Computer Systems Group
University of Waterloo

The Future of Metadata-Oriented Testing of Research Software: Automated Generation of Test Regimes and Other Benefits

WATERLOO
CHERITON SCHOOL OF COMPUTER SCIENCE
cs.uwaterloo.ca

Doug Mulholland
Paulo Alencar
Don Cowan

canarie

{dwm|palencar|dcowan}@csg.uwaterloo.ca

Computer Systems Group

- Software engineering research and development since early 1970s (mainframe, PC, web, mobile)
- > 75 operational systems in numerous sectors developed with metadata-driven technology

Philosophy

- Refocus the role of
  - Computer scientists (less design/coding, remove a bottleneck/“gatekeeper”), focus on the technical/logic challenges
- “Big red button” approach
  - Enable partners to access and manage their own data, interface, partnerships

In Practice

- A modest amount of common code, very rarely changed
  - Listings (multiple records), Forms (editable fields), Reports (usually one detailed record)
- Data (datasources, tables and columns) selected using “metadata”, i.e., additional data that describes how listings, forms and reports should be constructed/presented

Common Usage

- Metadata is initially set up by an application developer
- Presentation details (layouts, formatting details, system navigation, …) defined by a designer, incorporated by application developer (CSS, possibly some JavaScript, …)
- Reasonably detailed logs of requests and significant actions/transactions are recorded

System Testing

- Objective is to make testing as easy as possible
- Web-based test facility connects php-webdriver (Selenium Grid Server with php interface) to database tables and columns with sequences of test directives
- Any test can be entered manually (the usual listings, forms have been set up to access them) but it can be a bit tedious

Test Results

- Tests can be run on demand (click a link) or more automatically (timed, from a DB trigger, etc.)
- Results of each step and collection of steps (“suite”) are recorded in DB tables
- Results can be marked as a “comparison standard” – i.e., a desirable result; subsequent test runs are compared against these

Test Generation

- Tests can also be entered using other database queries, including queries that access the application definition metadata
  - For example, a form with a numeric input field that accepts integer values in the range 0 – 99 should be tested for inputs of at least -1, 100, probably 100,000,000, 1.5, 0, 1, 50, 98, 99, blank (empty), a space, “x” and any other values that the form creator deems to be significant

Scientific/Modelling Applications

- Input value domain testing extends to all "significant" values in an application domain
  - E.g., modelling for solar radiation received over a calendar year by latitude – a partner ("domain expert") asked "how could it possibly be wrong?" regarding a 20,000 line code sequence to model stream flows – except it failed (math exception) when a station was moved a few degrees north (they forgot to convert degrees to radians)
  - A similar "concern" involved an open stream temperature that was calculated to be 107 C, in Canada in January

Workflow Applications

- Workflows have been captured as a data representation (Graham Twaddle, Michael A. Jackson, 1997)
- Tests of workflow scenarios can be generated from the workflow definition

Declarative Software Agents

- Data is used to describe an agent's input, rules and actions; results are logged to DB tables
- Actions such as comparisons between distributed, disparate databases (i.e., copies of data in different formats) can enable routine consistency checking – can change the usual rules of data access

Future Testing

- “checkpointDB” / “compareDBWithCheckpoint”
- Did everything that was supposed to happen as a result of an action actually happen?
- Did only that which was supposed to happen actually happen?

Conclusions

- As systems are used, maintained and age, automated testing and detailed logging are two facilities that will help to keep systems operating as intended
- As more aspects of systems are described with metadata, we claim that it will be possible to automate more testing and more aspects of testing, in particular: what, when, how to test.

Thank You!

- Questions?

Flowing Waters Informat

https://www.comap.ca/fwis/index.php

FLOWING WATERS
INFORMATION SYSTEM

Welcome to the Flowing Waters Information System (FWIS)

FWIS helps Ontario's conservation practitioners to manage info ms, including data about fisheries, benthos, habitat and more. Currently, FWIS can be used to:

- Review and map locations where data is collected
- Identify where and what type of data has been collected
- Identify which conservation organization collected the data, and
- Request data for specific sampling locations
- View/edit fish and site data collected at sampling locations
- Query fish locations collected using OSAP standards across Ontario
- Download fish and site data from sampling locations

Using FWIS

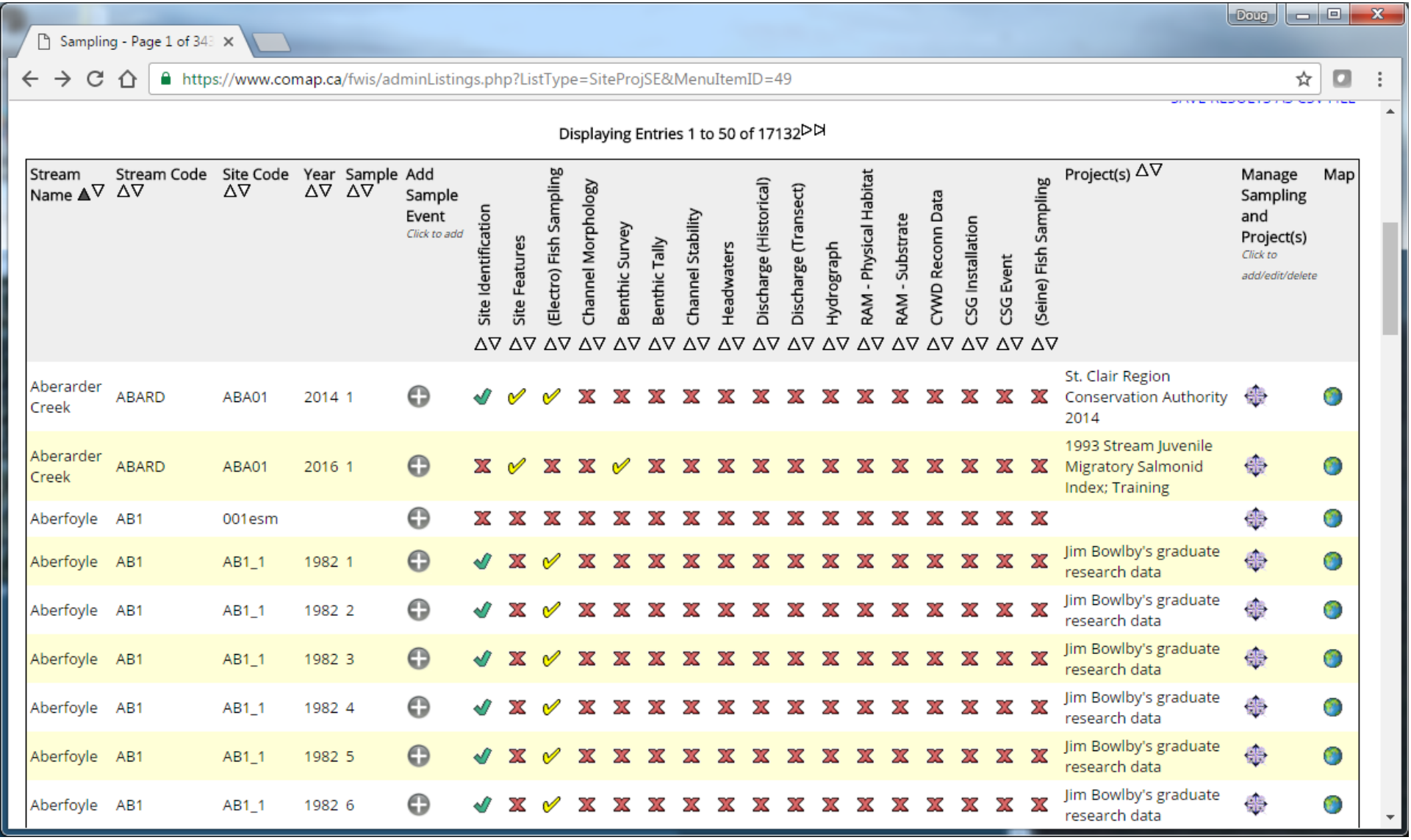
Click here to download the FWIS guide, *Using the Flowing Waters Information System Portal (May, 2014).*

American Fisheries Society 2014 (Quebec City) Presentation "Nothing Ventured, Nothing Gained - Lessons Learned from Developing a Flowing Waters Information Management System"
(Click here to download a PDF of the presentation)

Data included within FWIS are at present all collected using the Ontario Stream Assessment Protocol. The OSAP manual and videos that illustrate the methods as well as information on upcoming courses are available at http://www.trca.on.ca/osap/.

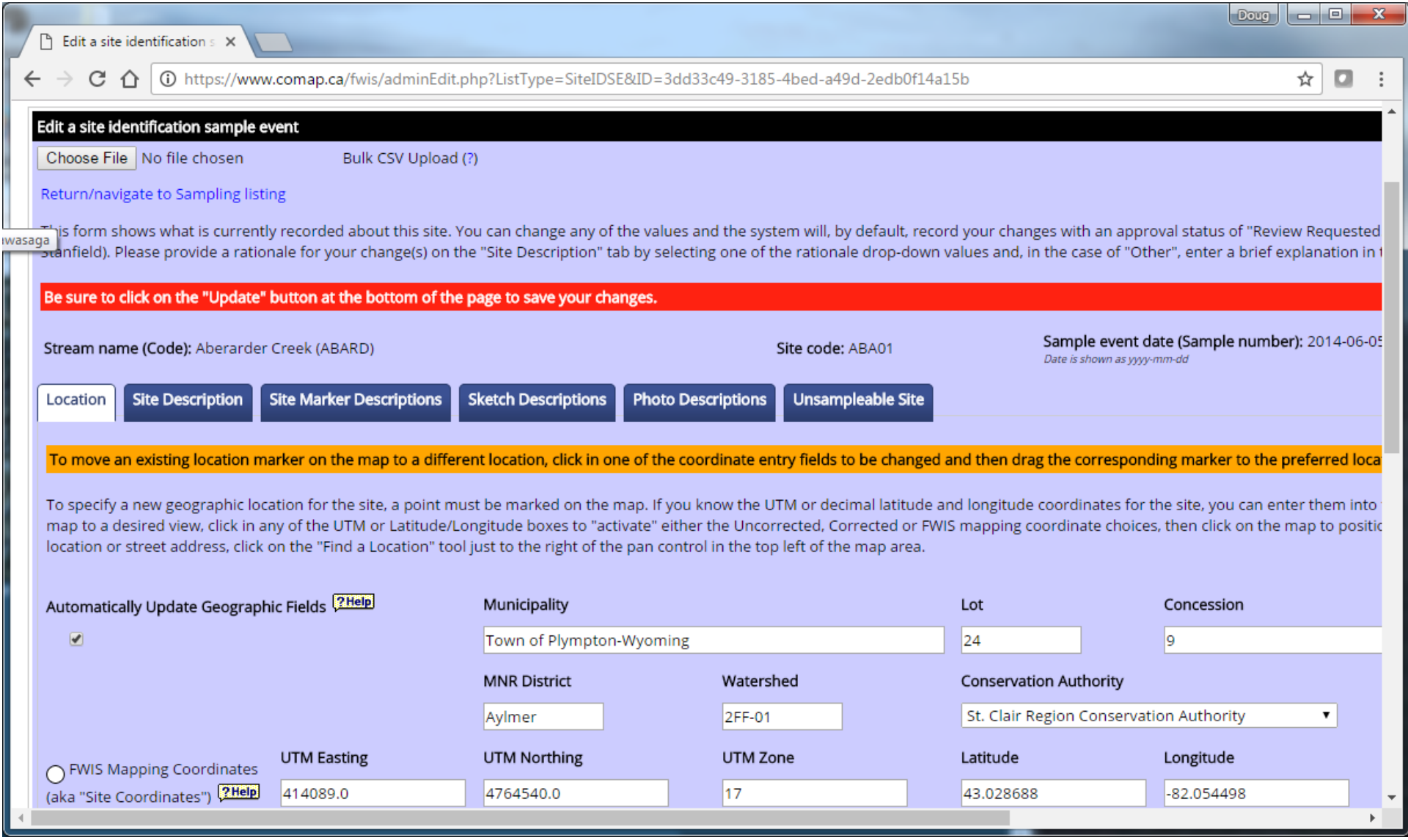
In the near future, FWIS will enable users to:

- Access other OSAP datasets
- Determine the protocol used to collect the data



Displaying Entries 1 to 50 of 17132

Stream Name	Stream Code	Site Code	Year	Sample	Add Sample Event *Click to add*	Site Identification	Site Features	(Electro) Fish Sampling	Channel Morphology	Benthic Survey	Benthic Tally	Channel Stability	Headwaters	Discharge (Historical)	Discharge (Transect)	Hydrograph	RAM - Physical Habitat	RAM - Substrate	CYWD Reconn Data	CSG Installation	CSG Event	(Seine) Fish Sampling	Project(s)	Manage Sampling and Project(s) *Click to add/edit/delete*	Map
Aberarder Creek	ABARD	ABA01	2014	1	⊕	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	St. Clair Region Conservation Authority 2014	✥	🌐
Aberarder Creek	ABARD	ABA01	2016	1	⊕	✗	✓	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	1993 Stream Juvenile Migratory Salmonid Index; Training	✥	🌐
Aberfoyle	AB1	001esm			⊕	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗		✥	🌐
Aberfoyle	AB1	AB1_1	1982	1	⊕	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	Jim Bowlby's graduate research data	✥	🌐
Aberfoyle	AB1	AB1_1	1982	2	⊕	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	Jim Bowlby's graduate research data	✥	🌐
Aberfoyle	AB1	AB1_1	1982	3	⊕	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	Jim Bowlby's graduate research data	✥	🌐
Aberfoyle	AB1	AB1_1	1982	4	⊕	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	Jim Bowlby's graduate research data	✥	🌐
Aberfoyle	AB1	AB1_1	1982	5	⊕	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	Jim Bowlby's graduate research data	✥	🌐
Aberfoyle	AB1	AB1_1	1982	6	⊕	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	Jim Bowlby's graduate research data	✥	🌐


Doug
Edit a site identification s
https://www.comap.ca/fwis/adminEdit.php?ListType=SiteIDSE&ID=3dd33c49-3185-4bed-a49d-2edb0f14a15b
Edit a site identification sample event
Choose File
No file chosen
Bulk CSV Upload (?)
Return/navigate to Sampling listing
This form shows what is currently recorded about this site. You can change any of the values and the system will, by default, record your changes with an approval status of "Review Requested
Be sure to click on the "Update" button at the bottom of the page to save your changes.
Stream name (Code): Aberarder Creek (ABARD)
Site code: ABA01
Sample event date (Sample number): 2014-06-05
Date is shown as yyyy-mm-dd
Location
Site Description
Site Marker Descriptions
Sketch Descriptions
Photo Descriptions
Unsampleable Site
To move an existing location marker on the map to a different location, click in one of the coordinate entry fields to be changed and then drag the corresponding marker to the preferred loca
To specify a new geographic location for the site, a point must be marked on the map. If you know the UTM or decimal latitude and longitude coordinates for the site, you can enter them into
map to a desired view, click in any of the UTM or Latitude/Longitude boxes to "activate" either the Uncorrected, Corrected or FWIS mapping coordinate choices, then click on the map to positio
location or street address, click on the "Find a Location" tool just to the right of the pan control in the top left of the map area.
Automatically Update Geographic Fields
?Help
Municipality
Town of Plympton-Wyoming
Lot
24
Concession
9
MNR District
Aylmer
Watershed
2FF-01
Conservation Authority
St. Clair Region Conservation Authority
FWIS Mapping Coordinates
(aka "Site Coordinates")
?Help
UTM Easting
414089.0
UTM Northing
4764540.0
UTM Zone
17
Latitude
43.028688
Longitude
-82.054498

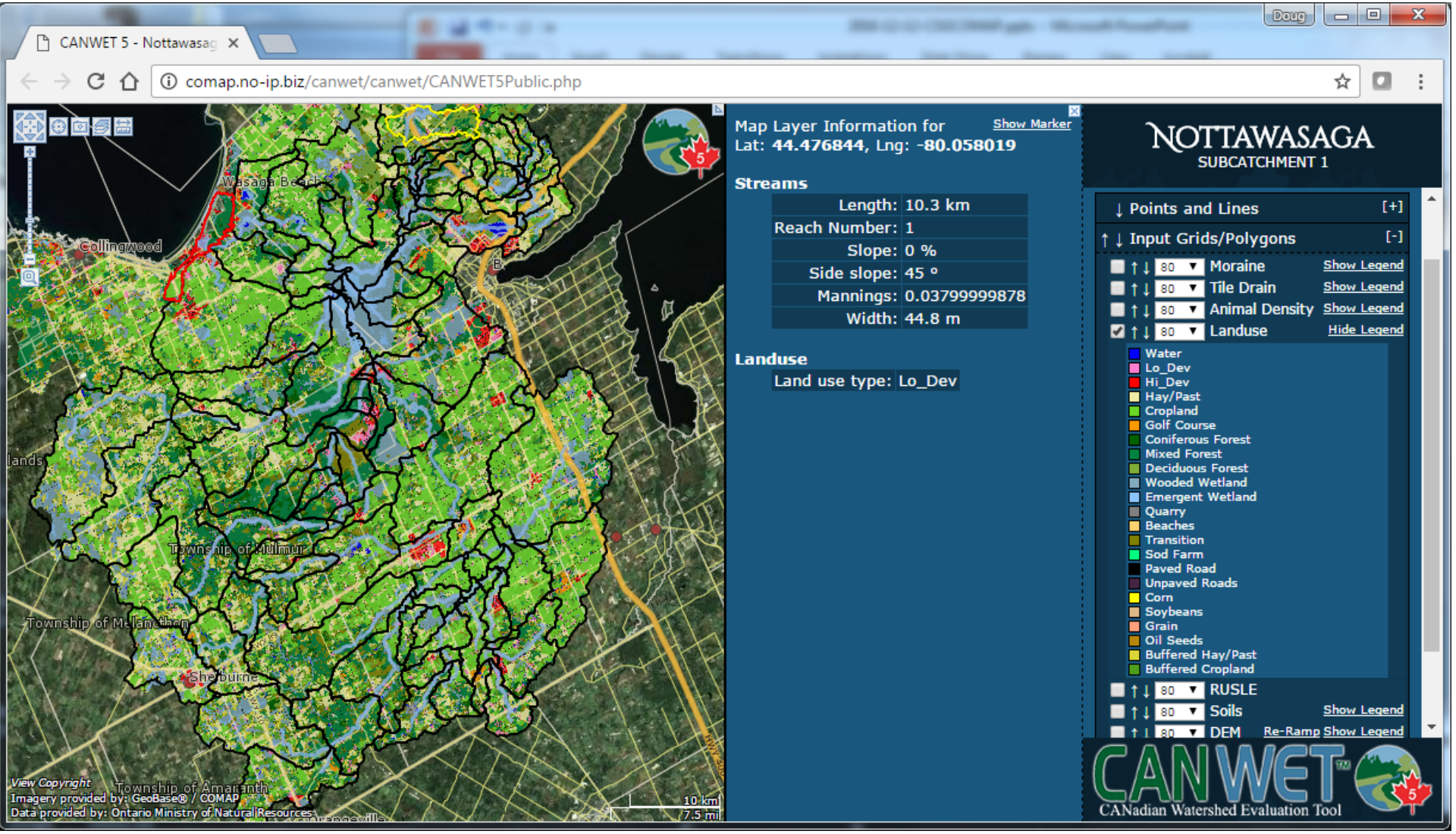
Edit a site identification

https://www.comap.ca/fwis/adminEdit.php?ListType=SiteIDSE&ID=3dd33c49-3185-4bed-a49d-2edb0f14a15b

	UTM Easting	UTM Northing	UTM Zone	Latitude	Longitude
FWIS Mapping Coordinates (aka "Site Coordinates") ?Help	414089.0	4764540.0	17	43.028688	-82.054498
Sample ?Help	414089.0	4764540.0	17	43.028688	-82.054498
Corrected ?Help	414089.0	4764540.0	17	43.028688	-82.054498

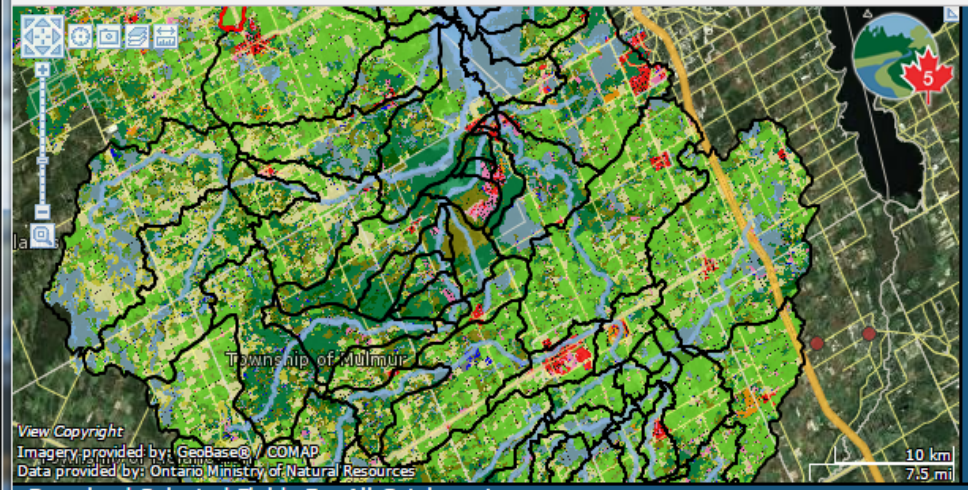
Correction Layer

Other Sites


CANWET 5 - Nottawasag
comap.no-ip.biz/canwet/canwet/CANWET5Public.php
Doug
Wasaga Beach
Collingwood
Township of Nulmur
Township of Melancthon
Shelburne
Township of Amaranth
Orangeville
View Copyright
Imagery provided by: GeoBase® / COMAP
Data provided by: Ontario Ministry of Natural Resources
10 km
7.5 mi
Map Layer Information for
Lat: 44.476844, Lng: -80.058019
Show Marker
Streams
Length: 10.3 km
Reach Number: 1
Slope: 0 %
Side slope: 45 °
Mannings: 0.03799999878
Width: 44.8 m
Landuse
Land use type: Lo_Dev
NOTTAWASAGA
SUBCATCHMENT 1
↓ Points and Lines [+]
↑ ↓ Input Grids/Polygons [-]
Moraine Show Legend
Tile Drain Show Legend
Animal Density Show Legend
Landuse Hide Legend
Water
Lo_Dev
Hi_Dev
Hay/Past
Cropland
Golf Course
Coniferous Forest
Mixed Forest
Deciduous Forest
Wooded Wetland
Emergent Wetland
Quarry
Beaches
Transition
Sod Farm
Paved Road
Unpaved Roads
Corn
Soybeans
Grain
Oil Seeds
Buffered Hay/Past
Buffered Cropland
RUSLE
Soils Show Legend
DEM Re-Ramp Show Legend
CANWET™
CANadian Watershed Evaluation Tool

CANWET 5 - Nottawasag

comap.no-ip.biz/canwet/canwet/CANWET5Public.php



Data Source: Landuse Output

Fields:
- Erosion (kg)
- Sediment (kg)
- [x] Phosphorus (kg)
- Precipitation (cm)

Catchment: Nottawasaga (Basin 1)

Land Use: Lo_Dev

Add Data Source

NOTTAWASAGA
SUBCATCHMENT 1

Map Layers

Chart Analysis

Chart Title: Nottawasaga

Chart Type: Line Chart

Legend Position: Bottom

Date Range: (2000 to 2013) 2000-01-01 - 2013-12-31

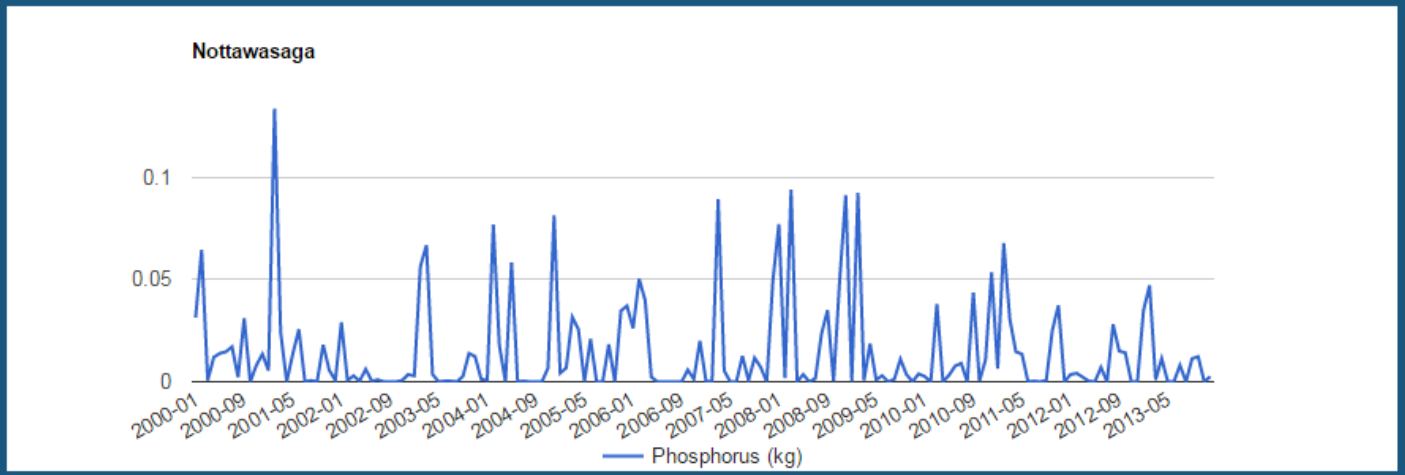
Timestep: Monthly

Aggregate: Average

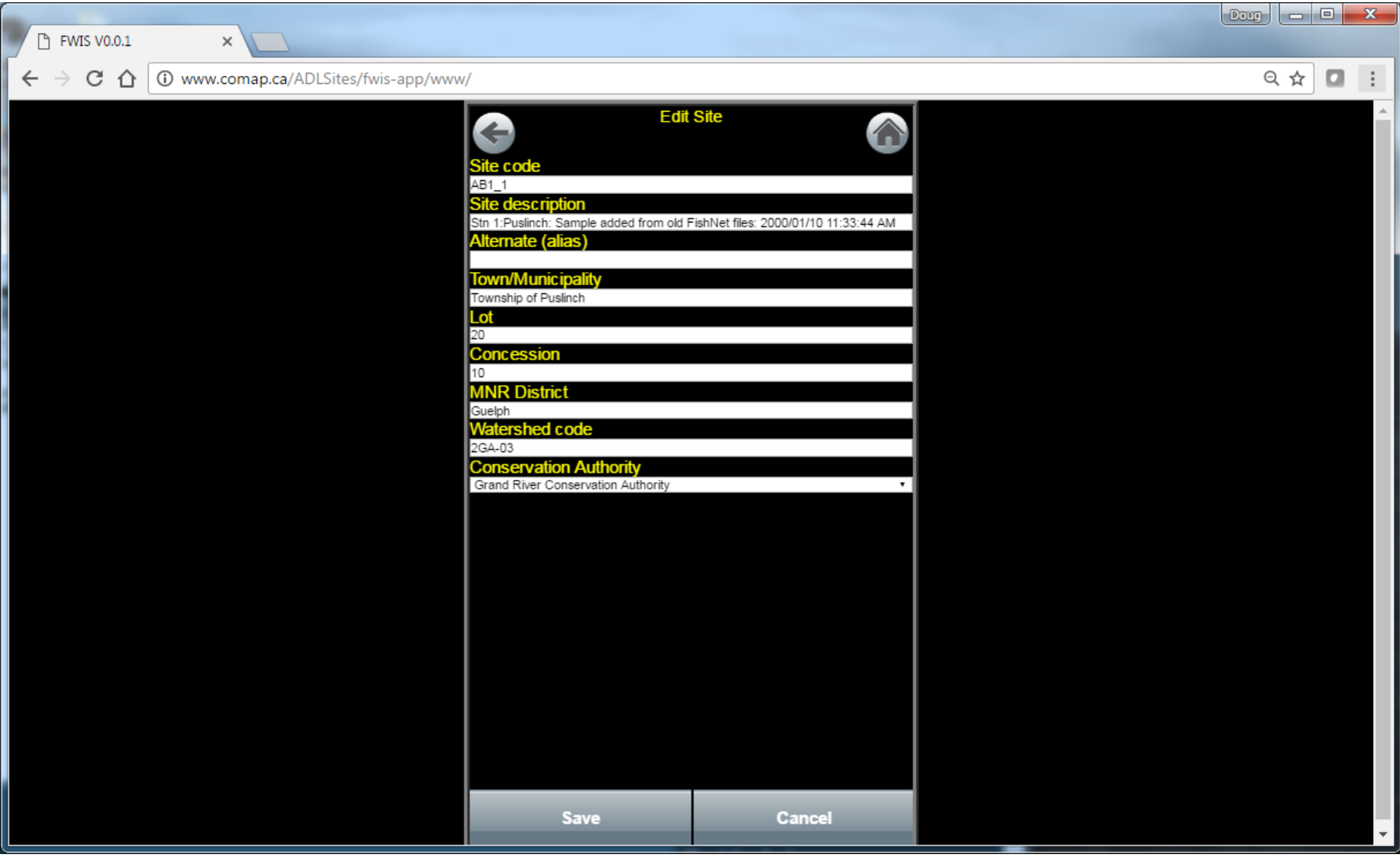
Y Axis Min/Max: Min: Max:

Download Selected Fields For All Catchments

Download Chart Data



CANWET™
CANadian Watershed Evaluation Tool


Doug
FWIS V0.0.1
www.comap.ca/ADLSites/fwis-app/www/
Edit Site
Site code
AB1_1
Site description
Stn 1:Puslinch: Sample added from old FishNet files: 2000/01/10 11:33:44 AM
Alternate (alias)
Town/Municipality
Township of Puslinch
Lot
20
Concession
10
MNR District
Guelph
Watershed code
2GA-03
Conservation Authority
Grand River Conservation Authority
Save
Cancel