# Water Quality Modeling for TMDLs: A Functional Overview


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# My Goal

To provide a general overview of water quality modeling with two objectives:

- Be able to have productive conversations as a stakeholder in the model development process
- Provide background towards deciding to take on the task internally or through contracts

# Outline

1. What is a model anyway?
   - Definitions and background
2. Choosing an appropriate model
   - The variety out there and some key decision points
3. What good are they?
   - An example of TMDL allocations
4. Resources

# What's a Model Anyway?

# What's a Model Anyway?

- *Essentially, all models are wrong, but some are useful.*
  - Box, G. E. P., and Draper, N. R., (1987), *Empirical Model Building and Response Surfaces*, John Wiley & Sons, New York, NY. P. 424

www.summitmedicalgroup.com


www.suggestkeyword.com

# What's a Model Anyway?

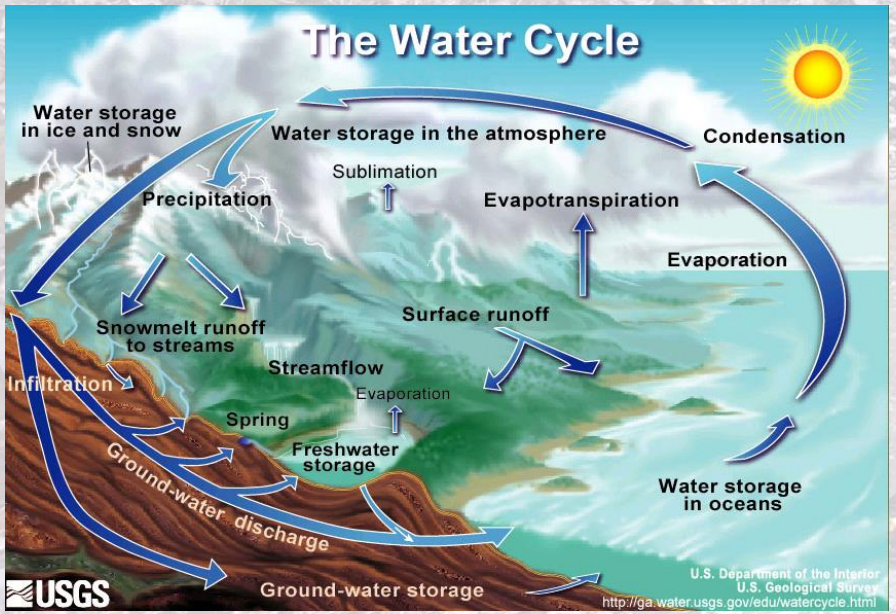
- *We have no idea about the 'real' nature of things … The function of modeling is to arrive at descriptions which are useful.*
  - Richard Bandler and John Grinder. (1979) Frogs into Princes: Neuro Linguistic Programming. Moab, UT: Real People Press. p. 7.
- *For such a model there is no need to ask the question "Is the model true?". If "truth" is to be the "whole truth" the answer must be "No". The only question of interest is "Is the model illuminating and useful?".*
  - Box, G. E. P. (1979), "Robustness in the strategy of scientific model building", in Launer, R. L.; Wilkinson, G. N., Robustness in Statistics, Academic Press, pp. 201–236

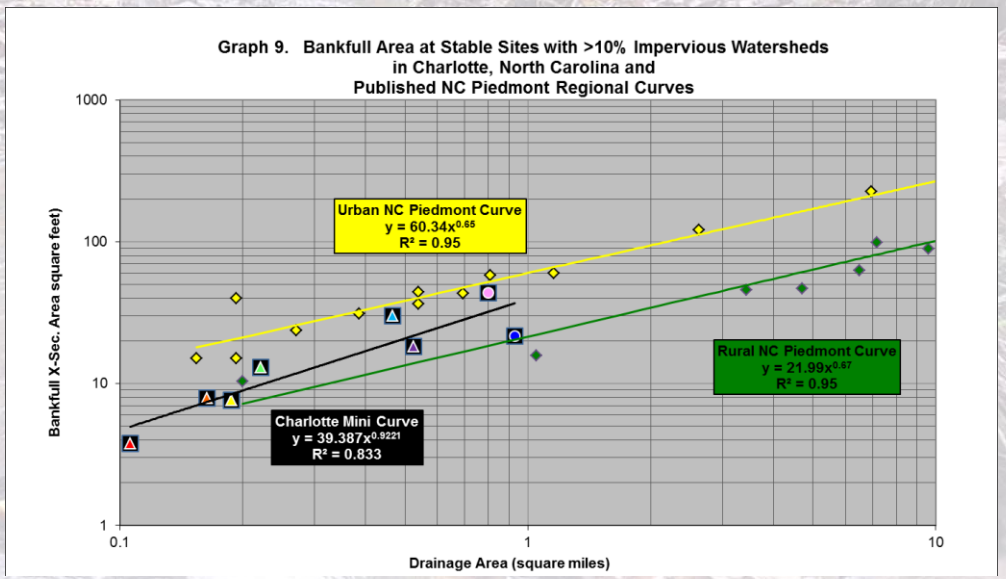
# What's a Model Anyway?

- EPA Definitions:
  - **Model:** A simplification of reality that is constructed to gain insights into select attributes of a physical, biological, economic, or social system.
    - **Computational models:** Models that use measurable variables, numerical inputs, and mathematical relationships to produce quantitative outputs.
- **Water quality models** can be useful tools to assist decision makers by simulating levels, distributions, and risks of chemical pollutants or environmental responses in a given water body.

# Model choices…and choices

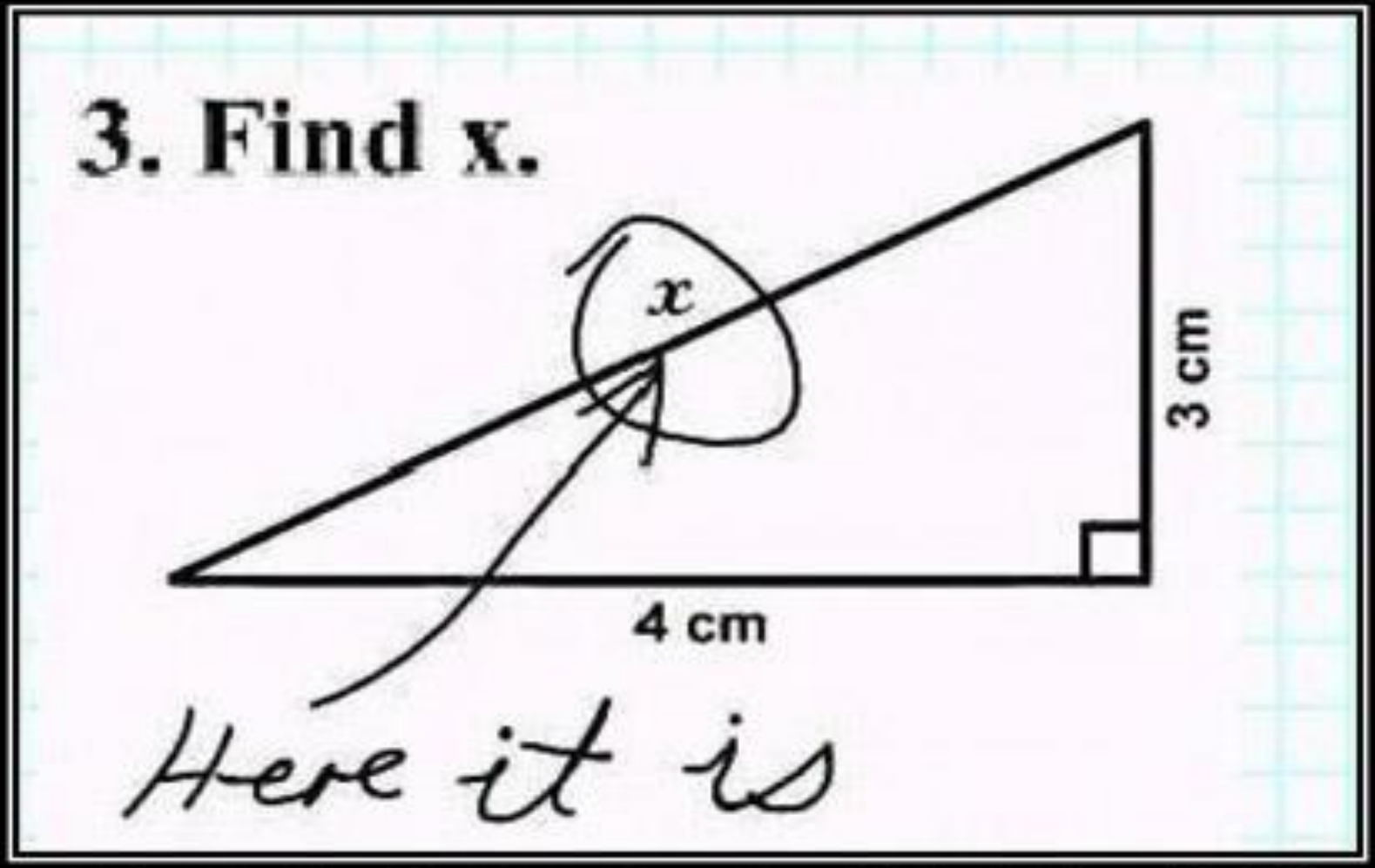
- Process-based (mechanistic)
  - Representation of a specific physical process
- Data-based (empirical or statistical)
  - Mathematical relationships developed between independently sampled datasets



# Choosing an appropriate Model

- What do you need out?
  - Least complex
    - Long-term Average
      - export coefficients
    - Annual Averages
  - More complex
    - Annual or Monthly Averages
  - Most complex
    - Hourly, Daily, Monthly, Seasonal, Annual

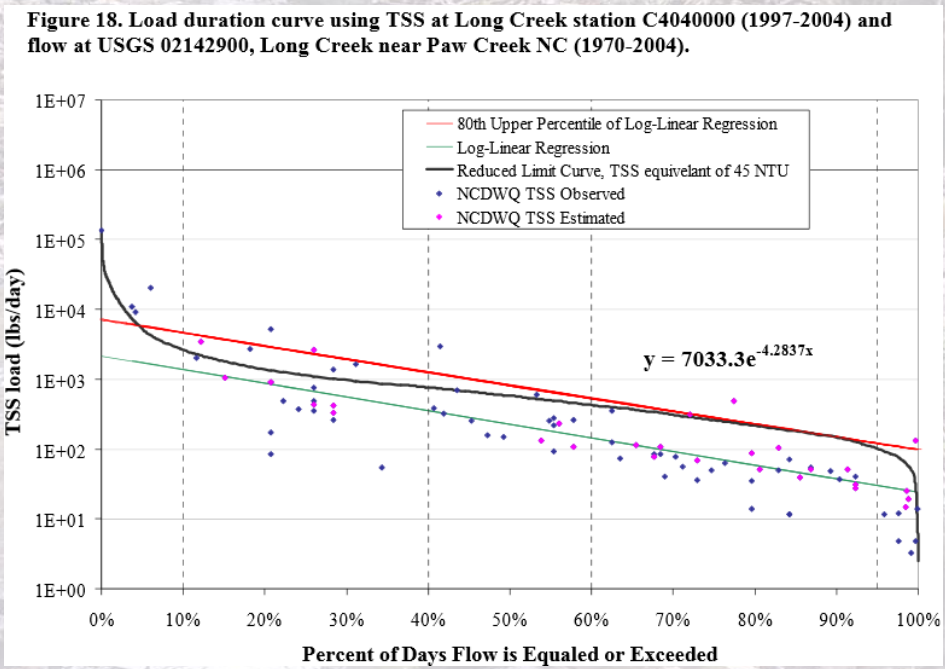




# SIMPLICITY

The simplest solutions are often the cleverest
They are also usually wrong

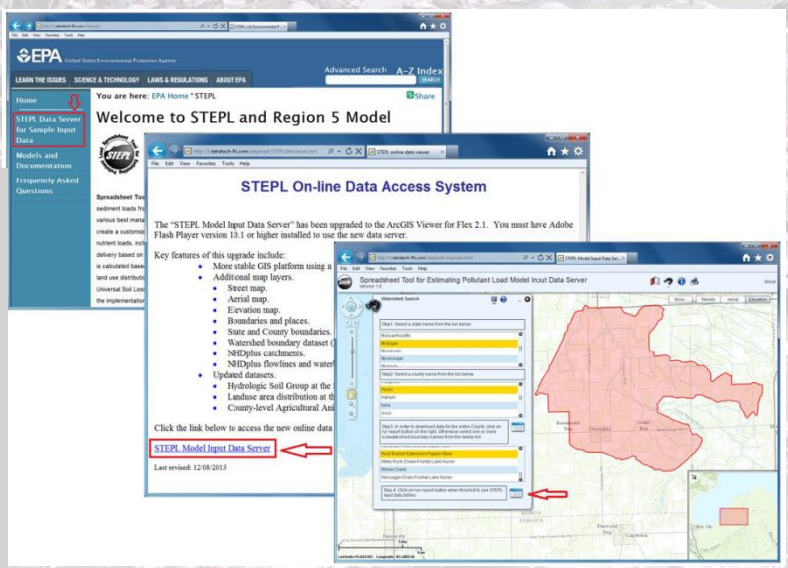
# Choosing an appropriate Model

- Least Complex ("simple-ish" equations)
  - Simple Method
    - L = 0.226 * Runoff * Concentration * Area
      - Runoff isn't simple
  - Load Duration
    - TSS = (0.39* Turb) –2.31
      - Requires Flow



# Choosing an appropriate Model

- More Complex (Spreadsheet)
  - Watershed Treatment Model (CWP)
  - STEPL (Tetra Tech)
  - TMDL USLE (Aqua Terra)





Welcome to

TMDL USLE, a practical tool for estimating diffuse sediment source loads within a watershed framework.

AQUA TERRA CONSULTANTS

Paul Hummel
John Imhoff
Robert Dusenbury
Mark Gray

United States Environmental Protection Agency

Robert Carousel
Work Assignment Manager

OWL
ONLINE WATERSHED LIBRARY

# Choosing an appropriate Model

- Most Complex (Watershed Based)
  (http://www.epa.gov/athens/wwqtsc/html/watershed_models.html)
  - BASINS (Better Assessment Science Integrating point & Non-point Sources)
    - 7 different models, varying complexity
  - LSPC (Load Simulation Program in C++)
    - hydrology, sediment, and general water quality on land as well as a simplified stream transport model

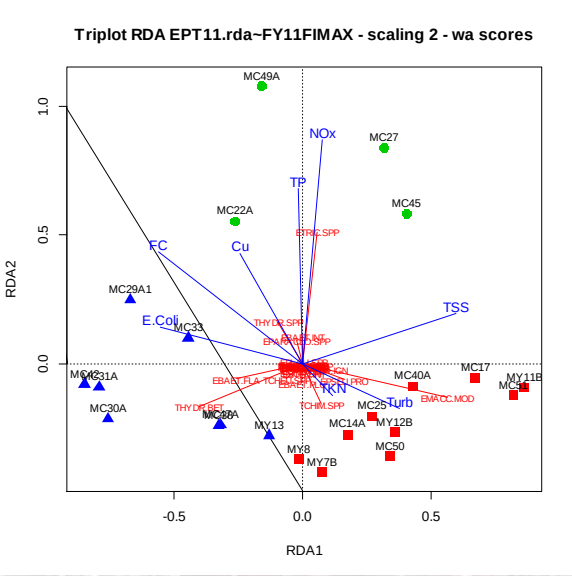
# Choosing an appropriate Model

- Most Complex (Watershed Based)
  (http://www.epa.gov/athens/wwqtsc/html/watershed_models.html)
  - WAM (Watershed Assessment Model)
    - both surface water and groundwater based on land use, soils, climate, and other factors
  - SWMM (Storm Water Management Model)
    - runoff quantity and quality from primarily urban areas
  - WARMF (Watershed Analysis Risk Management Framework)
    - road map to calculate TMDLs for most conventional pollutants (coliform, TSS, BOD, nutrients), includes stakeholder consensus guide

# Choosing an appropriate Model

- The model should link stressors and response variables
  - …and ideally management decisions

- Complexity of pollutant and data availability drive the choice
  - Complex pollutant + limited data = <u>more monitoring</u> or more uncertainty



# Choosing an appropriate Model

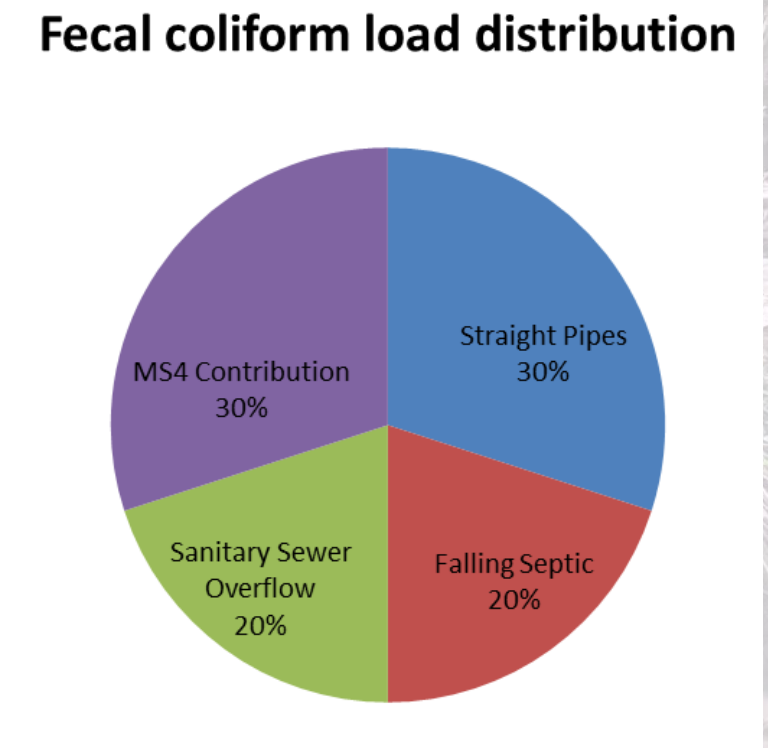
- Stakeholder buy-in
  - Development
    - Watershed Characterization
      - Watershed knowledge is key (have the right people)
    - Calibration
  - Implementation scenarios
    - Realistic solutions
    - Equitable reductions


# QUALITY

THE RACE FOR QUALITY HAS NO FINISH LINE-
SO TECHNICALLY, IT'S MORE LIKE A DEATH MARCH.

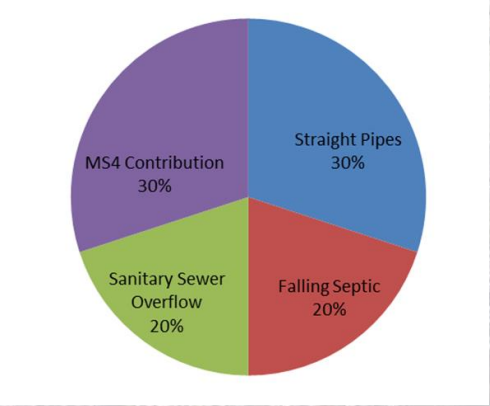
# If they are all wrong…What good is the model?

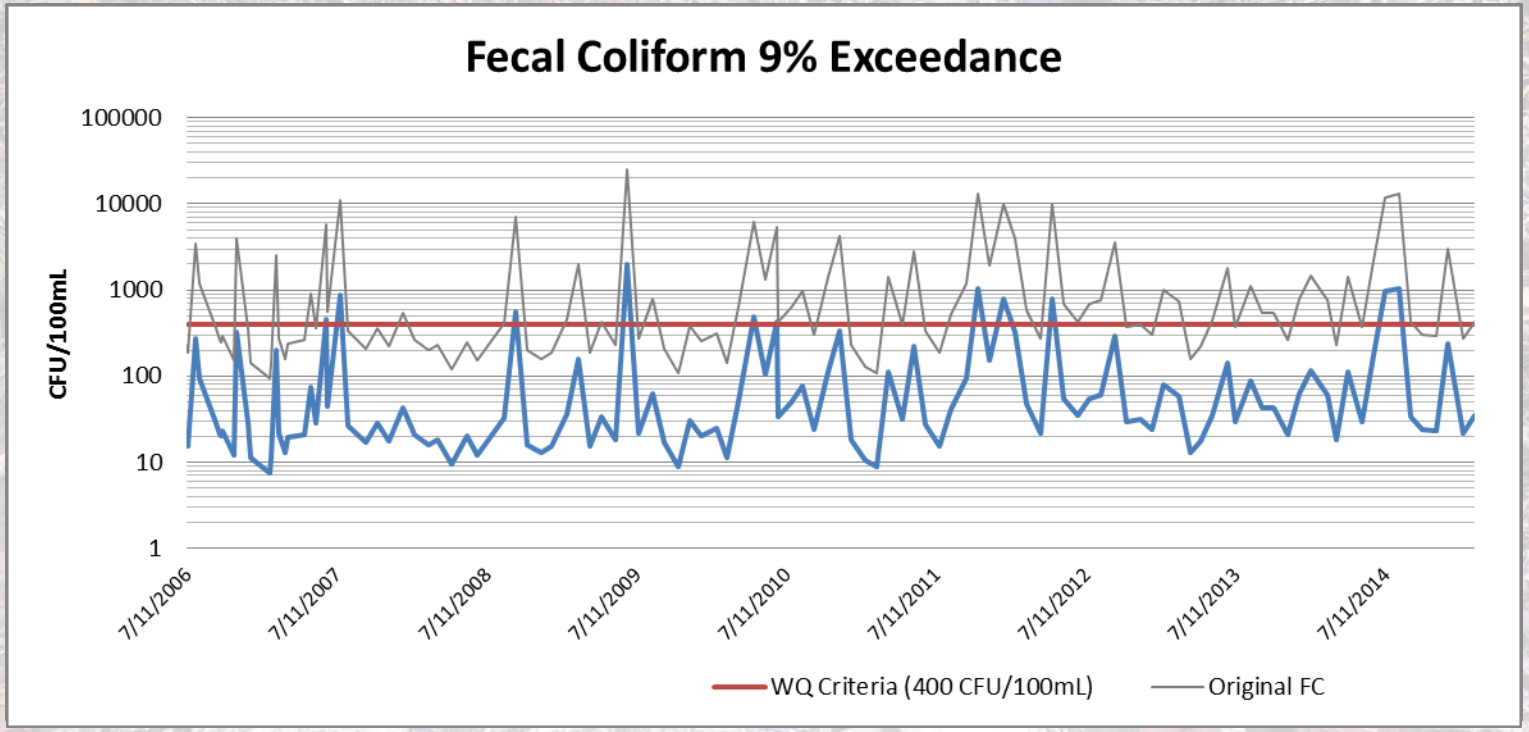
- Example watershed
  - Mostly rural with some urban infrastructure
  - Fecal Coliform TMDL developed
    - Sources represented in a way that reflects management options



# What good is the model?

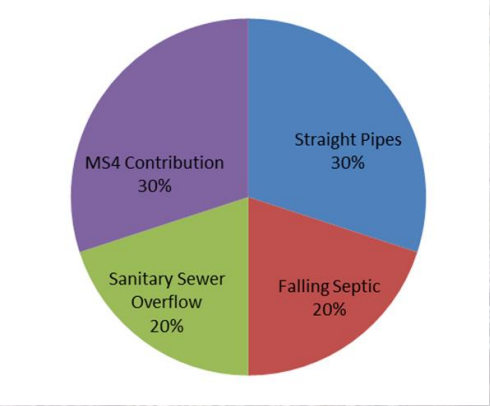
- Simulate Current Pollutants
- Reductions required to achieve targets

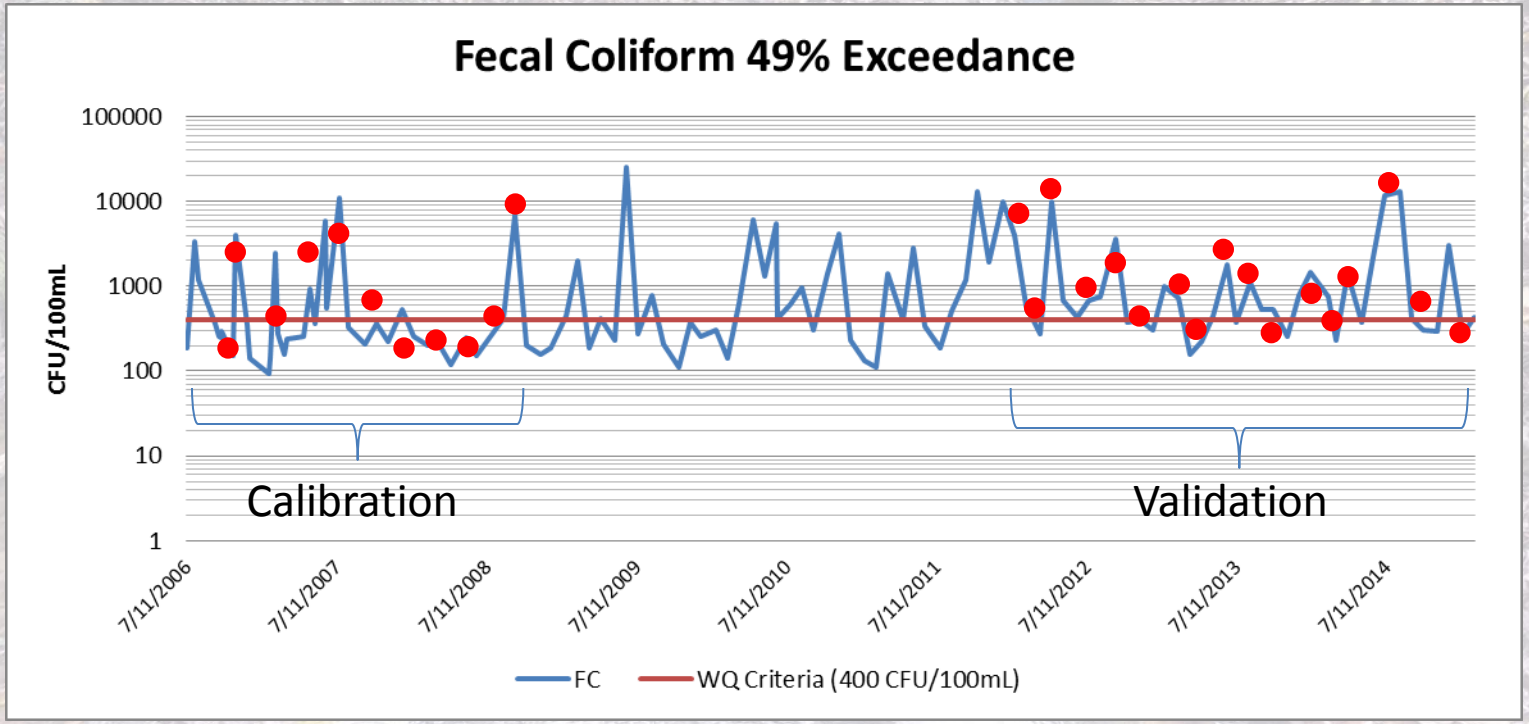


# What good is the model?

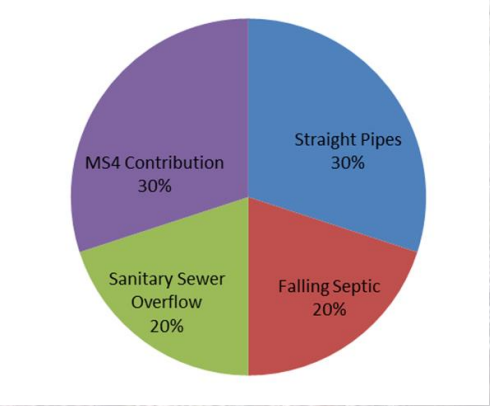
- Simulate Current Pollutants
  - Calibration
  - Validation

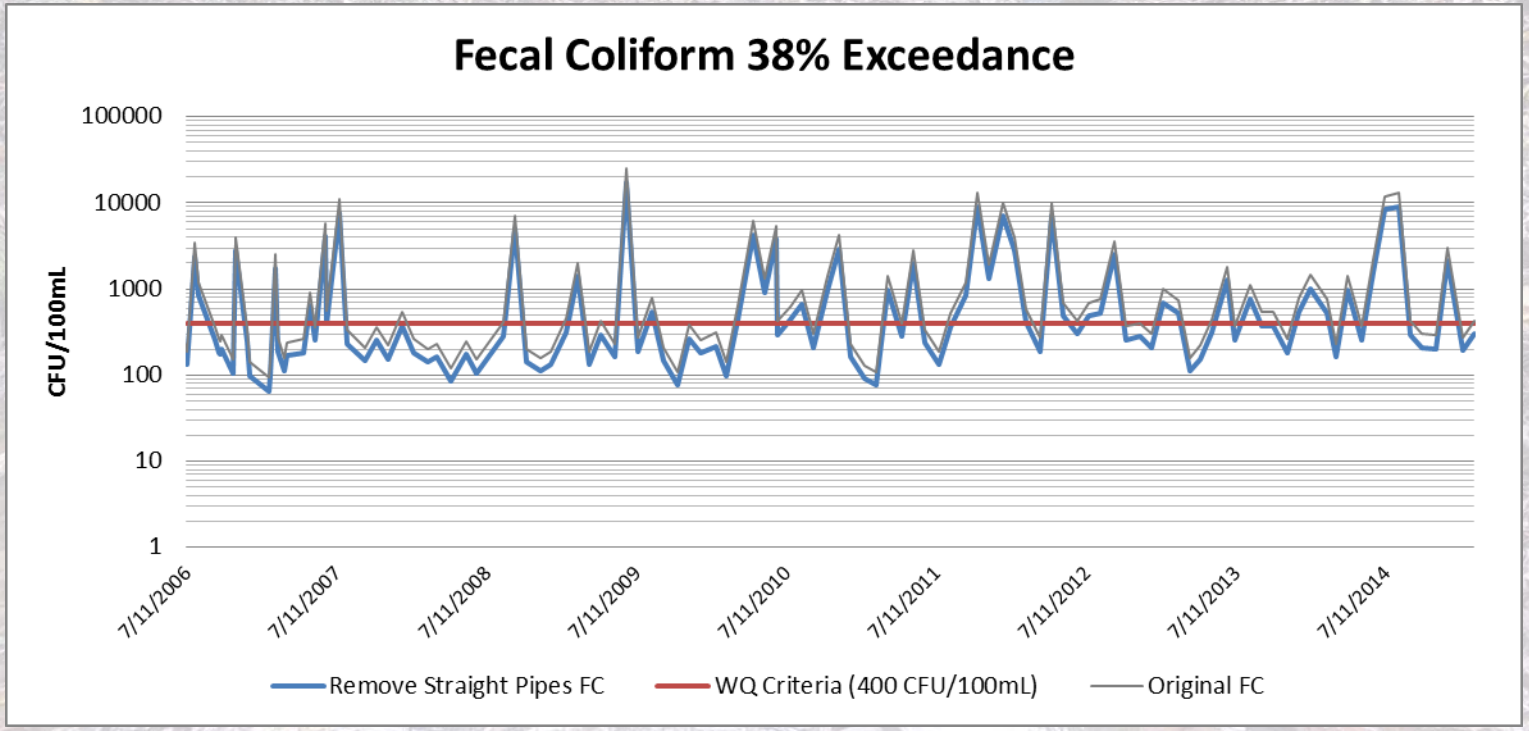


# What good is the model?

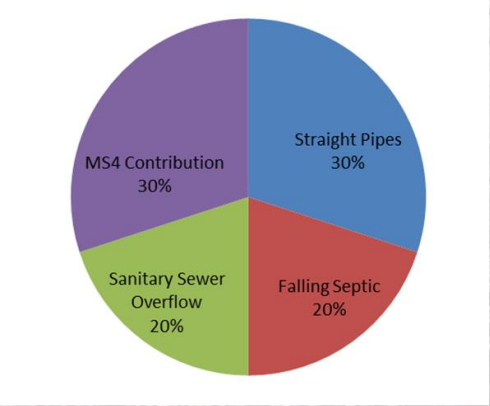
- Remove all straight pipes; 11% reduction (Illegal)

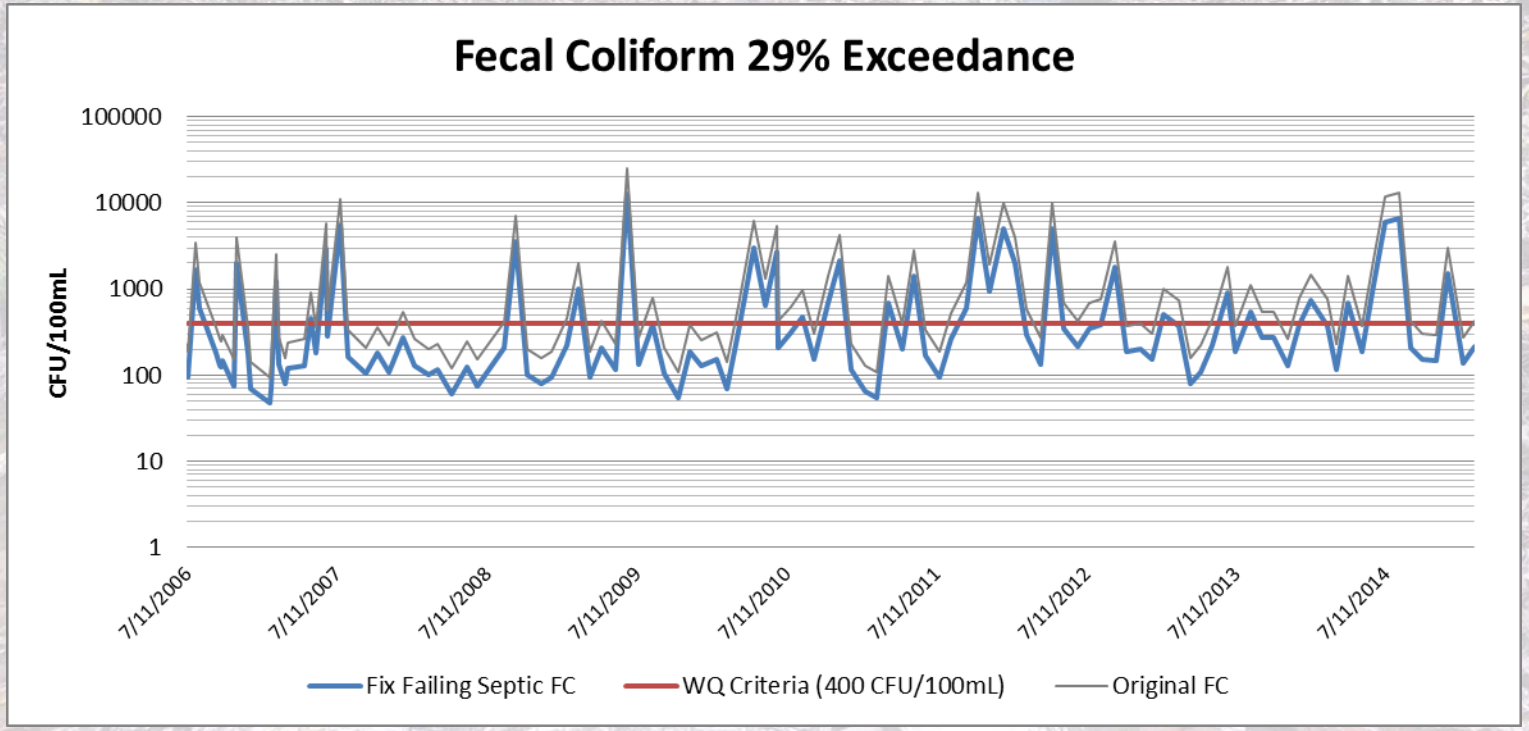


# What good is the model?

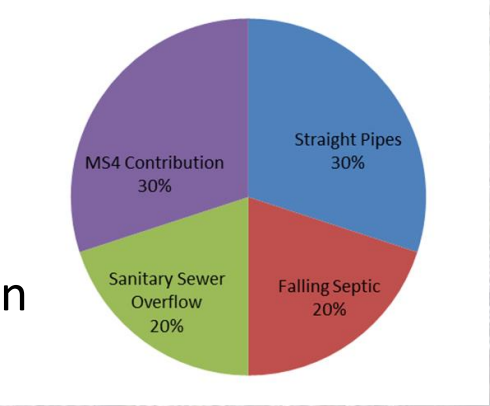
- Remove all straight pipes; 11% reduction (Illegal)
- Fix all failing septic; 9% reduction

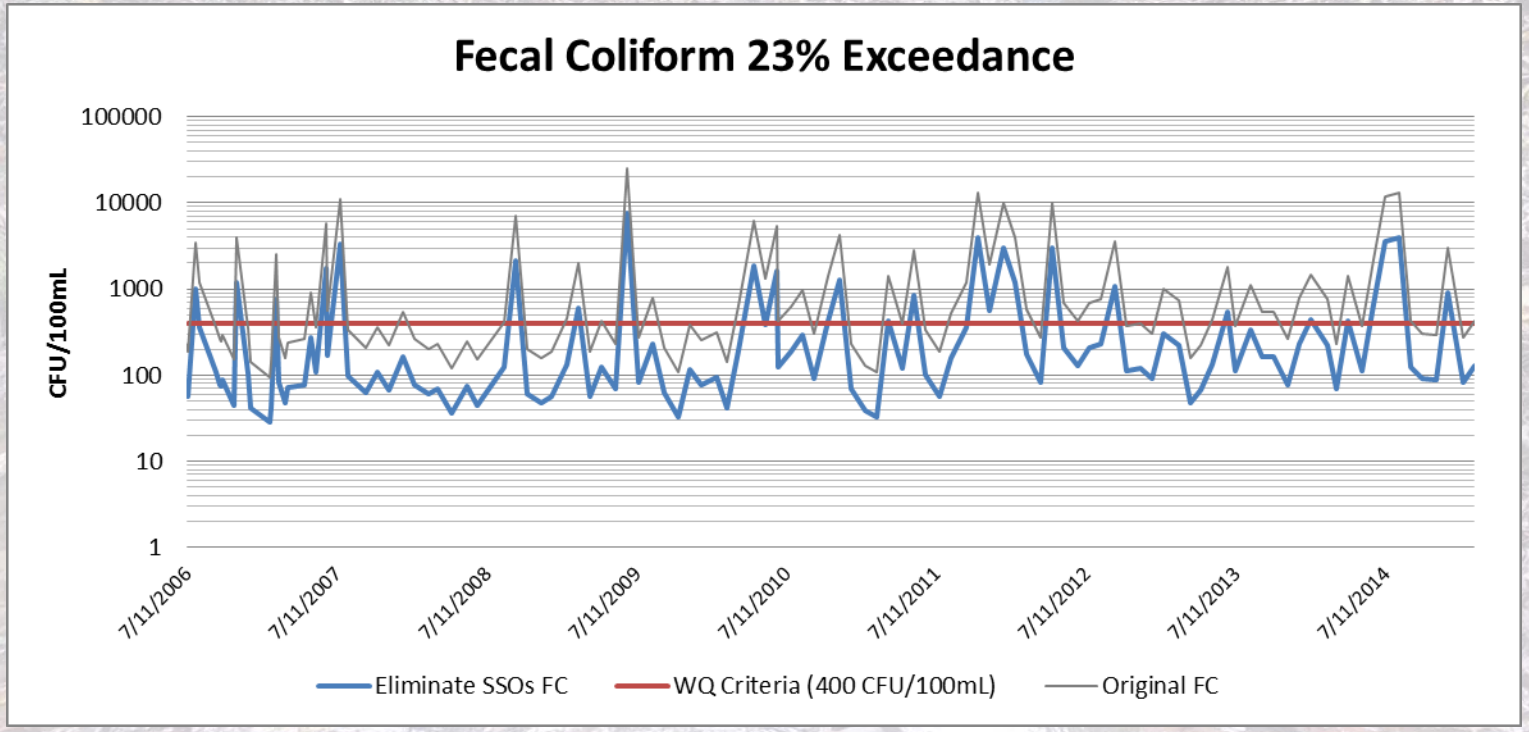


# What good is the model?

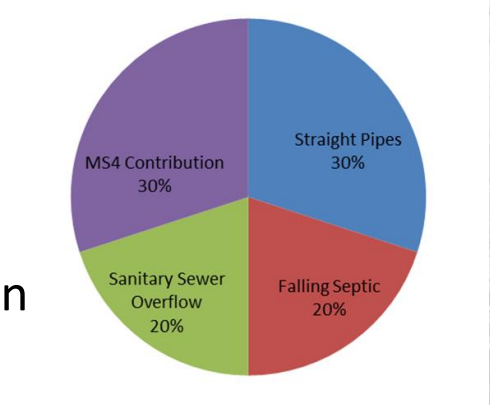
- Remove all straight pipes; 11% reduction (Illegal)
- Fix all failing septic; 9% reduction
- Eliminate 90% of sanitary sewer overflows; 6% reduction

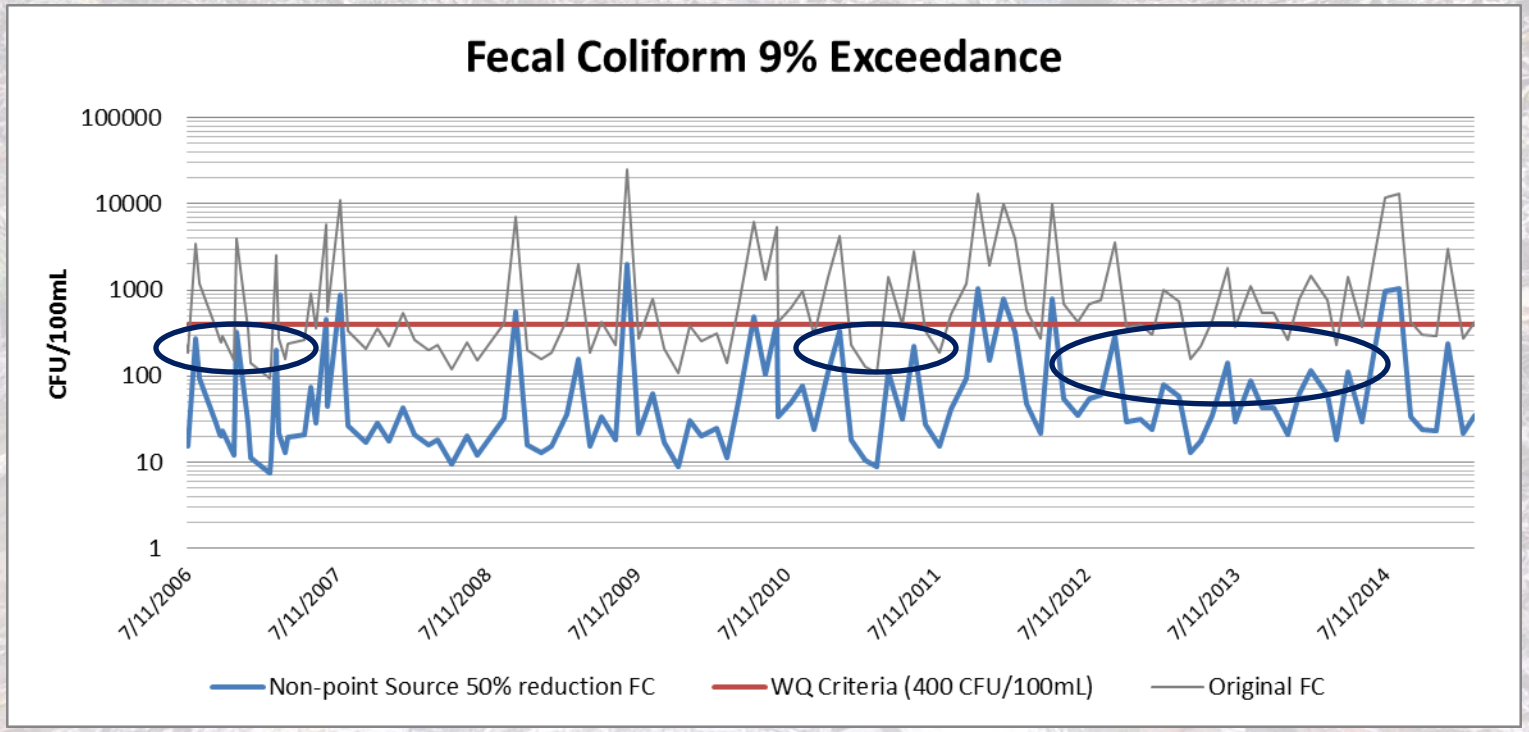


# What good is the model?

- Remove all straight pipes; 11% reduction (Illegal)
- Fix all failing septic; 9% reduction
- Eliminate 90% of sanitary sewer overflows; 6% reduction
- MS4 load reduced by 50%; 14% reduction



# Resources


http://www.epa.gov/athens/wwqtsc/index.html

# Resources

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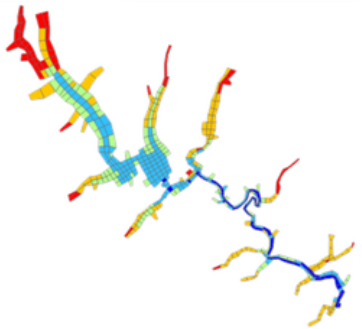
**Water Quality Modeling**

Water Quality Models are being increasingly used to help understand the effect of pollutants on waterbodies. Models help us understand the movement of pollutants from land-based sources to a waterbody (watershed model) or help us understand the fate, transport, and degradation of pollutants within a waterbody. DWR may use water quality models to help evaluate the effects of a new or expanded waste water discharge, or model the reduction of pollutants needed to restore good water quality to a lake.

The Modeling and Assessment Branch is often involved in models that are developed in support of a Nutrient Management Strategy, or TMDL load allocations. Third party models associated with a NPDES permit also require review by the MAB.

- Modeling Requirements
- Modeling 101 Presentation
- View Models
- Modeling Resources



**Model Requirements**

To enable DWR to confidently use water quality models for decision making purposes, DWR requires the following:

1. The person(s) planning to develop the model must have a scoping meeting with the MAB. This will ensure that the model will include all parameters needed.
2. A modeling plan must be prepared following the scoping meeting with DWR. Guidelines for preparing a modeling plan can be found here.
3. The model used must be listed in EPA's TMDL Modeling Toolbox, or the model code must remain available to the public. Other methods such as the load duration curve, and simplified tidal prism approach may be used when appropriate.
4. A modeling report or other appropriate documentation, along with all associated modeling files, must be submitted to DWR for review. Guidelines for preparing a modeling report can be found here.

http://portal.ncdenr.org/web/wq/ps/mtu/modeling

# Resources

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## BASINS (Better Assessment Science Integrating point & Non-point Sources)

Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) is a multipurpose environmental analysis system designed to help regional, state, and local agencies perform watershed- and water quality-based studies.

It was developed by the U.S. Environmental Protection Agency to assist in watershed management and TMDL development by integrating environmental data, analysis tools, and watershed and water quality models.

**Highlights**

- What's Different about BASINS 4.1?
- Framework and Features
- User Information and Guidance
- Download and Installation

A geographic information system (GIS) provides the integrating framework for BASINS. GIS organizes spatial information so it can be displayed as maps, tables, or graphics. GIS allows the user to analyze landscape information and display relationships among data.

http://water.epa.gov/scitech/datait/models/basins/index.cfm

# Questions??

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