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"Purdue Load Duration Curve Tool (P-LDC) using WQX and USGS data flows."

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for
Purdue University ABE and Office of Indiana State Chemist
September 27-28, 2012

EPA Grant Number – Program Code, Number, and Amendment Number:
OS – 83609801 – 0

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Quotes from the grant text:

Abstract:
This project will connect the Purdue *Flow and Load Duration Curve* tool, which is a tool used in constructing TMDLs, to data from WQX.

This enhancement to an existing tool will allow users to simultaneously consume USGS flow data, WQX water quality data, EPA Waters web services (GIS data)…

The project meets strategic goals for EPA, and in particular for the Exchange Network …

Define some Terms:

STORET and WQX

http://www.epa.gov/storet/wqx/

Water Quality Portal USGS/EPA/NWQMC

http://www.waterqualitydata.us/index.jsp

STEP-L

http://it.tetratech-ffx.com/steplweb/

LOADEST

http://water.usgs.gov/software/loadest/

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The STORET Data Warehouse is EPA's repository of the water quality monitoring data collected by water resource management groups across the country.

These organizations, including states, tribes, watershed groups, federal agencies, volunteer groups and universities, submit data to the STORET Warehouse in order to make their data publically accessible.

Data can then be re-used for analysis. WQX is the framework by which organizations submit data to the Warehouse.

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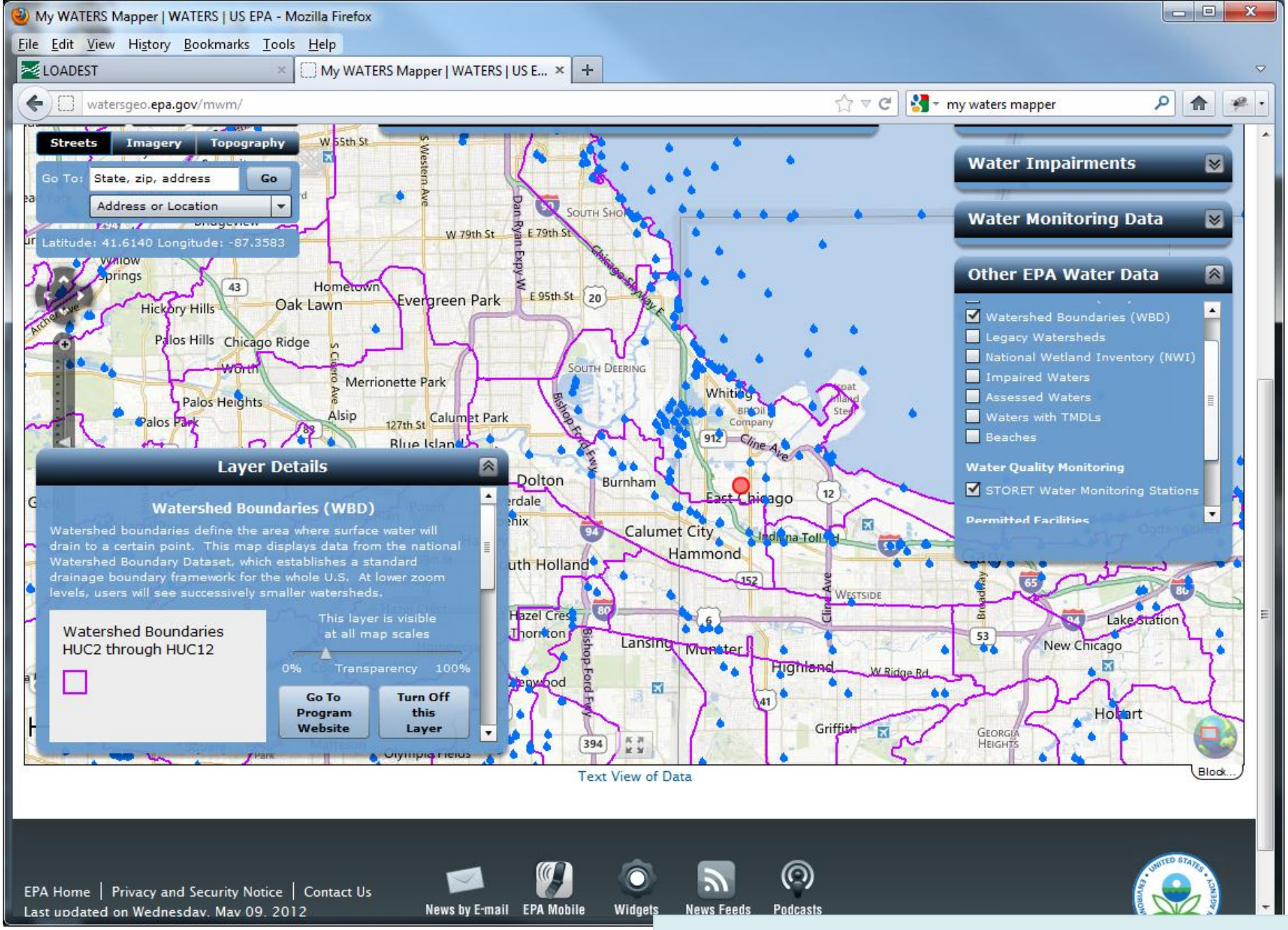
What is WQX?

The Water Quality Exchange (WQX) is a new framework that makes it easier for States, Tribes, and others to submit and **share** water quality monitoring data over the Internet.

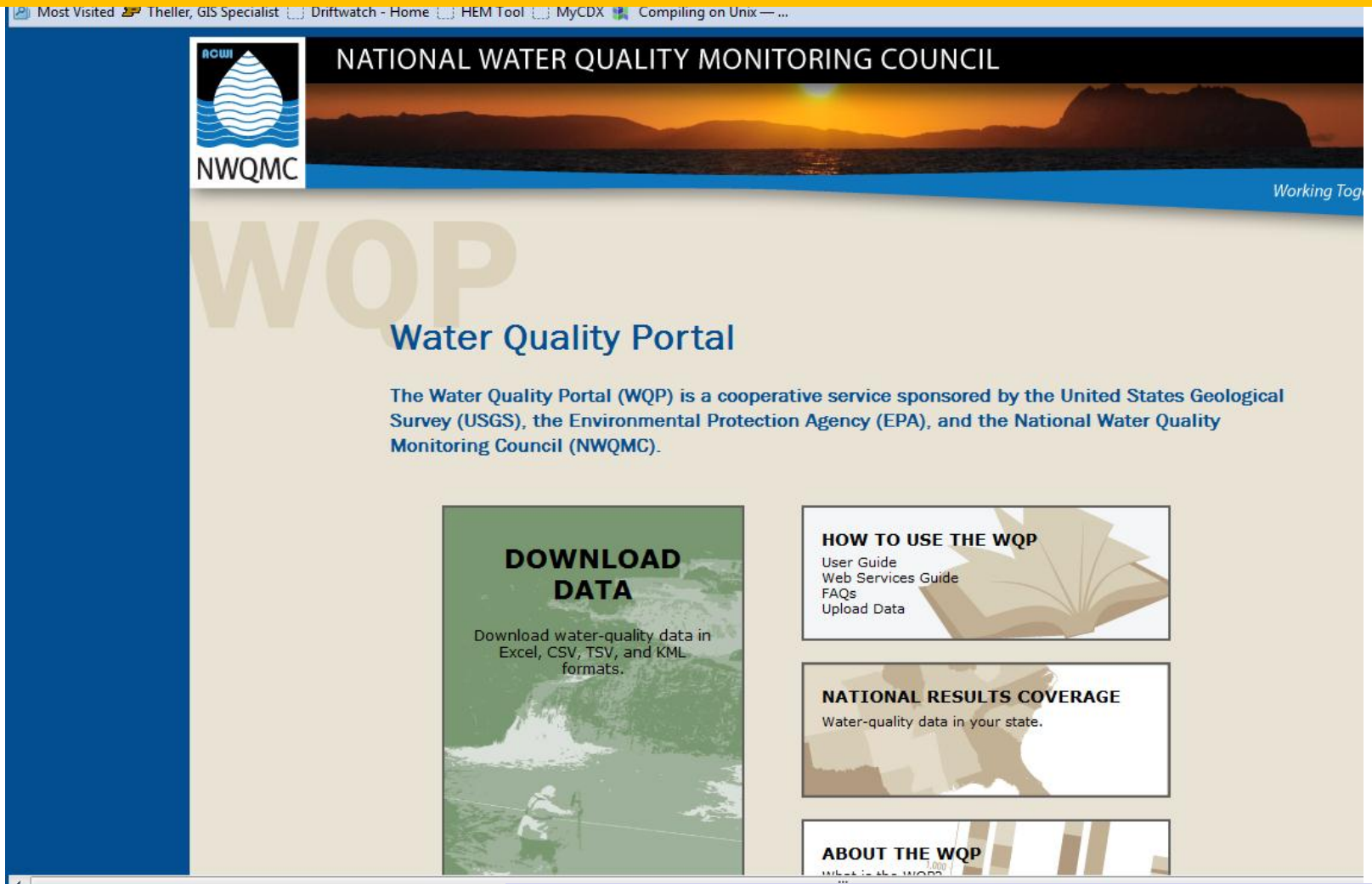
States, Tribes and other organizations can submit data directly to the publicly-accessible STORET Data Warehouse using the WQX framework.

Several methods exist to have map-based query access to this data.



http://watersgeo.epa.gov/mwm/

The Water Quality Portal (WQP) is a cooperative service sponsored by the United States Geological Survey (USGS), the Environmental Protection Agency (EPA) and the National Water Quality Monitoring Council (NWQMC) that integrates publicly available water quality data from the USGS National Water Information System (NWIS) and the EPA STOrage and RETrieval (STORET) Data Warehouse.



http://www.waterqualitydata.us/index.jsp

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NWQMC

NATIONAL WATER QUALITY MONITORING COUNCIL

Working Together for Clean Water

Water Quality Portal

WQP Home
Download Data
How to use the WQP
- User Guide
- Web Services Guide
- FAQs
- Upload Data

National Results Coverage
About the WQP
- What is the WQP?
- Contributing organizations
- Contact us

LOCATION

Country: US select
State: select
County: select

Point location: ?

Within: miles from:
Lat: Long:
my location

Bounding box: ?

North:
West: East:
South:

SITE PARAMETERS

Site Type: select
Organization ID: select
Site ID: ?
HUC: ?

SAMPLING PARAMETERS

Sample Media: select
Characteristic Group: select
Characteristics: select
Parameter Code: (NWIS ONLY) ?
Date range: from to (mm-dd-yyyy)

DOWNLOAD

Select database: All databases USGS NWIS only EPA STORET only
Select data: Sites only Sample results only

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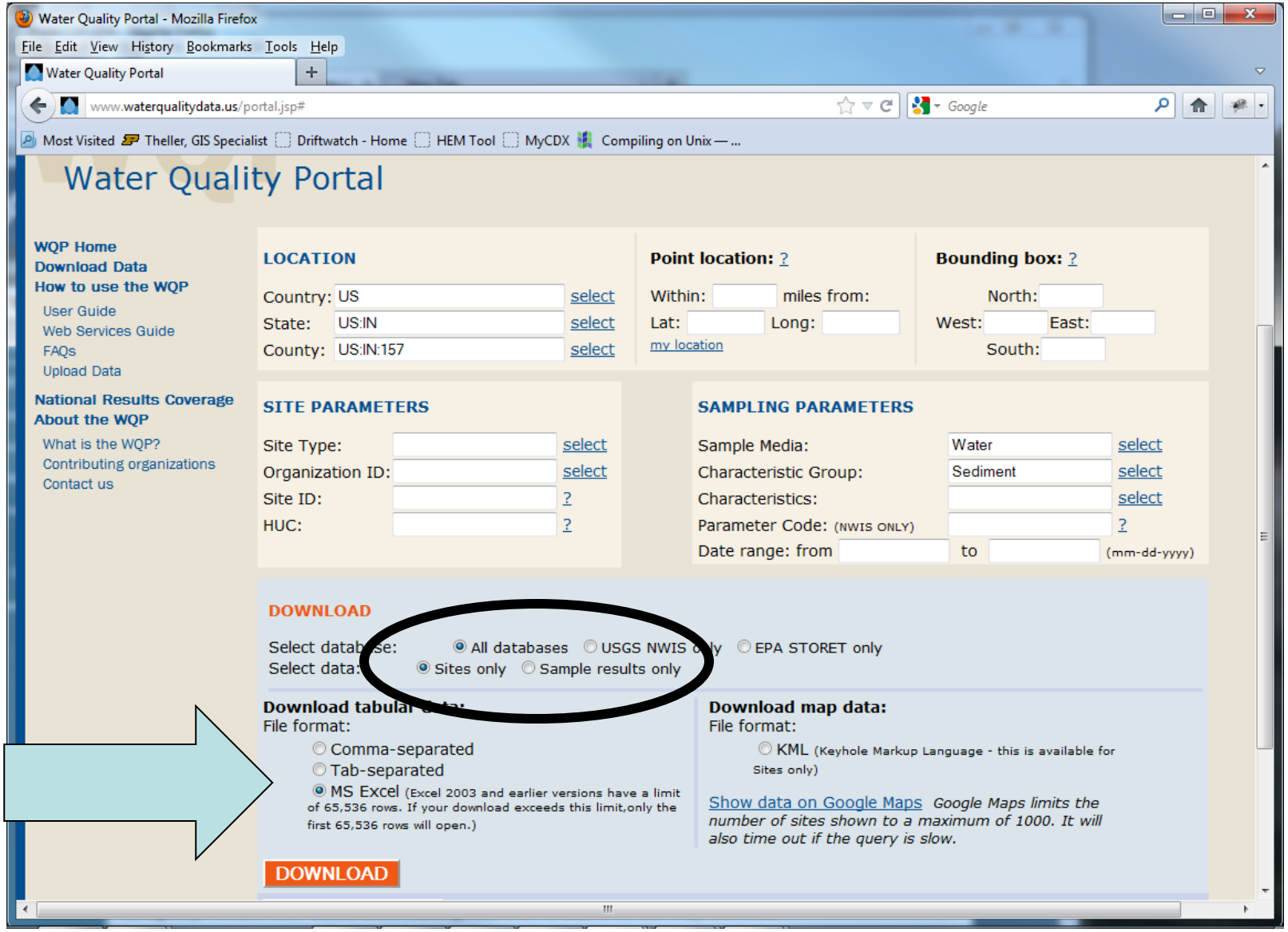

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EPA United States Environmental Protection Agency

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SEARCH

Home

STEPL Data Server for Sample Input Data

Models and Documentation

Frequently Asked Questions

You are here: EPA Home » STEPL

Share

Welcome to STEPL and Region 5 Model

Spreadsheet Tool for Estimating Pollutant Load (STEPL) employs simple algorithms to calculate nutrient and sediment loads from different land uses.

It calculates the load reductions that would result from the implementation of various best management practices (BMPs).

Region 5 Model is an Excel workbook that provides a gross estimate of sediment and nutrient load reductions from the implementation of agricultural and urban BMPs. The algorithms for non-urban BMPs are based on the "Pollutants controlled: Calculation and documentation for Section 319 watersheds

http://it.tetratech-ffx.com/steplweb/

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LOAD ESTimator (LOADEST) is a FORTRAN program for estimating constituent loads in streams and rivers.

Given a time series of streamflow, additional data variables, and constituent concentration, LOADEST assists the user in developing a regression model for the estimation of constituent load (calibration).

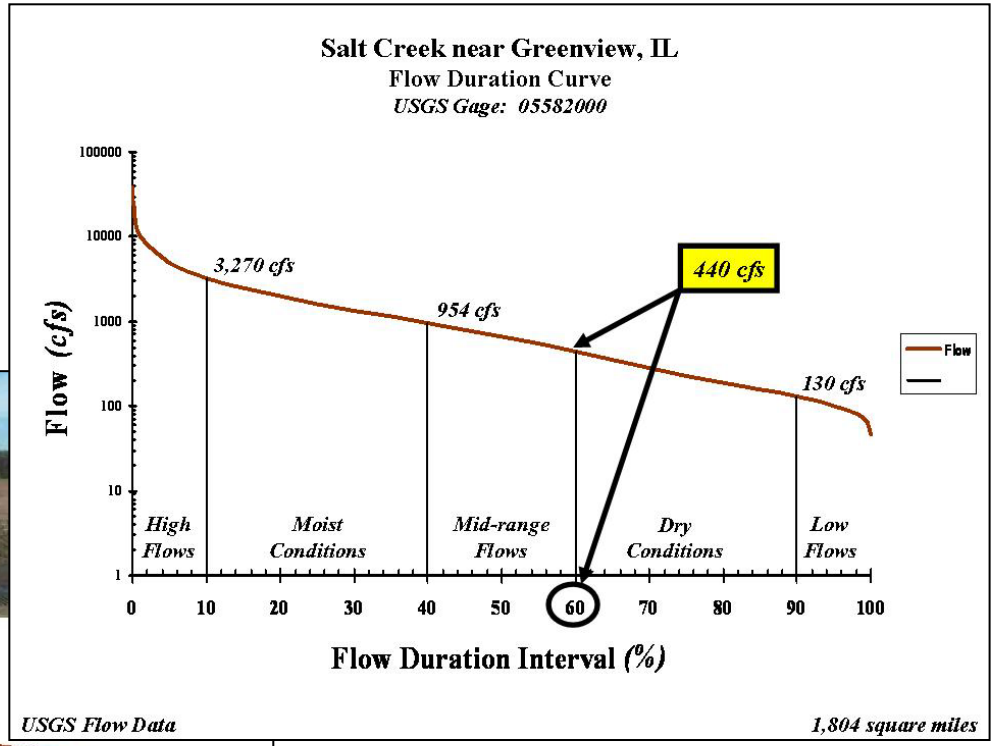
The formulated regression model then is used to **estimate loads over time** .

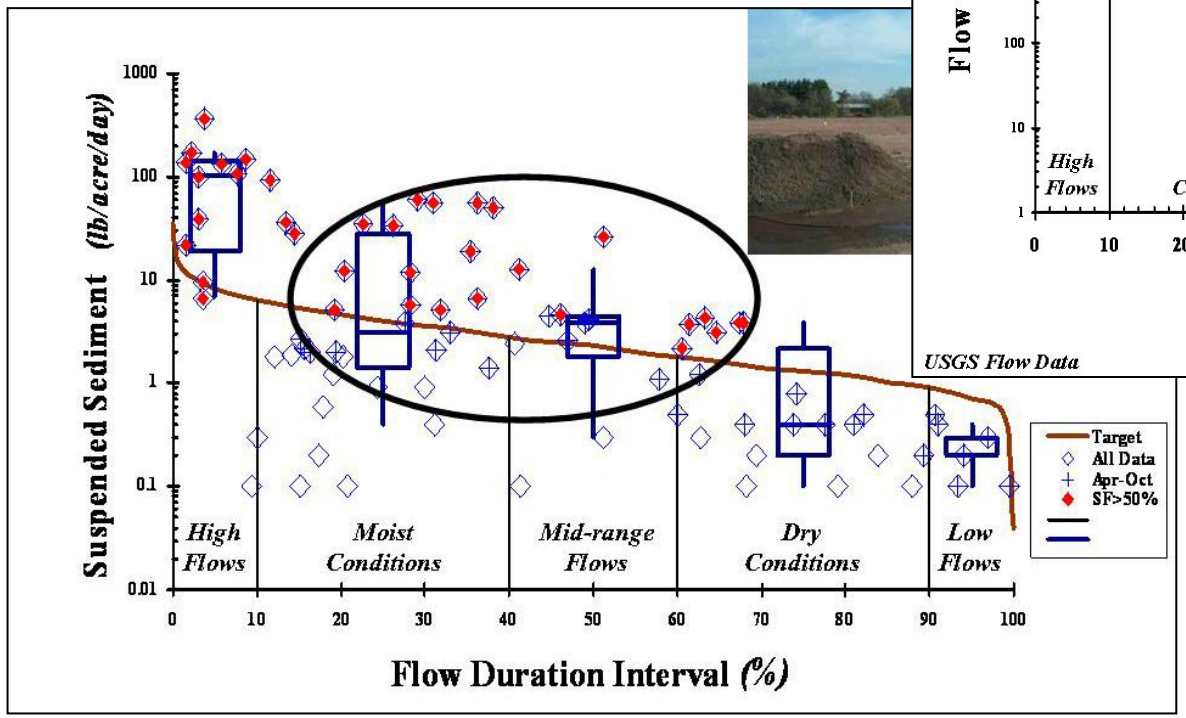
Mean load estimates, standard errors, and 95 percent confidence intervals are developed on a monthly and(or) seasonal basis.

http://water.usgs.gov/software/loadest/

Flow and Load Duration Curves

- Simple, quick, and statistical approach
- Cumulative frequency of historic data over a specified period





* USEPA, 2007. An approach for using load duration curves in the development of TMDLs. *U. S. Environmental Protection Agency*

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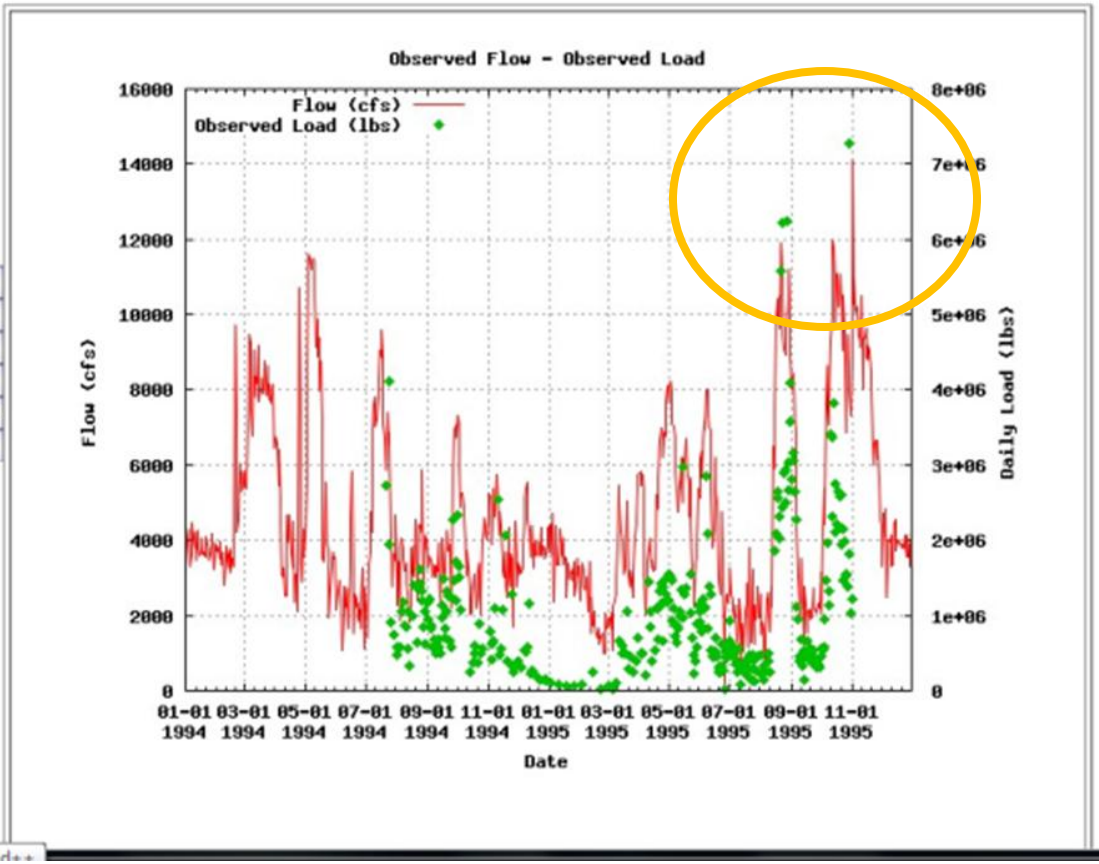
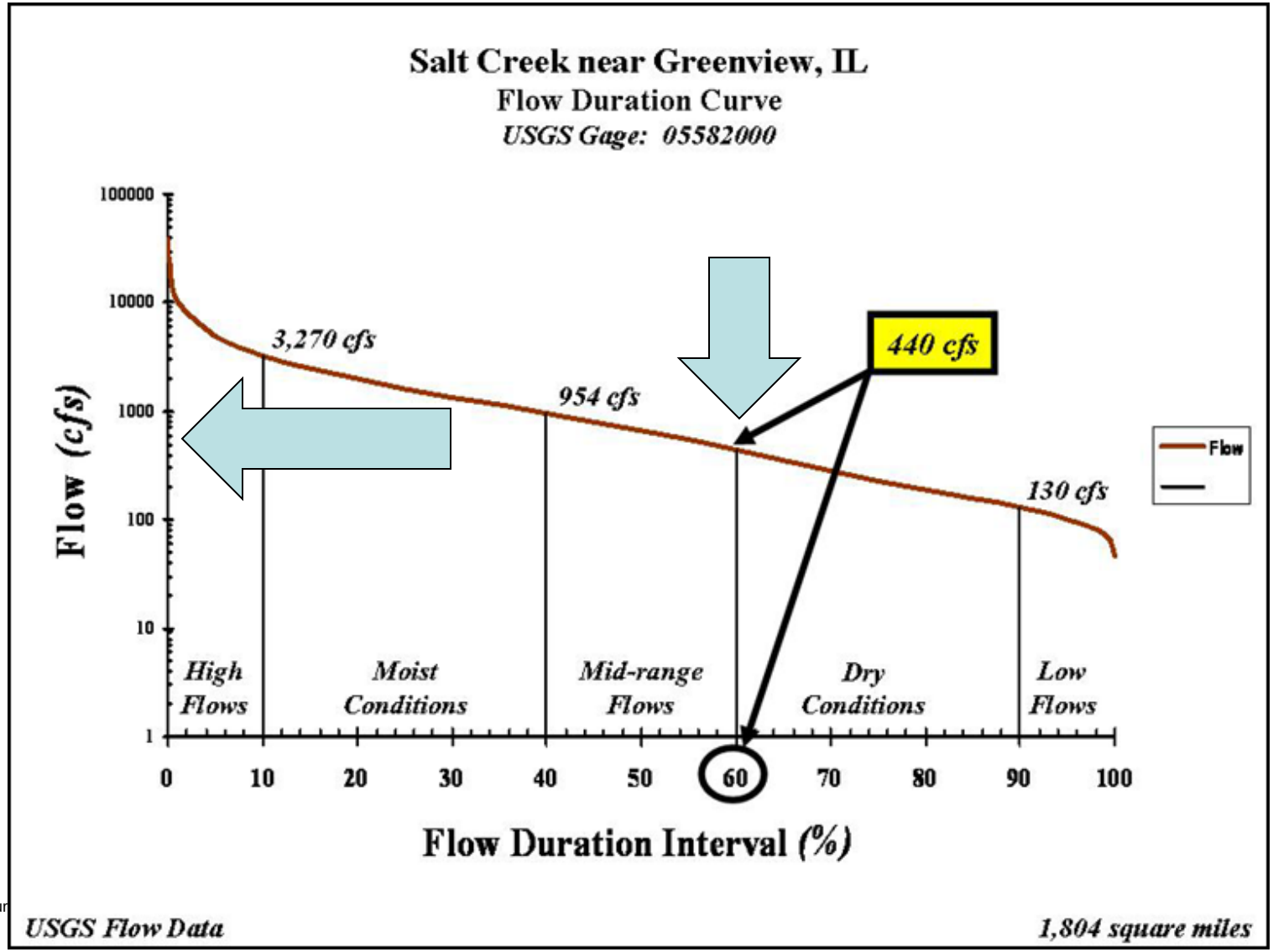
Load Duration Curve | Web-based LDC Tool | STORET/WQX

https://engineering.purdue.edu/~ldc/2013/load_duration.cgi

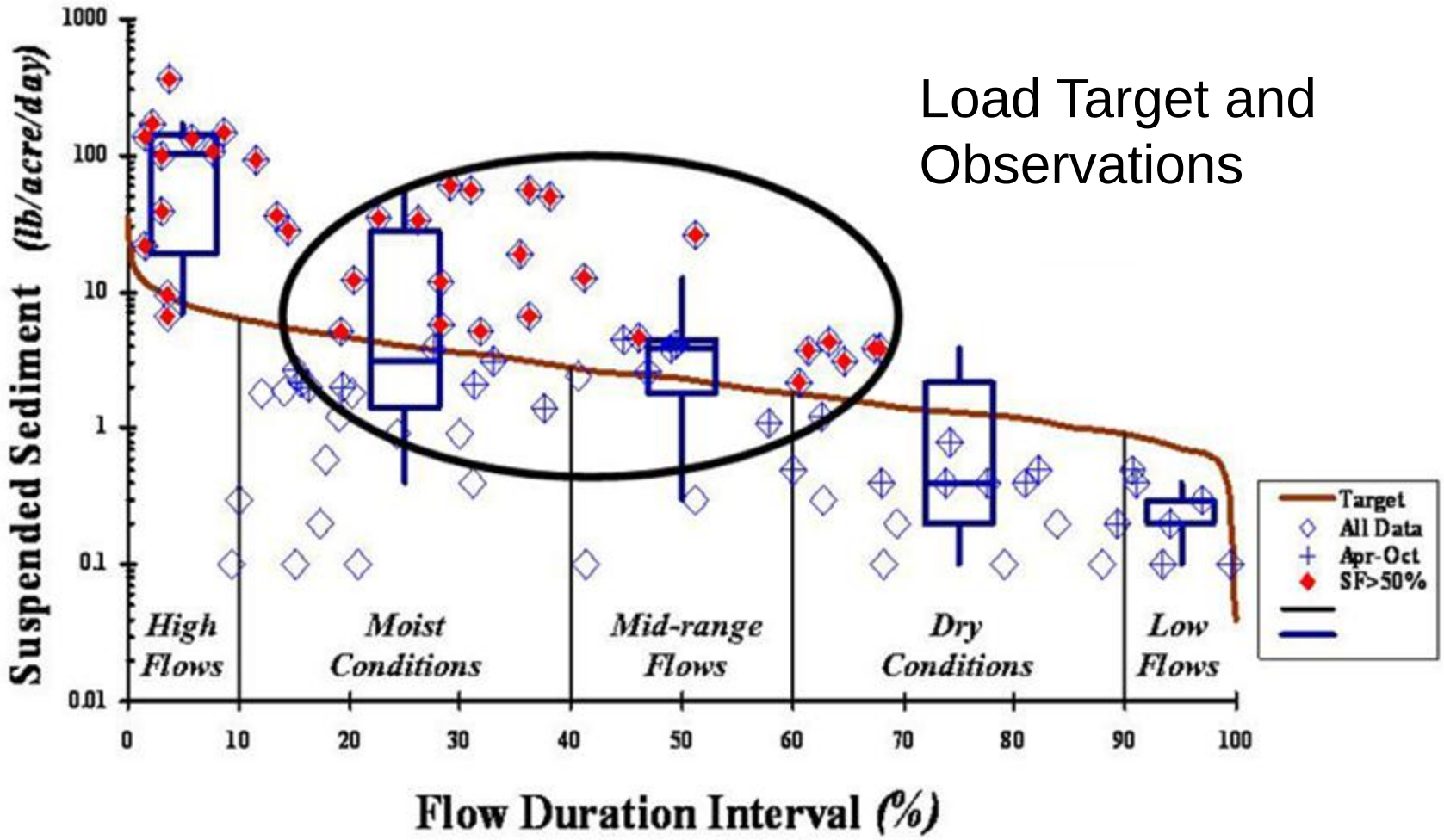
Time Series Plot



- TOP
- Flow Duration Curve
- Load Duration Curve
- Time Series Plot
- Target Concentration
- Download Files


Salt Creek near Greenview, IL
Flow Duration Curve
USGS Gage: 05582000
Flow (cfs)
100000
10000
1000
100
10
1
3,270 cfs
954 cfs
130 cfs
440 cfs
Flow
High Flows
Moist Conditions
Mid-range Flows
Dry Conditions
Low Flows
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
USGS Flow Data
1,804 square miles

Load Target and Observations



Adapted from USEPA

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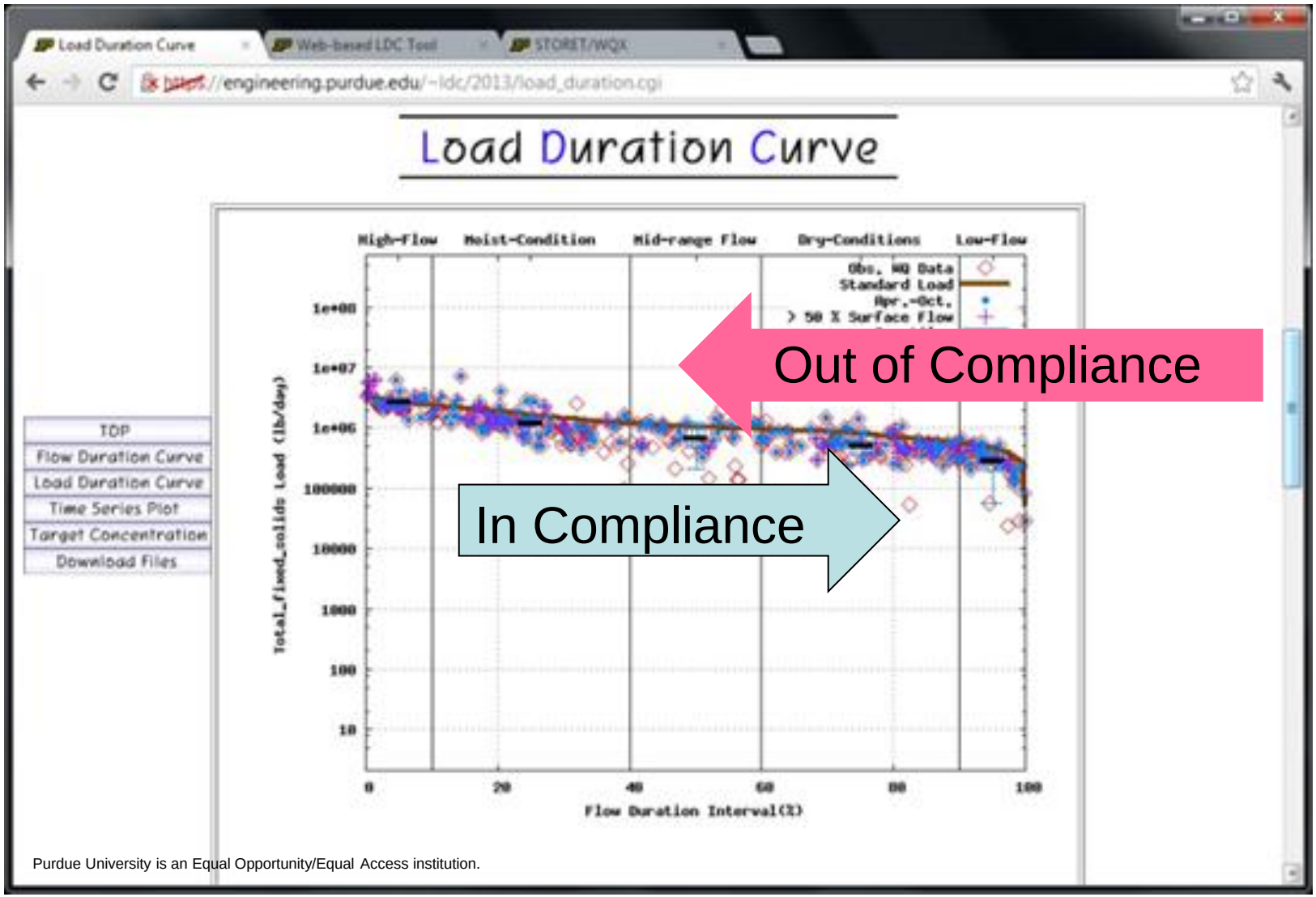
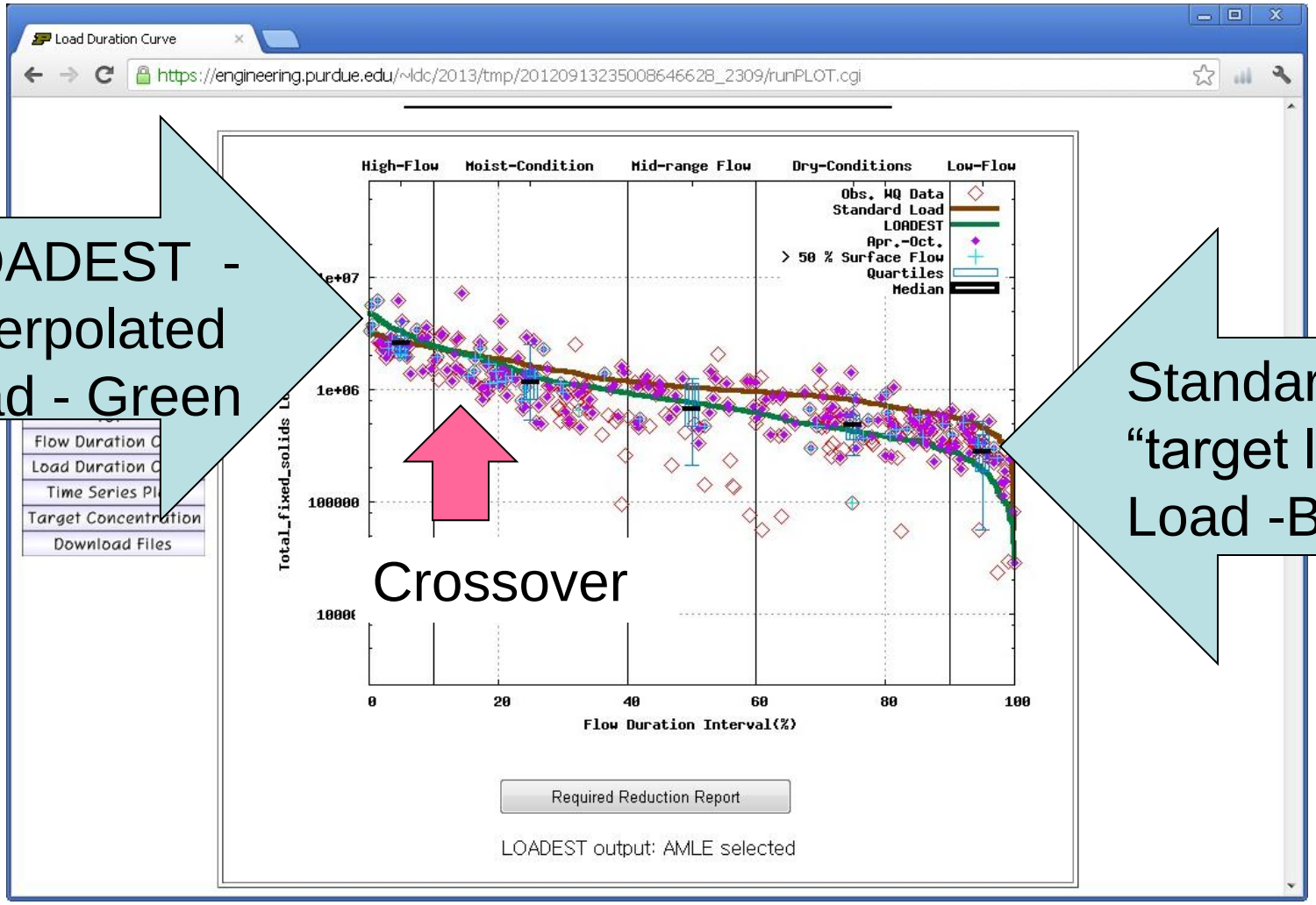


STEPL BMP Advisor Module for Web-based LDC Tool



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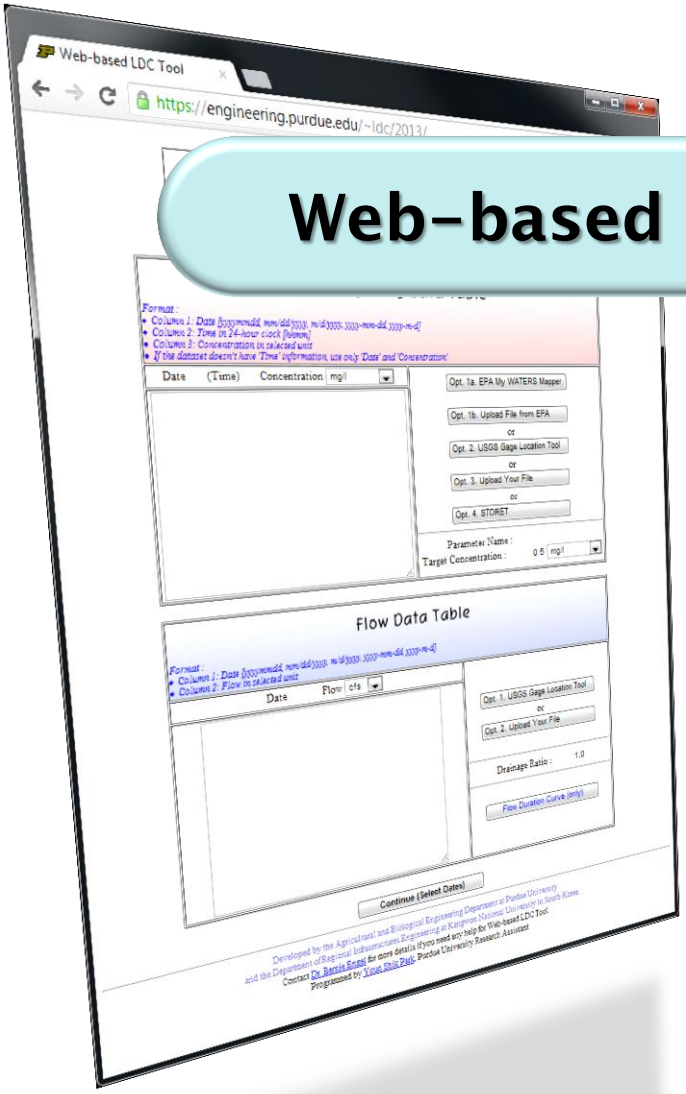
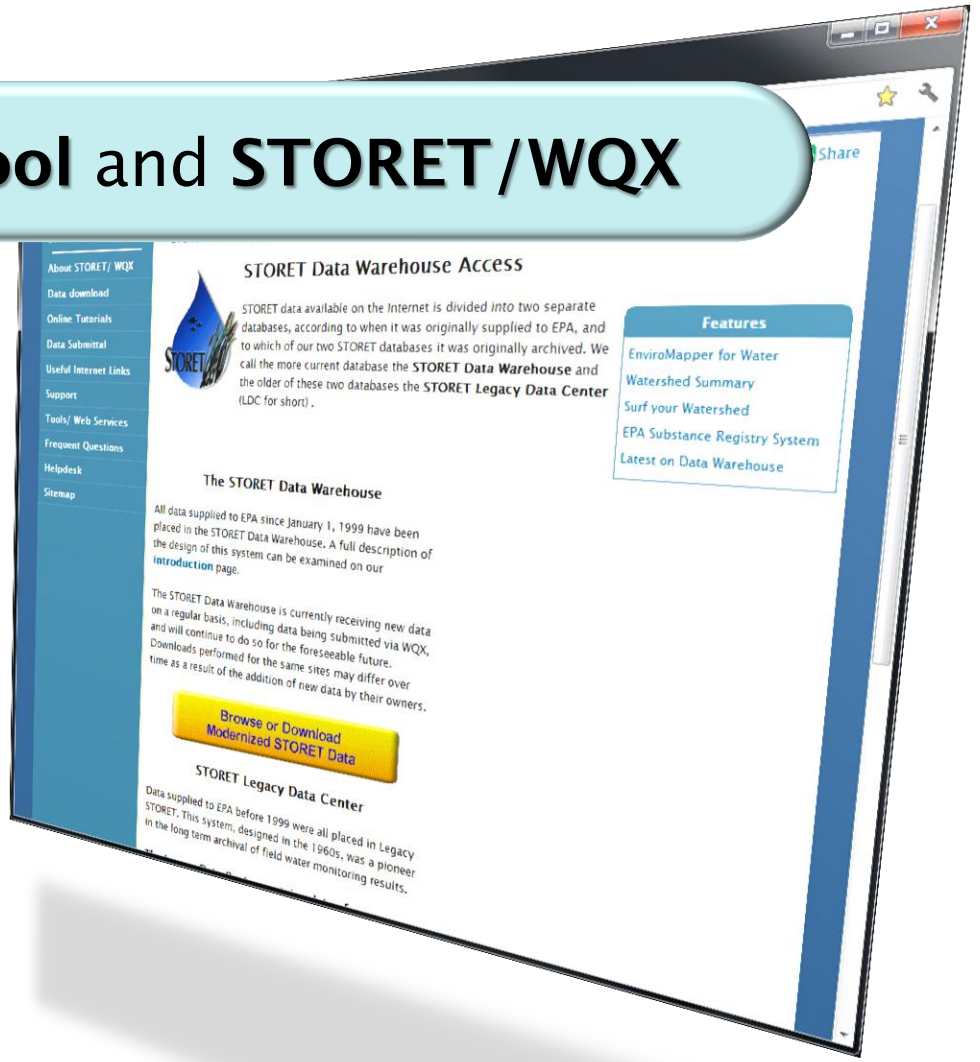
Web-based LDC Tool and STORET/WQX





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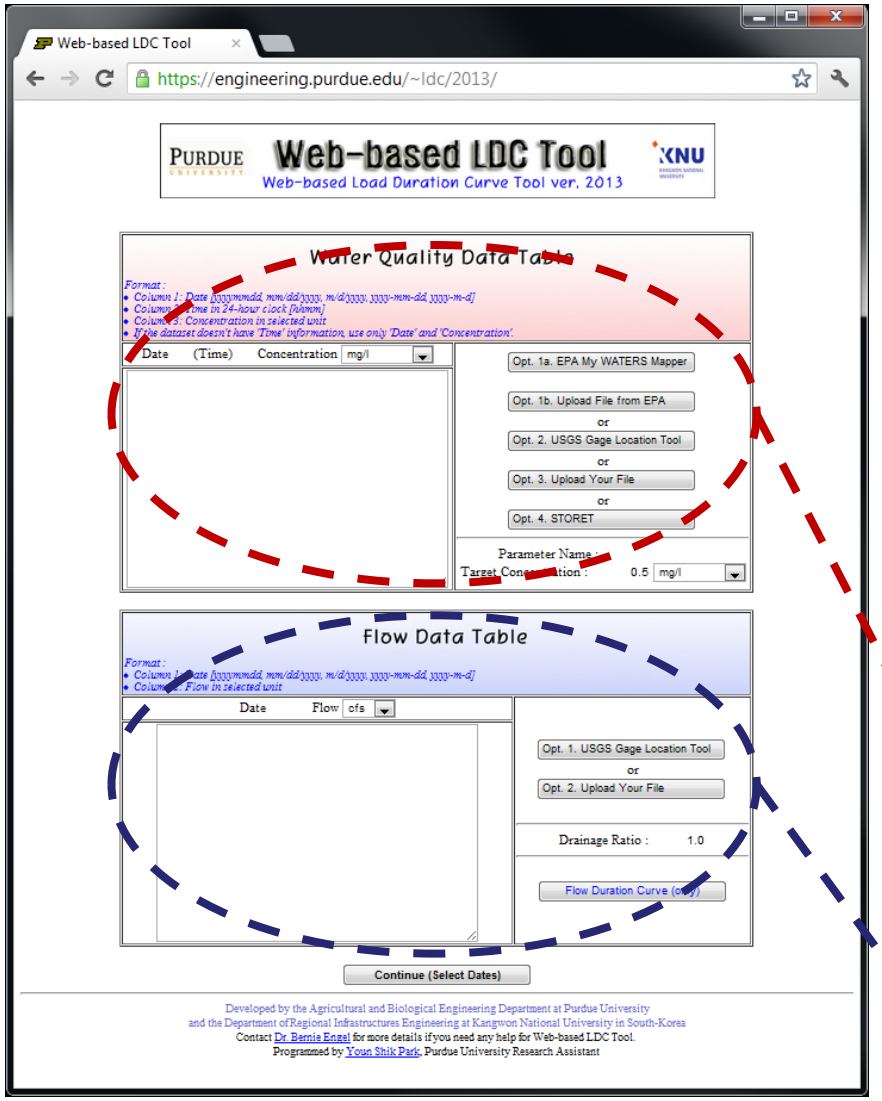

To plot Load Duration Curve (LDC), two data sets are required.

- **water quality (WQ)**
- **flow data.**

This table is for **WQ** data.

This table is for **flow** data.

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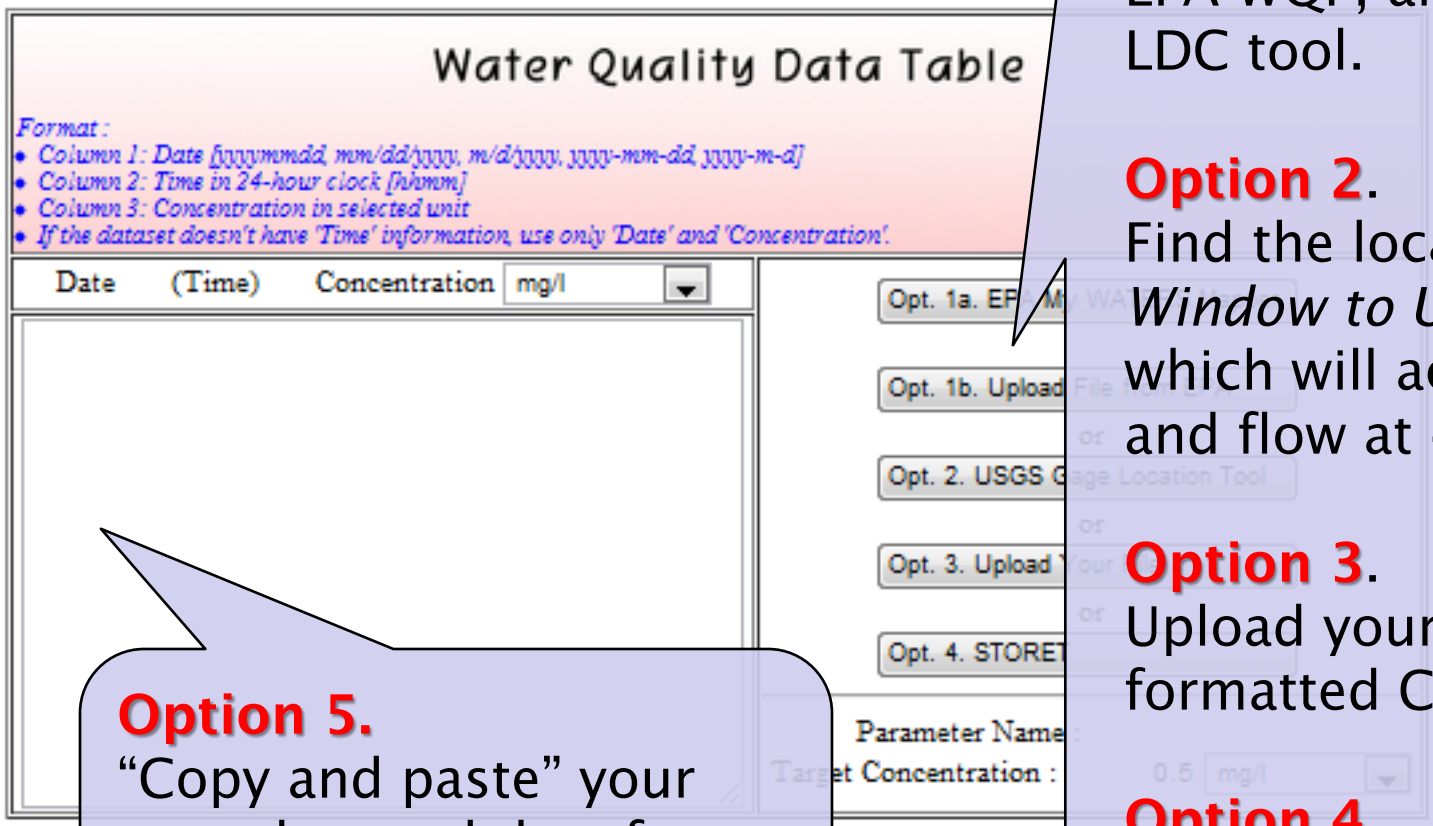
How is **WQ** data prepared ?



Option 1.
Use EPA MyWaters: Download the data from EPA WQP, and load it into LDC tool.

Option 2.
Find the location on *LDC Window to USGS Map*, which will access USGS WQ and flow at once.

Option 3.
Upload your own formatted CSV file.

Option 4.
Use EPA STORET Data Warehouse

Option 5.
"Copy and paste" your own observed data from a formatted spreadsheet. (e.g. Microsoft Excel)

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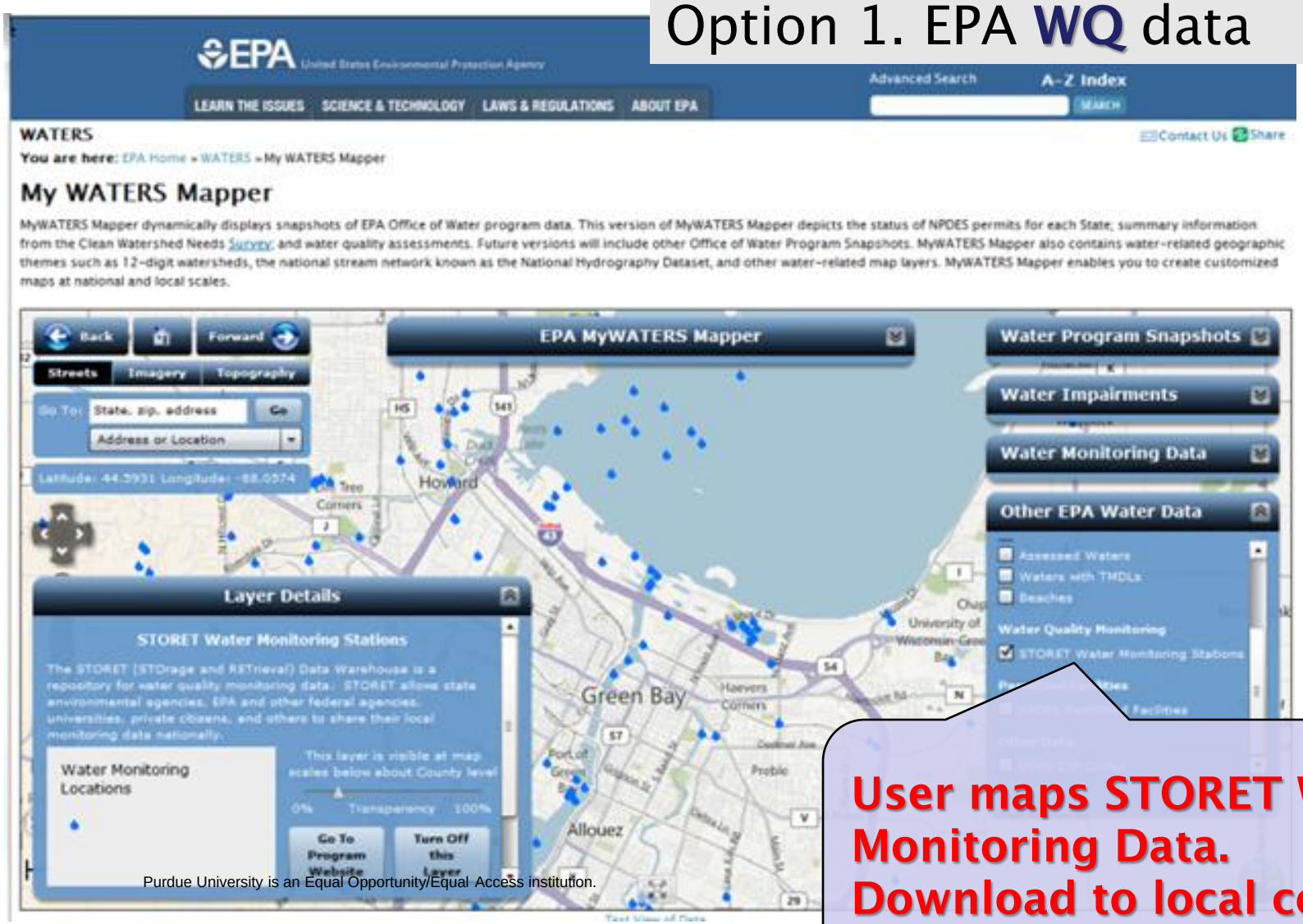
Option 1. EPA **WQ** data



User maps STORET Water Monitoring Data. Download to local computer.

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Option 1. EPA **WQ** data

Water Quality Data Table

Format :

- *Column 1: Date [yyyymmdd, mm/dd/yyyy, m/d/yyyy, yyyy-mm-dd, yyyy-m-d]*
- *Column 2: Time in 24-hour clock [hhmm]*
- *Column 3: Concentration in selected unit*
- *If the dataset doesn't have 'Time' information, use only 'Date' and 'Concentration'.*

Date	(Time)	Concentration	mg/l
20000223	1300	0.015	
20000315	1310	<0.028	
20000406	1240	0.026	
20000419	1300	<0.024	
2000[illegible]11	1320	0.013	
2000[illegible]	1410	0.021	
20[illegible]	1400	0.013	
[illegible]0621	1320	0.042	
20000721	1210	0.032	
20000811	1410	0.015	
20001030	1230	0.052	
20001128	1230	0.032	
20010110	1240	0.010	
20010207	1145	0.016	
20010306	1330	0.013	

Opt. 1a. EPA My WATERS Mapper

Opt. 1b. Upload File from EPA

or

Opt. 2. USGS Gage Location Tool

or

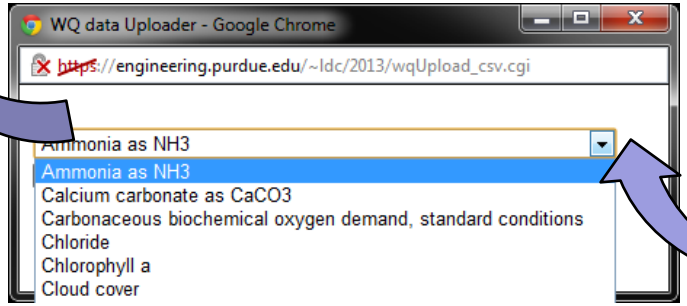
Opt. 3. Upload Your File

or

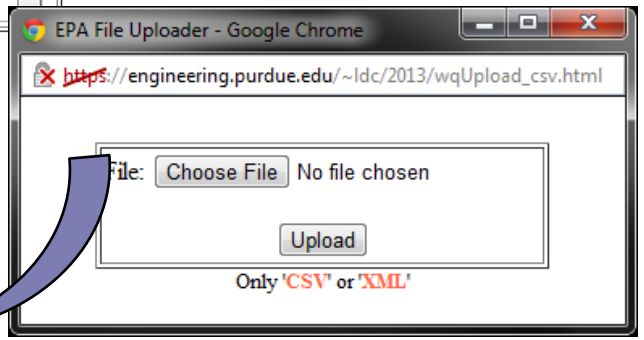
Opt. 4. STORET

Parameter Name :

Target Concentration : 0.5 mg/l



Select WQ parameter.



Load the downloaded file.

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Option 2. USGS **WQ** data

Water Quality Data Table

Format :
- *Column 1: Date [yyyymmdd, mm/dd/yyyy, m/d/yyyy, yyyy-mm-dd, yyyy-m-d]*
- *Column 2: Time in 24-hour clock [hhmm]*
- *Column 3: Concentration in selected unit*
- *If the dataset doesn't have 'Time' information, use only 'Date' and 'Concentration'.*

Date	(Time)	Concentration	mg/l
20000223	1300	0.015	
20000315	1310	<0.028	
20000406	1240	0.026	
20000419	1300	<0.024	
20000511	1320	0.013	
20000524	1410	0.021	
20000609	1400	0.013	
20000621	1320	0.042	
20000721	1210	0.032	
20000811	1410	0.015	
20001030	1230	0.052	
20001128	1230	0.032	
20010110	1240	0.010	
20010207	1145	0.016	
20010306	1330	0.013	

Opt. 1a. EPA My WATERS ...per

Opt. 1b. Upload File fro... A

or

Opt. 2. USGS Gage Location Tool

or

Opt. 3. Upload Your File

or

Opt. 4. STORET

Parameter Name :

Target Concentration : 0.5 mg/l

Flow Data Table

Format :
- *Column 1: Date [yyyymmdd, mm/dd/yyyy, m/d/yyyy, yyyy-mm-dd, yyyy-m-d]*
- *Column 2: Flow in selected unit*

Date	Flow	cfs
20000101	46	
20000102	48	
20000103	72	
20000104	184	
20000105	109	
20000106	85	
20000107	75	
20000108	68	
20000109	66	
20000110	66	
20000111	64	
20000112	58	
20000113	58	
20000114	55	
20000115	57	

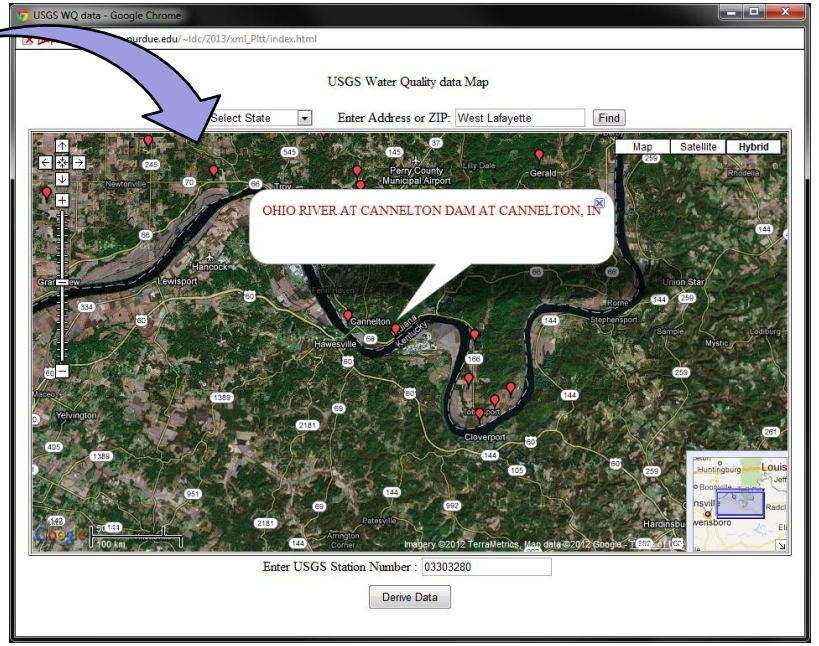
Opt. 1. USGS Gage Location Tool

or

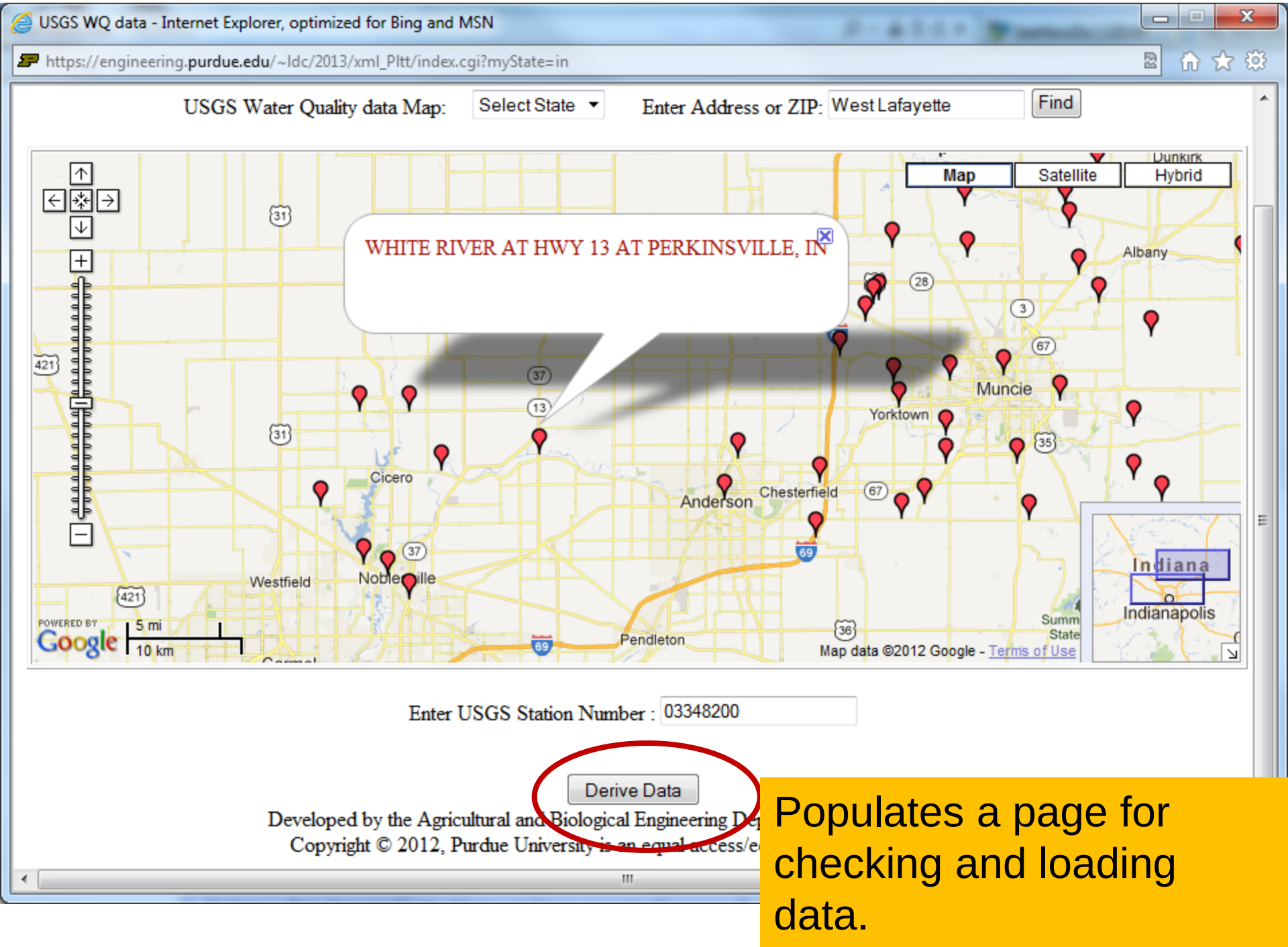
Opt. 2. Upload Your File

Drainage Ratio : 1.0

Flow Duration Curve (only)



Select WQ parameter and set time period in the following page.


USGS WQ data - Internet Explorer, optimized for Bing and MSN
https://engineering.purdue.edu/~ldc/2013/xml_Pltt/index.cgi?myState=in
USGS Water Quality data Map:
Select State
Enter Address or ZIP:
West Lafayette
Find
Map
Satellite
Hybrid
WHITE RIVER AT HWY 13 AT PERKINSVILLE, IN
Albany
Muncie
Yorktown
Cicero
Anderson
Chesterfield
Westfield
Pendleton
Indiana
Indianapolis
Map data ©2012 Google - Terms of Use
Enter USGS Station Number :
03348200
Derive Data
Developed by the Agricultural and Biological Engineering Dep
Copyright © 2012, Purdue University is an equal access/e
Populates a page for checking and loading data.

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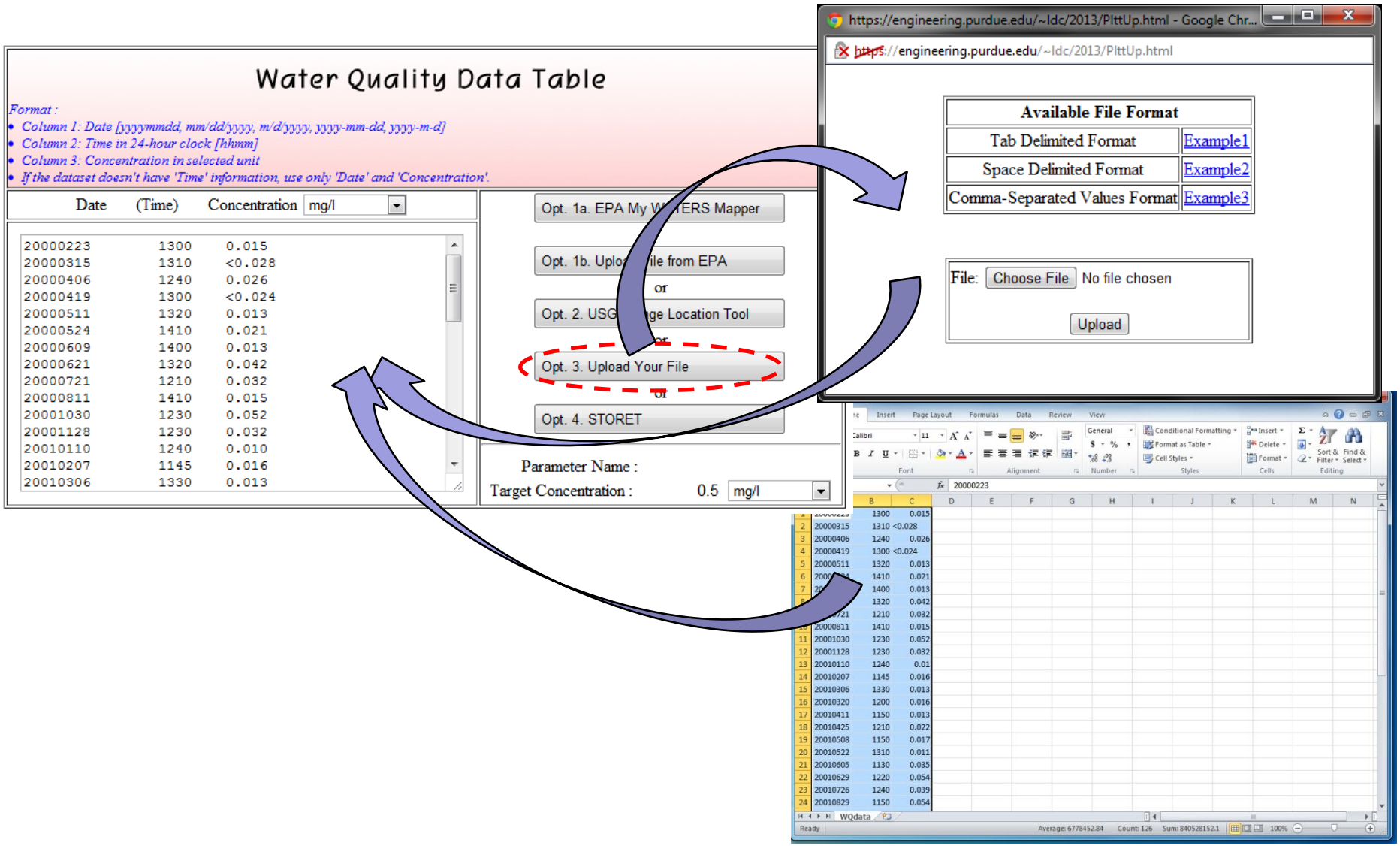
Option 3. Load the file or "Copy-Paste"



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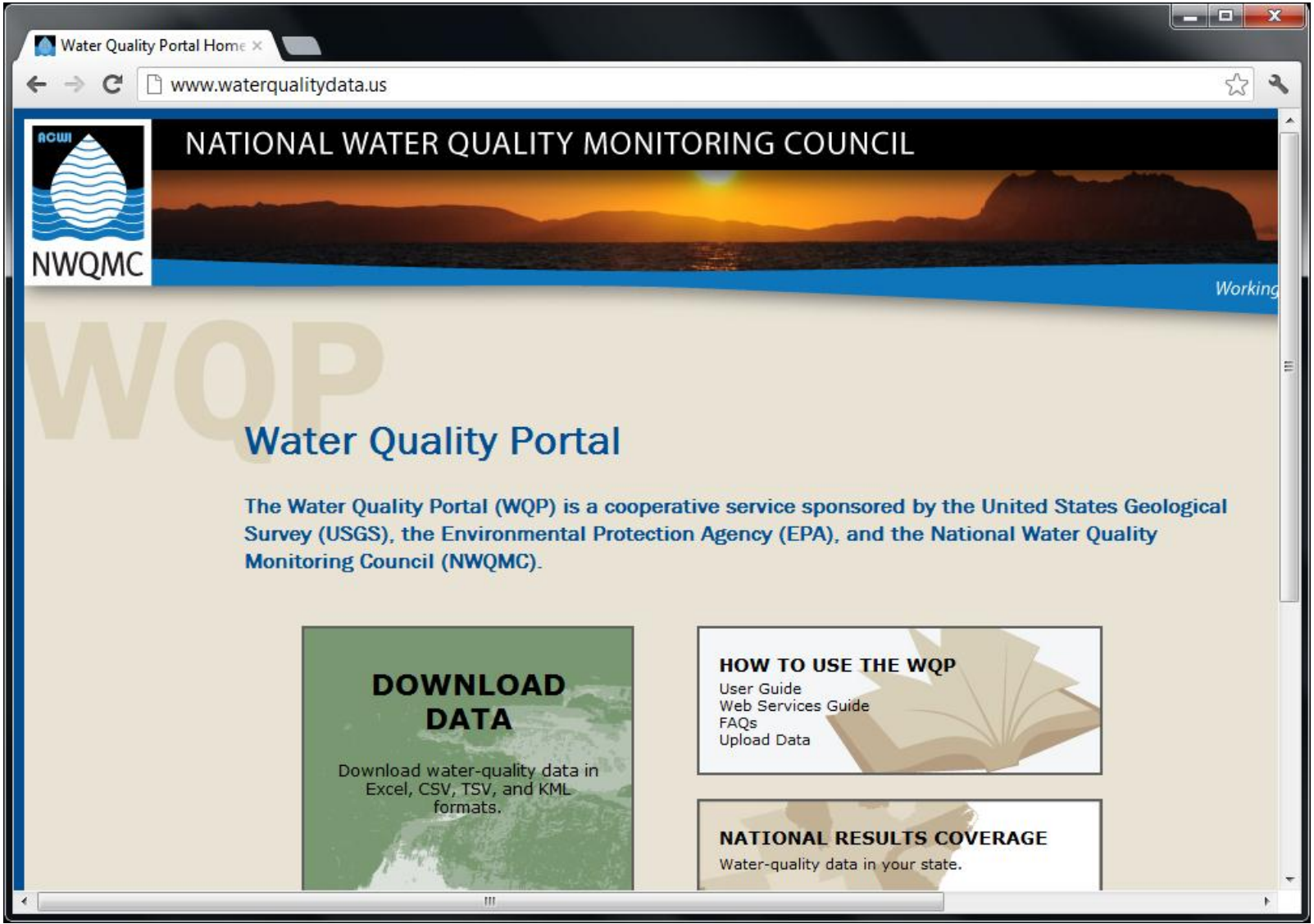
Option 4 STORET. Use the Water Quality Portal



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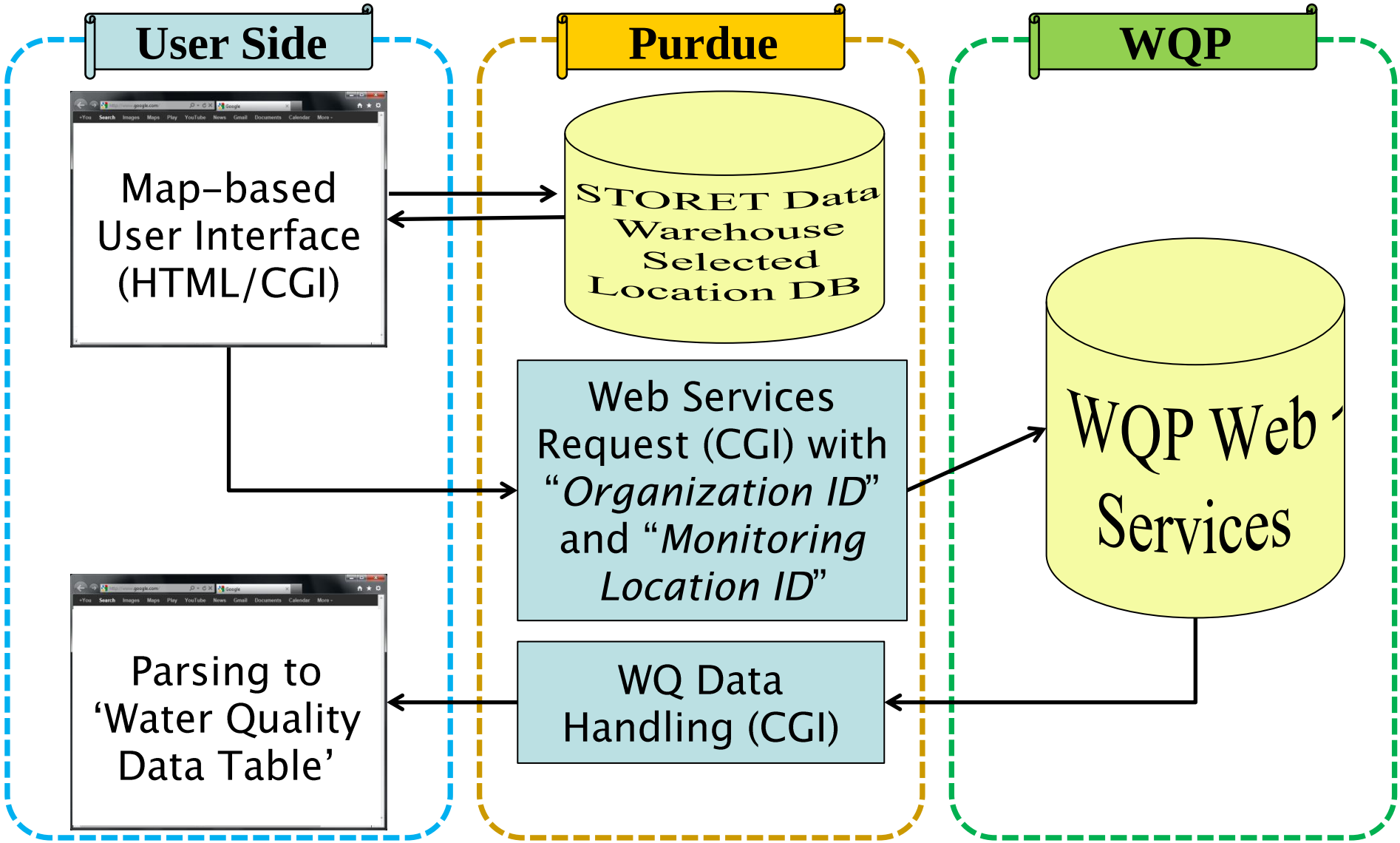

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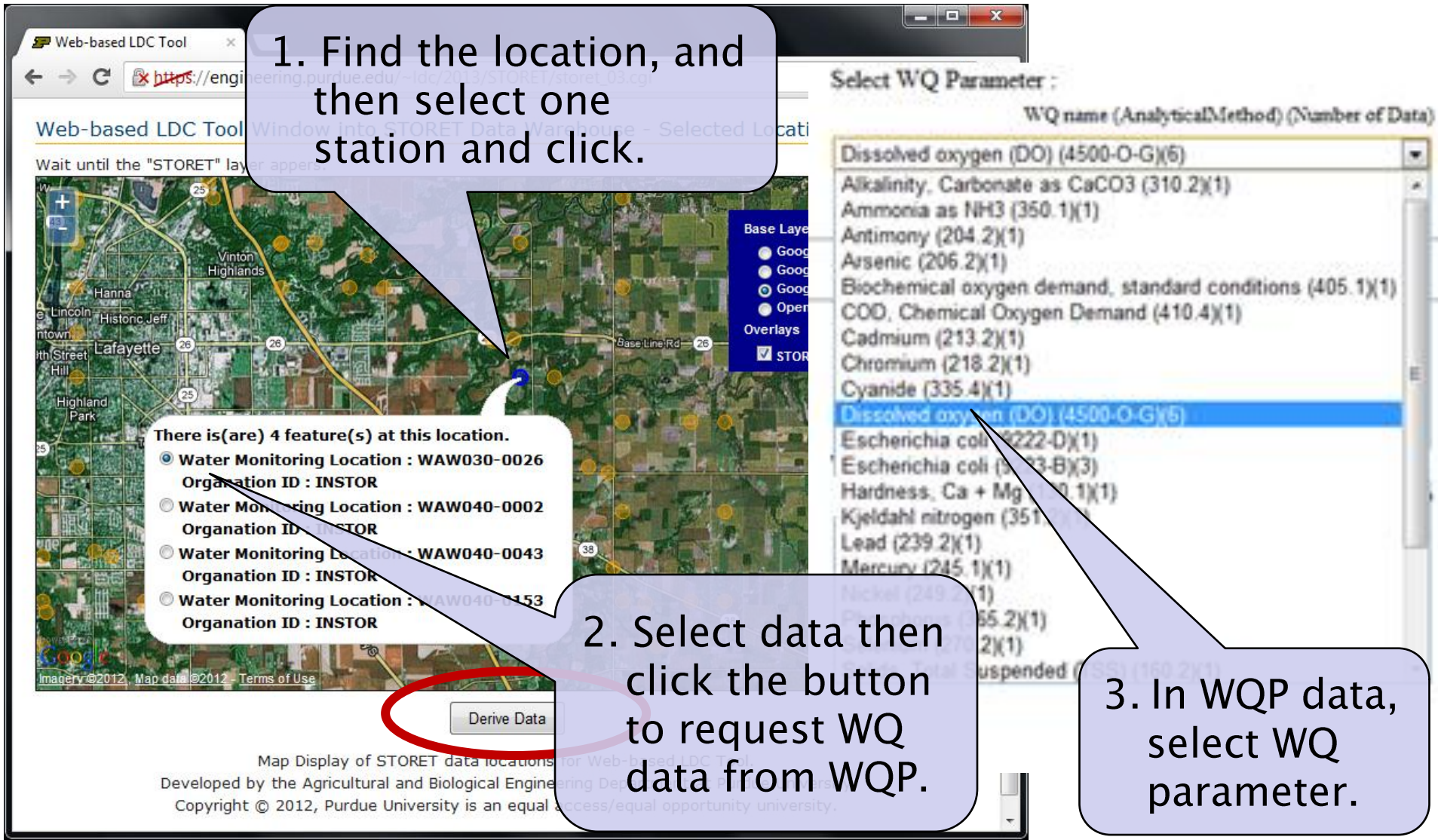
Option 4. Use of Water Quality Portal



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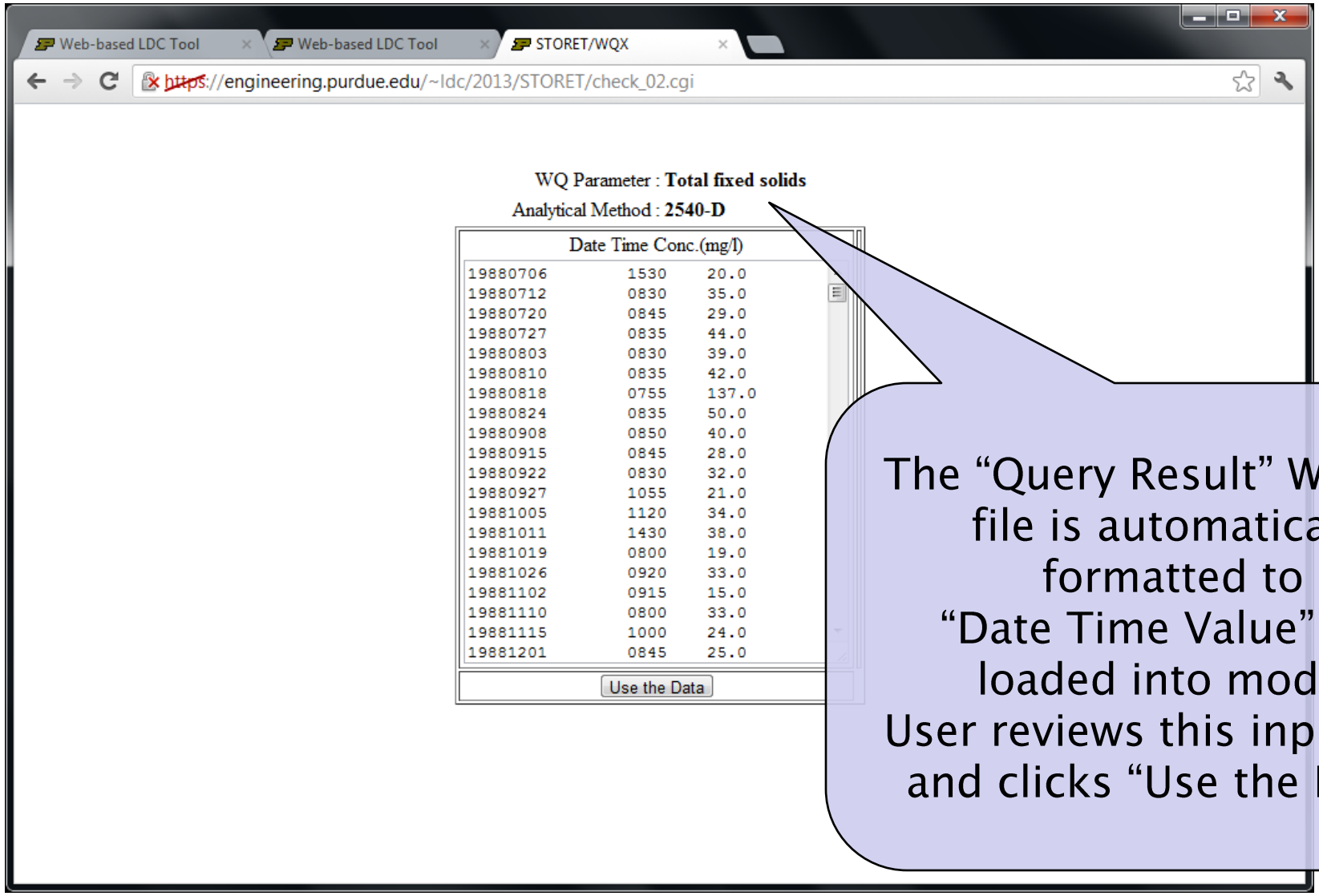
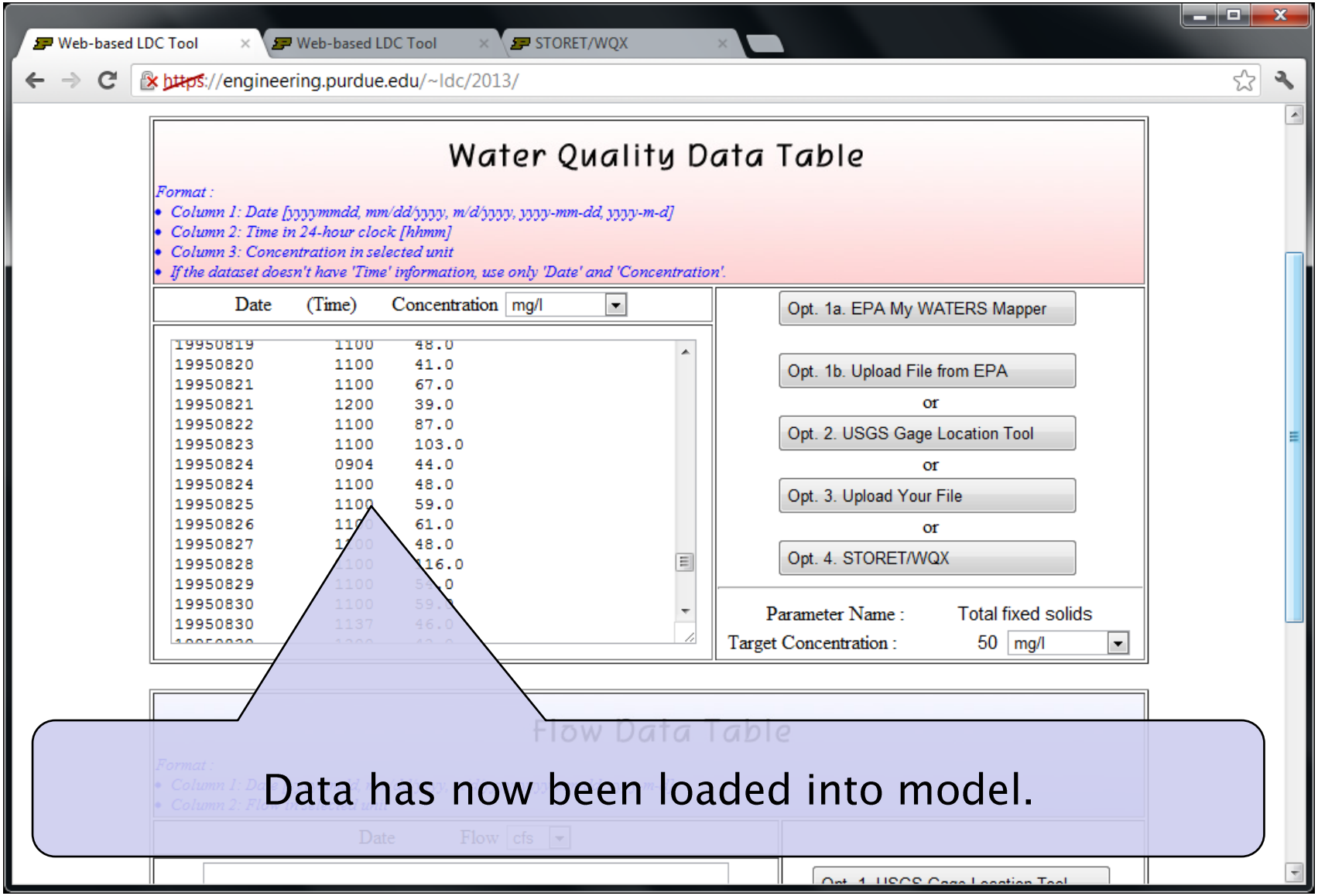
Preparing WQ data: Confirm WQ data selected



The "Query Result" WQ data file is automatically formatted to "Date Time Value" and loaded into model. User reviews this input data and clicks "Use the Data".

Preparing WQ data: WQ data now appears in the "Water Quality Data Table"



Data has now been loaded into model.

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Using Additional WQ Data

- LDC needs STORET locations with
~ 10 years of data and near a flow gage
- Currently rare in Indiana
- Access to Fixed Station dataset would provide more than 150,000 usable readings near gages.

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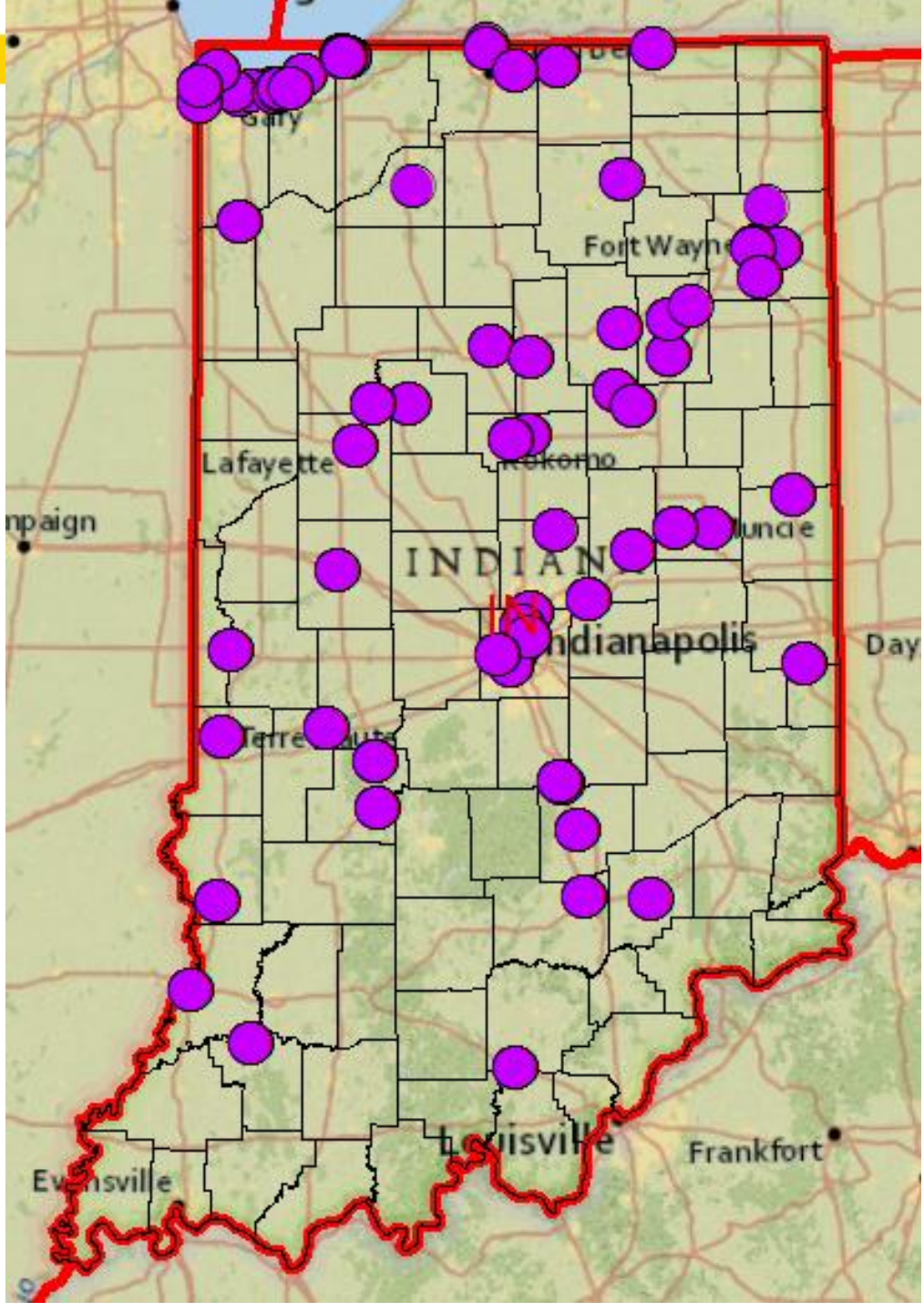
Fixed Station network has these locations near flowgages.

Many contain multiple-year readings which will be useful to LDC.



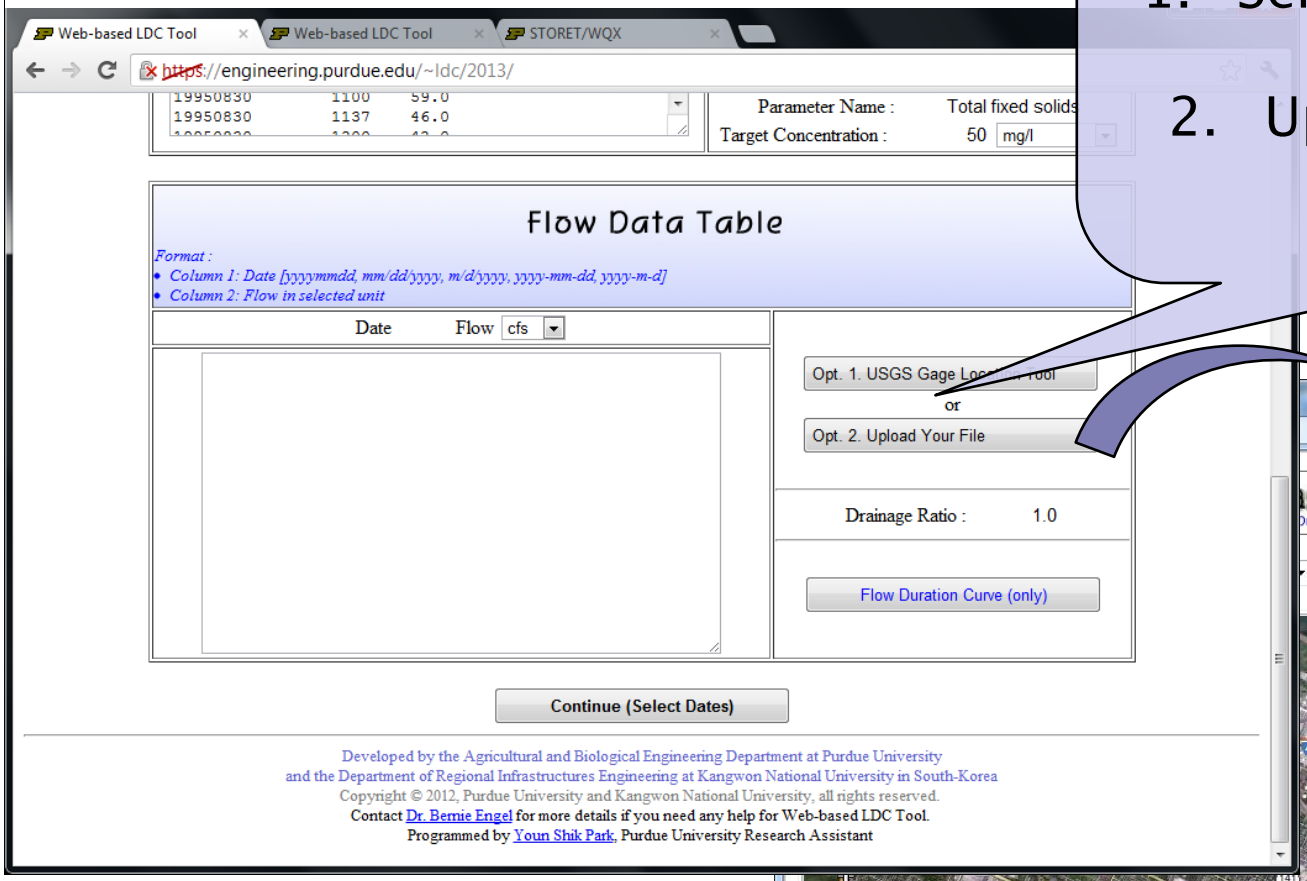
Prepare Flow data

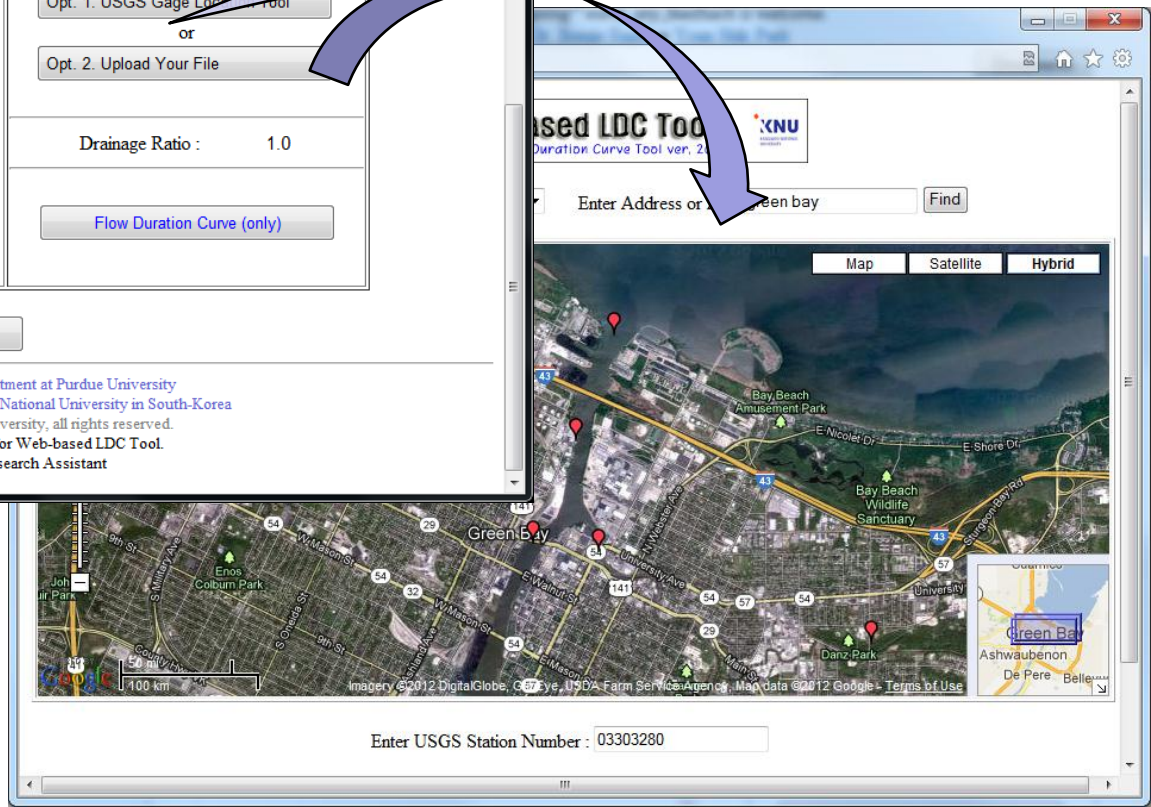
- USGS Gage
- Your data logger

Preparing Flow data: Click "Opt. 1 USGS Gage Location Tool"

There are two "flow data " options.

1. Select USGS stream gage from map *or*
2. Upload local flow from datalogger.





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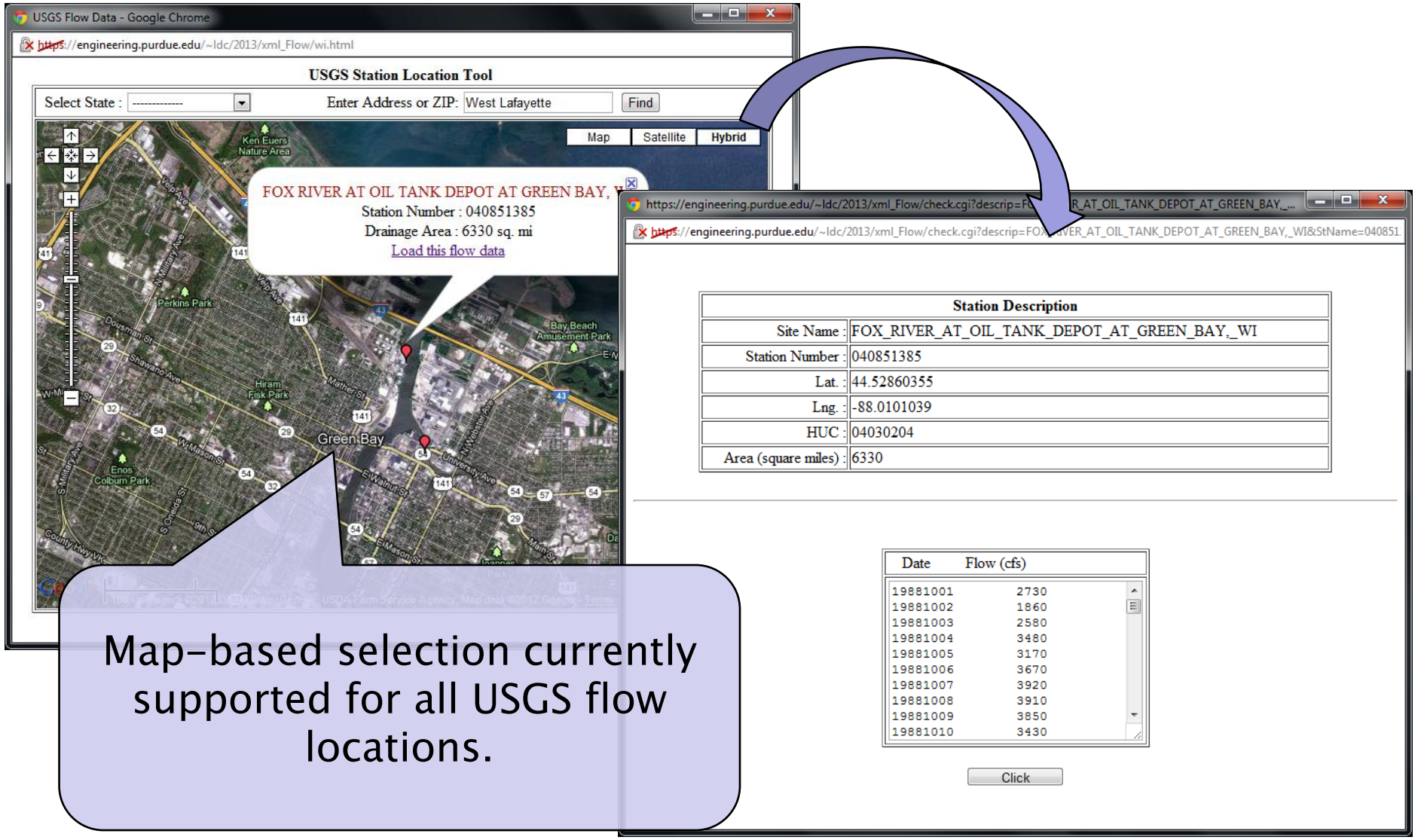
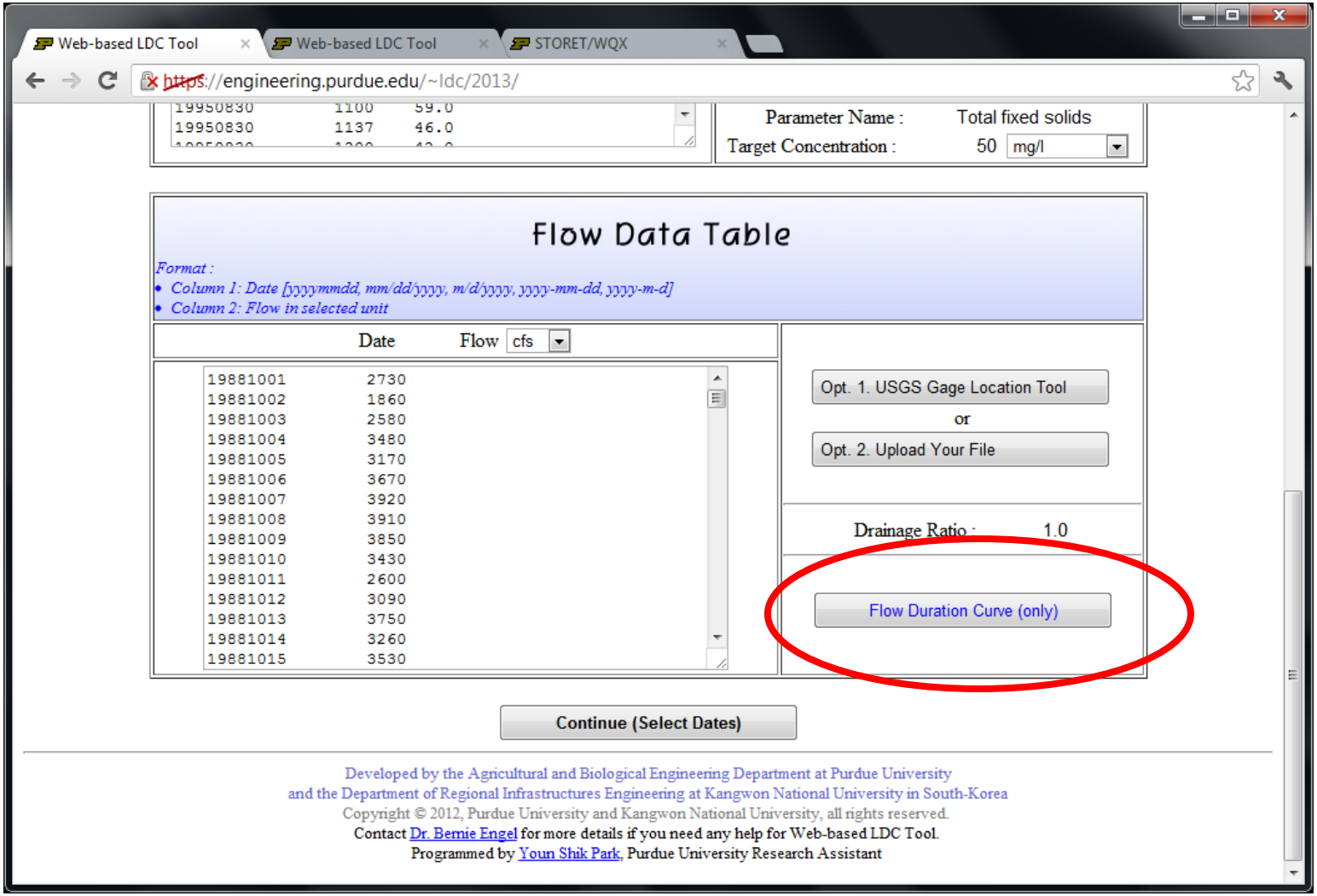
Preparing Flow data: Find the station



Map-based selection currently supported for all USGS flow locations.

Preparing Flow: USGS Flow data loads automatically.



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Flow data checking (gap analysis) by FDC module

https://engineering.purdue.edu/~ldc/2013/FDConly.cgi - Google Chrome

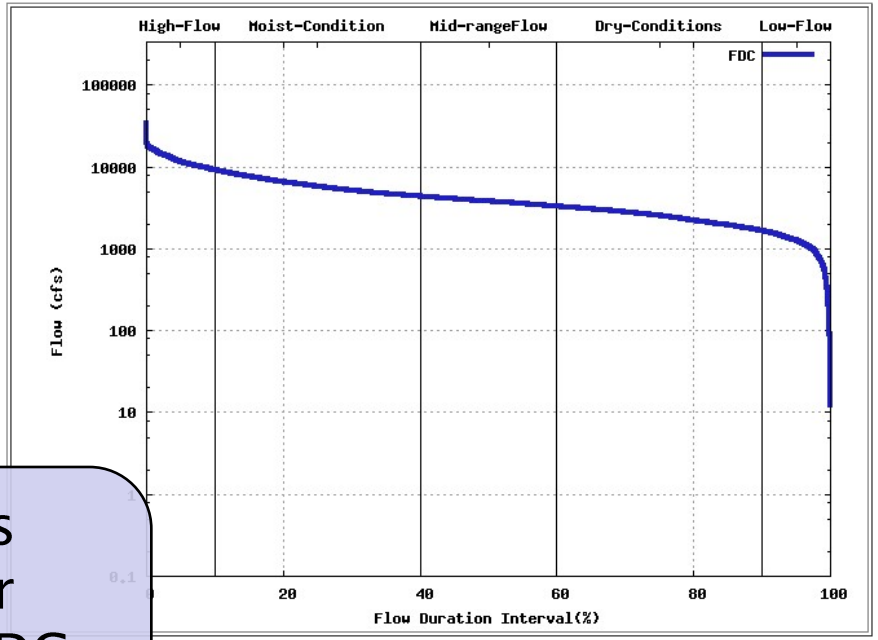
https://engineering.purdue.edu/~ldc/2013/FDConly.cgi

- Negative Value Detected on 19891017, Value of -830
- Negative Value Detected on 19891023, Value of -200
- Negative Value Detected on 19900420, Value of -835
- Negative Value Detected on 19900910, Value of -359
- Negative Value Detected on 19900919, Value of -321
- Negative Value Detected on 19901104, Value of -3260
- Negative Value Detected on 19911004, Value of -794
- Negative Value Detected on 19950626, Value of -211
- Negative Value Detected on 19970528, Value of -539
- Negative Value Detected on 19970911, Value of -12
- Negative Value Detected on 19980616, Value of -884
- Negative Value Detected on 19980912, Value of -340
- Negative Value Detected on 19980913, Value of -313
- Negative Value Detected on 19981003, Value of -21
- Negative Value Detected on 19990825, Value of -1230
- Negative Value Detected on 19990923, Value of -409
- Negative Value Detected on 19991023, Value of -239
- Negative Value Detected on 19991115, Value of -186
- Negative Value Detected on 20000729, Value of -211
- Negative Value Detected on 20000730, Value of -1050
- Negative Value Detected on 20000731, Value of -240
- Negative Value Detected on 20000802, Value of -106
- Negative Value Detected on 20080916, Value of -92
- Negative values were detected. Confirm the data.

https://engineering.purdue.edu/~ldc/2013/FDConly.cgi - Google Chrome

https://engineering.purdue.edu/~ldc/2013/FDConly.cgi

Flow Duration Curve



If the dataset has "missing data" or "negative value", FDC module detects them and alerts user.

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Set options

Select the time period to plot FDC and LDC. Set additional options.

	Beginning Date	Ending Date
FlowData	1988 - 10 - 01	2011 - 09 - 30
Water Quality Data	1988 - 10 - 05	1995 - 11 - 01
Load Estimation Period	1994 YEAR 1 MONTH 1 DAY	1995 YEAR 12 MONTH 31 DAY

Optional Inputs

Plot 50 % Surface Flow

Select and enter BFI value for separation of Surface Runoff :

Perennial streams with porous aquifers - BFI value : 0.80

Plot Growing Season

Select Period : From Apr. To Oct.

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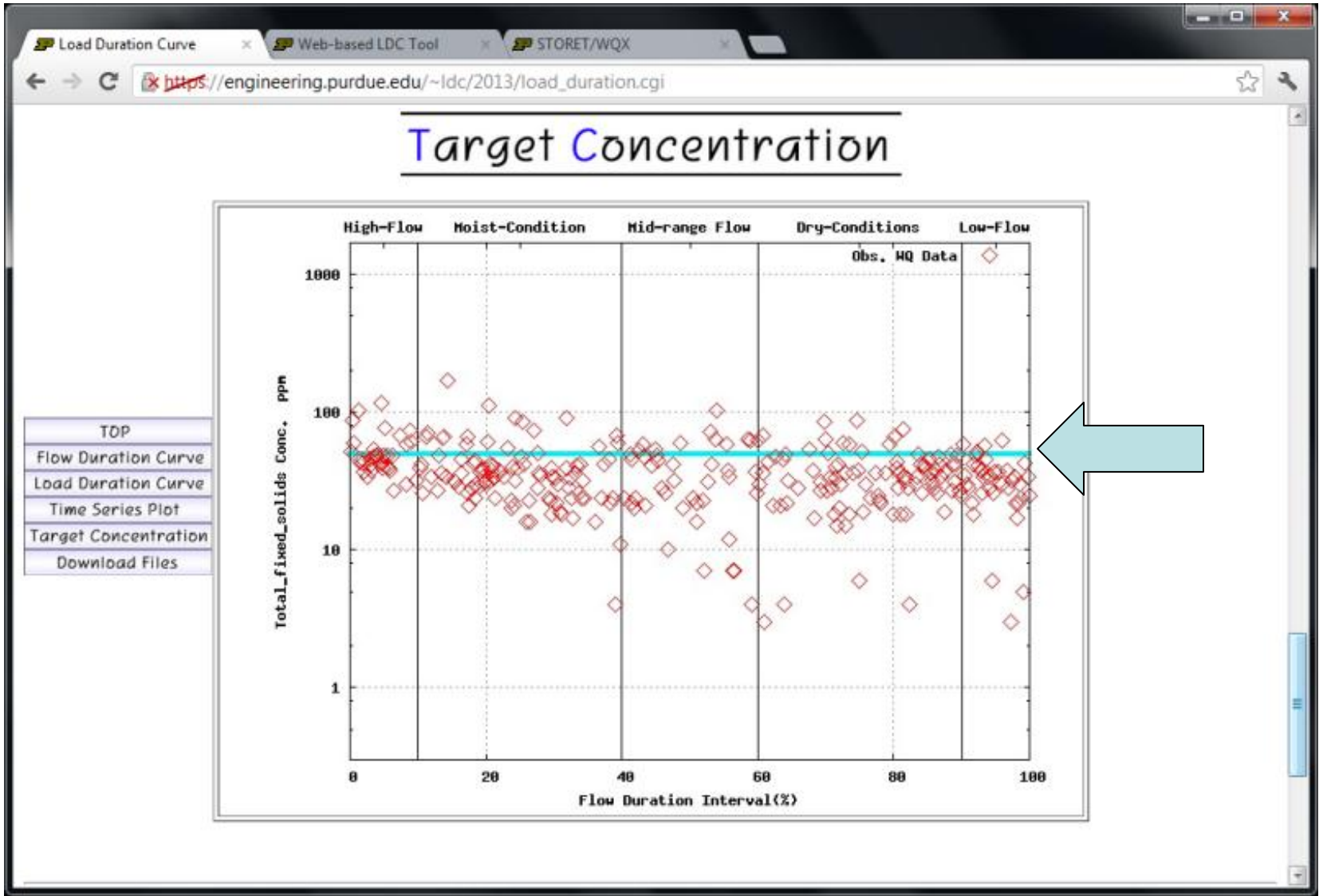
Results before LOADEST Execution



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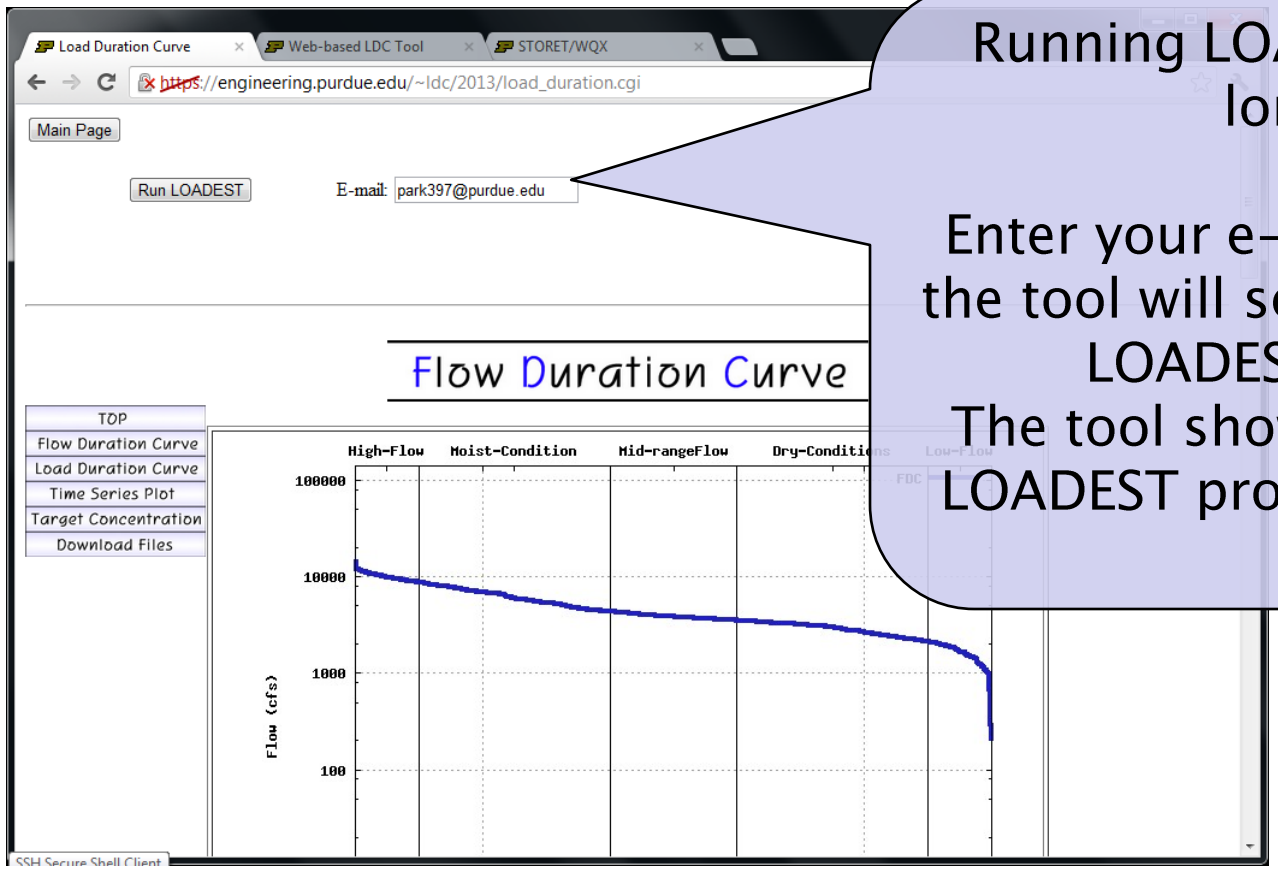
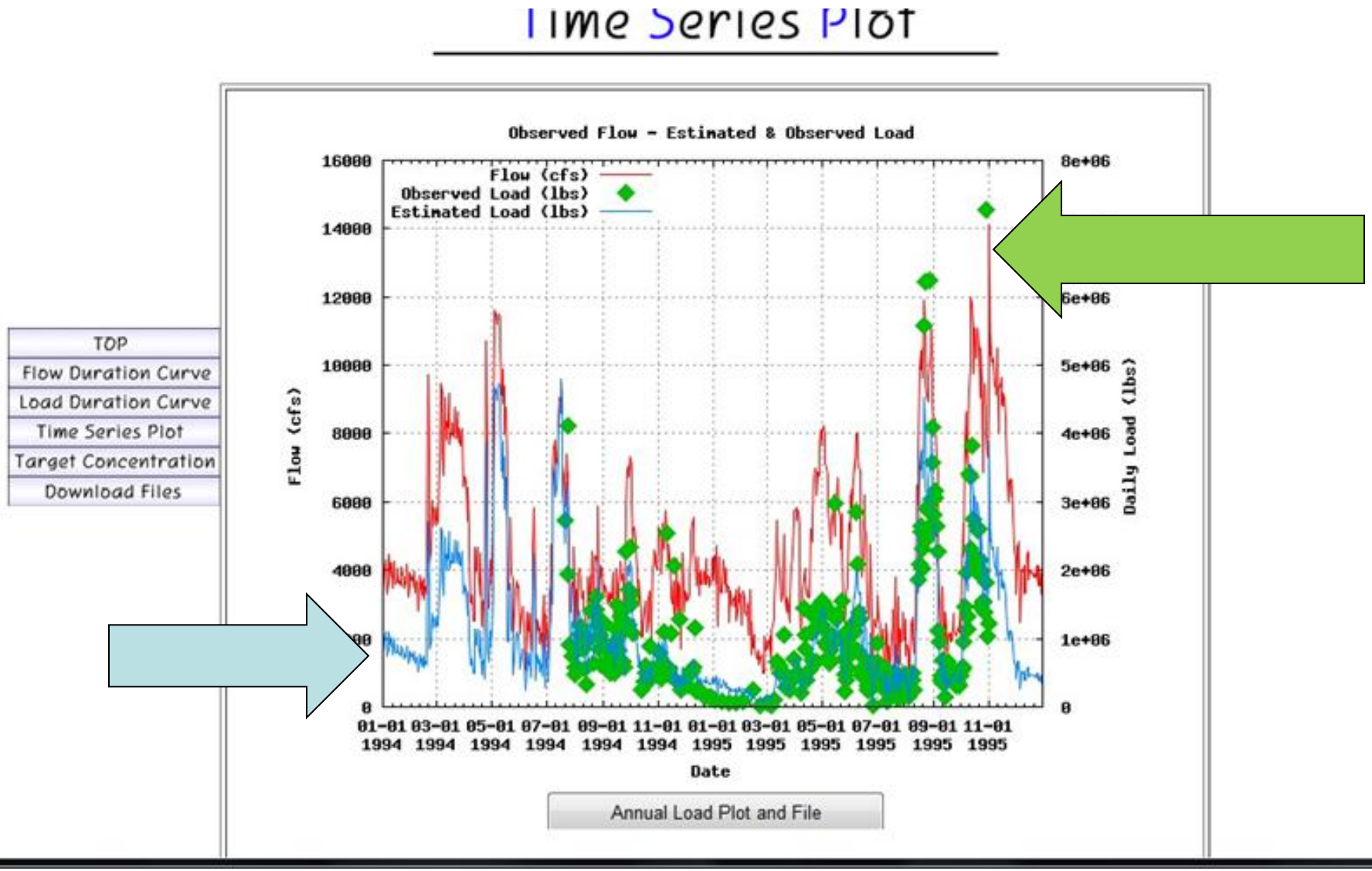
LOADEST Execution



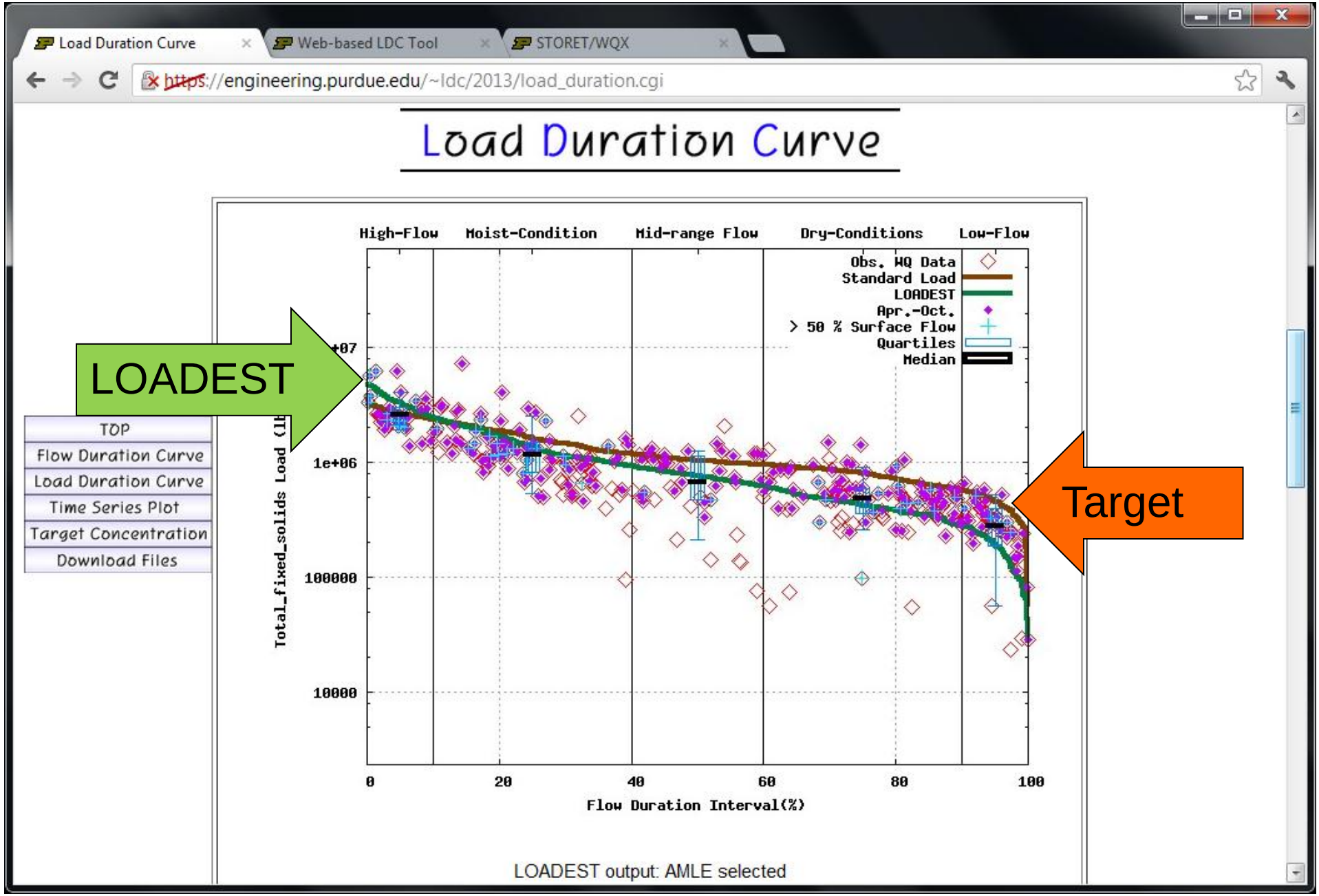
Running LOADEST may take a long time.

Enter your e-mail address here, the tool will send an e-mail when LOADEST is finished.
The tool shows progress of the LOADEST process on the server.

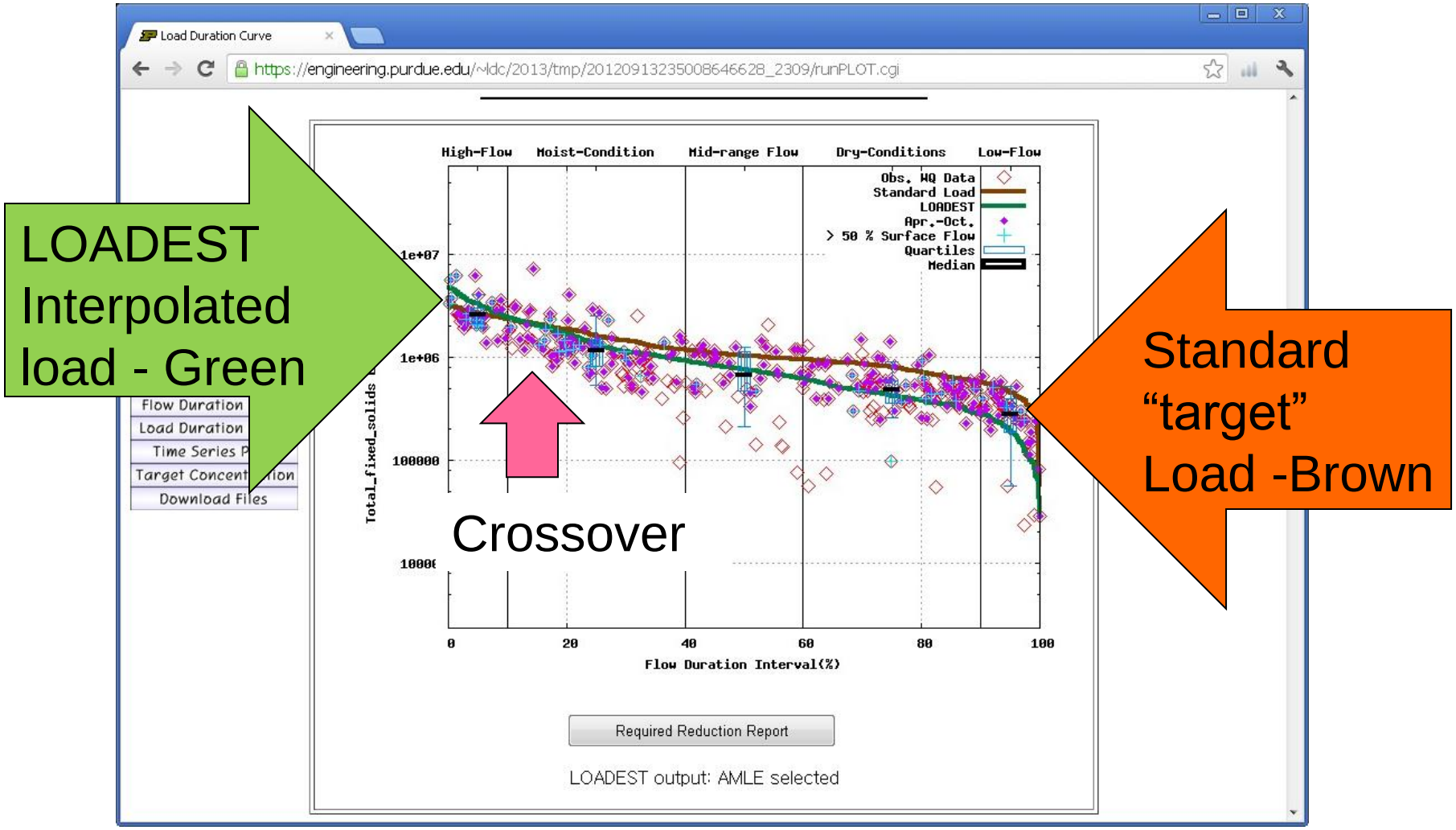
Estimated load (blue) versus Observed WQ data (green) – Results after LOADEST Execution



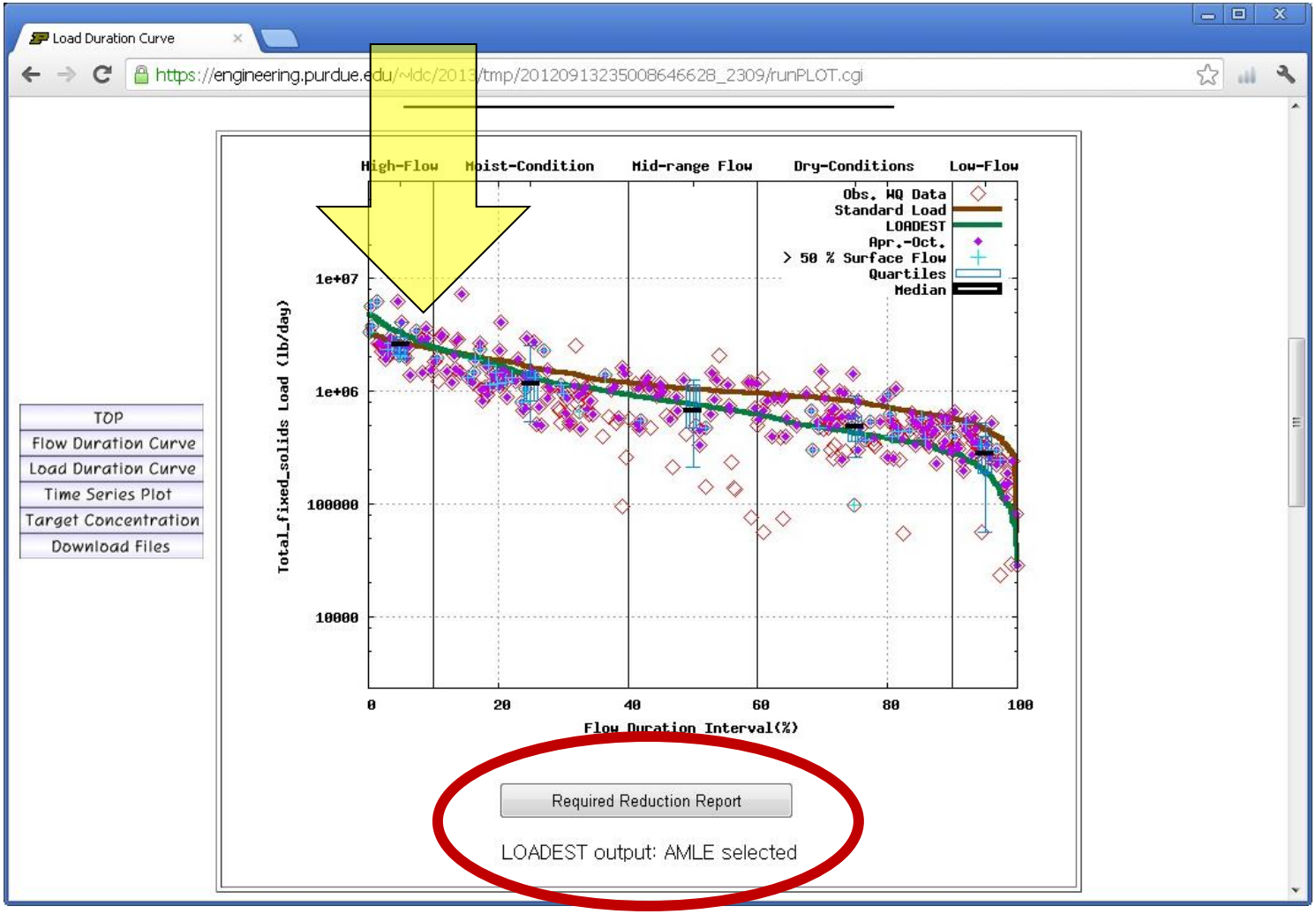
Load Results after LOADEST Execution



STEPL BMP Advisor Module for Web-based LDC Tool



After LOADEST execution is finished, we are exceeding pollutant loads only in “High-Flow” regime.



STEPL BMPs

Table B-4. Middle Fork LeBuche River TMDL Summary

TMDL SUMMARY	Loads expressed as *(tons per day)*				
	High	Moist	Mid-Range	Dry	Low
TMDL[1]	173.35	67.20	40.21	27.57	18.96
Allocations	118.32	48.24	34.47	21.83	6.90
Margin of Safety	55.03	18.96	5.74	5.74	12.06
Benchmark[2]	20.35	7.89	4.72	3.24	2.22
Reduction Estimate[3]	63%	27%	19%	0%	0%
Implementation Opportunities	*Post Development BMPs*				
	Streambank Stabilization				
	Erosion Control Program				
		Riparian Buffer Protection			
				Municipal WWTP	

Notes:
1. Expressed as a *"daily load"*; represents the upper range of conditions needed to attain and maintain applicable water quality standards
2. Based on annual average target identified in the applicable water quality standards
3. Developed using long-term fixed station ambient water quality monitoring data

Source: *An Approach for Using Load Duration Curves in the Development of TMDLs.* US EPA. 2007

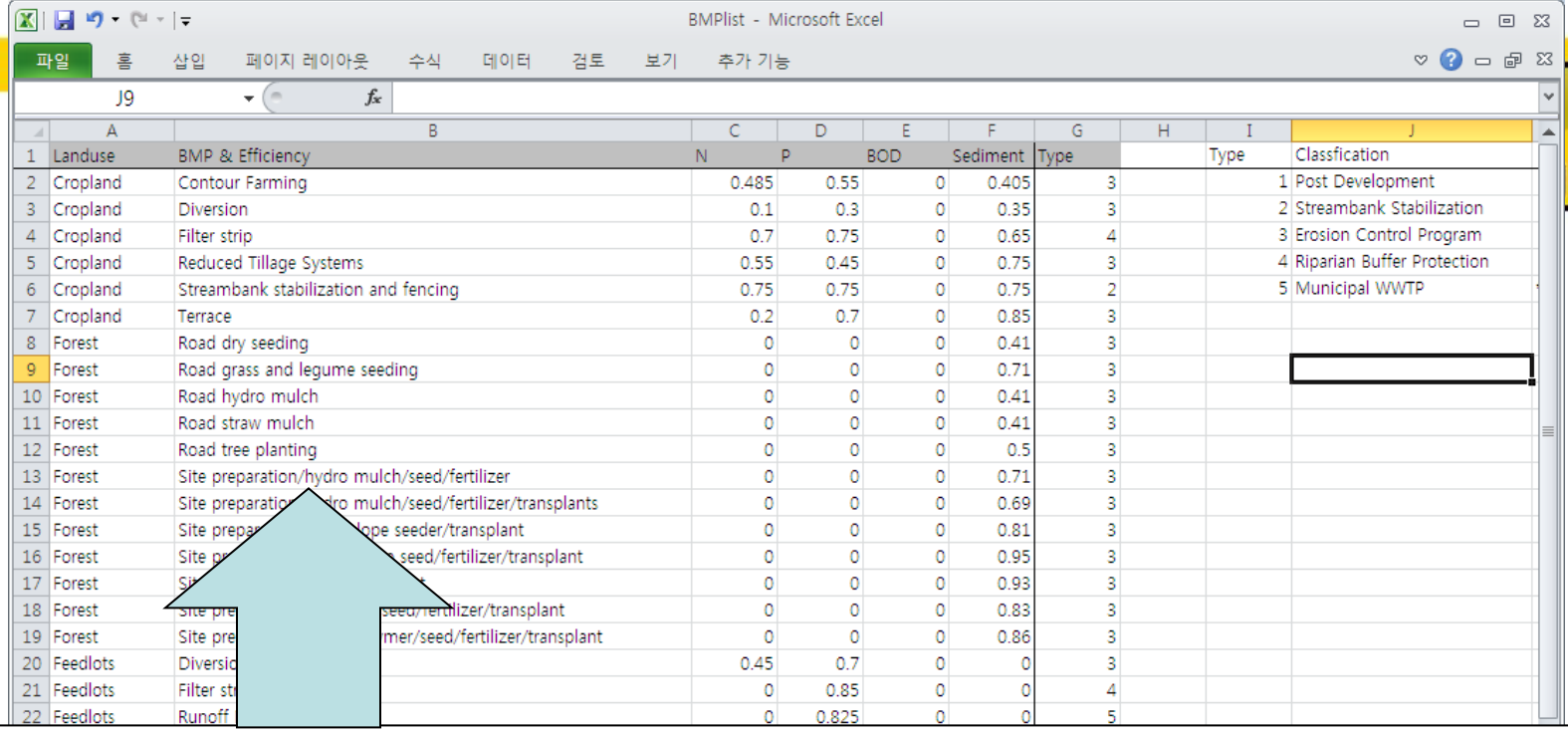
Based on the flow regimes, different BMPs need to be applied to reduce pollutant loads.

Logic and Program (cgi) flow

1. A BMP list for each flow regime requiring pollutant reduction is created from STEPL.

2. Program will select BMPs capable of producing the required reduction of pollutant load

3. Define the % of area to have BMP applied.
   For example, the required reduction is 19.70 % :
   If the BMP efficiency is 80%, the BMP needs to be applied to approximately 25% of the area.



	A	B	C	D	E	F	G	H	I	J
1	Landuse	BMP & Efficiency	N	P	BOD	Sediment	Type		Type	Classfication
2	Cropland	Contour Farming	0.485	0.55	0	0.405	3		1	Post Development
3	Cropland	Diversion	0.1	0.3	0	0.35	3		2	Streambank Stabilization
4	Cropland	Filter strip	0.7	0.75	0	0.65	4		3	Erosion Control Program
5	Cropland	Reduced Tillage Systems	0.55	0.45	0	0.75	3		4	Riparian Buffer Protection
6	Cropland	Streambank stabilization and fencing	0.75	0.75	0	0.75	2		5	Municipal WWTP
7	Cropland	Terrace	0.2	0.7	0	0.85	3			
8	Forest	Road dry seeding	0	0	0	0.41	3			
9	Forest	Road grass and legume seeding	0	0	0	0.71	3			
10	Forest	Road hydro mulch	0	0	0	0.41	3			
11	Forest	Road straw mulch	0	0	0	0.41	3			
12	Forest	Road tree planting	0	0	0	0.5	3			
13	Forest	Site preparation/hydro mulch/seed/fertilizer	0	0	0	0.71	3			
14	Forest	Site preparati ro mulch/seed/fertilizer/transplants	0	0	0	0.69	3			
15	Forest	Site prepa lope seeder/transplant	0	0	0	0.81	3			
16	Forest	Site p seed/fertilizer/transplant	0	0	0	0.95	3			
17	Forest	Si	0	0	0	0.93	3			
18	Forest	Site pre ilizer/transplant	0	0	0	0.83	3			
19	Forest	Site pre mer/seed/fertilizer/transplant	0	0	0	0.86	3			
20	Feedlots	Diversio	0.45	0.7	0	0	3			
21	Feedlots	Filter st	0	0.85	0	0	4			
22	Feedlots	Runoff	0	0.825	0	0	5			

Selected BMP categories from STEPL

BMP Group 1: Post Development BMPs

BMP Group 2: Streambank Stabilization

BMP Group 3: Erosion Control Program

BMP Group 4: Riparian Buffer Protection

BMP Group 5: Municipal Wastewater Treatment Program

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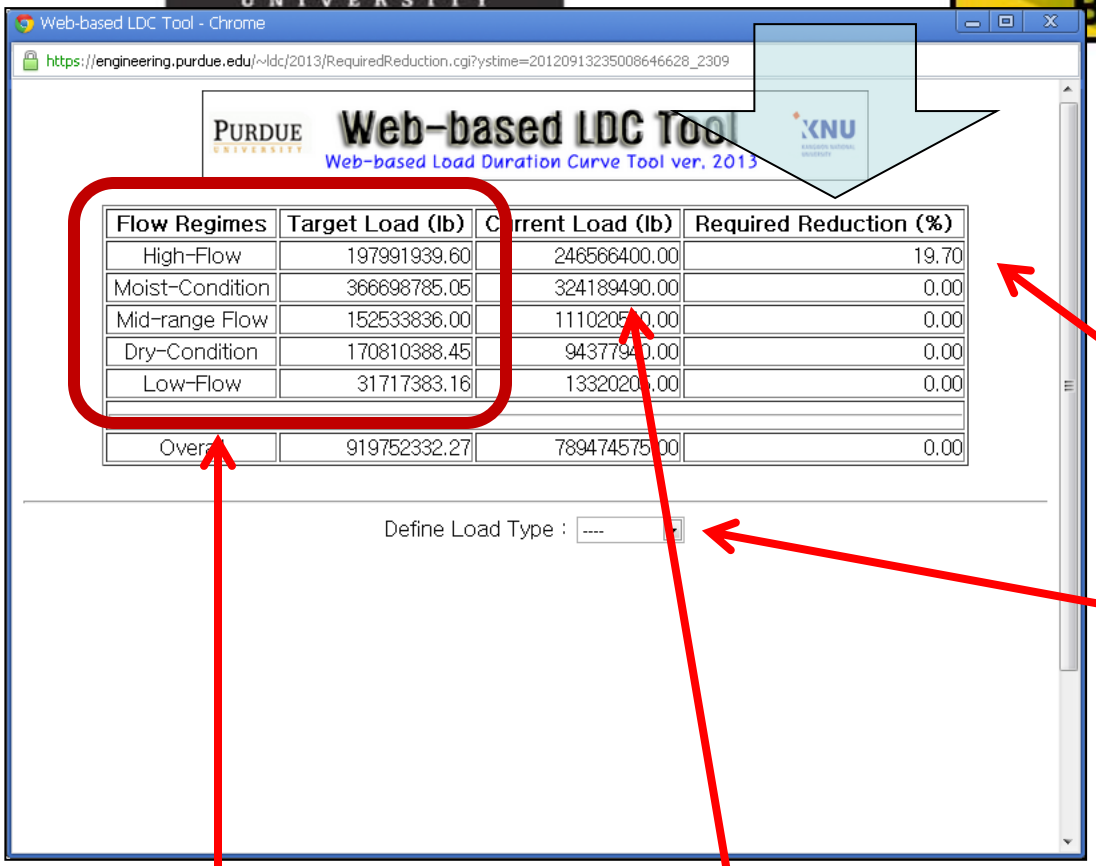
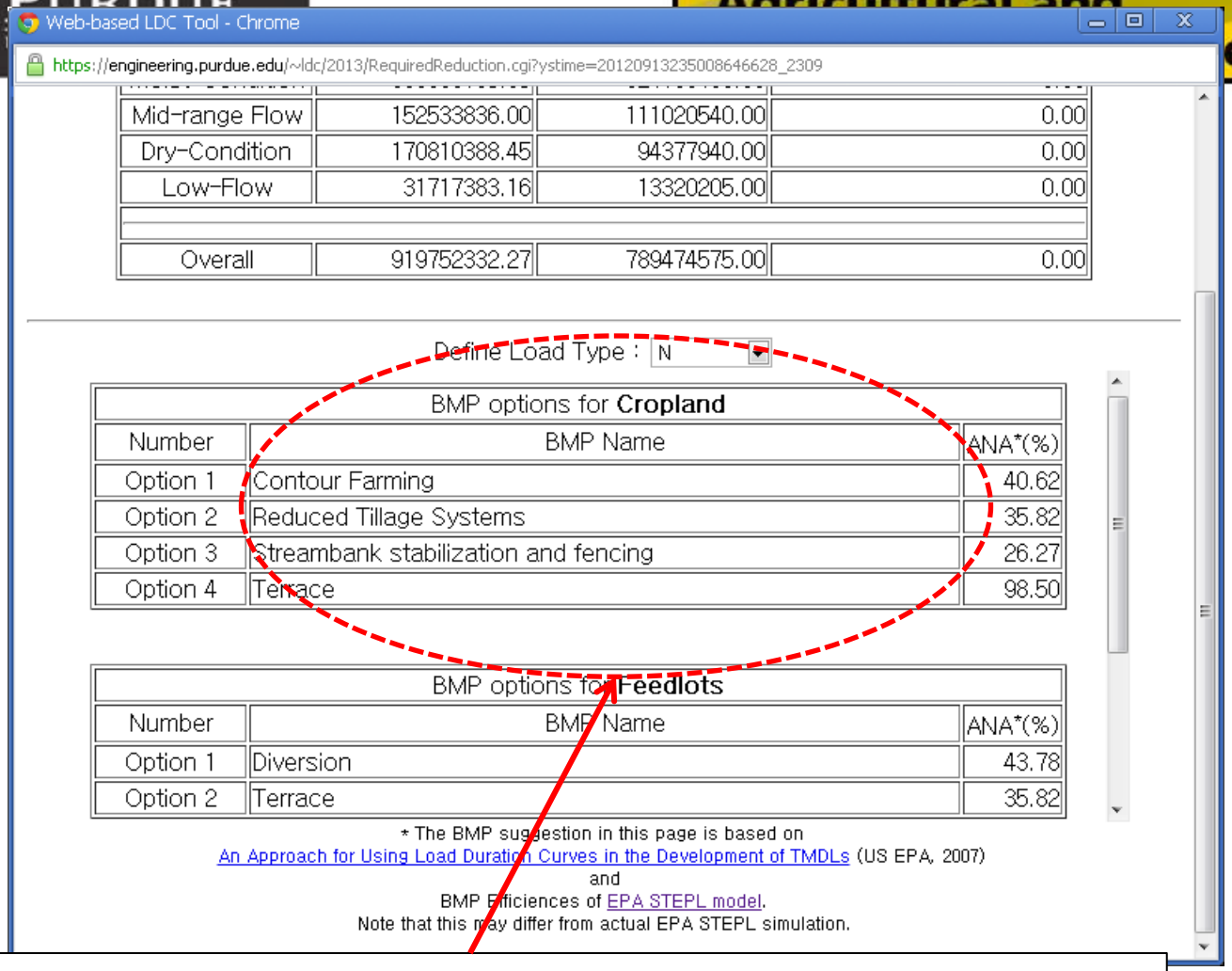


Required Reduction Percentage

Pollutant Constituent for Load
(N, P, BOD, or Sediment)

Target Load in each flow regime

Estimated Load by LOADEST in each flow regime

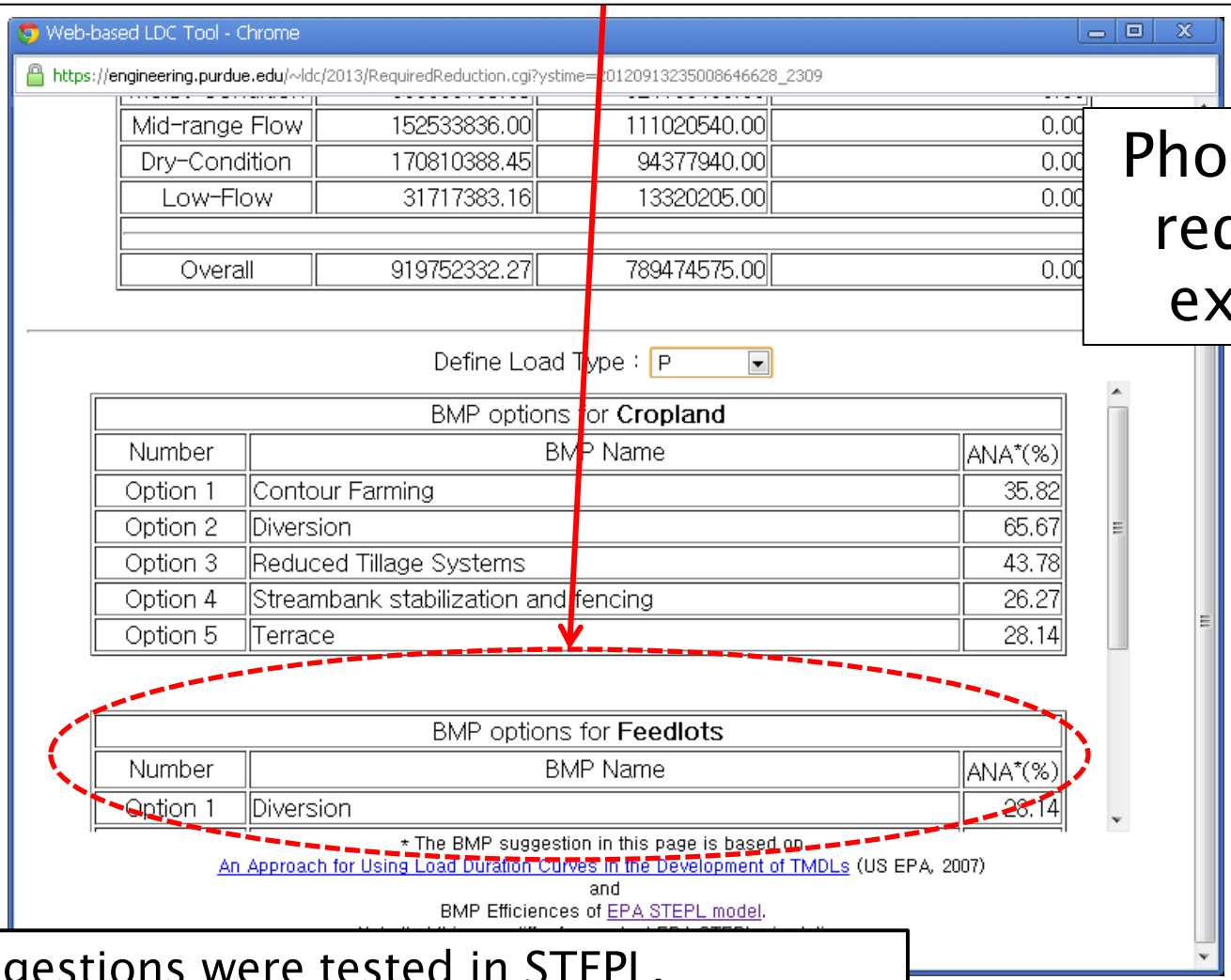


BMP List for **each** Landuse
The user needs to select an option in each landuse table.

Nitrogen reduction example

BMP List for each Landuse

The user needs to select an option in each landuse table for interactive results which may be used in models.



Phosphorus reduction example

The BMP suggestions were tested in STEPL. Required Reduction percentage from LDC was found to be similar to STEPL reductions.

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Future Steps

- Seamless import from MyWaters to replace down-then-up load,
- Expand LDC – USGS WQ connection for geographic coverage beyond Region 5
- Add more non-WQX WQ data sets
- Add user-friendly dialogs in LDC
- Create ability to categorize scenarios by BMP costs

Indiana Water Monitoring Inventory

A central hub for water monitoring locations of Indiana streams, lakes, and groundwater.

Introduction | Fact Sheet | Video Instructions | Provide Feedback | Monitoring Protocol | FAQs | Newsletters | Contact Us

Indiana:
Various long-term nutrient/metals data sets collected by watershed groups

Some non-STORET datasets could be loaded as services

View Monitoring Locations

NHD Water Layer:

All
Aquatic Plants/Algal Biomass
Bacteriology/Microbiology
Fish
Flow/Stage
General Chemistry
Groundwater Level
Groundwater Quality
Habitat
Lake Clarity
Macroinvertebrates
Metals
Nutrients
Organics/Pesticides
Radiological

Enter Your Monitoring Locations

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The End