



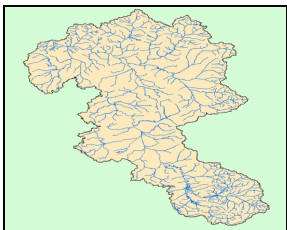


## A National Geospatial Surfacewater Framework

(<http://www.epa.gov/waters>)

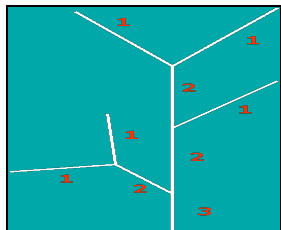
NHDPlus is a suite of application-ready geospatial products that build upon and extend the capabilities of the National Hydrography Dataset (NHD) by integrating it with the National Elevation Dataset and National Watershed Boundary Dataset. NHDPlus provides:

### Enhanced NHD Network & Names



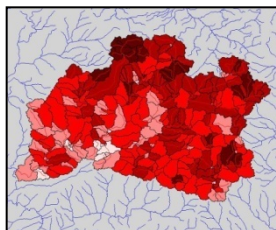
Updated network relationships enable robust up/downstream navigation. Additional hydrographic feature names enable improved map labeling, query-by-name, and linking of water quality data.

### Value-Added Attributes



Fourteen different Value-Added Attributes, including stream order, are derived from the underlying NHD and enable advanced query, analysis and display functionality.

### Catchments With Attributes



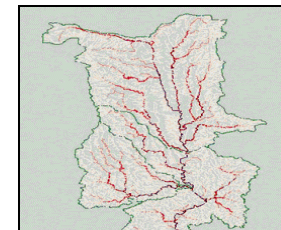
Incremental and cumulative drainage areas for each stream segment in the NHD network enable analysis of associated landscape characteristics, including temperature, precipitation and land cover.

### Flow Direction & Accumulation Grids

|    |    |     |
|----|----|-----|
| 32 | 64 | 128 |
| 16 |    | 1   |
| 8  | 4  | 2   |

Flow direction and accumulation grids associate the land surface (topography) with the NHD network enabling landscape analysis and characterization.

### Flow Volume and Velocity Estimates



Mean annual stream flow volume and velocity for each stream segment in the NHD network enable time-of-travel and pollutant dilution modeling.

## The National Hydrography Dataset

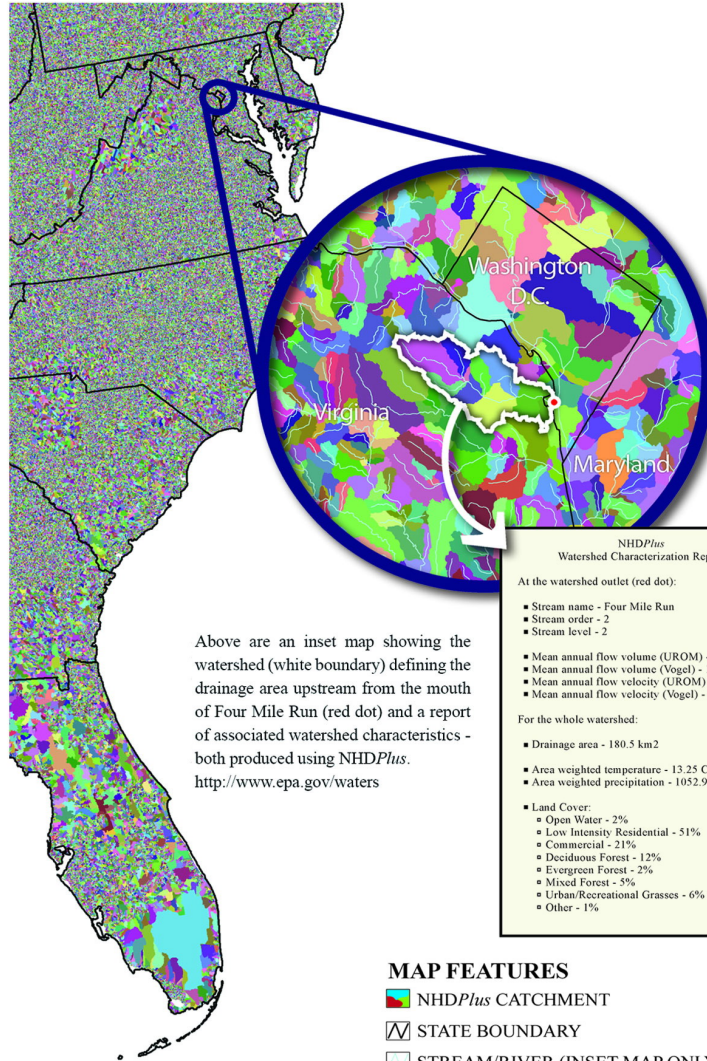
is a comprehensive set of digital geospatial data that contains information about surface water features such as streams, rivers and lakes. The NHD provides:

**A rich set of hydrographic features** for making maps.

**A stream addressing system** for linking water quality data to the NHD network.

**A drainage network** for supporting up/downstream query, analysis and modeling.

# ELEVATION-DERIVED CATCHMENTS FROM THE NATIONAL HYDROGRAPHY DATASET PLUS (NHDPlus)



Above are an inset map showing the watershed (white boundary) defining the drainage area upstream from the mouth of Four Mile Run (red dot) and a report of associated watershed characteristics - both produced using NHDPlus.  
<http://www.epa.gov/waters>

NHDPlus  
Watershed Characterization Report




At the watershed outlet (red dot):

- Stream name - Four Mile Run
- Stream order - 2
- Stream level - 2
- Mean annual flow volume (UROM) - 128.6 cfs
- Mean annual flow volume (Vogel) - 123.7 cfs
- Mean annual flow velocity (UROM) - 0.95 fps
- Mean annual flow velocity (Vogel) - 0.87 fps

For the whole watershed:

- Drainage area - 180.5 km<sup>2</sup>
- Area weighted temperature - 13.25 C
- Area weighted precipitation - 1052.9 mm
- Land Cover:
  - Open Water - 2%
  - Low Intensity Residential - 51%
  - Commercial - 21%
  - Deciduous Forest - 12%
  - Evergreen Forest - 2%
  - Mixed Forest - 5%
  - Urban/Recreational Grasses - 6%
  - Other - 1%

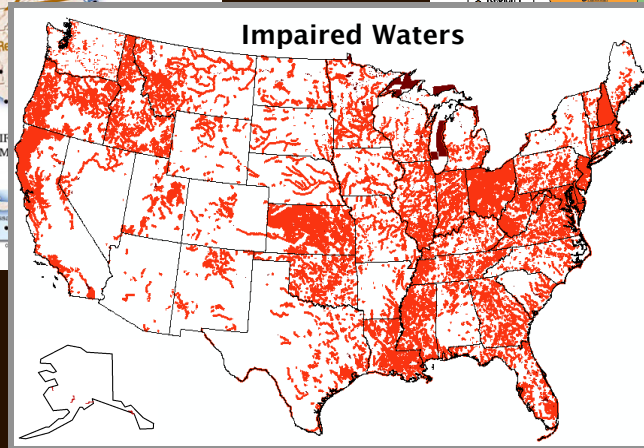
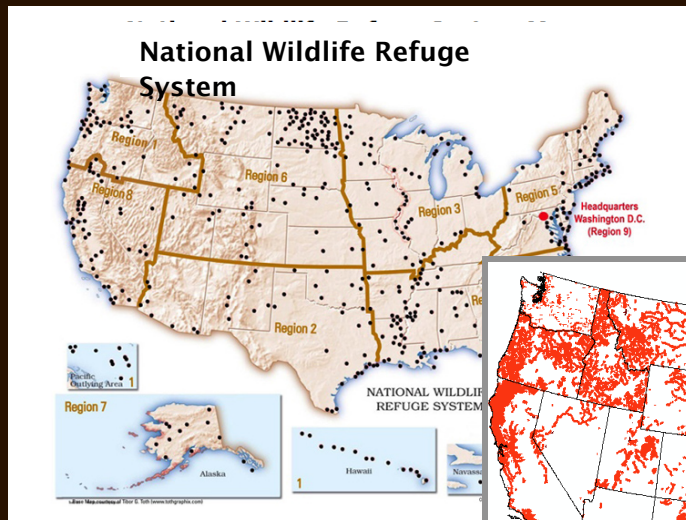
## MAP FEATURES

-  NHDPlus CATCHMENT
-  STATE BOUNDARY
-  STREAM/RIVER (INSET MAP ONLY)



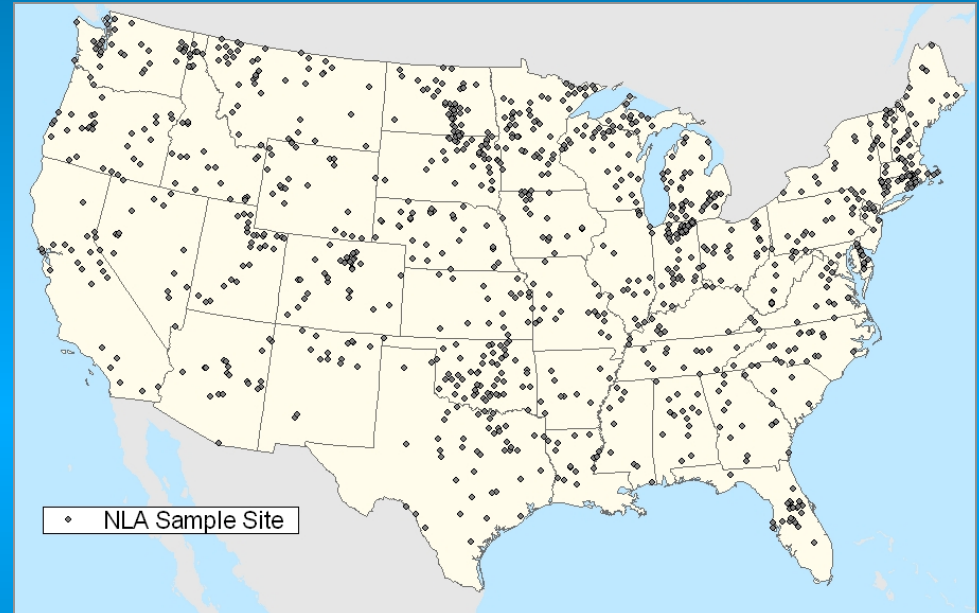
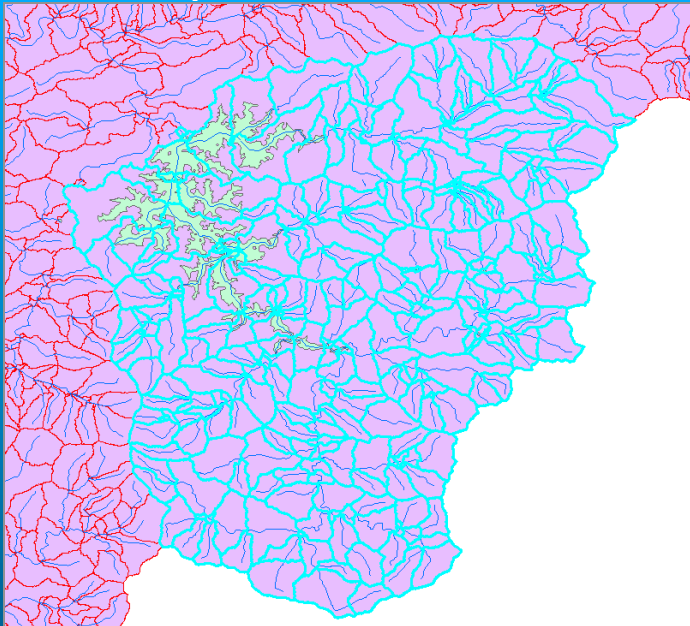
# Co-Occurrence of Impaired Waters and FWS Properties

An EPA, FWS and USGS Joint National Assessment



# EPA National Aquatic Resource Surveys

NHD*Plus* served as the basis for establishing the National Lakes Assessment sample frame – from which a representative set of sample sites (right) were randomly selected.

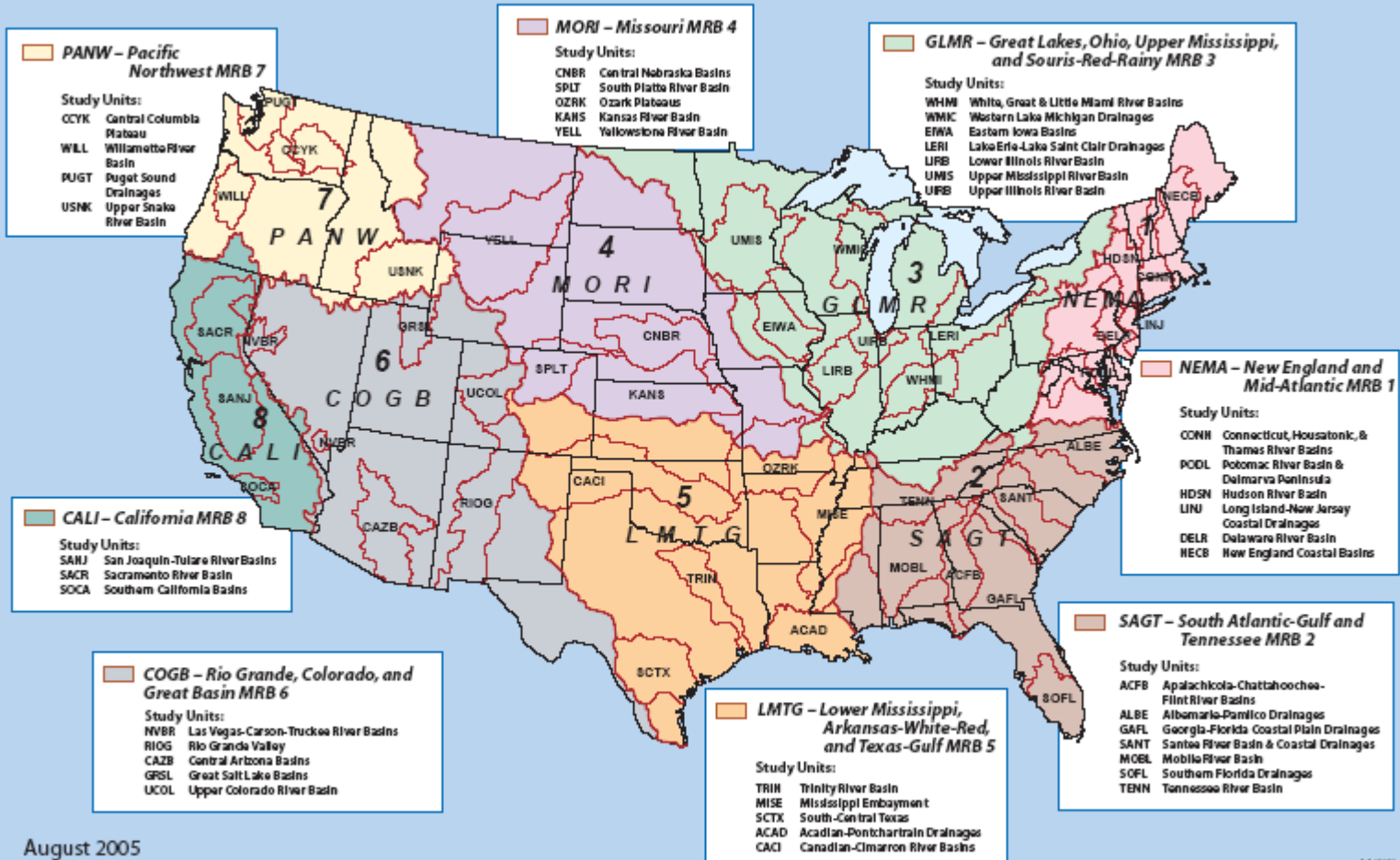


NHD*Plus* is also being used to calculate drainage areas for lake sampling sites (left) to support data analysis.

([www.epa.gov/owow/lakes/lakessurvey](http://www.epa.gov/owow/lakes/lakessurvey))

# USGS NAWQA SPARROW Models for Major River Basins

Locations of Regional Assessments of Streams and Rivers



August 2005



National Water-Quality Assessment Program

8/1/05

# Other Noteworthy NHD*Plus* Applications

- First ever spatially-based national pesticide risk assessment
- Clean Water Act jurisdictional analysis update
- National Fish Habitat Action Plan
- ESRI Hydro Base Map
- Native American historical migration paths
- Aquatic habitat classification

(Share your NHD*Plus* applications with others)



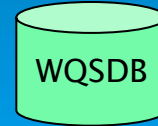
# WATERS Data Architecture

(Watershed Assessment, Tracking, & Environmental Results)  
([www.epa.gov/waters](http://www.epa.gov/waters))



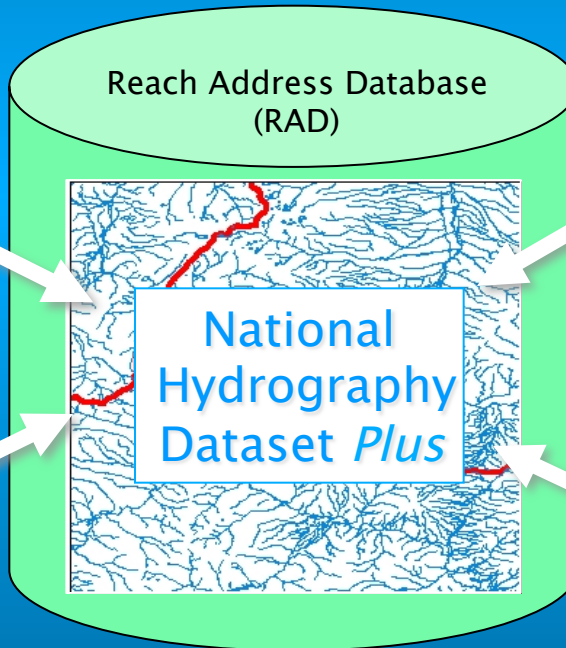
GRTS

Nonpoint Source Grants



WQSDB

Water Quality Standards



Reach Address Database (RAD)

National Hydrography Dataset *Plus*



ATTAINS

Water Quality Assessments,  
Impaired Waters &  
Total Maximum Daily Loads



STORET

Water Quality Monitoring



# Data Accessible Through *WATERS*

## Public Access

- Listed Impaired Waters
- Assessed Waters
- Beaches
- Clean Watershed Needs
- Combined Sewer Overflows
- CWSRF Benefits Reporting
- Permitted Dischargers
- Fish Consumption Advisories
- Fish Tissue Data
- Impaired Waters with TMDLs
- Sewage No Discharge Zones
- Nonpoint Source Projects
- Water Quality Standards
- Water Quality Stations

## Internal Access Only

- Drinking Water Intakes
- Source Water Areas
- Special Appropriations Projects

# WATERS Core Data and Tools

- Data

- National Hydrography Dataset Plus (NHD*Plus*)
- Water program system *linkages* (stream addresses)

- Tools

- Linking water program data to NHD*Plus*
- Forms-based search, analysis and reporting
- Map-based search, display and analysis
- Sharable Web services

- Visit [www.epa.gov/waters/tools](http://www.epa.gov/waters/tools)

# Viewing WATERS Data in Google Earth

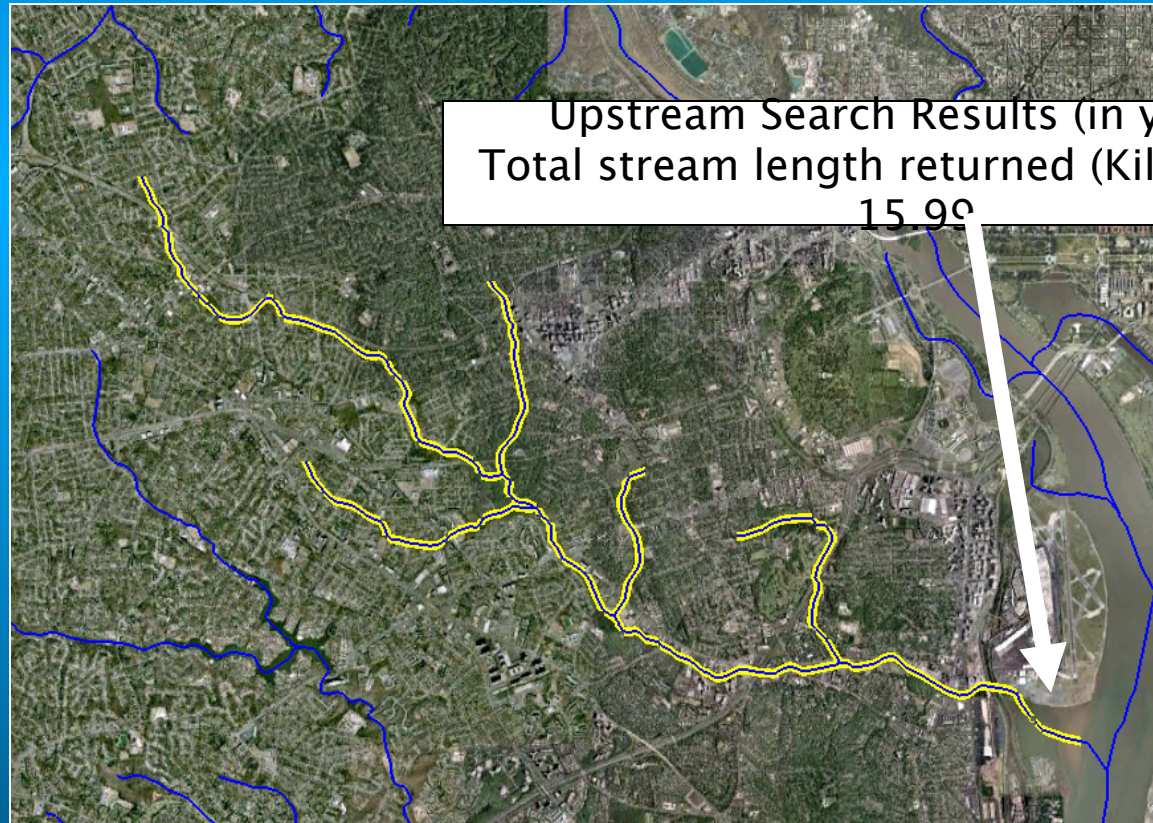
The screenshot shows the Google Earth Pro interface with a satellite view of a watershed boundary highlighted in yellow. A pop-up window titled "WATERS | US EPA - Windows Internet Explorer provi..." displays the "NHDPlus Watershed Characterization Report" for the Four Mile Run watershed. The report includes the following data:

| Category                 | Parameter                         | Value                |
|--------------------------|-----------------------------------|----------------------|
| At the watershed outlet: | Stream Name                       | Four Mile Run        |
|                          | Stream Order                      | 0                    |
|                          | Stream Level                      | 2                    |
|                          | Drainage area                     | 53.6 km <sup>2</sup> |
| For the whole watershed: | Mean annual flow volume (UROM)    | 23.6 efs             |
|                          | Mean annual flow volume (Vogel)   | 22.2 efs             |
|                          | Mean annual flow velocity (UROM)  | .7 fps               |
|                          | Mean annual flow velocity (Vogel) | .7 fps               |
|                          | Drainage area                     | 53.6 km <sup>2</sup> |

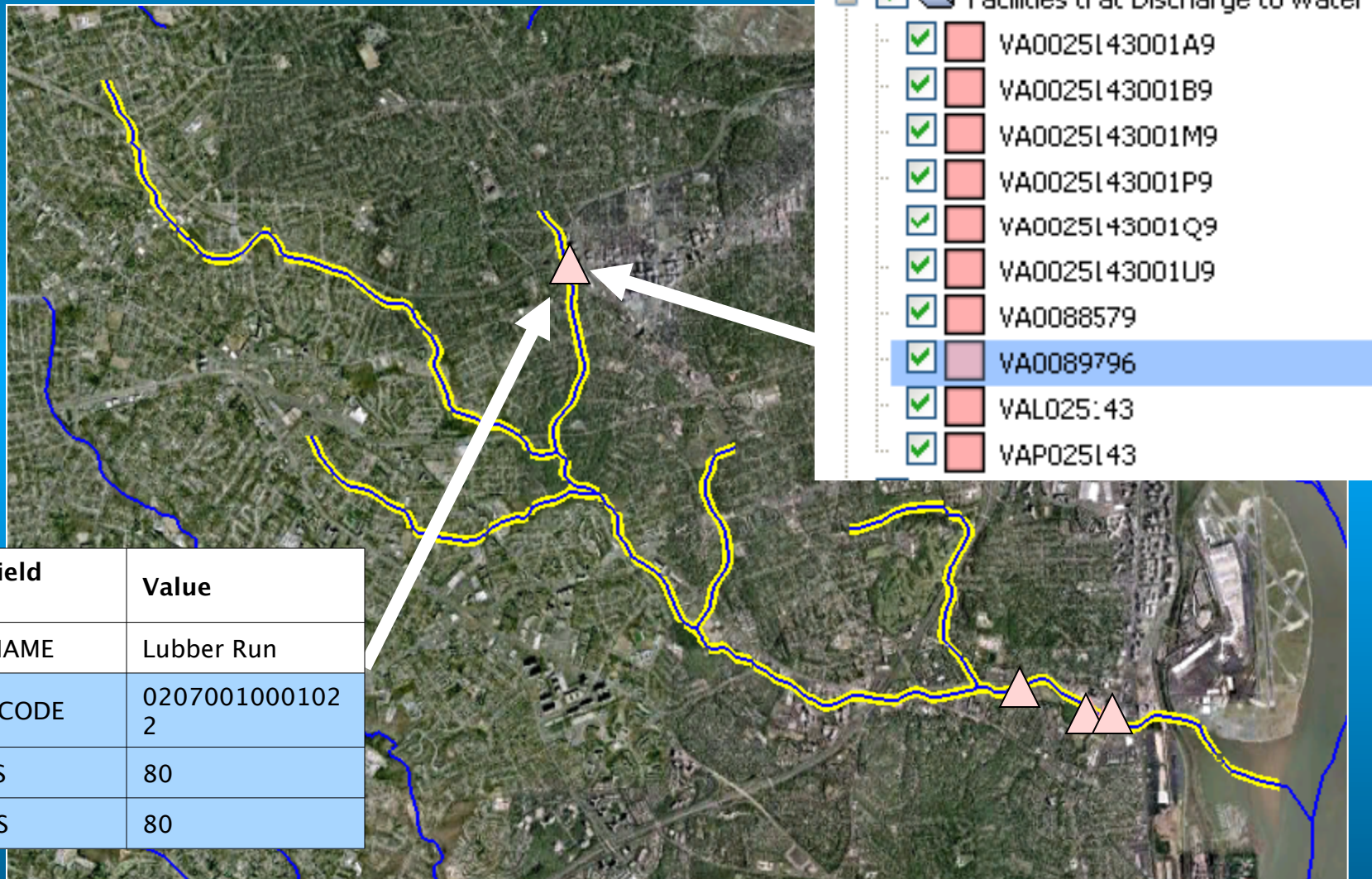
The interface also shows a "Places" sidebar with "Surfacewater Features" and "EPA Water Program Features" categories, and a "Layers" sidebar at the bottom. The "MyWATERS" logo is overlaid at the bottom right of the screenshot.

- Access to framework geospatial datasets stored in the WATERS Database and to general purpose interactive service panels.
- Dialog boxes providing access to tools, services, and information, such as NHD feature name query, total waters, up/downstream navigation, watershed reports, ATTAINS reports, etc.
- Access to indexed water program features, with hyperlinks to additional attributes, and context sensitive services, such as up/downstream navigation and watershed reports.

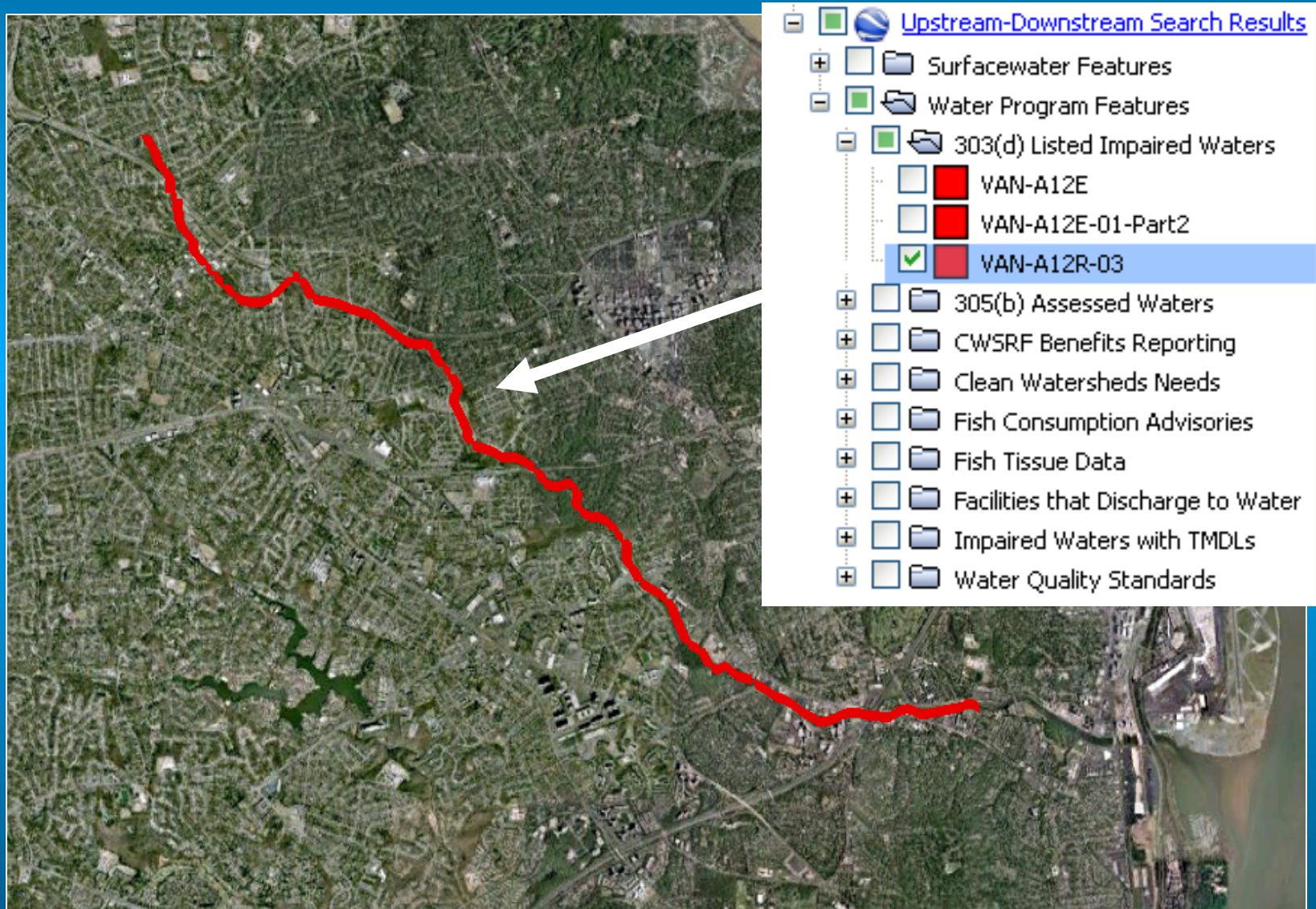
# Hydro Network Search (It's All About the 'Nets ... the Hydro Net on the Internet)



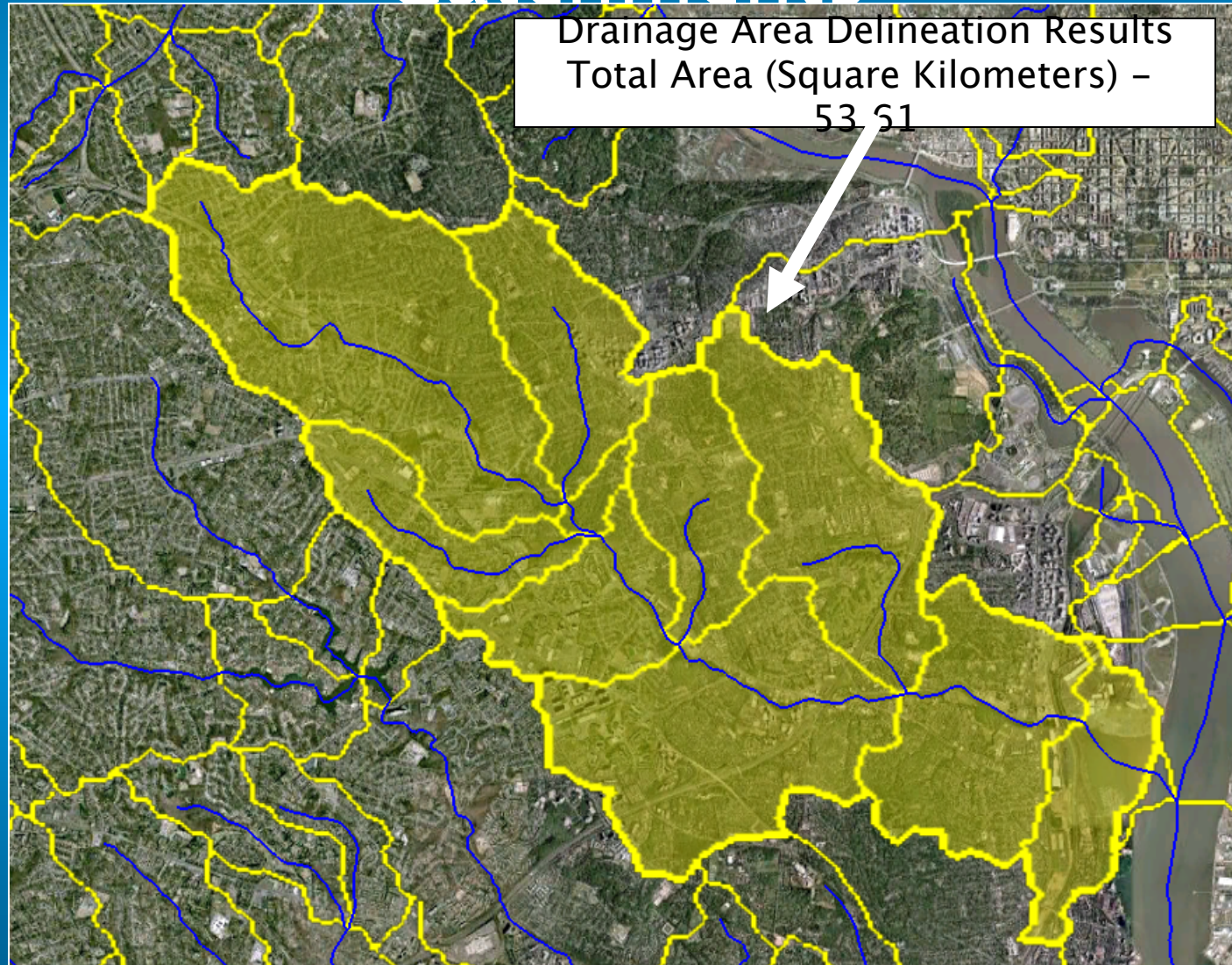
# ... with Associated Observations



# Linear 'Observations' Are Also Linked to the Hydro Network



# Drainage Area Delineation Based Upon Aggregated Catchments



# Enhancements to NHD*Plus*

- Medium Resolution (1:100,000-scale NHD)
  - Complete build/refresh toolset (2010)
  - National refresh (2010–2011)
    - Latest NHD and National Elevation Dataset (NED)
    - Now completed Watershed Boundary Dataset (WBD)
    - Monthly flow estimates
    - Ability to incorporate water additions and removals
  - Future spatial integration of NHD and WBD through stewardship program
- High Resolution (1:24,000-scale or better NHD)
  - State pilots



# Proposal for the Estimation of Streamflow Statistics for *NHDPlus* Reaches

## 1. Select gages

1. Delineate drainage area boundaries for all active and discontinued USGS gages
2. Compute basin characteristics for the selected gages.
3. Determine regulation status of the gages with 10 or more years of record
4. Eliminate regulated gages and gages with drainage areas from the NWIS database that do not agree with drainage areas computed from the *NHDPlus* dataset

## 2. Compute desired flow statistics for selected gages

1. Time series analysis: remove trends
2. Extend gage records with short record lengths by correlation with gages with longer records

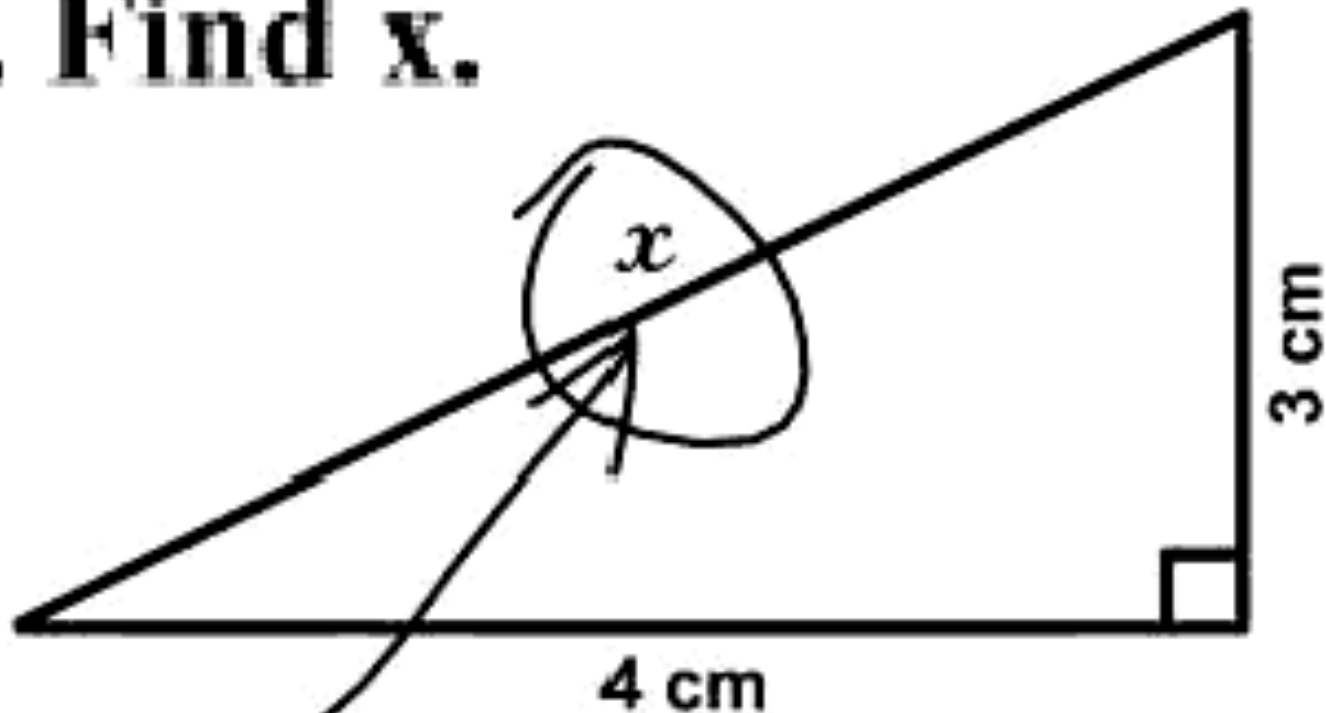
## 3. Re-compute flow statistics for gages using trend-adjusted and extended-record time series

## 4. Estimation of flow statistics for *NHDPlus* reaches

Building and applying NHD/  
NHD*Plus* –  
along the way we learned ...

Use simple solutions when they exist

**3. Find  $x$ .**



*Here it is*

Letting things  
get too  
complicated  
can be risky

$$c = a + b + d$$

$$c = (T \cdot S \cdot (\alpha - 10^\circ) + 3\alpha + 2 \cdot 3 \ln 11)^2$$

$$c = (T \cdot S \cdot \log \frac{4}{2+2} + 3\alpha + 6 \ln 11)^2$$

$$c = \left[ \int_{x_1}^{x_2} \sum_{i=1}^{\infty} \alpha dx + \frac{3[(3+7x)^2 + 6 + 3T]}{(5+y)(8+z)+1} + 6 \ln 11 \right]^2$$

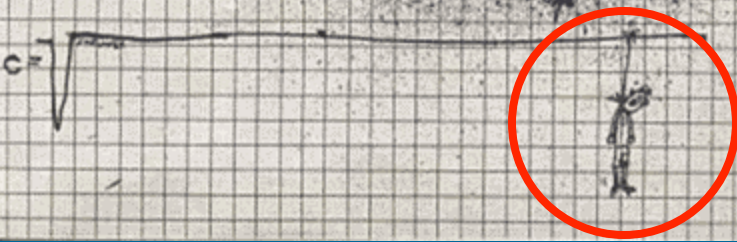
$$c = \left[ \int_{x_1}^{x_2} \sum_{i=1}^{\infty} \frac{(3+7x)^2 + 6 + 3T}{(5+y)(8+z)+1} dx + \frac{3[(3+7x)^2 + 6 + 3T]}{(5+y)(8+z)+1} + 6 \ln 11 \right]^2$$

$$c = \left[ \int_{x_1}^{x_2} \sum_{i=1}^{\infty} \frac{(3+7x)^2 + (\beta - 100^\circ) + 3T}{(5+y)(8+z)+1} dx + \frac{3[(3+7x)^2 + (\beta - 100^\circ) + 3T]}{(5+y)(8+z)+1} + 6 \ln 11 \right]^2$$

$$c = \left[ \int_{x_1}^{x_2} \sum_{i=1}^{\infty} \frac{\sqrt{3+7x} + (\beta - 100^\circ) + 3T}{(5+y)(8+z) + \log 8} dx + \frac{\sqrt{3+7x} + (\beta - 100^\circ) + 3T}{(5+y)(8+z) + \log 8} + 6 \ln 11 \right]^2$$

$$c = \sqrt{\left[ \int_{x_1}^{x_2} \sum_{i=1}^{\infty} \alpha dx + \frac{3\sqrt{3+7x} + (\beta - 100^\circ) + 3T}{(5+y)(8+z)} + 6 \ln 11 \right]^2 + \frac{\log 8}{1042 + 6T - 1}}$$

$$c = \sqrt{\left[ \int_{x_1}^{x_2} \sum_{i=1}^{\infty} \alpha dx + \frac{3\sqrt{3+7x} + (\beta - 100^\circ) + 3T}{(5+y)(8+z)} + 6 \ln 11 \right]^2 + \frac{\log 8}{1042 + 6T - 1}}$$



# Complex problems require creative solutions

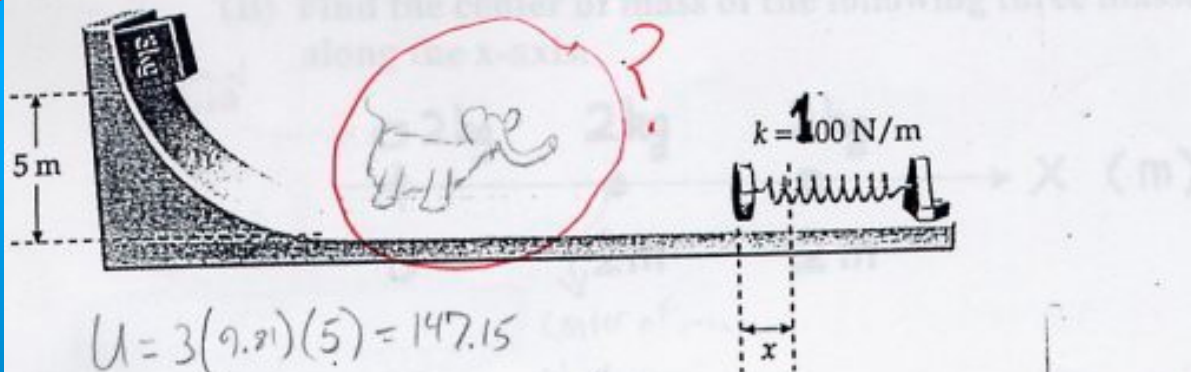
2. A 3-kg object is released from rest at a height of 5m on a curved frictionless ramp. At the foot of the ramp is a spring of force constant  $k = 100 \text{ N/m}$ . The object slides down the ramp and into the spring, compressing it a distance  $x$  before coming to rest.

10

(a) Find  $x$ .

5

(b) Does the object continue to move after it comes to rest? If yes, how high will it go up the slope before it comes to rest?



$$U = 3(9.81)(5) = 147.15$$

$$U_s = \frac{1}{2}(100)x^2 = 50x^2 \quad \dots?$$

NO. there is an elephant in the way.



# Questions?



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dewald.tommy@epa.gov

([www.epa.gov/waters](http://www.epa.gov/waters) > *NHDPlus* Quicklink)