

# Sources of Microbial Contamination In Urban Streams and Ocean Beaches Santa Barbara, California



## PROBLEM AND SCOPE

Urban streams and ocean beaches in the Santa Barbara area have fecal indicator bacteria concentrations that exceed public health standards for recreational water.

The source of the contamination and consequently potential mitigation strategies are not known.

Scope of this study includes collection of hydrologic, geochemical, and microbiological data along Mission Creek and East Beach west of Mission Creek.

## WORK TASKS

1. Analysis of existing data
2. Collection of hydrologic data from urban streams
3. Collection of hydrologic data from ocean beaches
4. Characterization of dissolved organic carbon composition
5. Genetic and molecular microbiological analysis
6. Tracers of wastewater origin

## ANALYSIS OF EXISTING DATA

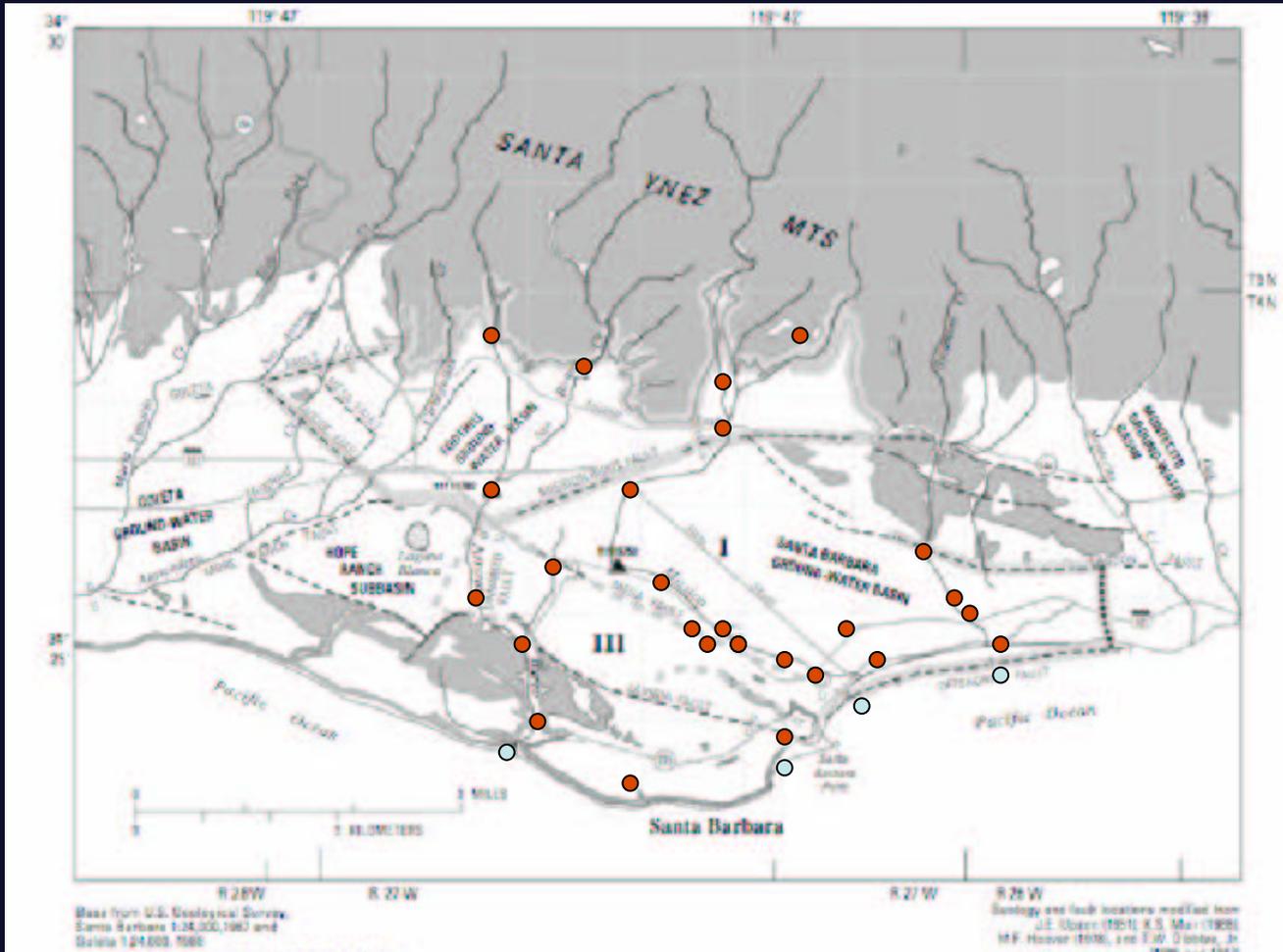
Statistical analysis of data from urban streams.

1. Correlation with available streamflow data
2. Estimation of loads and potential magnitude and seasonality of source

Statistical analysis of data from ocean beaches

1. Correlation with tidal cycles
2. Seasonality
3. Correlation with flow events

# LOCATION OF SAMPLE COLLECTION SITES

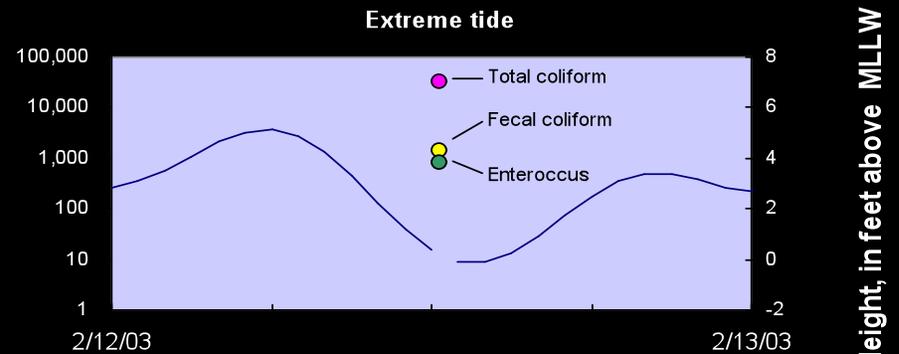
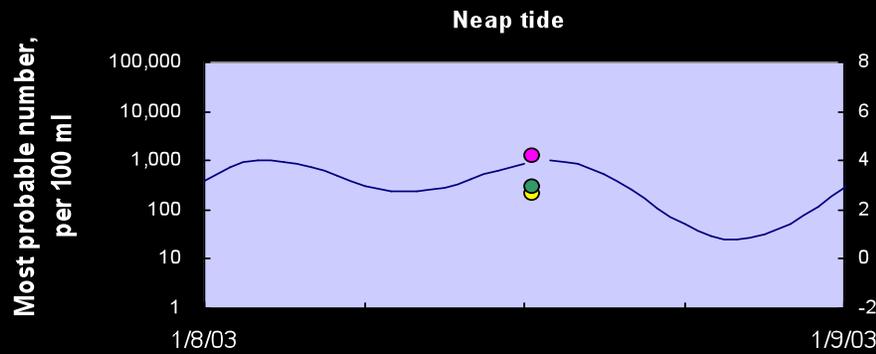
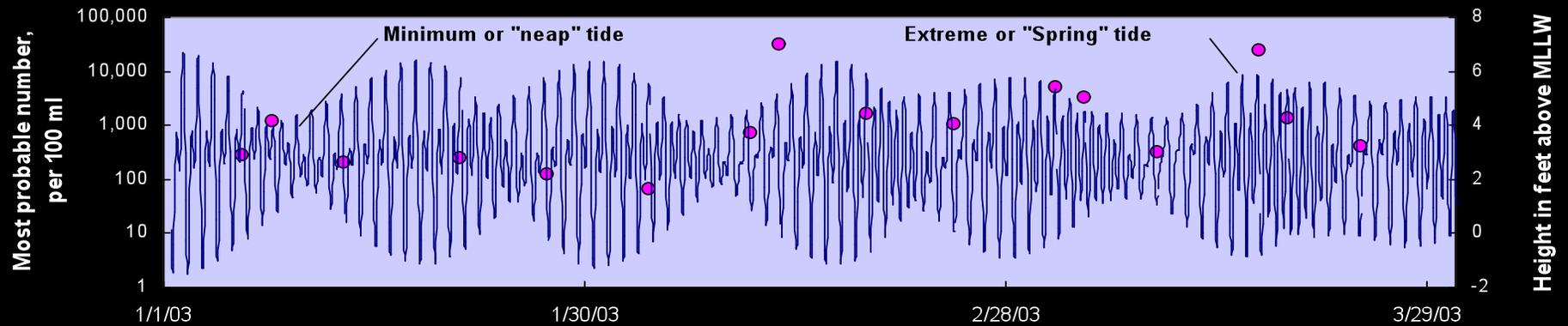


## EXPLANATION

- Surface-water sites
- Ocean beach sites



# BACTERIAL CONCENTRATIONS AND TIDES



# INSTRUMENT INSTALLATION AND DATA COLLECTION

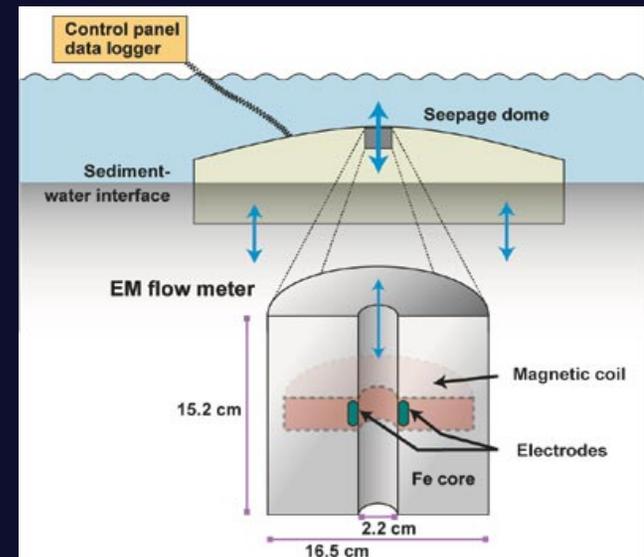
Seepage-runs along streams to evaluate changes in flow and quality (MaFadden, Polinoski, and Martin, 1991)



Seepage meter and subsurface temperature data collection

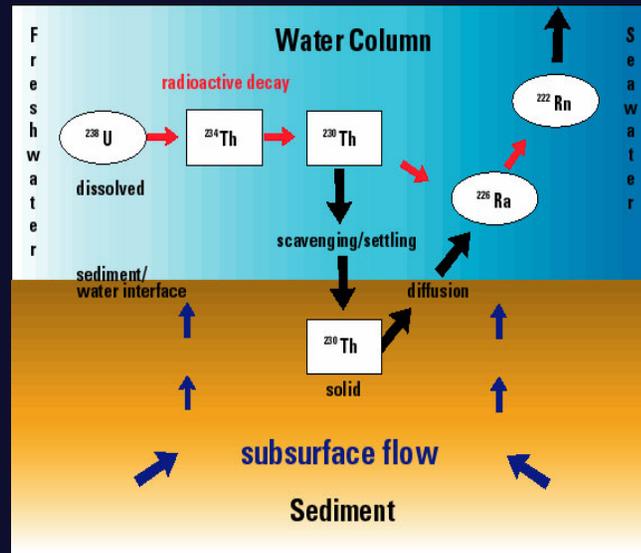
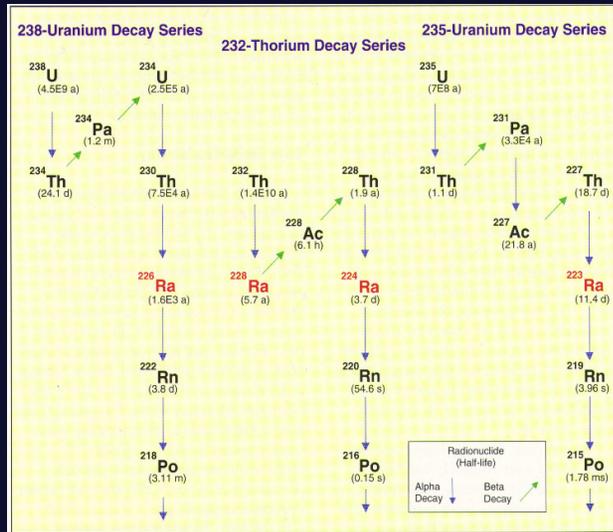


Shallow water-table wells installed using a cone-penetrometer (CPT) rig



# RADIUM ISOTOPE SYSTEMATICS

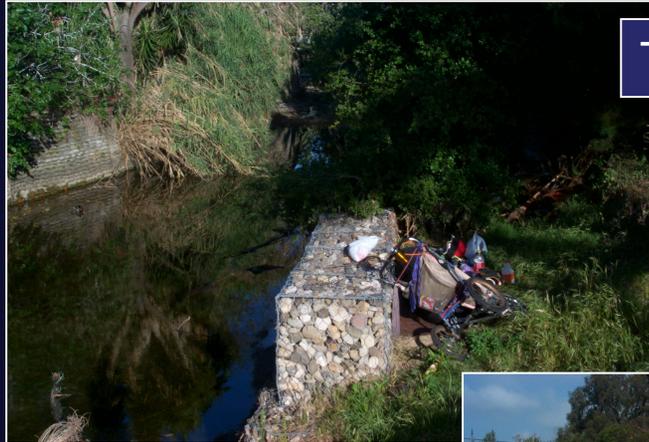
Four isotopes having a wide range of half-lives



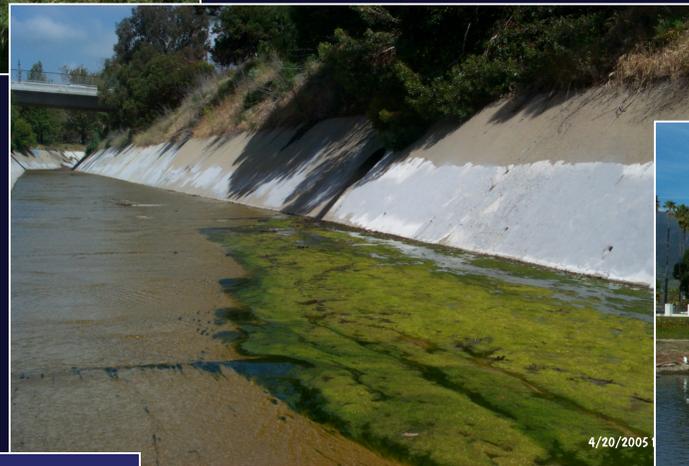
Chemistry similar to calcium. Large difference in concentrations in ground water and seawater governed by exchange reactions.

Estimates of ground-water discharge supported by estimates calculated from water-level and seepage-meter data under a range of tidal and hydrologic conditions

# Possible sources of fecal bacteria contamination to urban streams and beaches

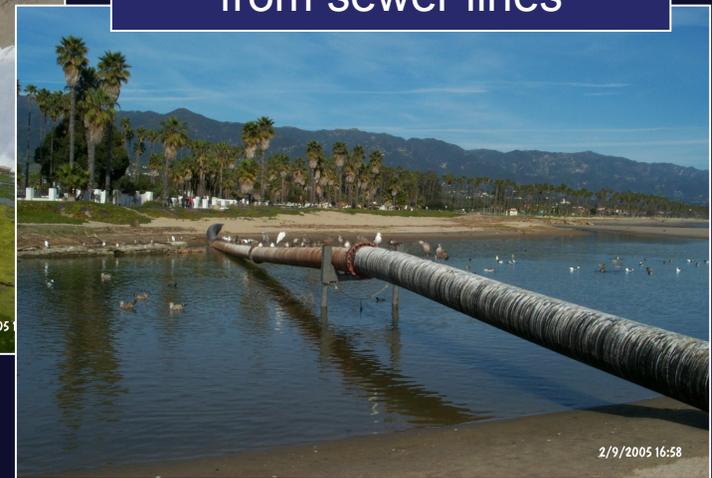


Transient human populations

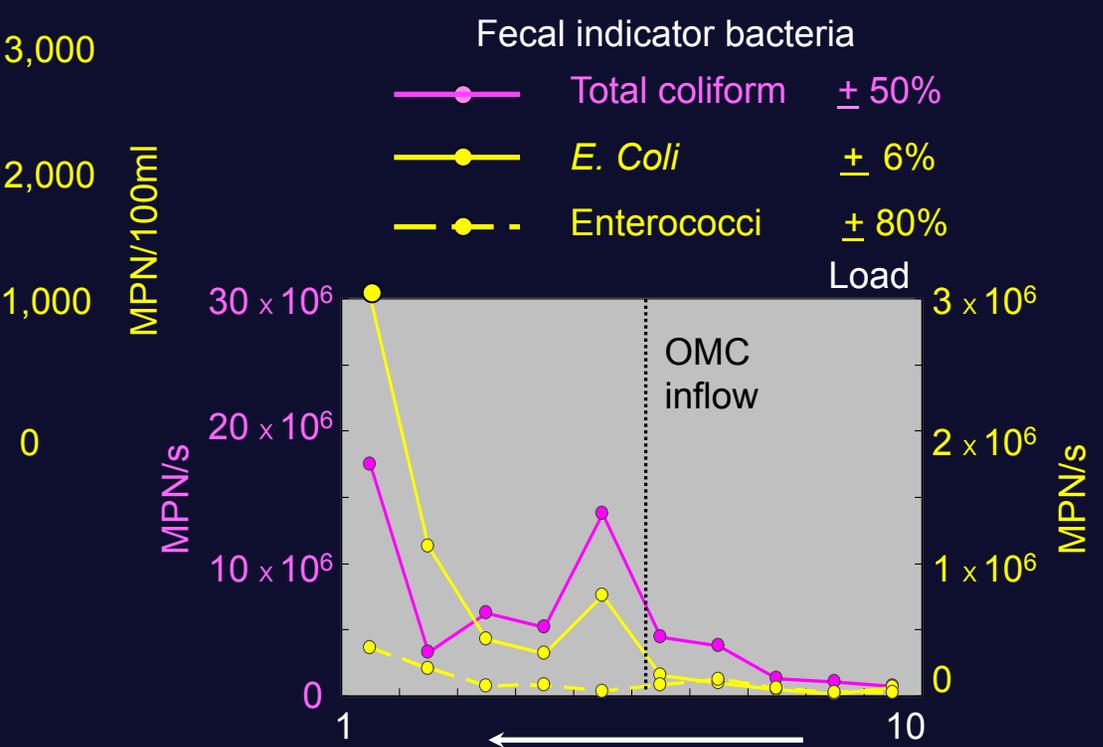
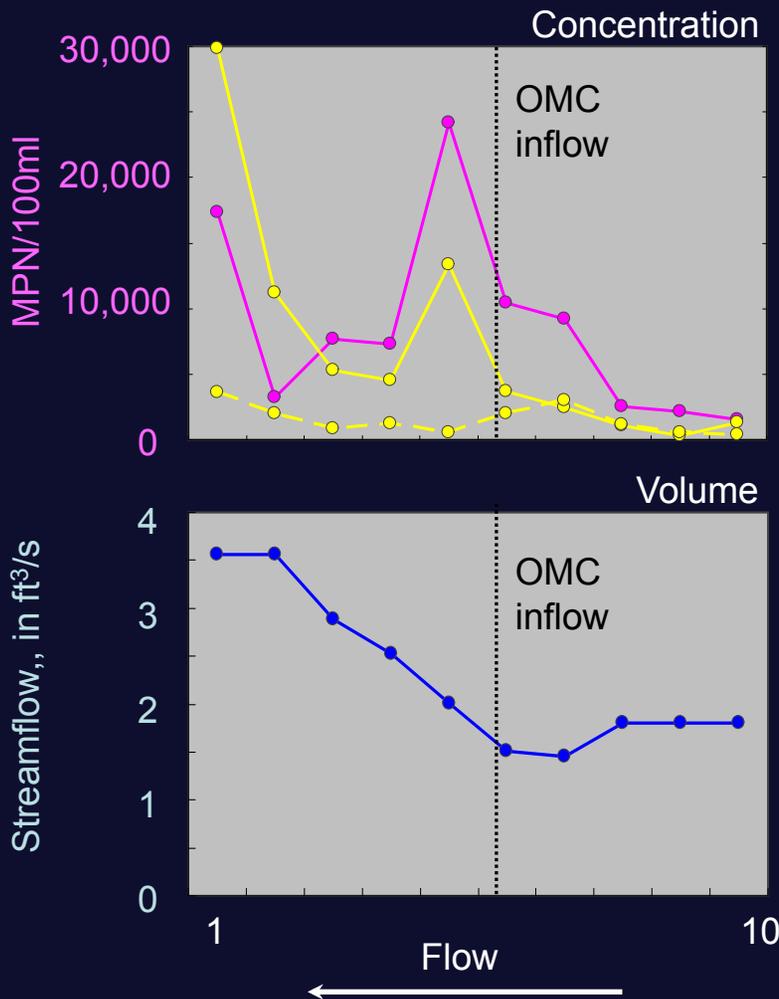


Urban nuisance flows

Birds and direct leakage from sewer lines



# Mission Creek streamflow and water-quality data, April 19-20, 2005

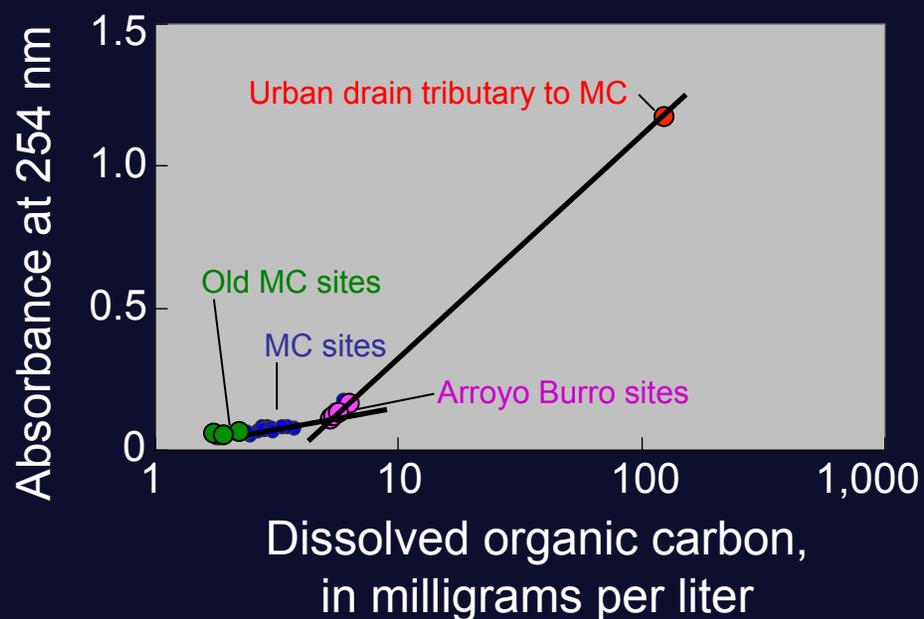


- Large concentrations and loads for total coliform and *E. coli* at Old Mission Creek (OMC) inflow and mouth
- Absence of enterococci at OMC and in sampled urban drains
- General increase in *E. coli* with distance downstream



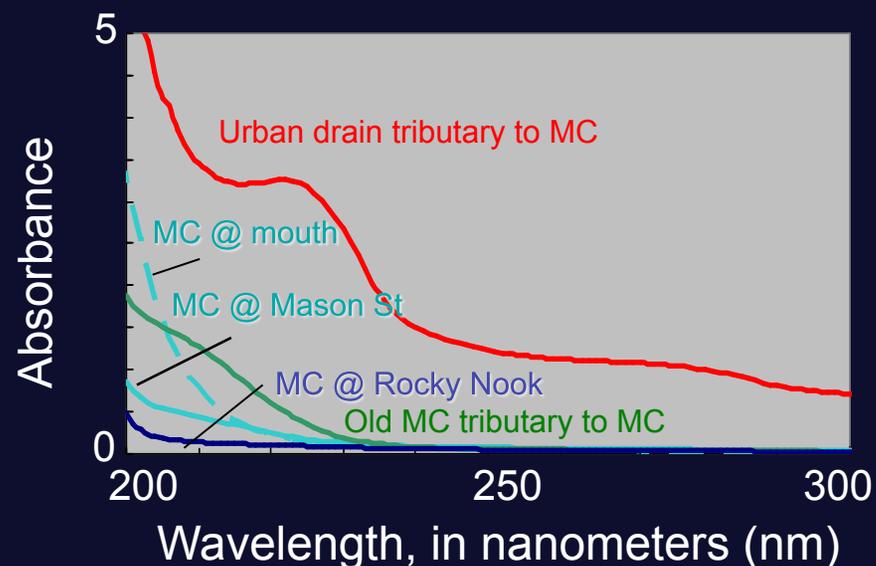
Concentration × Volume = Load  
 $MPN/L^3 \times L^3/t = MPN/t$

# Dissolved organic carbon (DOC) and ultraviolet (UV) absorbance data April 19-21, 2005

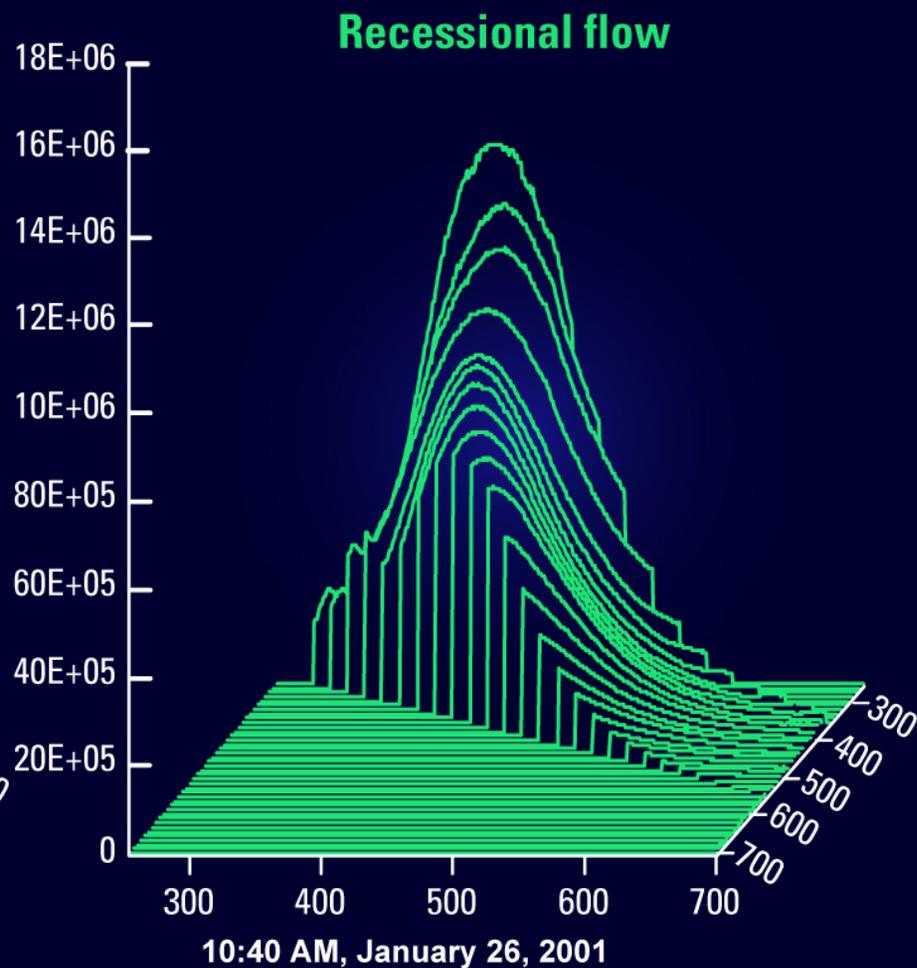
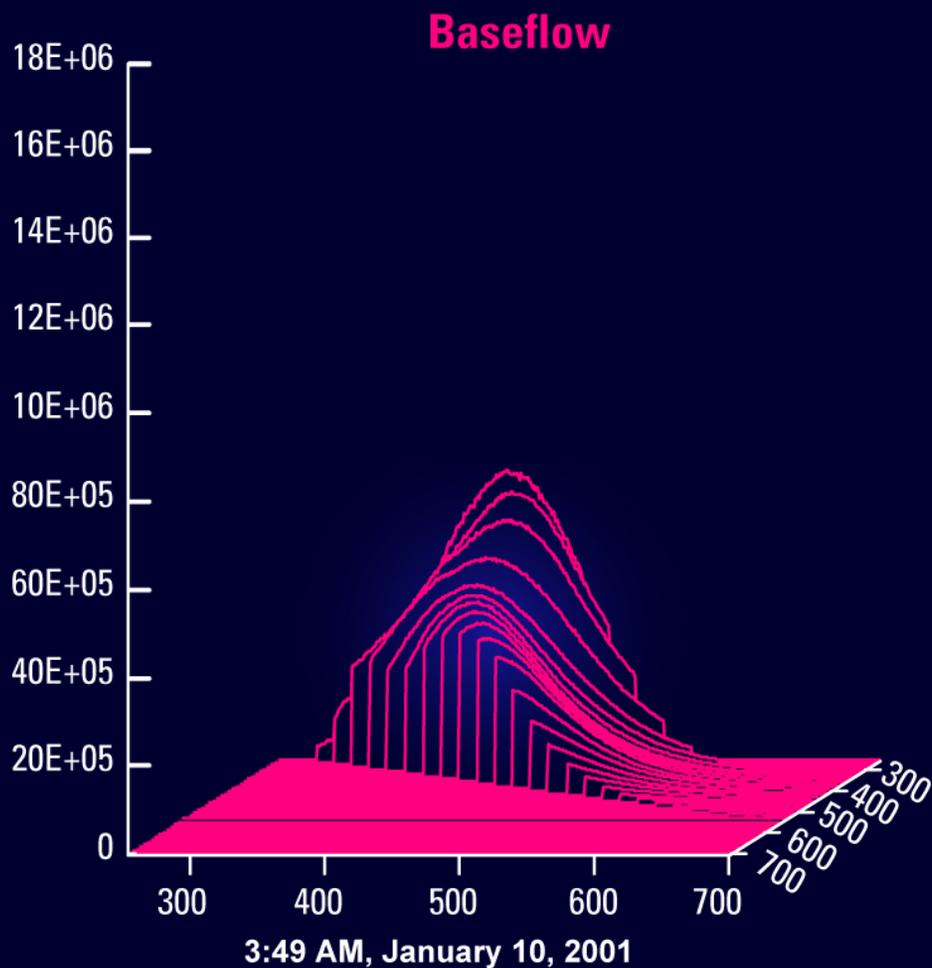


Fecal indicator bacteria concentrations in Arroyo Burro was selected for comparison and contrast with data from Mission Creek (MC). Arroyo Burro flows perennially as a result of urban nuisance flows and does not receive ground water inflow

Changes in concentration and composition of dissolved organic carbon from different sources associated with fecal indicator bacteria contamination



# Excitation/emission fluorescence (EEM) data



# MOLECULAR MICROBIOLOGY

## TWO BROAD TYPES OF DATA AND TWO BROAD TYPES OF INTERPRETATIONS PRODUCING VERY DIFFERENT INFORMATION

### **TYPES OF DATA—Genetic (T-RFLP) and molecular (PLFA) data.**

Terminal-Restriction Fragment Length Polymorphism (T-RFLP) data reflect the genetic material from specific organisms.

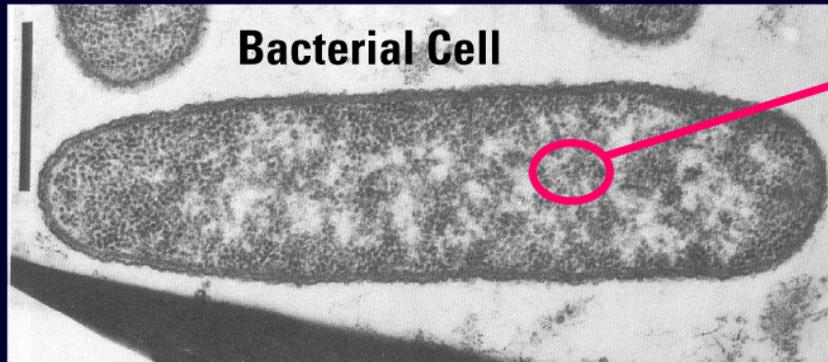
Phospholipid Fatty Acid (PLFA) data reflect different organisms having common metabolic processes

### **TYPES OF DATA INTERPRETATIONS—Microbial Source Tracking and Microbial Community Structure Analysis.**

Microbial Source Tracking provides a genetic "fingerprint" fecal indicator bacteria from different sources to identify source of bacteria.

Microbial Community Structure Analysis evaluates changes in the abundance, type, and diversity of organisms within the entire microbial population resulting from environmental conditions. These changes are used with other data to infer the source of the microorganisms.

# Polymerase Chain Reaction (PCR) - a molecular copy machine



## Ribosomes

Evolutionarily conserved, translate genetic information into proteins

## 70s Ribosome

## 50s Subunit

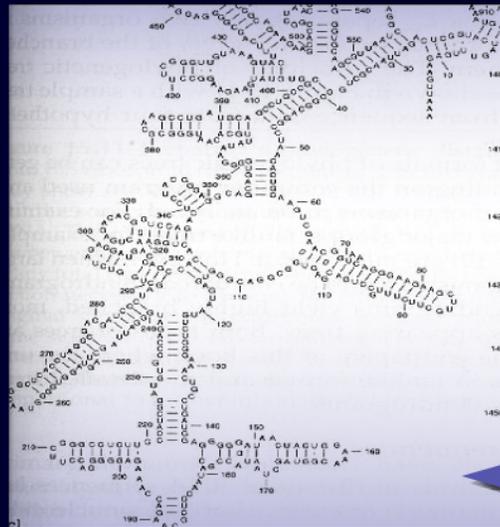
## 30s Subunit

## 5s

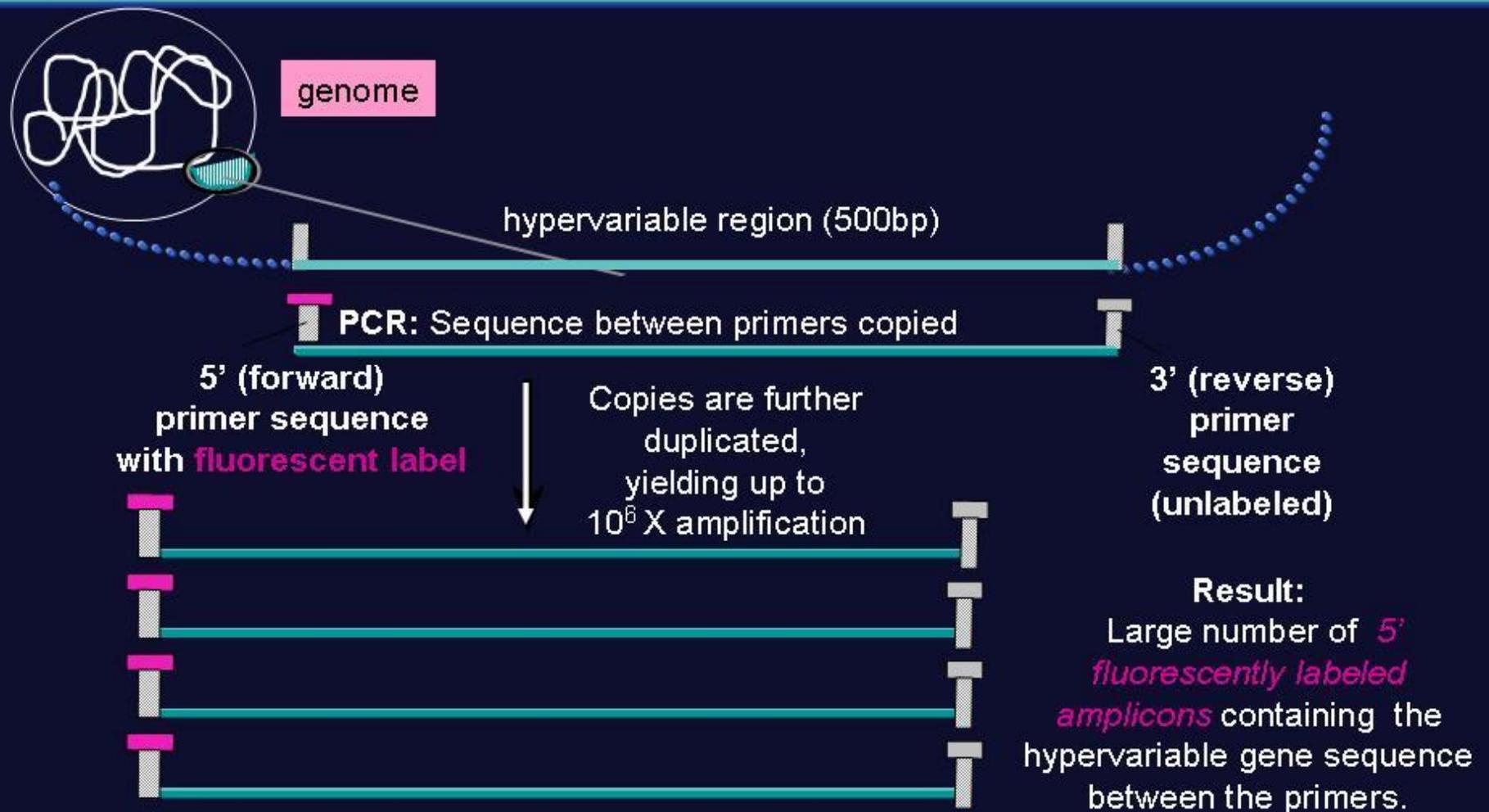
## 16s

## 23s

Sequence of the 16S rRNA gene serves as a stable genetic "fingerprint" for each organism

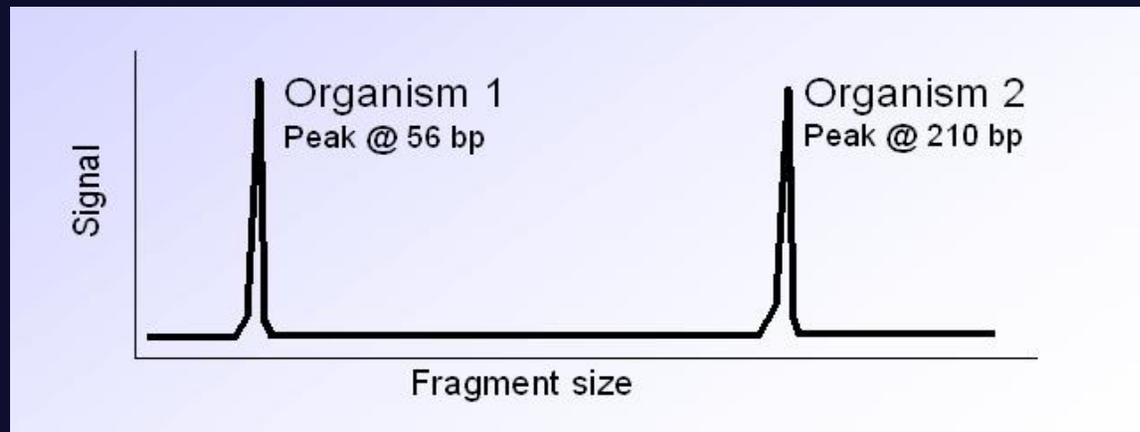
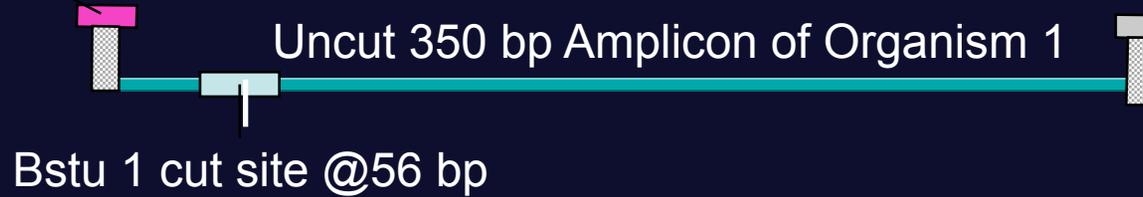


# Polymerase Chain Reaction (PCR) and Terminal Restriction Fragment Length Polymorphism (T-RFLP)

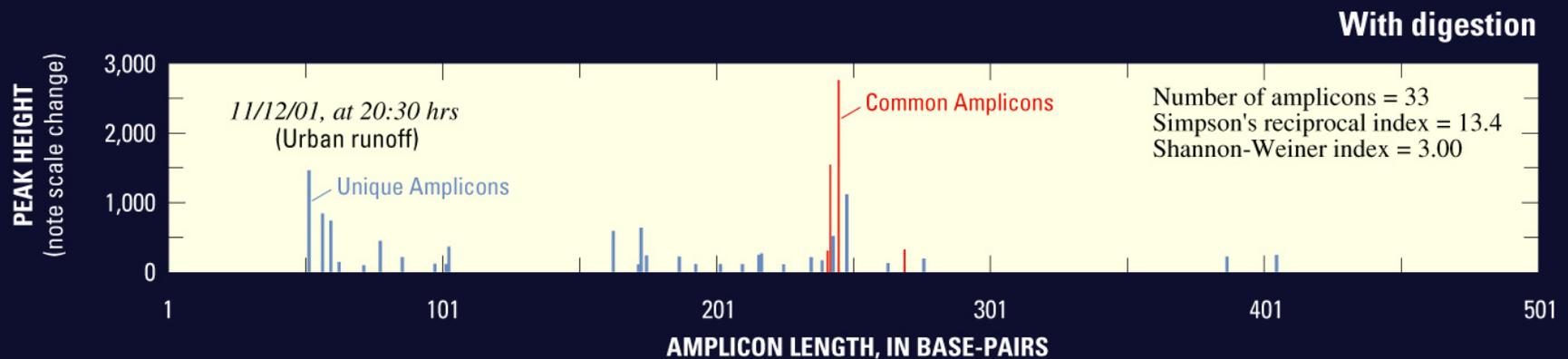
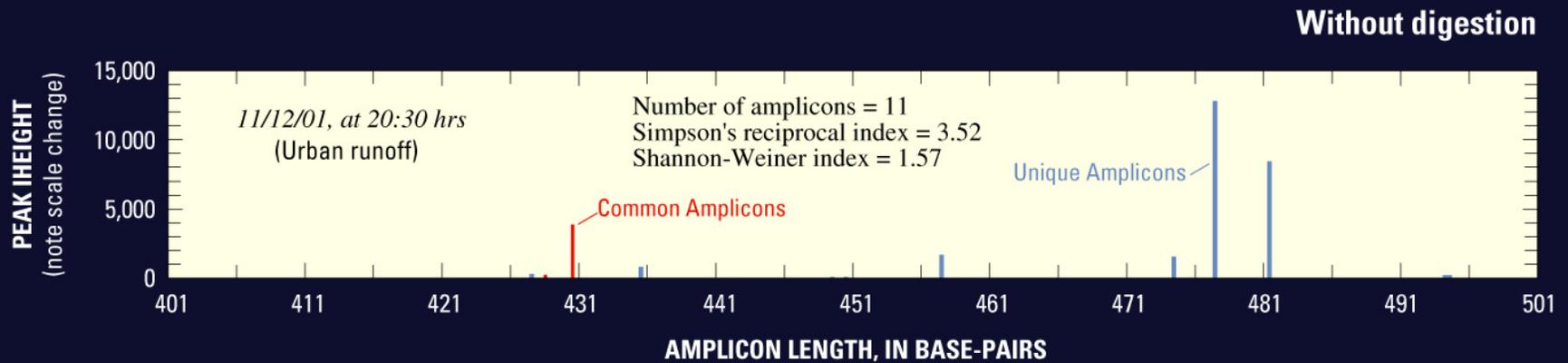


# Terminal-Restriction Fragment Length Polymorphism (T-RFLP)

Fluorescent label

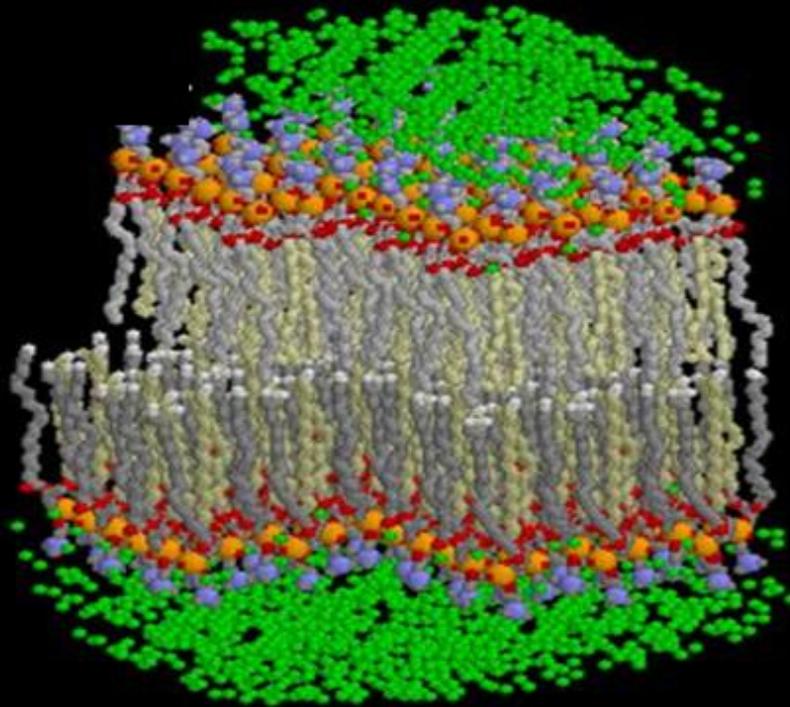


# Amplicons without and with endonuclease digestion



## Phospholipid Fatty Acids (PLFA)

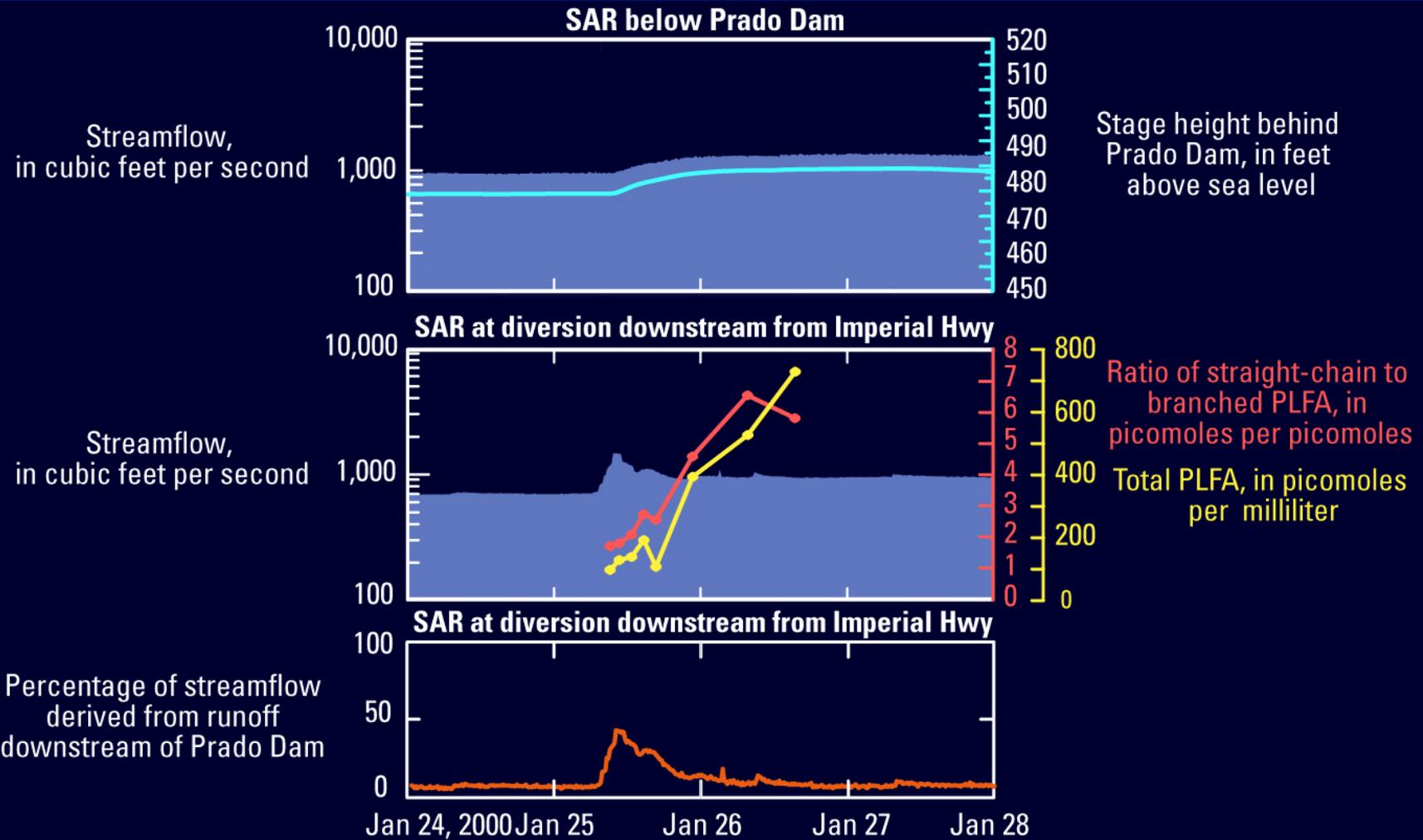
### LIPID BI-LAYER IN A MICROBIAL CELL MEMBRANE



Carbon/Palmitic Oleic  
Nitrogen Oxygen Phosphorus  
Water Oxygens

H Heller, M Schaefer, K Schulten,  
J Phys Chem 97:8343, 1993.  
RasMol Image by E Martz

# Changes in phospholipid fatty acid (PLFA) concentrations and composition during stormflow



# OPTICAL PROPERTIES OF DISSOLVED ORGANIC CARBON

Ultraviolet (UV) absorbance and excitation/emission fluorescence (EEM)

Simplified characterization of dissolved organic carbon (DOC) from different sources. Less expensive than hierarchical approaches that separate DOC on the basis of polarity and molecular weight, or on the basis of functional groups.

Can we use these data to characterize the source of dissolved organic carbon and potentially associate that information with the source of fecal indicator bacteria?

## TRACERS OF WASTEWATER ORIGIN

Not naturally occurring, associated with human use and consumption, and measurable in low concentrations. Some of these compounds may or may not have associated environmental risks.

More than 60 compounds analyzed in the part per trillion range.

Classified into two broad categories:

- Compounds produced by humans

  - Coprostanol (low solubility, associated with colloidal fraction)

  - Urobilin

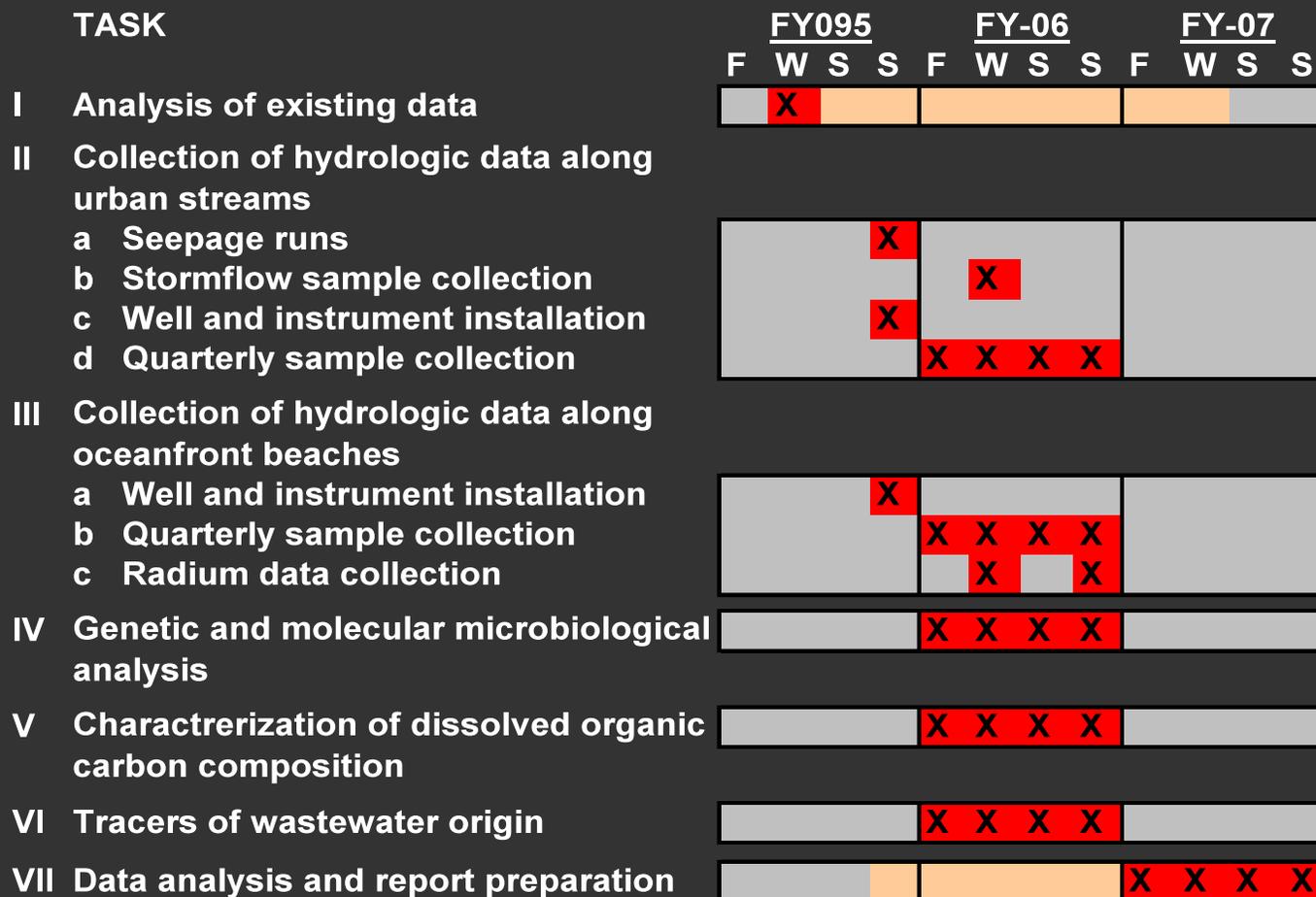
  - Estrogen

- Compounds used by humans

  - Caffeine

  - Pharmaceuticals and personal health-care products (PPCP's)

# PROJECT TIMELINE



## PROJECT STAFF

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# QUESTIONS AND ANSWERS

