

Understanding The Now: Efforts to Reduce Indicator Bacteria Concentrations

PRESENTED BY

Brandon Steets, PE
Geosyntec Consultants

ADDITIONAL SUPPORT BY

Jared Ervin, PhD
Geosyntec Consultants

Geosyntec 
consultants




Presentation Outline

- Sources and Migration Pathways
- Efforts to Reduce Fecal Indicator Bacteria (FIB)
 - In dry weather
 - In wet weather
- Outcomes
- Conclusions and Takeaways


Sources and Migration Pathways

FIB Sources & Categorization Framework




Common Human Waste Sources

- Sanitary Sewer Overflows (SSOs)
- Leaky Sewer Pipes (Exfiltration)
- Illicit Connections to MS4
- Leaky or Failing Septic Systems
- Porta-Potties
- Bathers and Open Defecation
- Boats and RVs
- Dumpsters and Trash Cans
- Garbage Trucks
- Illegal Dumping
- Illegal Discharges
- Gray Water Discharges



Common Non-Human Sources Related to Human Activities

- Pets (Dogs, Cats, etc.)
- Livestock (Horses, Cows, etc.)
- Rodents (Mice, Rats, etc.)
- Dumpsters and Trash Cans
- Garbage Trucks
- Animal Manure/Compost
- Washwater
- Green Waste
- Litter
- Grease Bins/Traps
- Irrigation Runoff



Common Non-Human Sources Independent of Human Activity

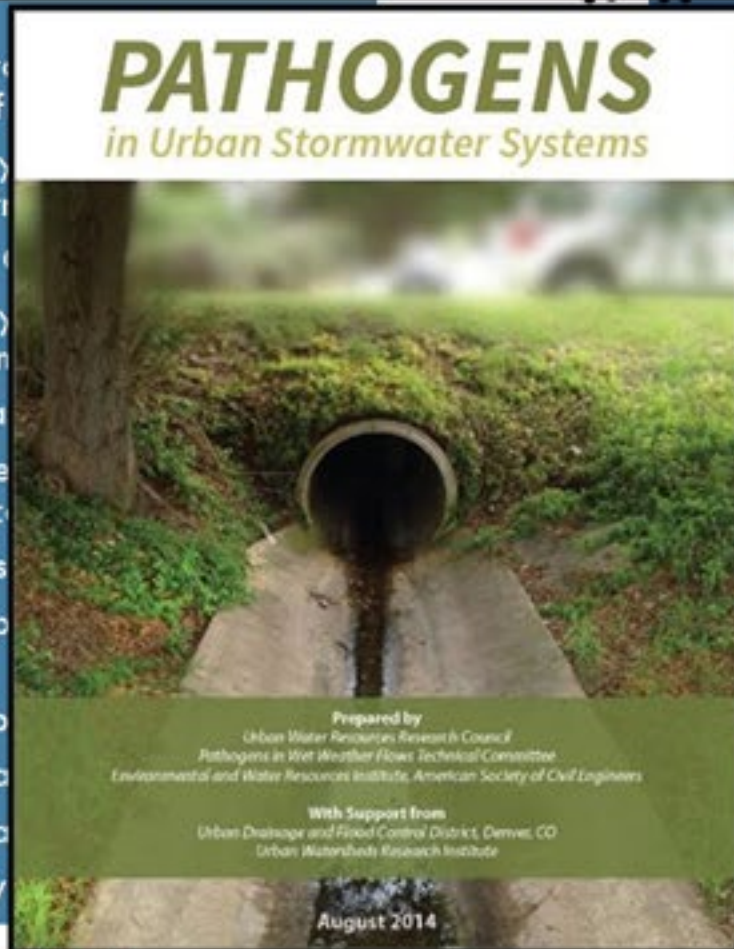
- Birds (Geese, Gulls, Pigeons, etc.)
- Wildlife (Raccoons, Birds, Deer, Coyote, etc.)
- Non-Fecal Sources:
 - Decaying Plants
 - Algae and Biofilms
 - Soil/Sediment

FIB Sources & Categorization Framework

For further discussion of sources & categorization framework, see available nationwide guidance:

Common Human Waste Sources

- Sanitary Overflows
- Leaky (Exfiltration)
- Illicit Connections
- Leaky Sewer Systems
- Portable Toilets
- Bathing and Defecation
- Boats
- Dumpsters
- Garbage
- Illegal Dumping
- Gray Water

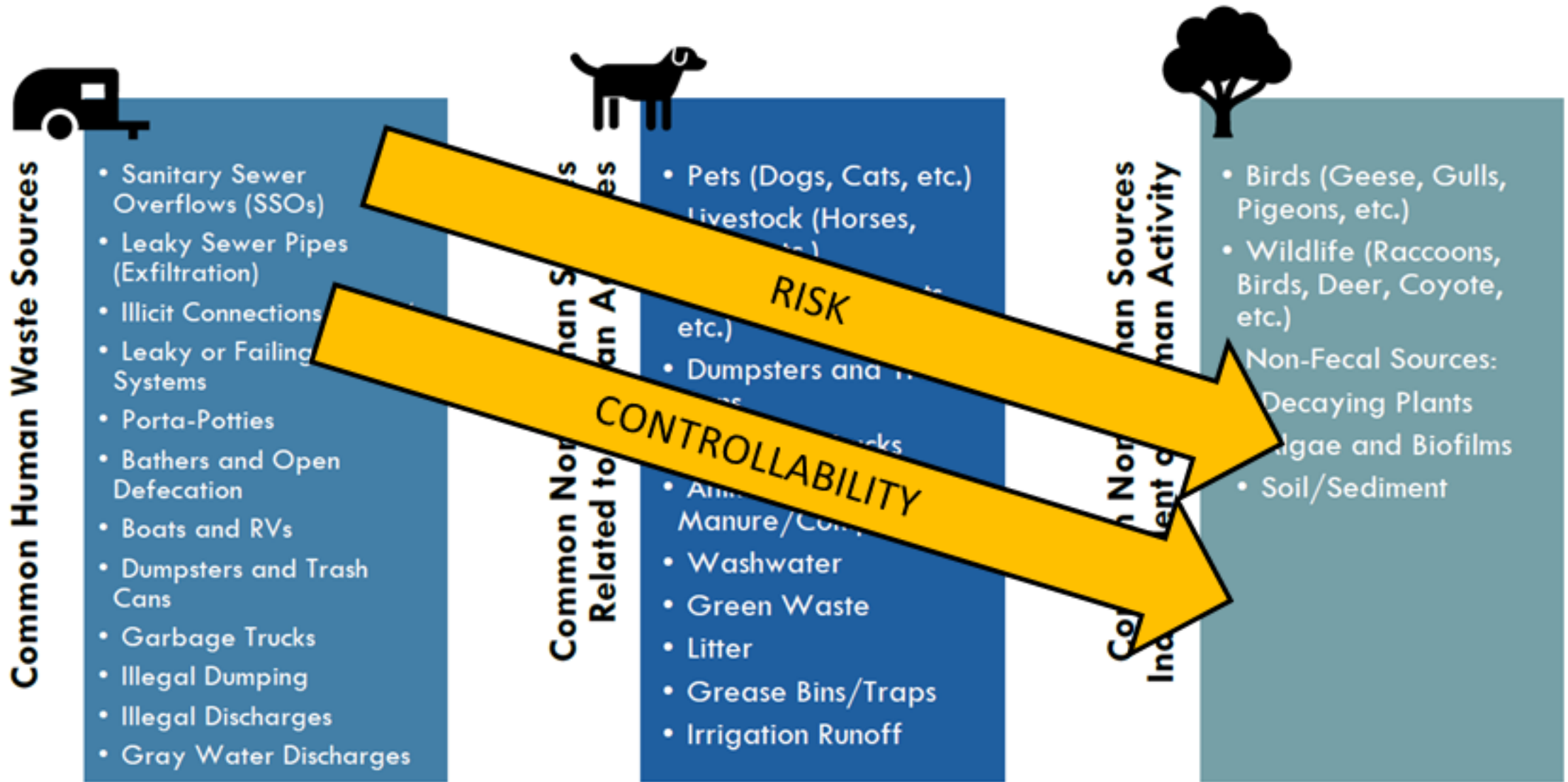


Colorado *E. coli* Toolbox: A Practical Guide for Colorado MS4s



- Birds (Geese, Gulls, Loons, etc.)
- Wildlife (Raccoons, Squirrels, Deer, Coyote, etc.)
- Non-Fecal Sources:
 - Decaying Plants
 - Algae and Biofilms
 - Soil/Sediment

FIB Sources & Categorization Framework

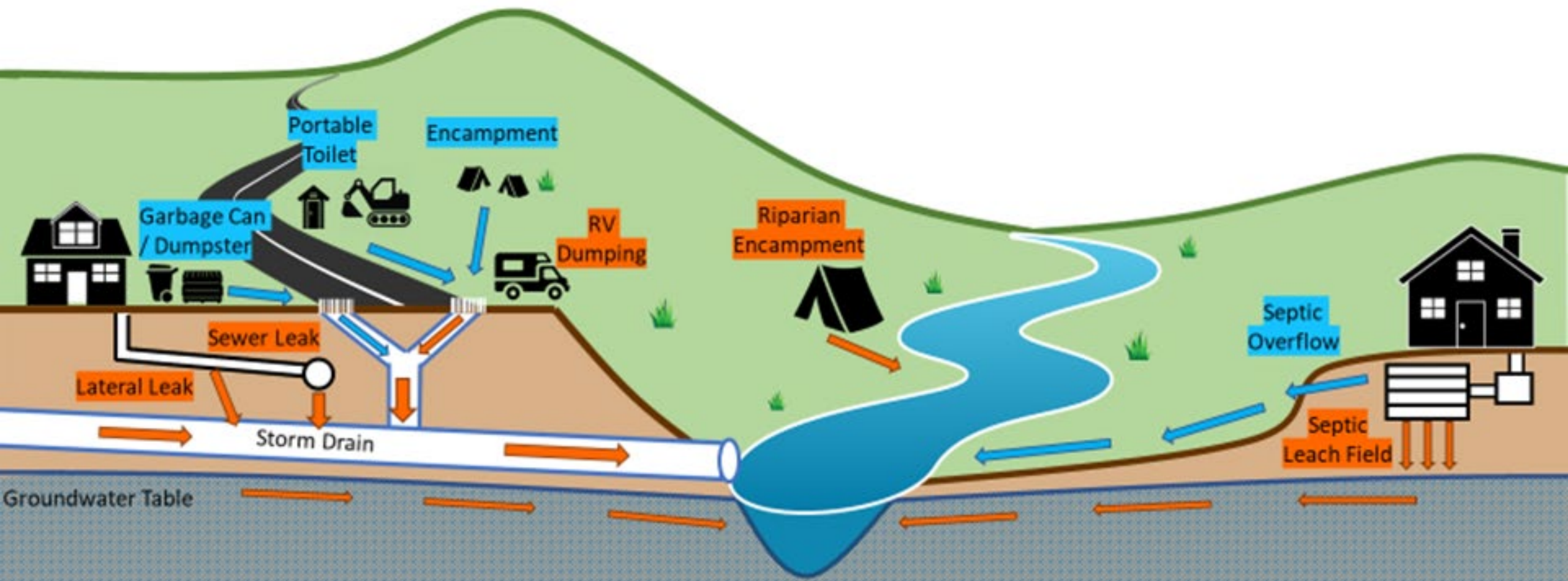


Conceptual site model of typical dry and wet weather human waste sources and their migration pathways

Legend

Source contributes during wet and dry weather

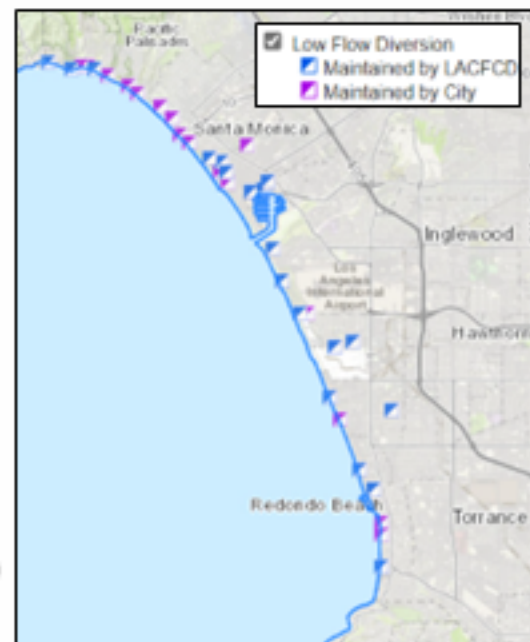
Source contributes during wet weather only



Efforts to Reduce FIB

Low Flow Diversions (LFDs) to Sanitary Sewer

- Dry weather strategy
- Numerous examples across coastal Southern California (e.g., Santa Monica Bay Beaches)
- Benefits (dry weather only)
 - Achieves MS4 compliance (by preventing discharge)
 - May improve receiving water quality (multi-pollutant)
 - May improve health risk (where waste sources diverted)
- Limitations
 - High cost per diversion (up to \$1M+)
 - Not feasible everywhere (e.g., no nearby sewer, sewer owner restrictions, easement challenges, no power access)
 - Minimal wet weather benefit (even disincentivizes IDDE so waste sources persist in wet weather)
 - Environmental impact (e.g., power, prevents natural flows)



Low Flow Treatment (e.g., UV disinfection)

- Dry weather strategy
- Numerous examples across coastal Southern California (e.g., Santa Barbara, Orange, and SD Counties)
- Benefits (dry weather only)
 - Achieves MS4 compliance (by meeting concentration limits)
 - May improve receiving water quality (multi-pollutant)
 - May improve health risk (where pathogens sterilized)
- Limitations
 - High cost per system (often \$1M+)
 - Requires pretreatment to remove solids and organics
 - Not feasible everywhere (e.g., easement challenges, no power access, vandalism risks)
 - Minimal wet weather benefit (even disincentivizes IDDE so waste sources persist in wet weather)
 - Environmental impact (e.g., power, sterilizes natural fauna)

Stormwater Capture and Green Infrastructure (GI)

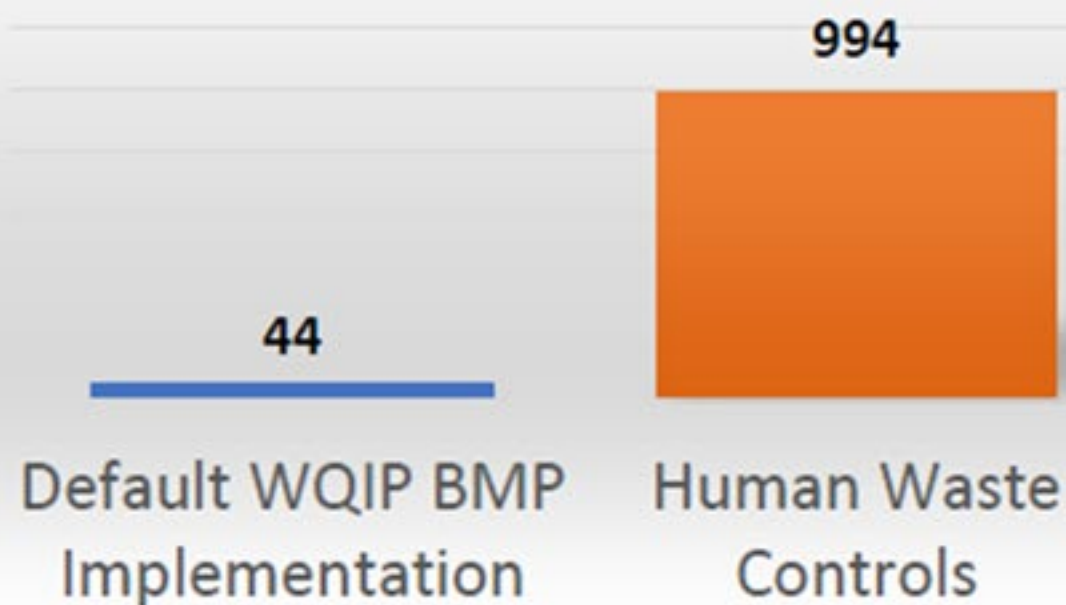
- Mostly wet weather strategy
- Numerous examples across Southern California (especially LA, SD)
- Benefits
 - Achieves *interim* wet weather compliance through Reasonable Assurance Analysis (RAA) modeling
 - Projects often multi-benefit and/or sited in disadvantaged communities
- Limitations
 - High cost (>\$15B in LA/SD regions) is beyond available funding
 - Reduces volumes and loads but possibly not FIB concentrations, so unknown if it will actually achieve FIB objectives in receiving waters
 - Not currently designed for human waste/pathogen reduction, e.g.,
 - Green streets often designed for surface runoff capture, missing belowground waste inputs
 - Siting based on opportunity and maximizing volume capture (or FIB load), not maximizing *pathogen* capture

Human Waste Control Strategy

- Dry and wet weather strategy
- Examples: South OC (dry and wet), SD County (dry only)
- Benefits
 - Controls pollutants at the source (typically preferred strategy for stormwater)
 - May improve receiving water quality (multi-pollutant)
 - Designed to reduce health risk (by reducing pathogen loading)
 - Lower cost than structural controls – greater illness risk reduction per dollar
- Limitations
 - Often does not reduce FIB significantly, so compliance outcome is less certain
 - May require regulatory modification (Basin Plans, TMDLs), otherwise structural controls may still be needed
 - Intermittent human waste sources may be infeasible to identify and abate

Premise for Human Waste Control Strategy

Avoided Infectious Illnesses per 1 Million Dollars Invested



Implementation Costs (Million \$)

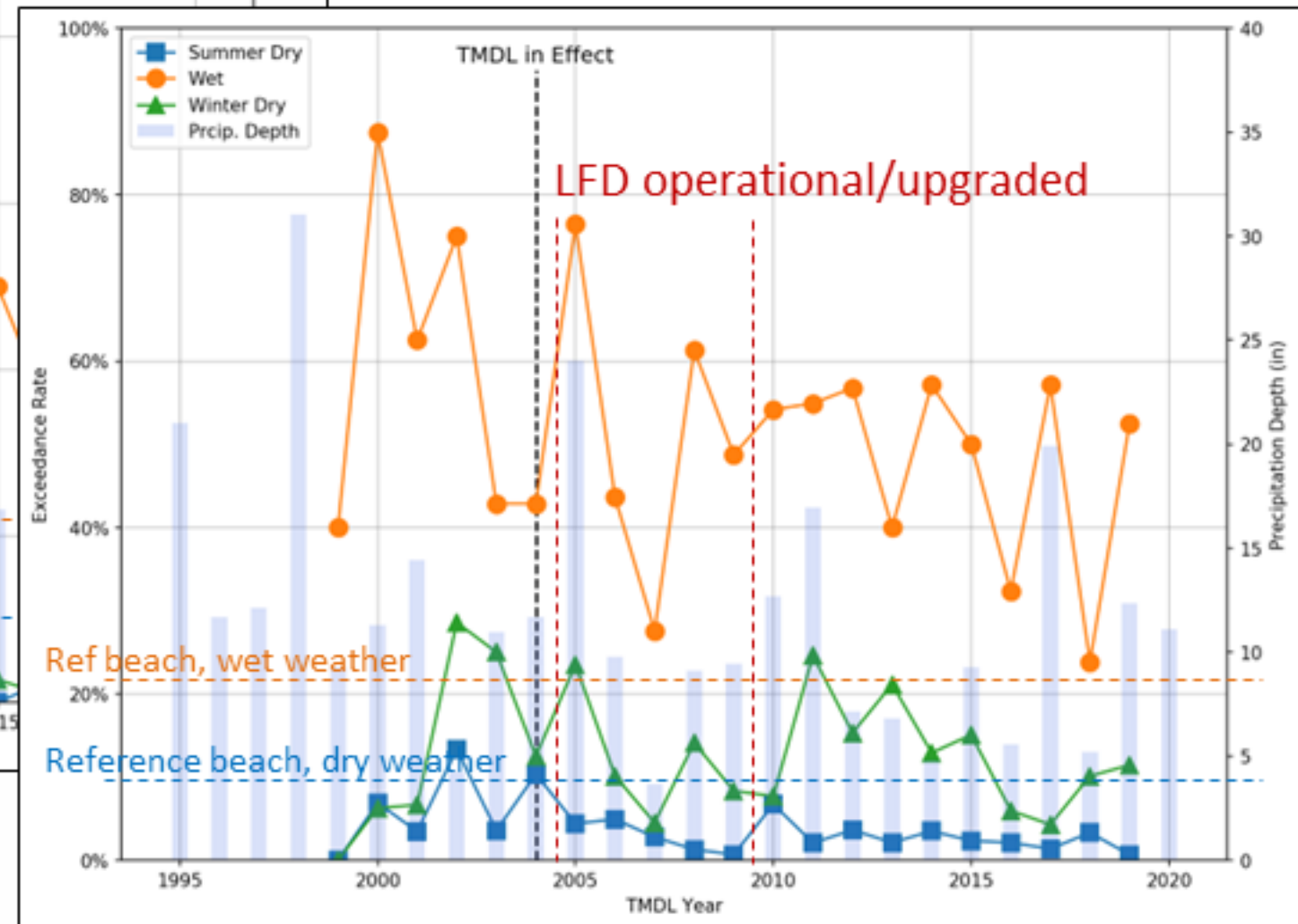
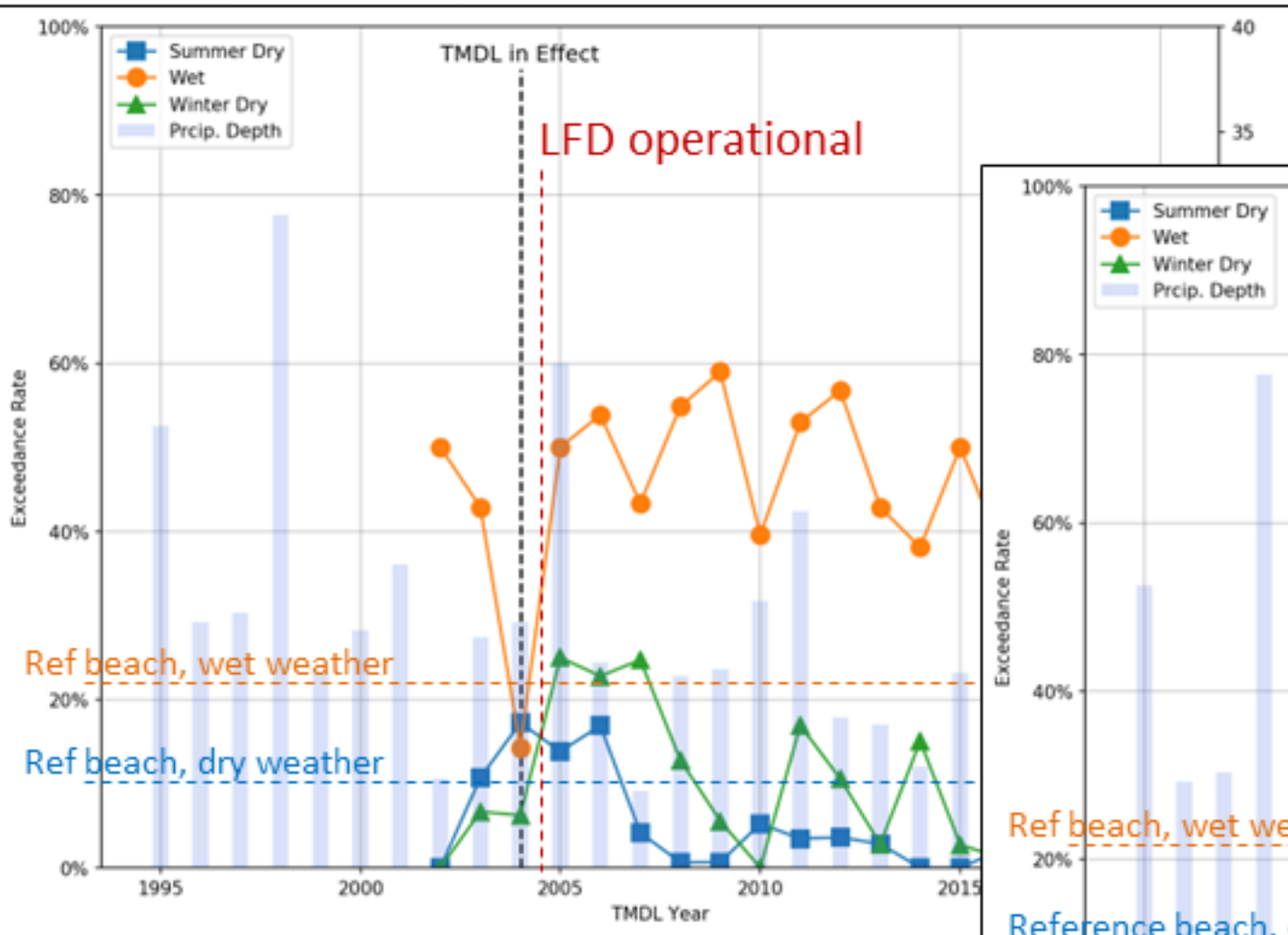


Data Source: Cost Benefit Analysis of San Diego Region Bacteria TMDLs

Outcomes
(aka, What's Working?)

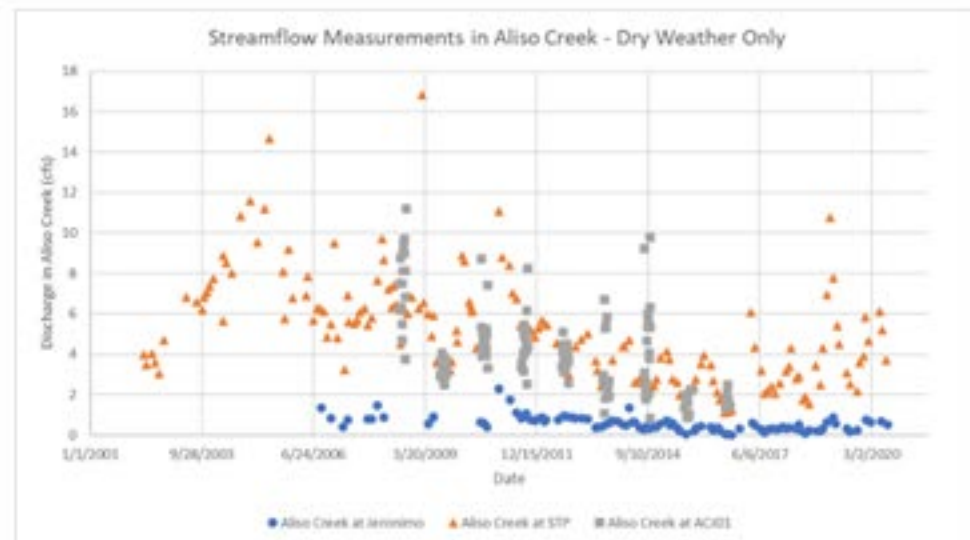
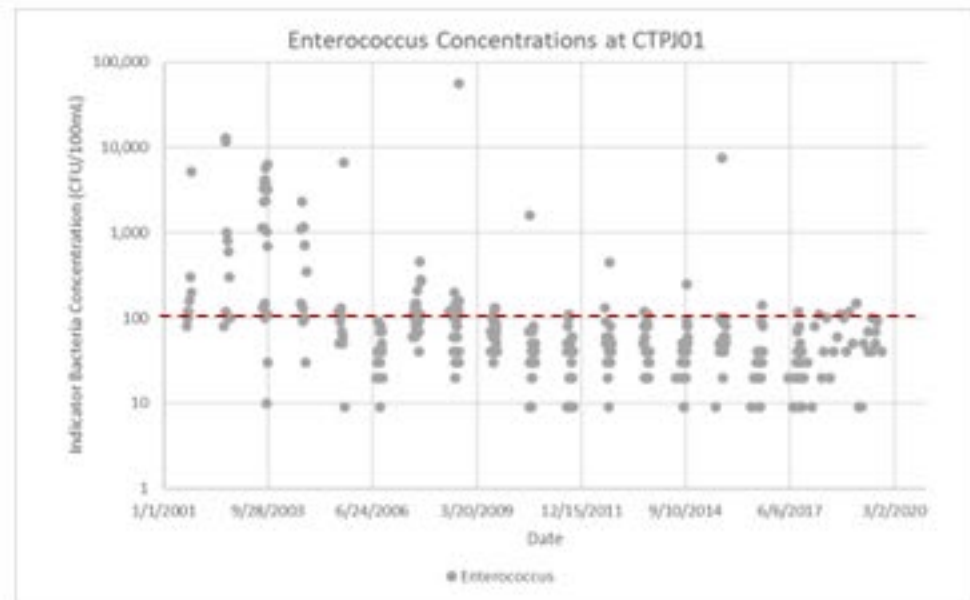
LFDs at Santa Monica Bay Beaches

Dry weather improvement evident, though objectives still occasionally exceeded



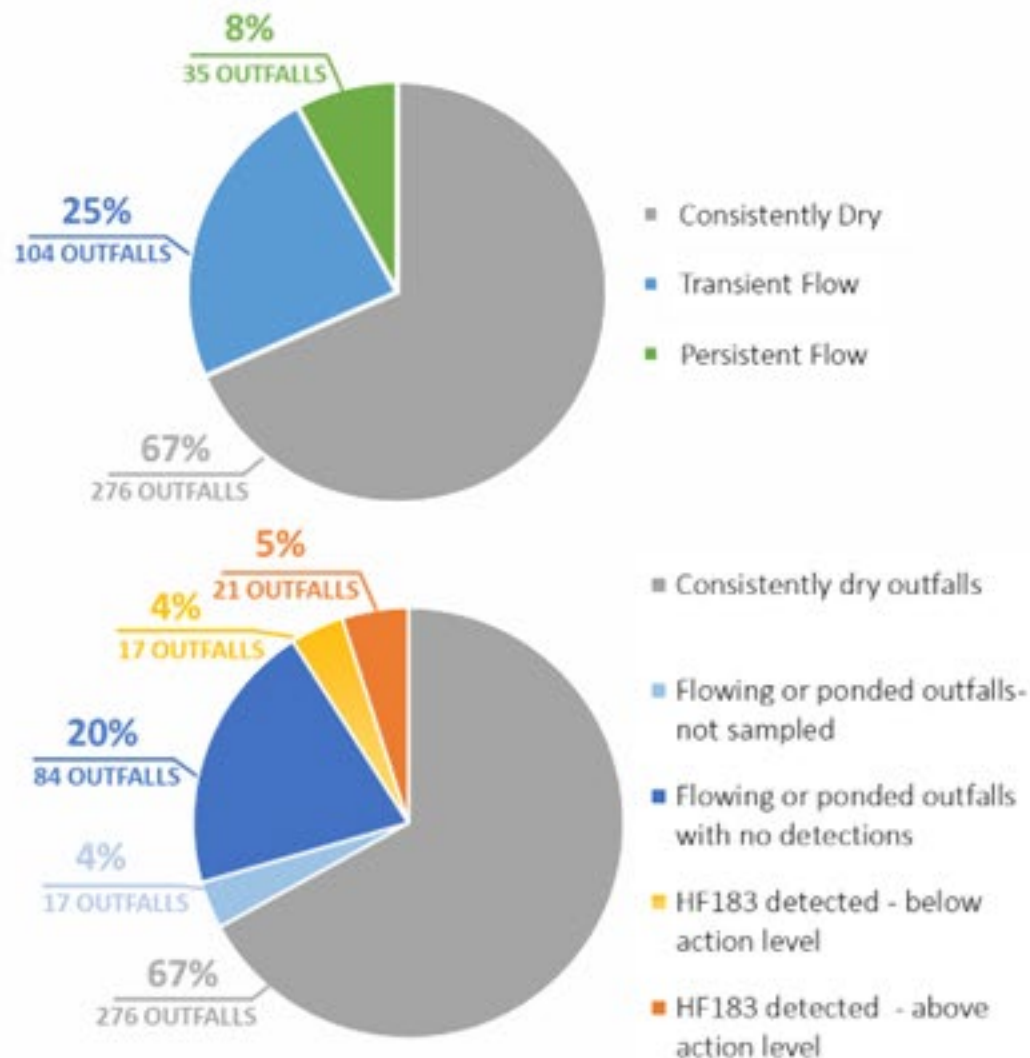
Human Waste Control Strategy in South OC

- Controlling sources of both bacteria and unnatural flows
- Methods: enhanced IDDE (including with advanced analytical forensics) and targeted low flow structural controls
 - Diversions, UV disinfection, wetlands
- Outcome: 2021 dry weather TMDL compliance demonstration showed
 - Receiving water limits met at 22 of 29 TMDL beach and creek segments, and
 - For many others, >90% bacteria load reduction from TMDL baseline (in Aliso, San Juan, and Salt Creeks)



Human Waste Control Strategy in SD County

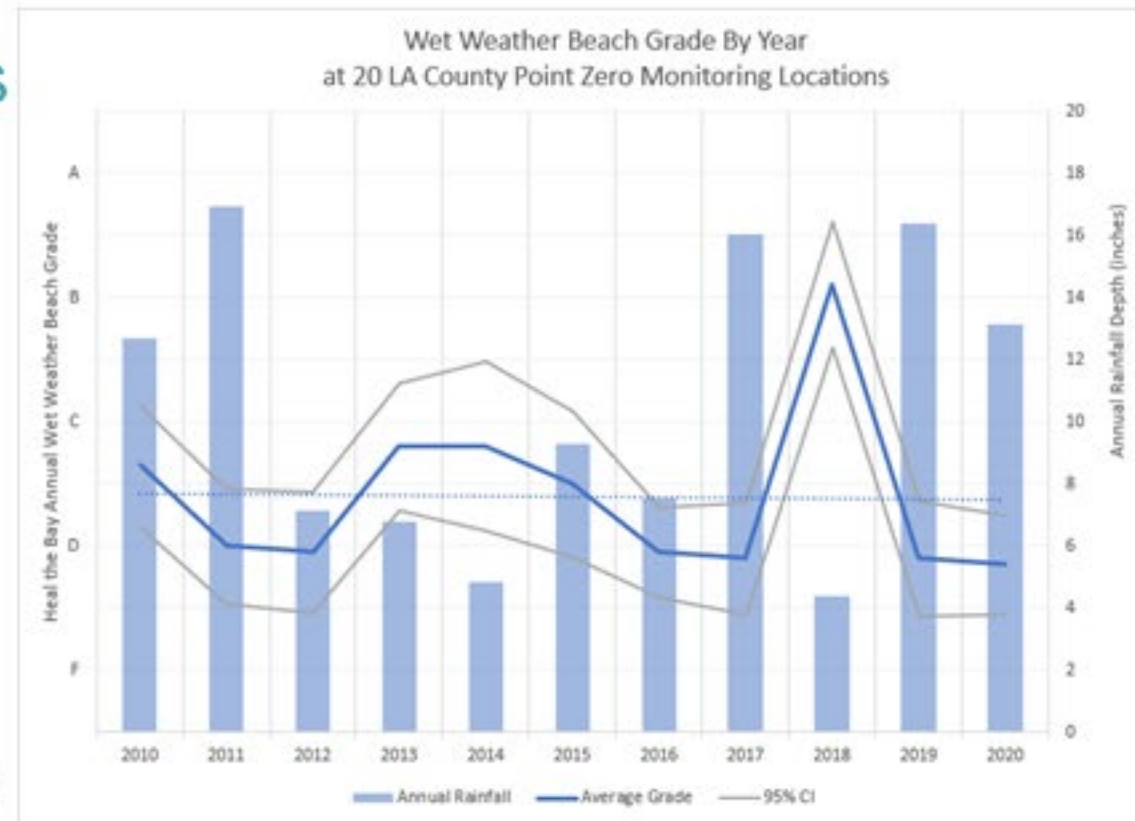
- Over 400 outfalls screened for flow condition and HF183
 - Many screened multiple times annually
 - Follow-up investigation and abatement conducted at outfalls with elevated HF183
 - Flow and HF183 detections tracked annually to demonstrate progress
- **Results Support**
 - Bacteria TMDL compliance at most outfalls (via no flow)
 - Source demonstration at others (via no/low human waste contribution)
- **Similar screening also being conducted in other watersheds**



What's working for wet weather?



- We don't know yet!
- Anticipate load reductions from stormwater capture projects, but meeting FIB objectives will be challenging because not all storms can be captured everywhere
- Variability in wet weather data makes it challenging to see statistically significant improvement, even where significant partial structural implementation is complete



Conclusions

Conclusions / Takeaways

- 1. Dry weather FIB compliance is often (but not always) feasible using structural controls and/or source controls**
 - Easier at beaches than creeks
 - Source control typically less compliance-certain but more sustainable
- 2. Wet weather compliance is the greater challenge, and FIB is driving much of SoCal's GI-heavy TMDL implementation activity**
 - There may be examples of compliance, but they tend to be outfall-specific, using a non-receiving water permit pathway (e.g., 85th percentile retention, load reduction, implementation-based), and not watershed-scale
 - These pathways vary significantly region-to-region
 - There are not examples we're aware of for long-term wet weather attainment of receiving water limits (both single sample/STV and geomean) for an urban receiving water

Conclusions / Takeaways

3. Risk-based implementation approaches are growing, but it's early so we don't know effect on FIB or risk-proxies, or how/whether it will achieve compliance
 - Was intended as a science-based, “true source control” solution that better targets drivers of risk, and for much lower cost than structural controls
 - However, question remains whether wet weather waste/pathogen sources can be controlled at watershed-scale
 - SD Investigative Order actions and proposed LA Pathogen Study may help to answer
 - If ‘no’, then are structural solutions (e.g., GI or treatment) our final option?

THANK YOU

Questions? Please reach out!

Brandon Steets: BSteets@Geosyntec.com

Jared Ervin: JErvin@Geosyntec.com

Geosyntec 
consultants





EXTRAS

Conclusions / Takeaways

4. The means to reach a solution that is both health-protective AND feasible will likely require:
 - More research (to fill key remaining knowledge gaps)
 - Affordable implementation solutions that truly reduce risk
 - Modified standards (making site specific modifications more accessible, where science supports)
 - Also legislation modifications due to AB411?
 - Attainable MS4 permit compliance demonstration pathways (science-based, legally-defensible) that incentivize the right actions

How to Measure “What’s Working”?

- *Permit compliance defines success for the MS4 agencies*
 - In some areas is based on implementation of an approved plan
 - In other areas (e.g., LA and SD regions), numeric targets for FIB must be achieved
 - Structural BMPs including LFDs and GI are generally effective for achieving this in dry weather...
 - ...but it's uncertain whether this has measurable affect on illness risks
- *So what do we know about illness risks?*
 - CA studies that actually measure risk (e.g., SHS, prior epi studies) suggest low baseline illness rates... but questions have been raised
 - SD CBA concluded alternate approach could provide greater risk reduction at much lower cost
 - State of the science has enabled this by providing advanced tools (e.g., DNA markers, viruses, bacterial community analysis), to compliment traditional IDDE tools, to identify high-risk sources of waste
 - Sewage sources have successfully been identified and abated using MST in many urban source investigations
 - 2018 SD Water Board Triennial Review for REC-1 WQOs cited these studies and noted the need to update MS4 permits to emphasize human sources/health risks

RESULTS

Source: Cost Benefit Analysis of San Diego Region Bacteria TMDLs

PUBLIC HEALTH COST-EFFECTIVENESS

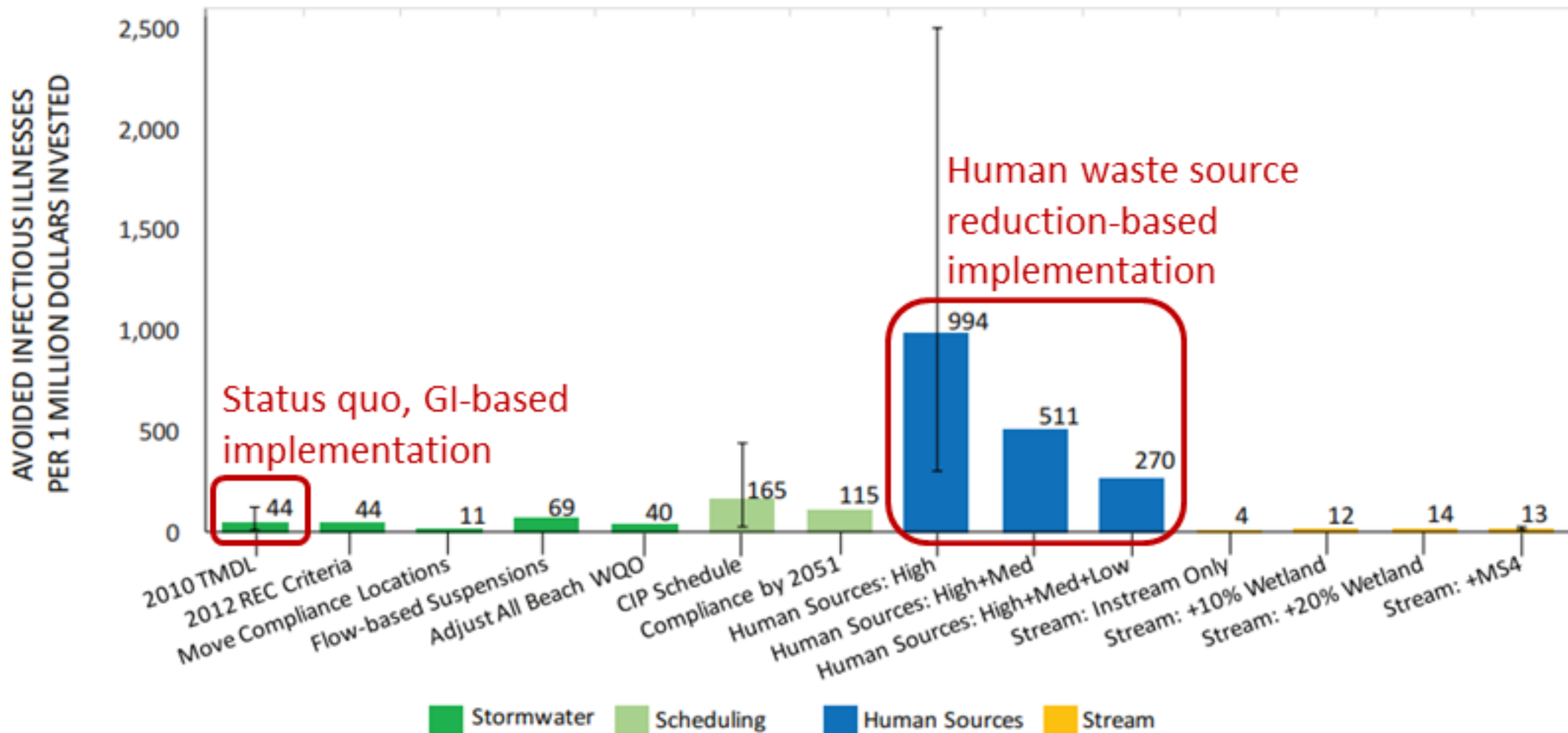


Figure 2: A chart showing number of illnesses avoided throughout the 65-year analysis period per million dollars invested. Human Sources scenarios (blue bars) provide many times greater cost-effectiveness compared to other scenarios. Whiskers indicate the ranges of uncertainty calculated using appropriate methods for each scenario; creating statistical high and low bracket values based on the important drivers of uncertainty in each scenario's benefits and costs.

Key Source Investigation #1: San Diego River Investigative Order (IO)

- ~\$4-5M Investigation currently being performed
 - Led by SCCWRP
 - Funded by NPDES Permittees in the lower SD River Watershed
- **Study Objectives:**
 1. *Quantify the loading of fecal contamination to the San Diego River from human sources (in dry and wet weather, with focus on wet weather)*
 2. *Use the loading estimates to compare relative contributions among the sources of human fecal inputs (which is the greatest potential source of human fecal inputs?)*
 3. *Identify the factors that might lead to the greatest risk of loading (where and when does the greatest human fecal loading occur?)*
 - Inform control actions to be implemented by Permittees based on study results
- **Sources Being Investigated:**
 - Sanitary Sewers (including Exfiltration, Overflows, and Illicit Connections)
 - Homeless Populations
 - Private Sewer Laterals
 - Onsite Wastewater Treatment Systems (OWTS)

Key Source Investigation #2: LA Region Pathogen Reduction Study

- ~\$9M Investigation Currently Proposed
 - Led by the Gateway Water Management Authority (GWMA)
 - Funding sought by the Safe, Clean Water Program
- Study Objectives:
 1. *Determining the sources with the highest risk to human health*
 2. *Identifying the beaches and inland waterbodies within the MS4 Permit area where the risk to human health is higher*
 3. *Identifying management actions to address high-risk sources and areas more effectively*
- Sources to be Investigated:
 - Stormwater runoff
 - Exfiltration from sanitary sewers
 - Homeless encampments
 - Illicit connections / illicit discharges