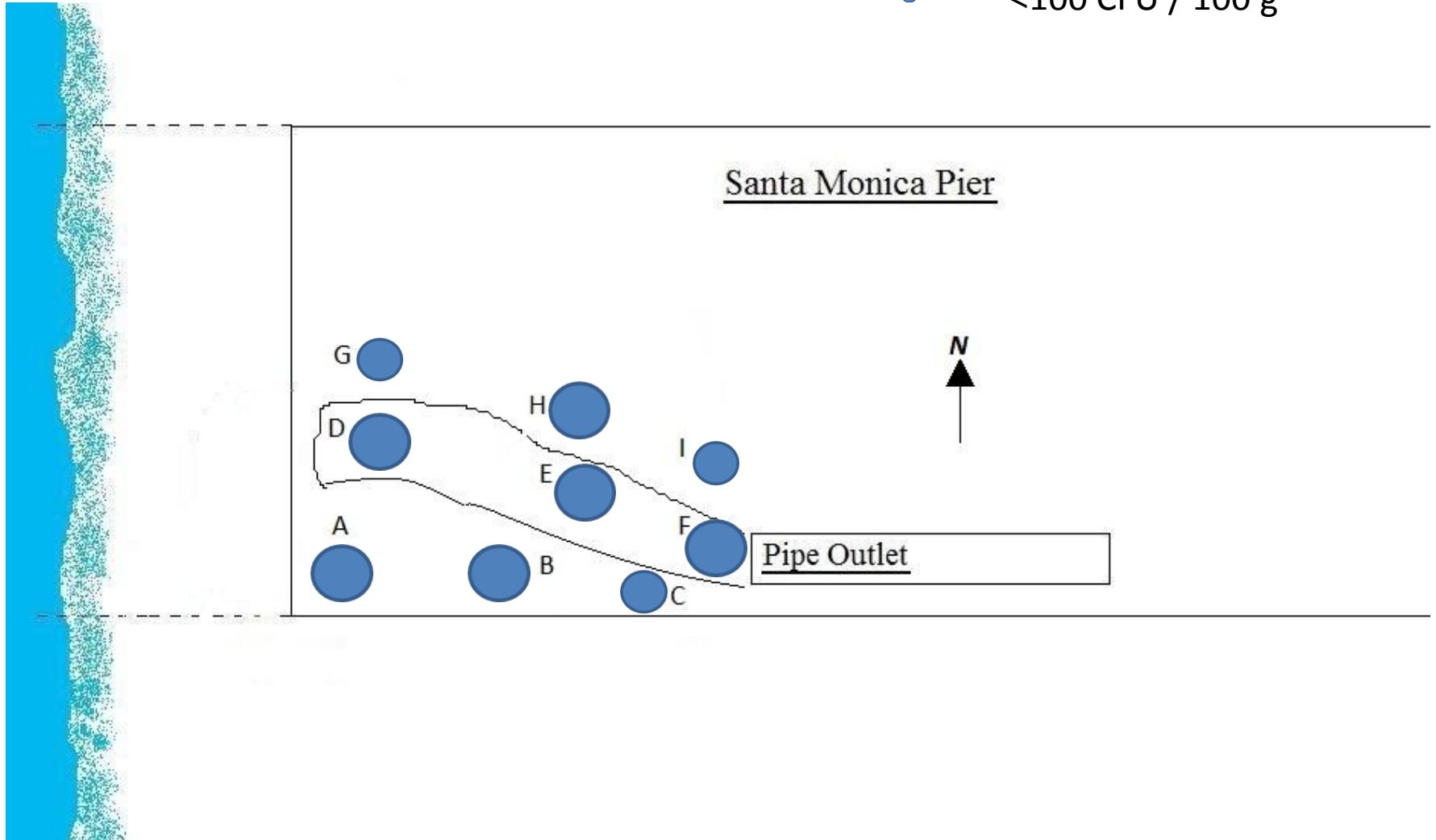
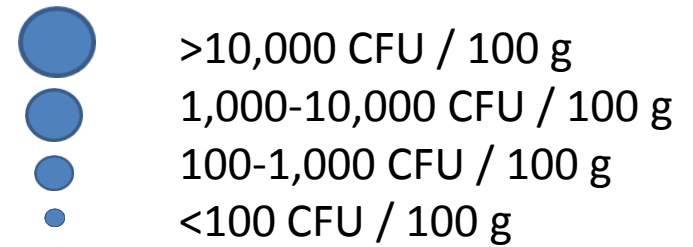
- Spatial FIB surveys (May – November 2010)
 - FIB results
 - FIB / moisture content results
- Moisture microcosm (April – October 2011)
 - May (10% - 20% moisture)
 - FIB
 - General Bacteroidales
 - October (0.1% - 14% moisture)
 - FIB
 - General Bacteroidales
- Source-specific snapshot study (November 2011)

Importance of Sand...



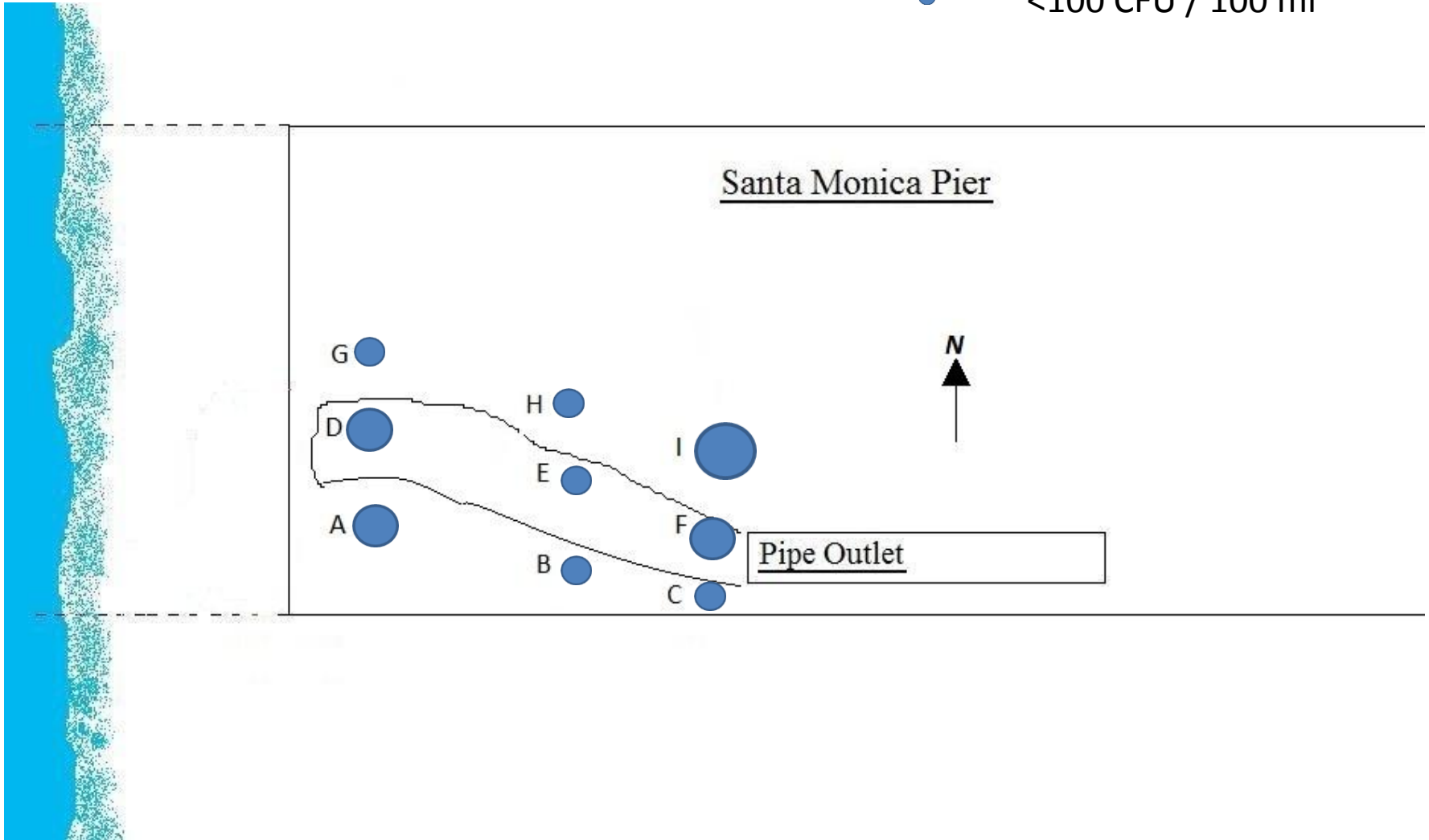
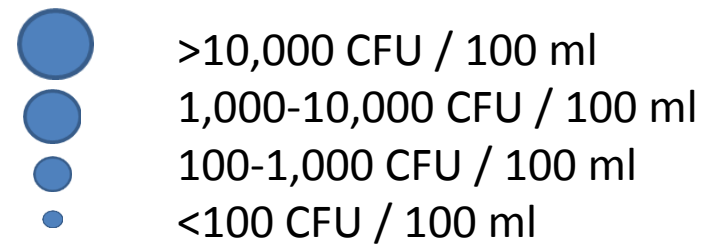
Health standards exceeded due to fecal pollution or FIB regrowth in sand?

Spring Survey 3: enterococci in sand



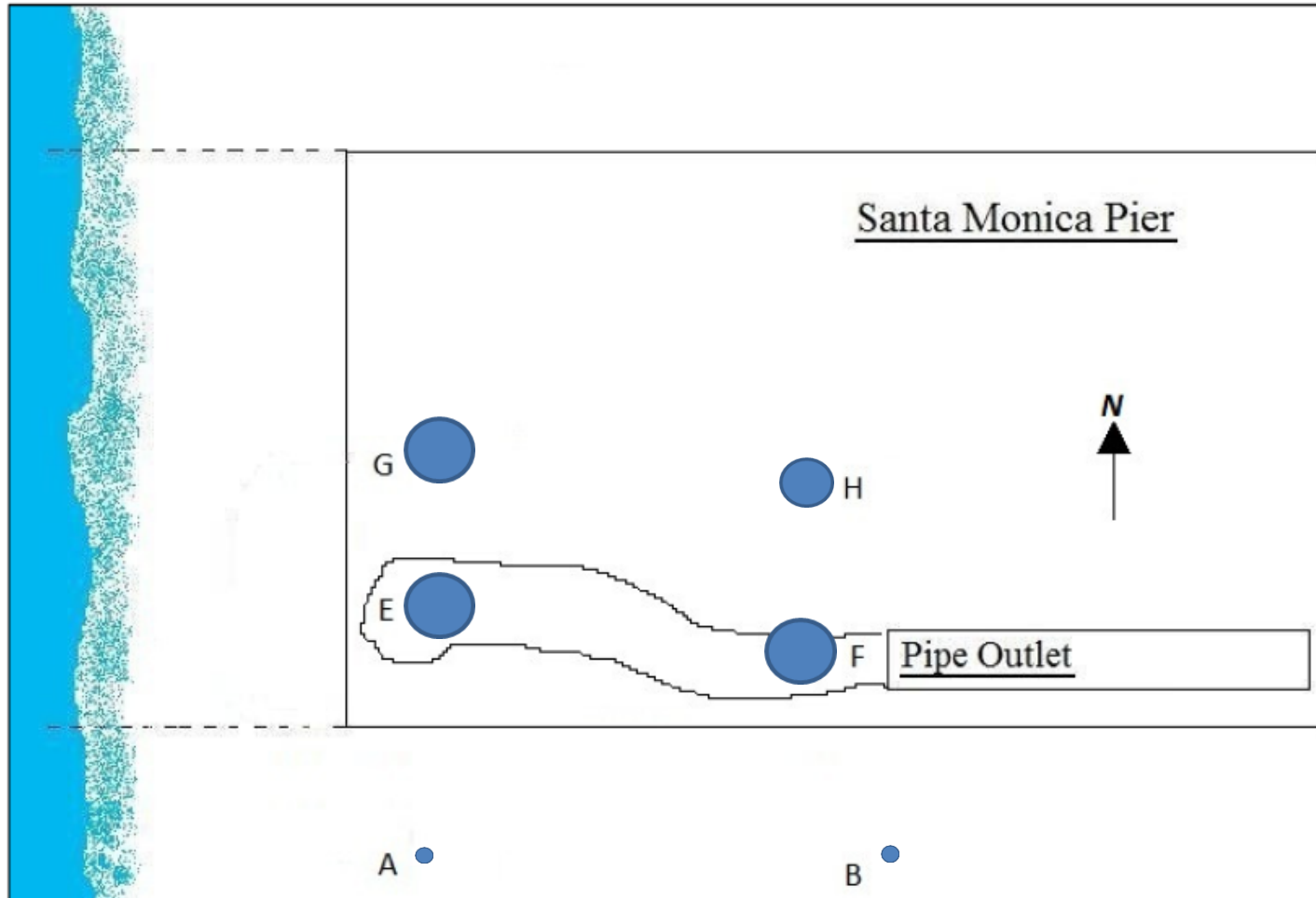
Enterococci concentrations were not significantly higher within the channel than without (unpaired t-test, $p > 0.05$).

Spring Survey 3: enterococci in water



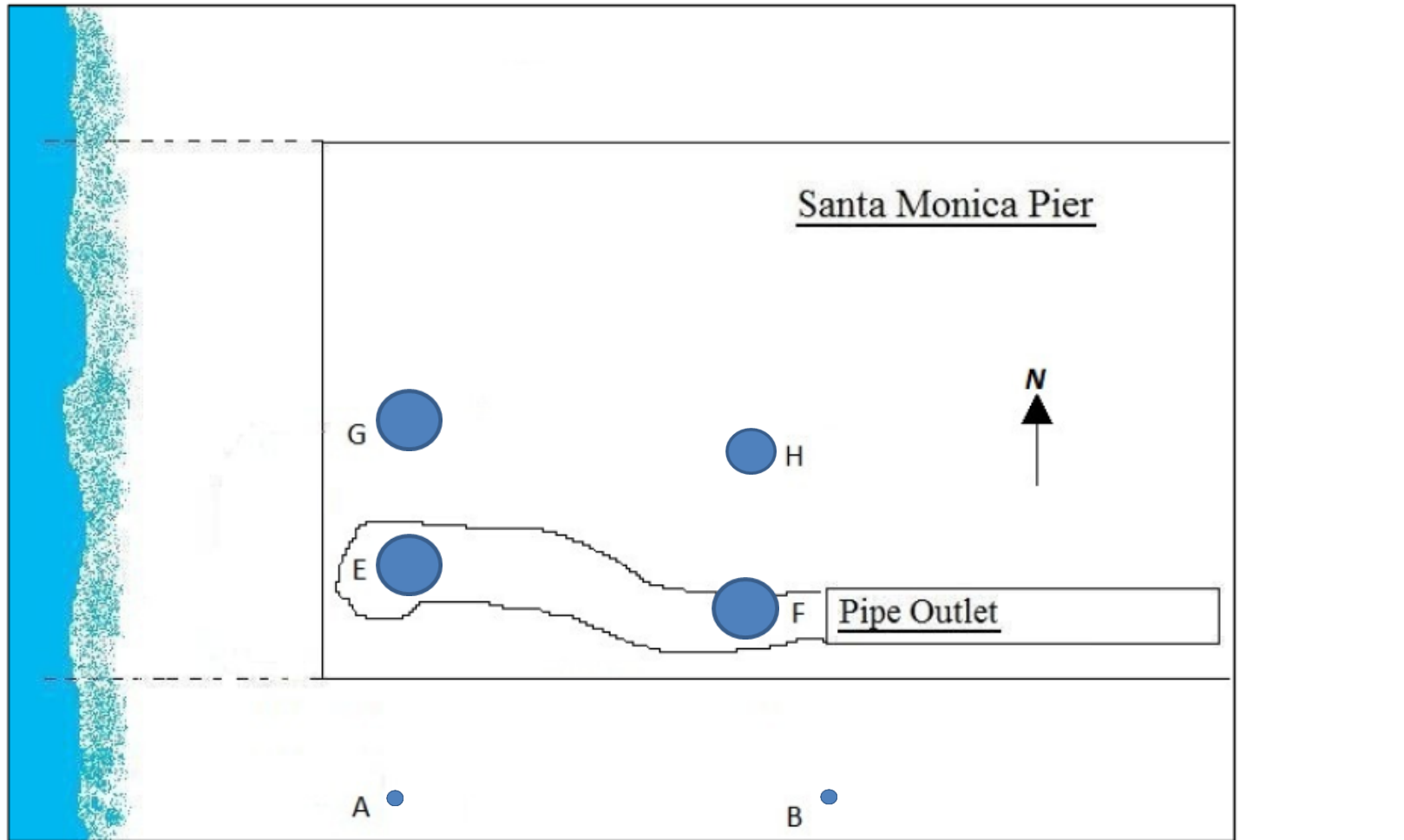
Water in channel generally higher in channel than outside, with the exception of site I. Site I had highest levels measured this day.

Summer Survey 1: enterococci in sand



According to unpaired t-test, concentrations of FIB under the pier were significantly higher than those outside of the pier for both sediment and groundwater. Accordingly, next set of samples focused on area under the pier.

Summer Survey 1: enterococci in water

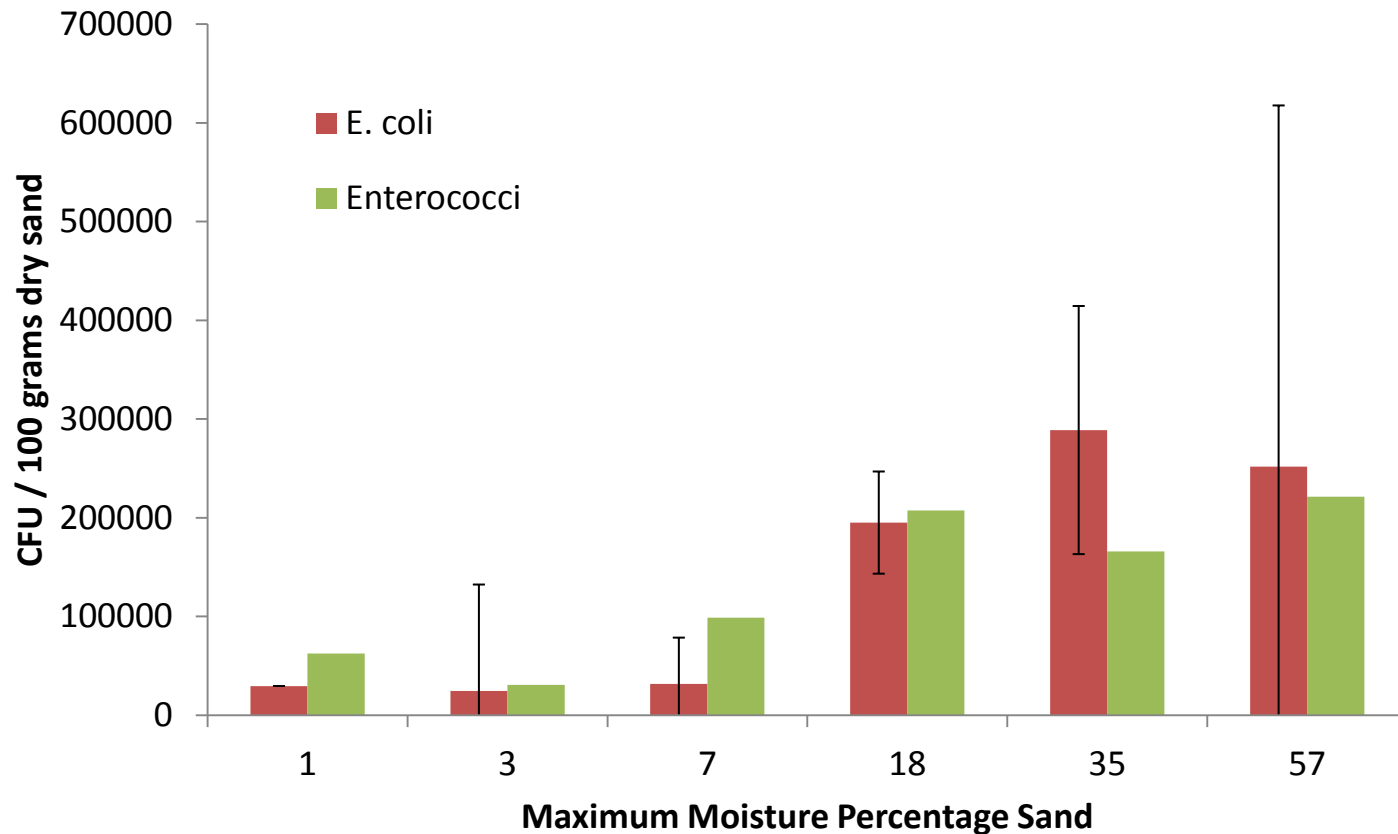


According to unpaired t-test, concentrations of FIB under the pier were significantly higher than those outside of the pier for both sediment and groundwater. Accordingly, next set of samples focused on area under the pier.

Outline

- Spatial surveys (May – November 2010)
 - FIB results
 - FIB / moisture content results
- Moisture microcosms (April – October 2011)
 - May (10% - 20% moisture)
 - FIB
 - General Bacteroidales
 - October (0.1% - 14% moisture)
 - FIB
 - General Bacteroidales
- Source-specific snapshot study (November 2011)

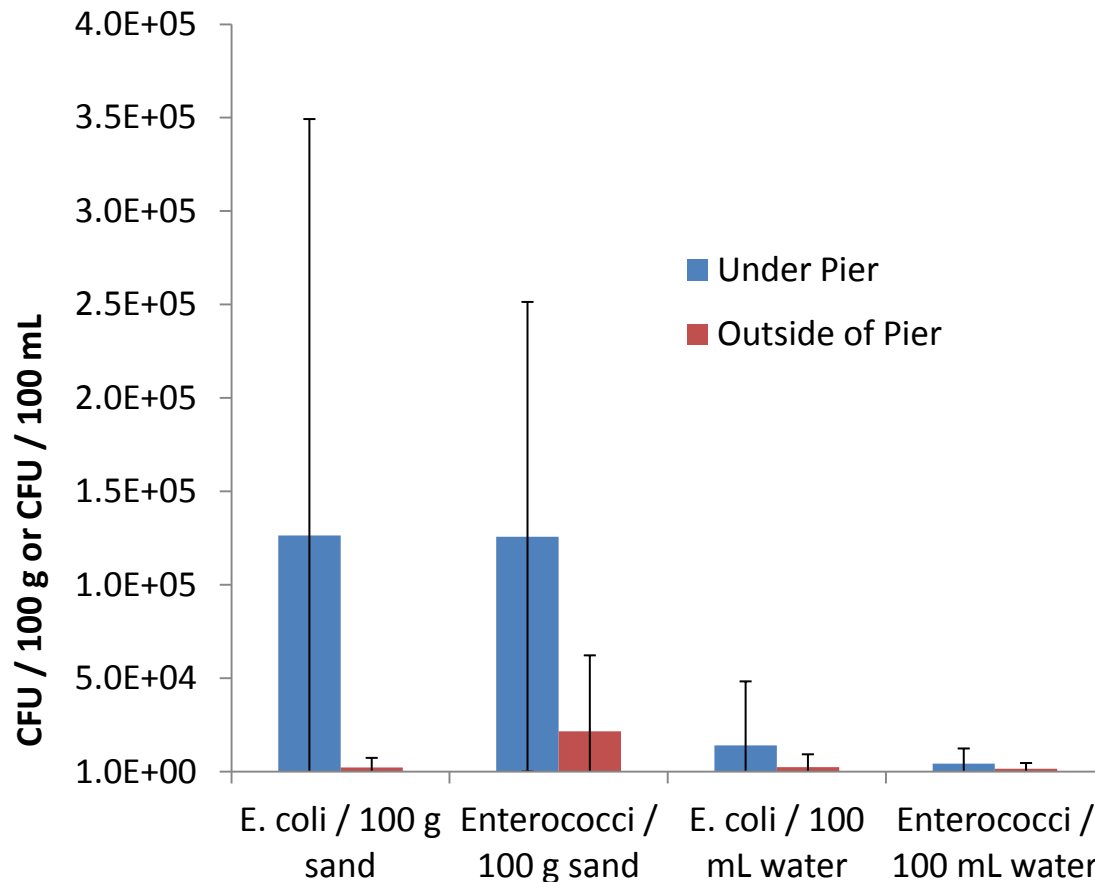
FIB Concentrations Binned by Sand Moisture Content



Moisture Percentage Range <1%, 1-3%, 3-7%, 7-18%, 18-35%, 35-57%

A bar chart of the FIB levels in sand after being grouped by moisture content of the sand shows a trend of generally lower levels of FIB in drier sediment. The large error bars also demonstrate the variability of FIB levels in sediment, particularly in the wettest sediment.

Sand/Water grouped by Location



Values were higher under the pier than outside the pier for both *E. coli* and enterococci in sand and water. Enterococci levels were higher outside the pier than *E. coli* levels, and present at similar levels under the pier.

Spatial Sampling Summary

Since we saw:

- Generally higher levels under the pier than outside it and inside the channel than outside
- Generally higher levels of FIB in sand with greater moisture contents

We decided to:

- Explore the effects on FIB concentrations of maintaining varied moisture contents in sand collected from various locations under the pier.

Outline

- Spatial surveys (May – November 2010)
 - FIB results
 - FIB / moisture content results
- Moisture microcosms (April – October 2011)
 - May (10% - 20% moisture)
 - FIB
 - General Bacteroidales
 - October (0.1% - 14% moisture)
 - FIB
 - General Bacteroidales
- Source-specific snapshot study (November 2011)

Sources of Fecal Contamination

Local Wildlife



Sewage Spills



Septic Tanks/ Lagoons



Swimmers

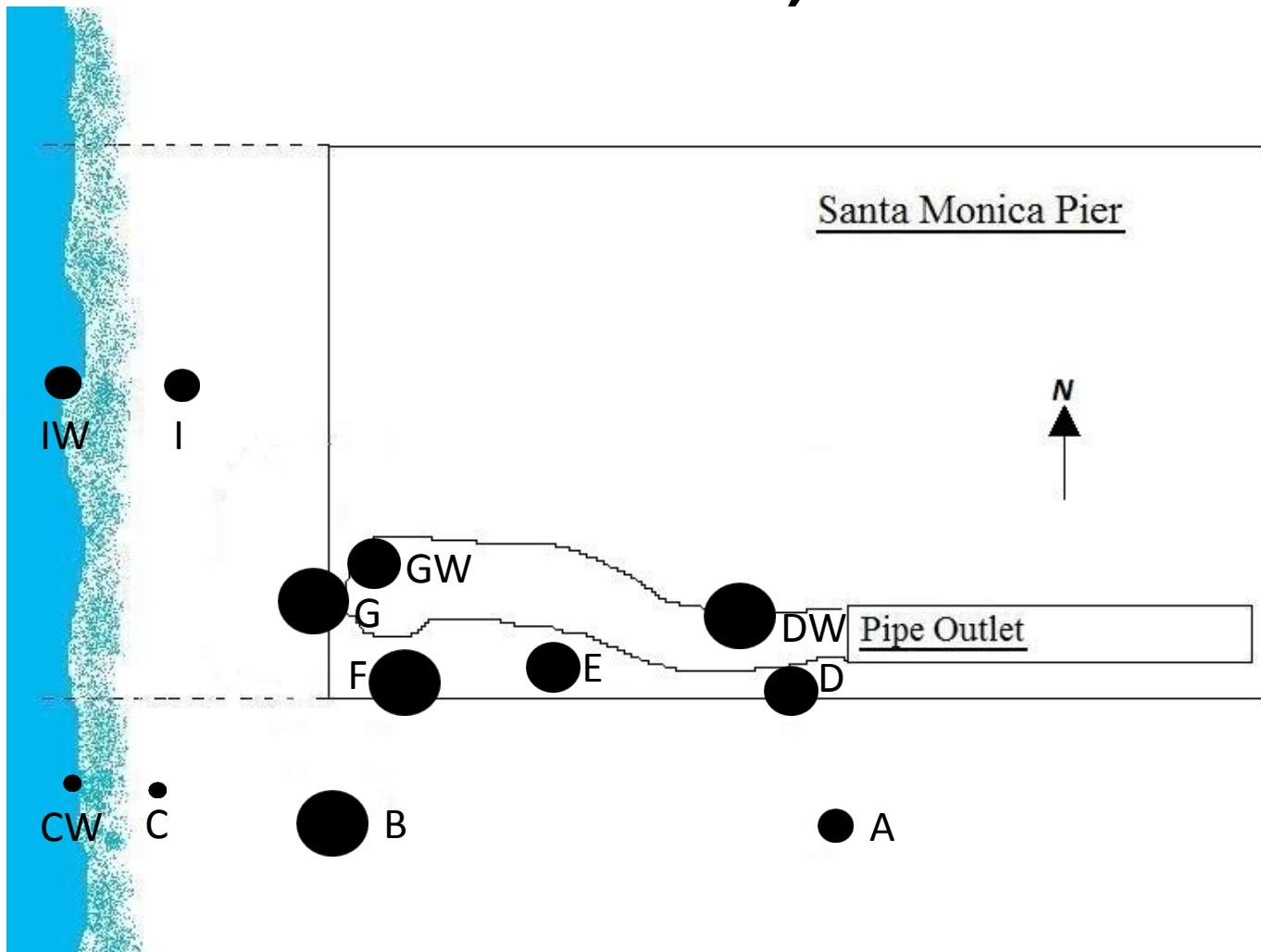


Storm Drain Discharges

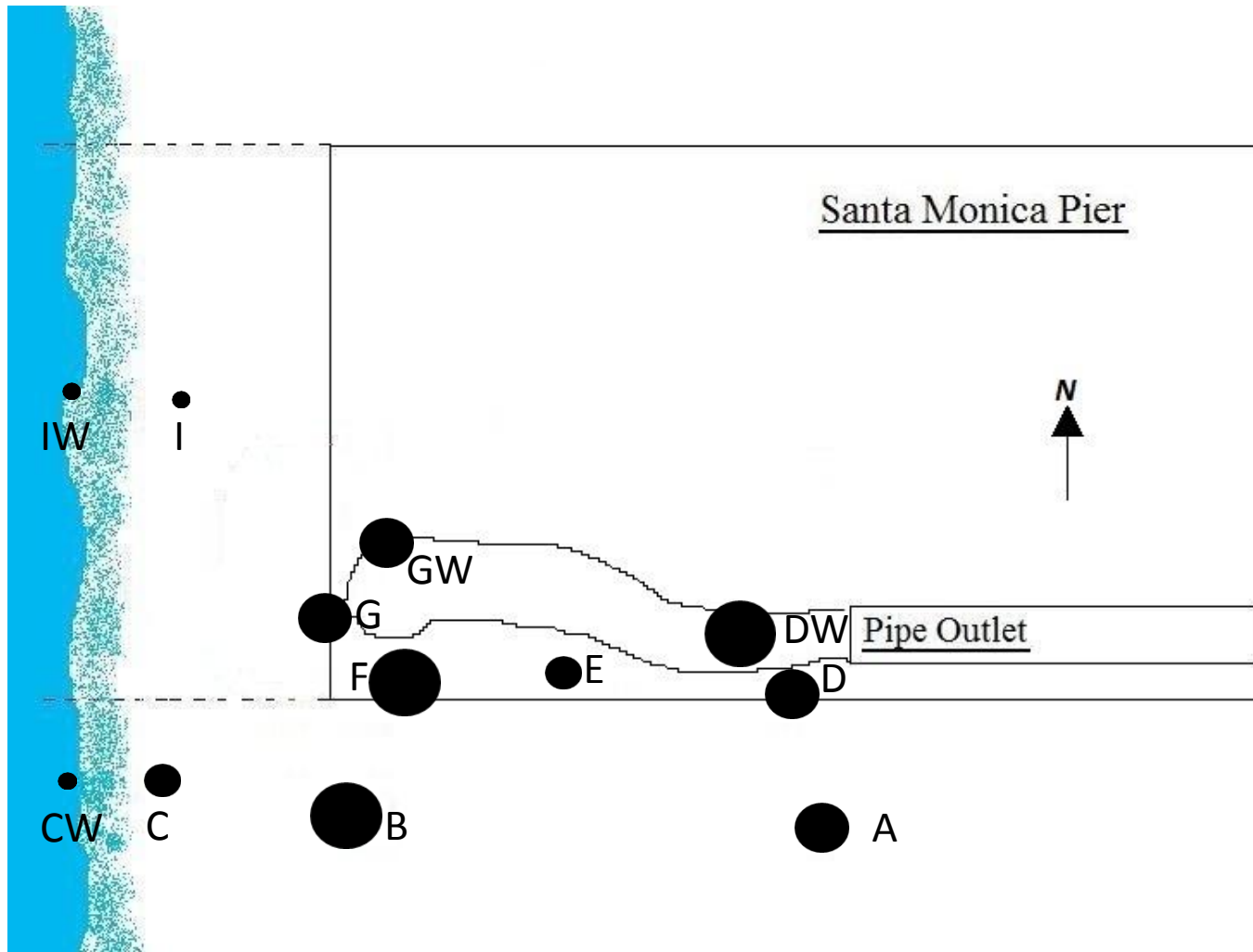
Source-Specific qPCR Assays

- Human fecal marker assay 1: Taq HF183 (Haugland 2010)
 - Associated with species *Bacteroides dorei*
 - Detected in 40% of non-human host (chicken and dog) but at levels an order of magnitude lower than in human host
- Human fecal marker assay 2: HumM2 (Shanks 2009)
 - Demonstrated 99.2% specificity when tested against 265 fecal DNA extracts from 22 different animal species (2 false positives with chicken feces)
 - Detected human fecal markers in all samples of human feces and effluent tested
- Gull / Pelican fecal marker assay (Lu 2008)
 - Detects *Catelliboccus marimammalium*, a bacterial species found in feces of gulls (tested on samples from California, Georgia, Ohio, Wisconsin, and Toronto, Canada) and pelicans

E. coli results, Nov 30 2011



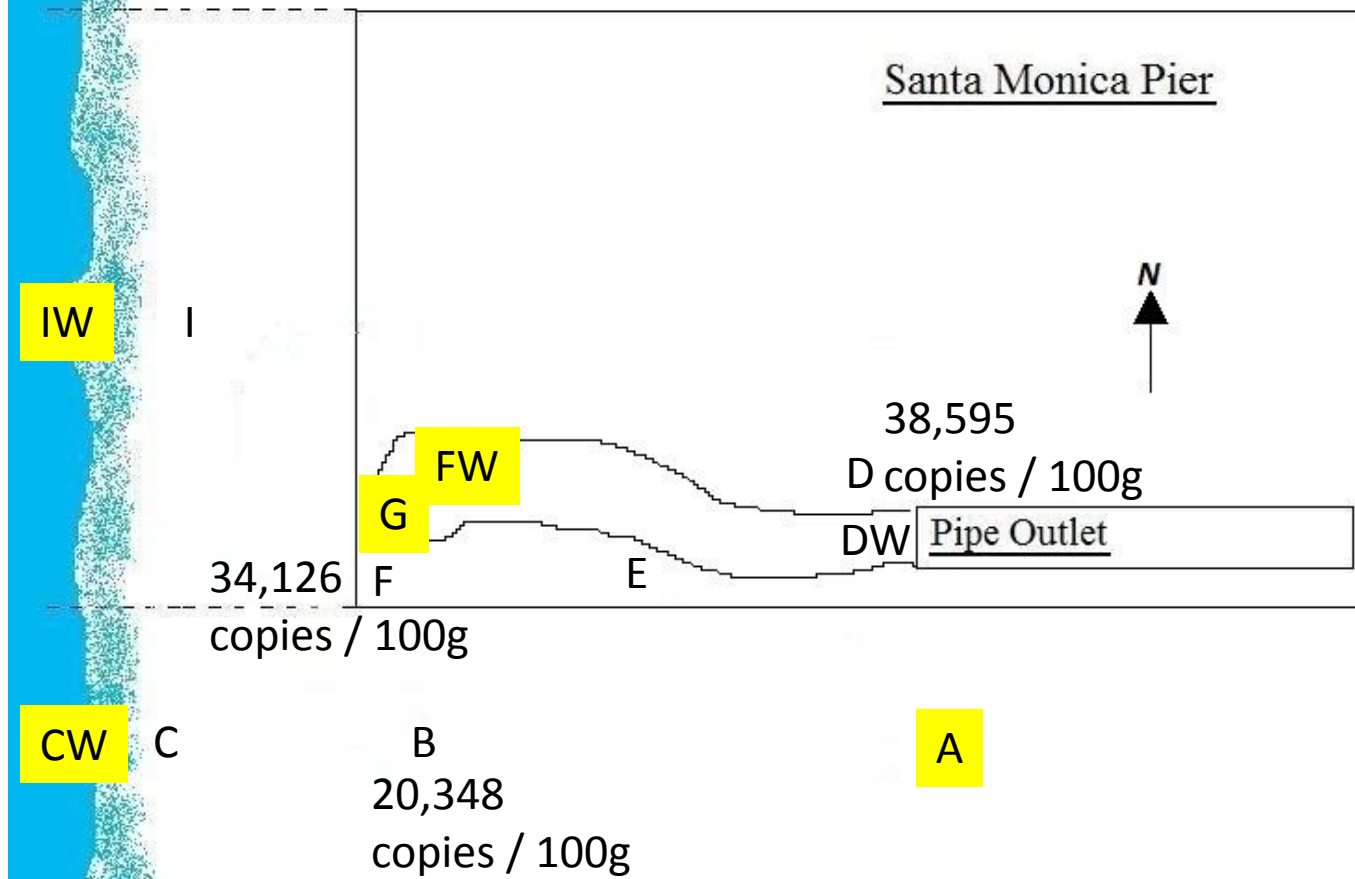
Enterococci results, Nov 30 2011



Human qPCR assay results

- TaqHF183 – human markers below detection limit at all sample locations.
- Human assay (Hum M2) - human markers below detection limit at all sample locations.

Gull/Pelican qPCR results, Nov 30 2011

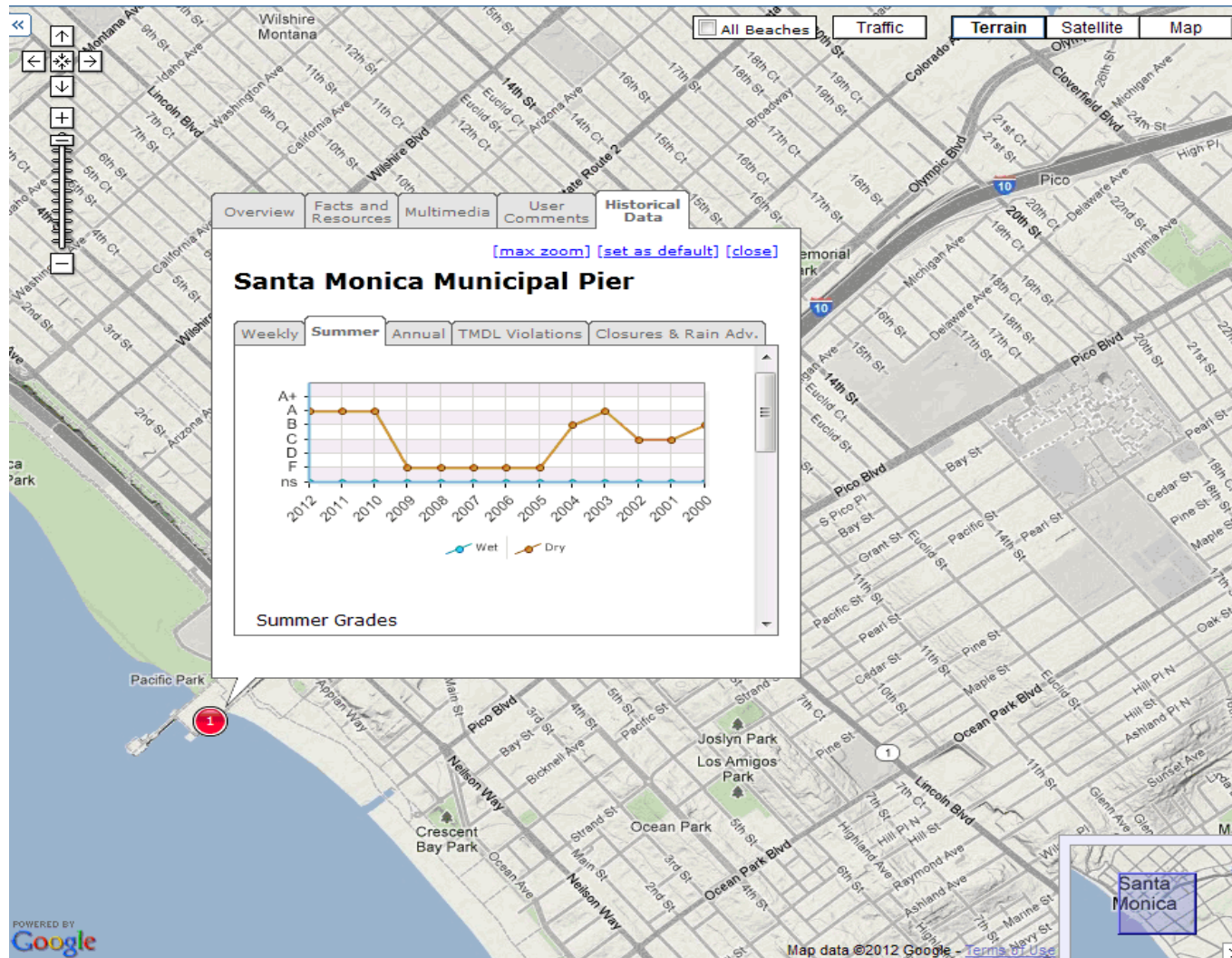


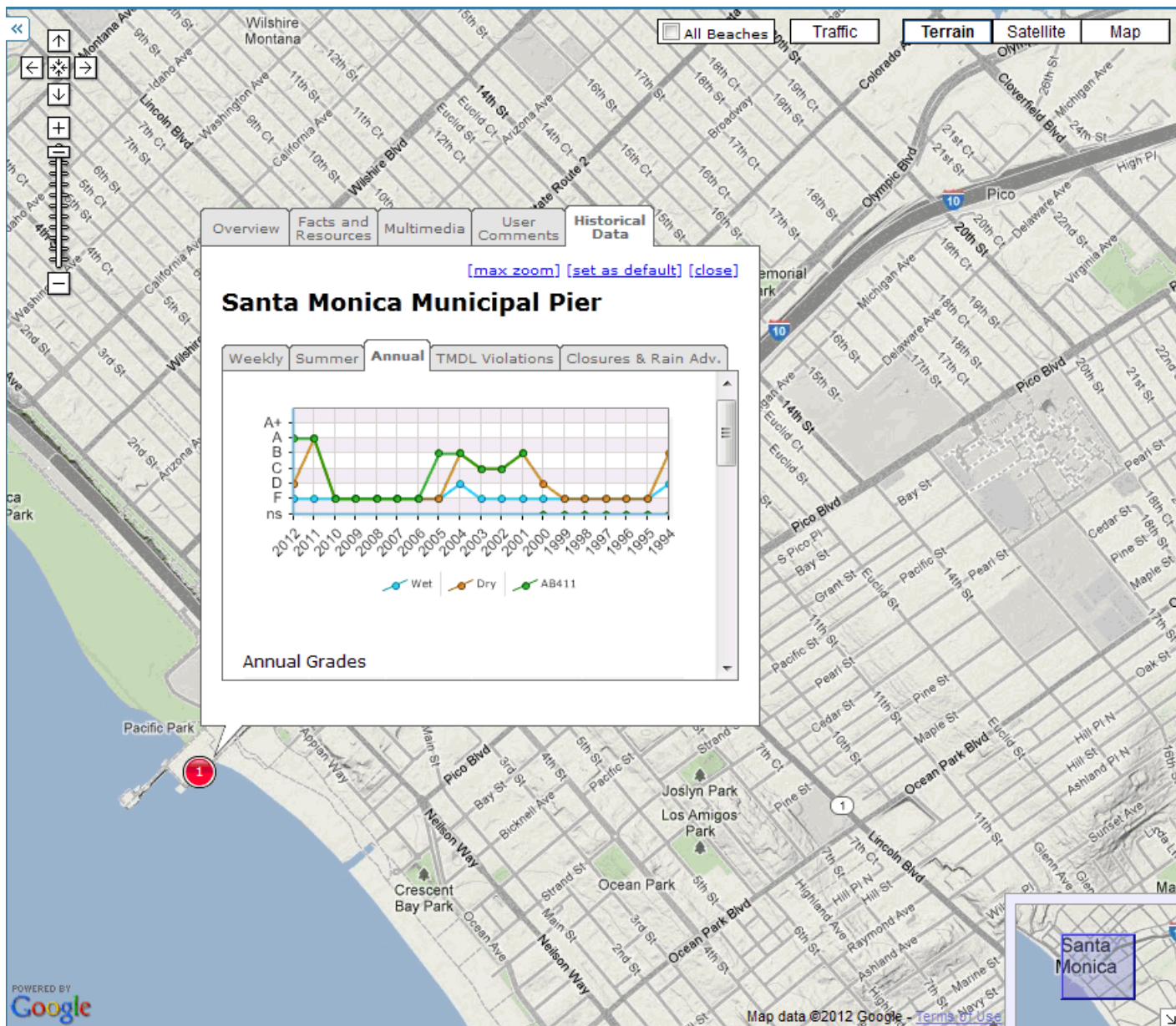
Despite significant inhibition with the qPCR reaction, the presence of gull feces was detectable at 3 locations (F, B, and D). Due to the presence of inhibition, negative results do not necessarily mean there was no gull feces. Interestingly, sample location B, with high levels of FIB in sand outside of the pier had detectable gull. As human markers were not detectable here using Taq HF183, this points to gull as potential FIB source. Highlighted IDs had detections but they were below level of quantification (BLOQ).

Conclusion

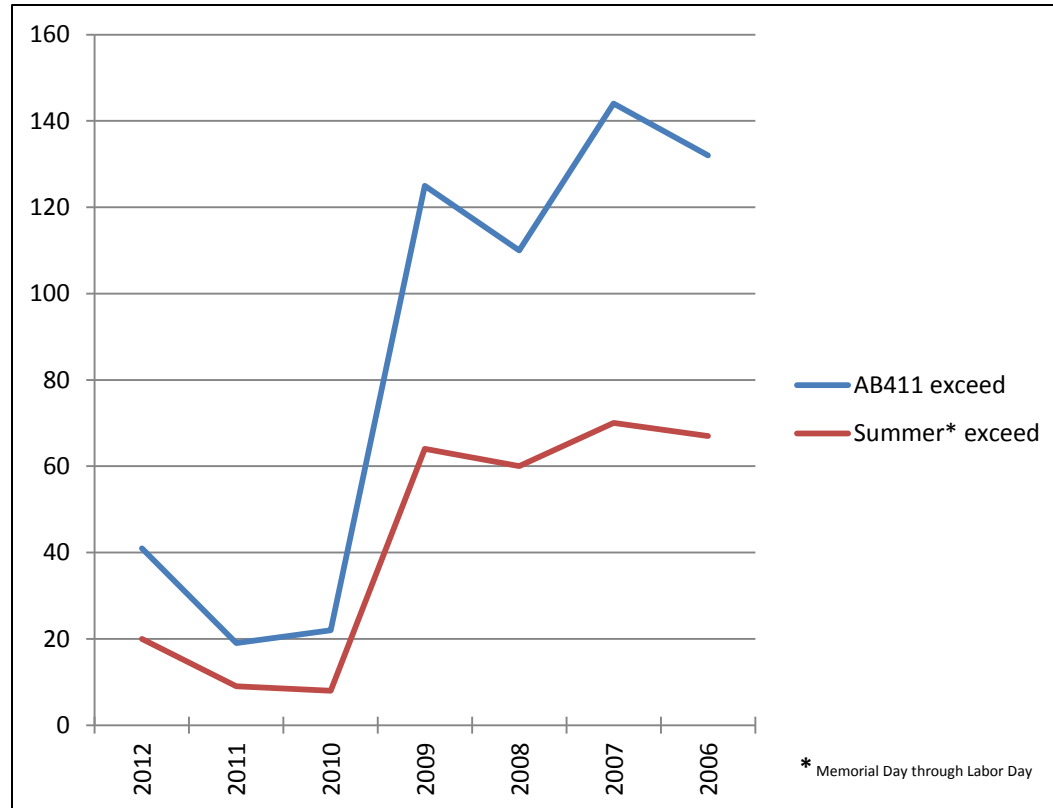
- Due to shading, moisture, or wetting/drying FIB levels under the Pier tend to be higher than outside of the pier in both sand and water.
- In one microcosm experiment, high levels (20%) of moisture decrease survival relative to 10%. However, another experiment with drier sand at lower moisture showed high persistence at low moisture levels.
Hypotheses: 1) Biofilms in sand under the pier protect FIB from dessication. 2) FIB communities under the pier are tolerant to dry sand.
- No genetic markers for human feces were detectable in samples under and next to the pier. However, genetic markers for gull feces were found.

Santa Monica Pier Water Quality





Santa Monica Pier Exceedance Counts 2006-2012



When to Use the Natural Source Exclusion



Only After Elimination of All Human Influenced Sources

- Dry weather flow from stormdrain – diverted
- Elimination of ponded runoff and sea water from high tide in scour pond
- Pigeons roosting under the pier
- Trash cans
- Illegal wash off
- Leaks
- Microbial demonstration of no human sources

When NOT to Use the Natural Source Exclusion



Questions?

