

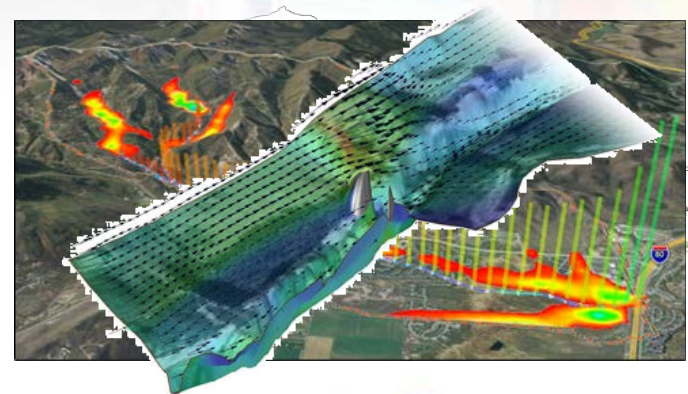
Web Applications to Support Municipal Water Works

Nathan R. Swain, PhD



Steven Jones, MS, PE







Columbia River Winter Operations Study



Kearns Improvement District 5 MG Tank



CWP High-Head Wells Project





**Governor's Energy Innovator
of the Year Award**



2015 WINNER
BEST OF STATE

Civil Engineering

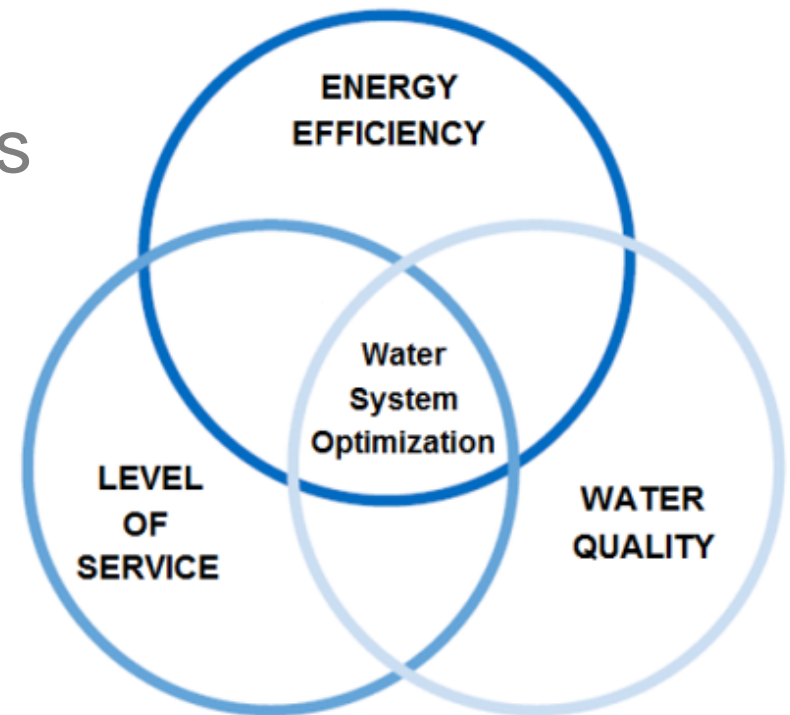


2016 WINNER
BEST OF STATE

Civil Engineering



- Master Planning
- Water and energy audits
- System optimization studies
- Strategic energy management programs
- Water quality, energy and hydraulic modeling

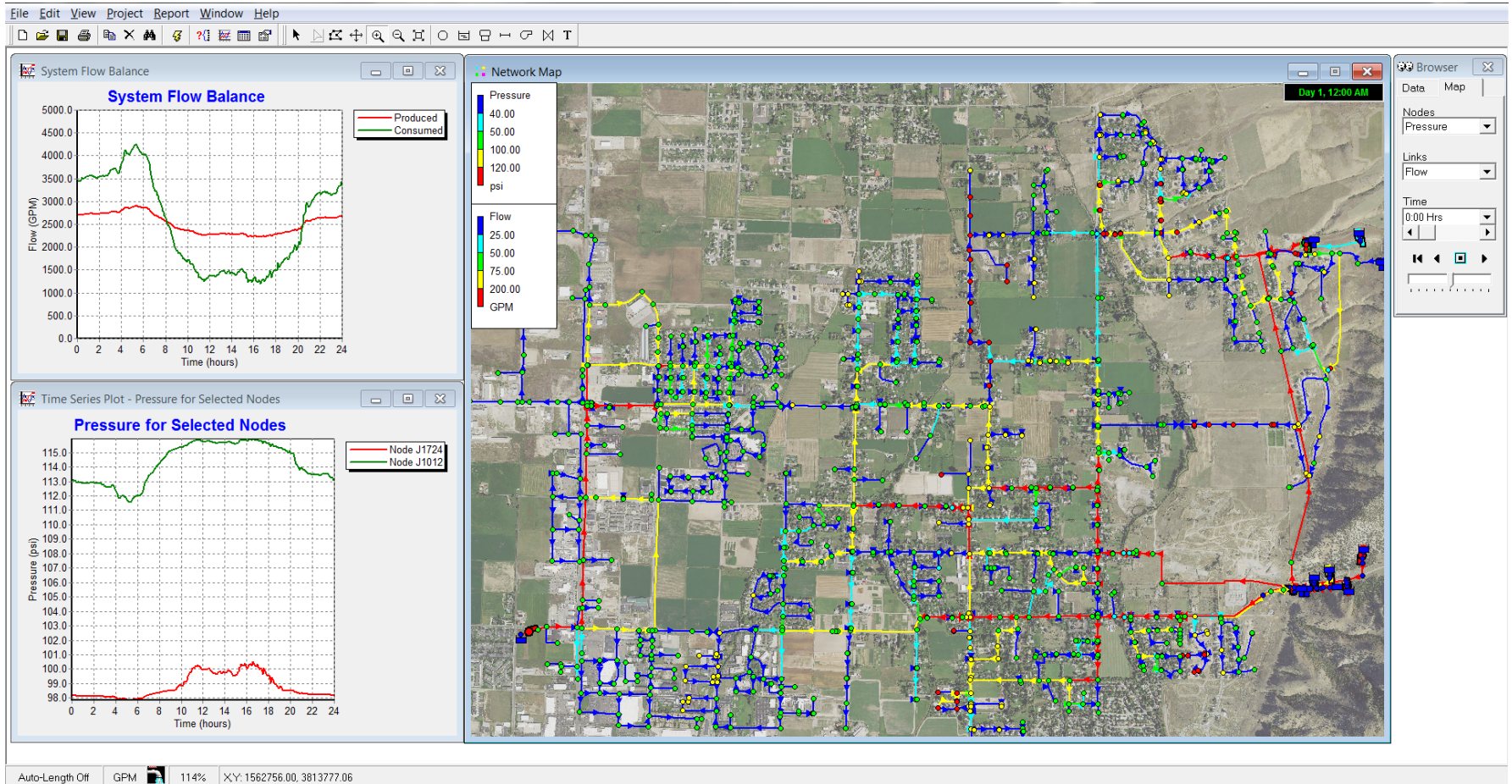


60+ water utilities
of all sizes

8,000,000
kilowatt-hours saved

10 years of experience in water
system energy efficiency





Utah DWR Groundwater Tool

Utah.gov Services Agencies Search all of Utah.gov »

Utah Division of Water Rights

Import Wells ▾ Add Well

Diversion	Top Depth	Btm Depth	Location
ac-ft	ft	ft	Lat, Lon
1	2000	100	500
			Set by map click
			37.662325, -113.17351 X

Run Simulation

☒ Submitted Job -- Status and Results

Tool Output:

- [PDF Report](#)

Map Legend:

New Well

Drawdown

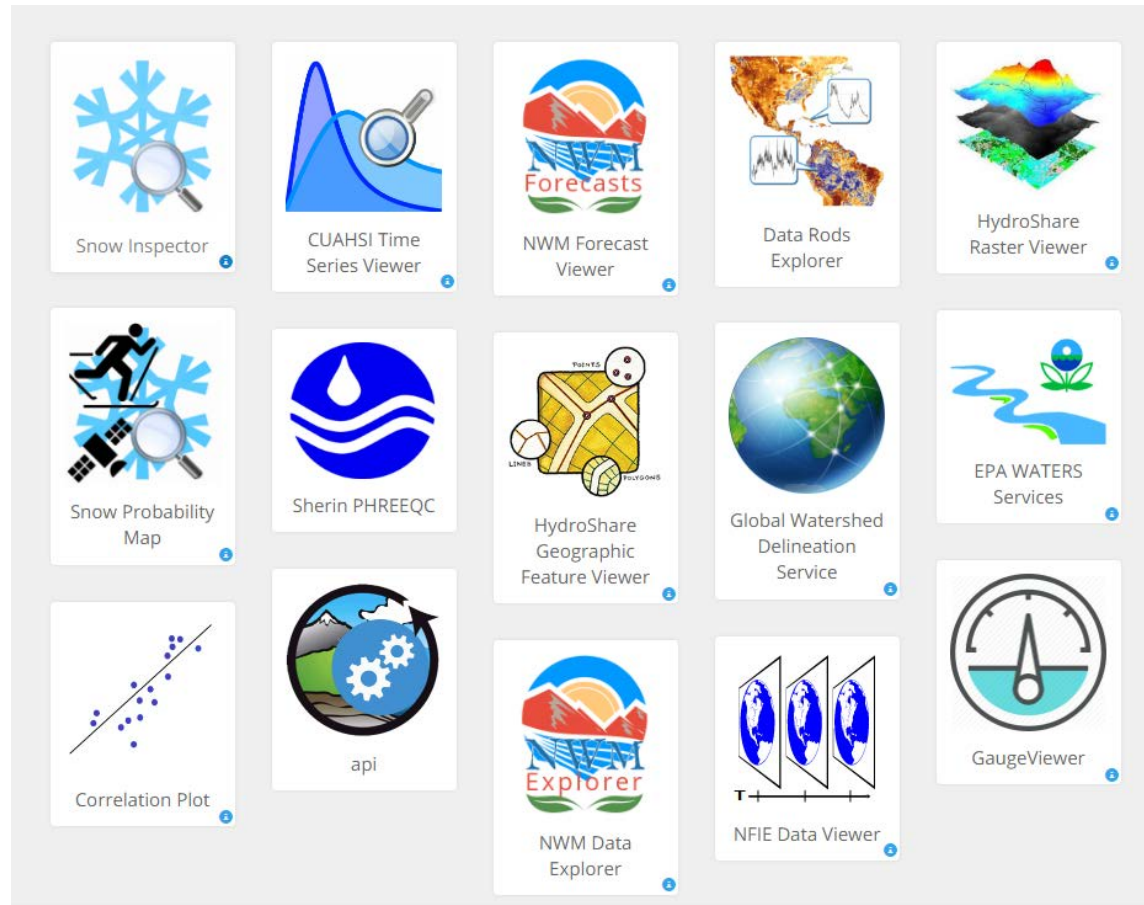
- 1 ft
- 5 ft
- 15 ft
- 50 ft

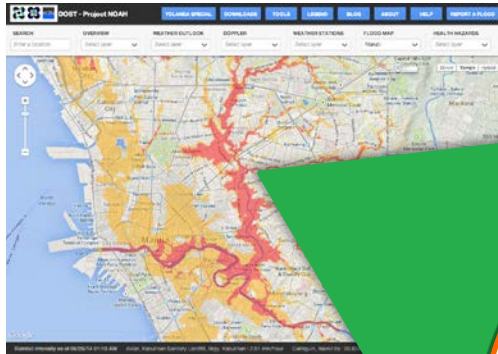
Job Messages:

- Executing (DrawdownFromWell): DrawdownFromWell 4 "Feature Set"
- Start Time: Thu Aug 11 16:21:22 2016
- Executing (DrawdownFromWell): DrawdownFromWell 4 "Feature Set"
- Start Time: Thu Aug 11 16:21:22 2016
- Running script DrawdownFromWell...
- Using the Cedar City Valley model.
- Well "1" was added to MODFLOW layer 2.
- Well placed at IJK: 5385
- Running MODFLOW.
- Reading simulation results.
- Maximum drawdown is 163.4 ft. in layer 2.
- Considering drawdown in layers 2 and 3
- Interpolating...
- Contouring...
- Creating PDF map.
- Completed script DrawdownFromWell...
- Succeeded at Thu Aug 11 16:21:49 2016 (Elapsed Time: 26.99 seconds)
- Succeeded at Thu Aug 11 16:21:49 2016 (Elapsed Time: 26.99 seconds)

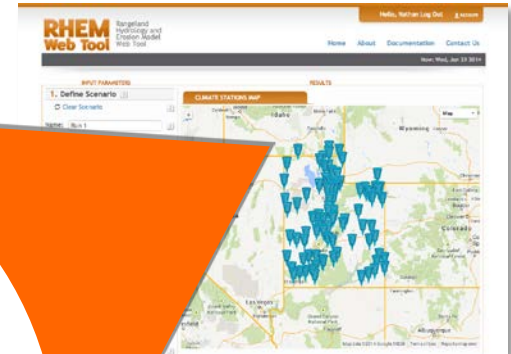
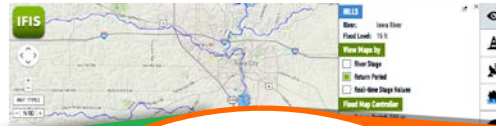


Decision Support Web Apps

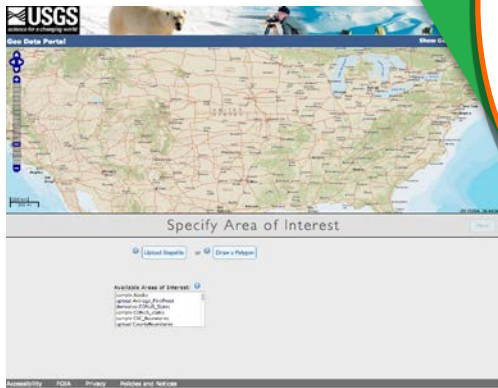




NOAH (Alconis et al., 2010)



RHEM (Goodrich et al., 2008)



GeoData Portal (Kunicki et al., 2011)



DEM Explorer (Han et al., 2012)



BASHYT (Cau et al., 2013)



Environmental Modelling & Software 67 (2015) 108–117



Contents lists available at ScienceDirect

Environmental Modelling & Software

journal homepage: www.elsevier.com/locate/envsoft



Review

A review of open source software solutions for developing water resources web applications



Nathan R. Swain^{a,*}, Kilisimasi Latu^b, Scott D. Christensen^a, Norman L. Jones^a,
E. James Nelson^a, Daniel P. Ames^a, Gustavious P. Williams^a

^a Civil and Environmental Engineering, Brigham Young University, Provo, UT, USA

^b Infrastructure Engineering, University of Melbourne, Melbourne, VIC, Australia

ARTICLE INFO

Article history:

Received 28 October 2014

Received in revised form

17 January 2015

Accepted 20 January 2015

Available online

Keywords:

Water resources

Web app

FOSS

FOSS4G

ABSTRACT

Water resources web applications or “web apps” are growing in popularity as a means to overcome many of the challenges associated with hydrologic simulations in decision-making. Water resources web apps fall outside of the capabilities of standard web development software, because of their spatial data components. These spatial data needs can be addressed using a combination of existing free and open source software (FOSS) for geographic information systems (FOSS4G) and FOSS for web development. However, the abundance of FOSS projects that are available can be overwhelming to new developers. In an effort to understand the web of FOSS features and capabilities, we reviewed many of the state-of-the-art FOSS software projects in the context of those that have been used to develop water resources web apps published in the peer-reviewed literature in the last decade (2004–2014).

© 2015 Elsevier Ltd. All rights reserved.

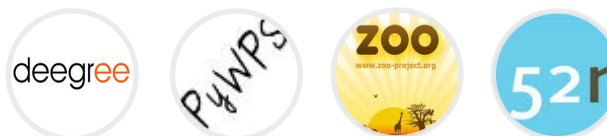


Open Source Solution

Spatial Data Storage



Spatial Analysis



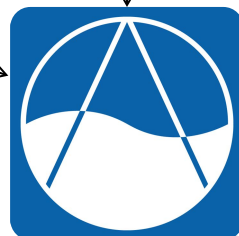
Spatial Visualization



Web Framework




Spatial Publishing







Source: <http://pattayadesignstudios.com/what-are-languages-used-for-web-development/>




 Tethys Platform

Apps Developer 


Apps Library




Canned GSSHA



GSSHA Index Map Editor




Observed Hydrologic Data



Parleys Creek Management Tool

Copyright © 2015 Your Organization

Powered by  Tethys Platform





Canned GSSHA

Exit

Temperature [°F]

20 100 60

Temperature Amplitude [°F]

5 20 12.5

Rain Duration [hours]

1 10 7

Rain Intensity [mm]

10 100 55

Rain Start [hour]

0 24 12

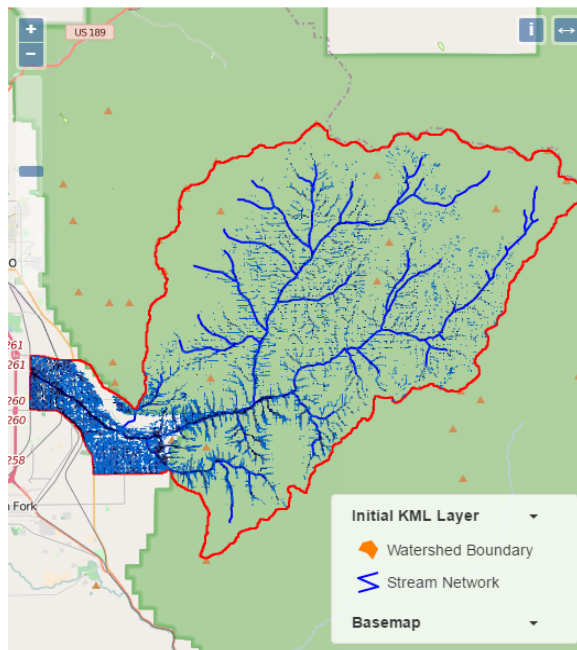
Snow Line [m]

-100 400 150

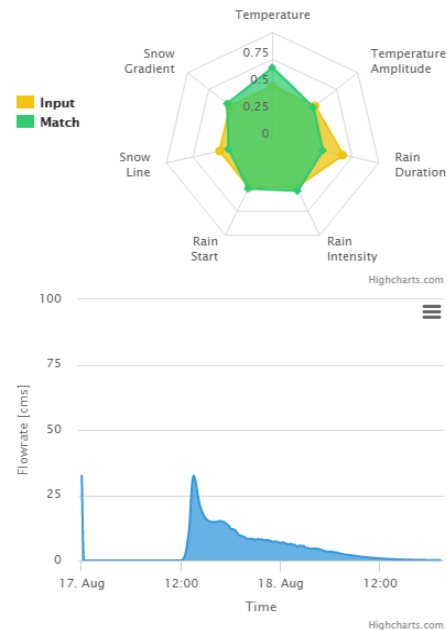
Snow Gradient [m/m]

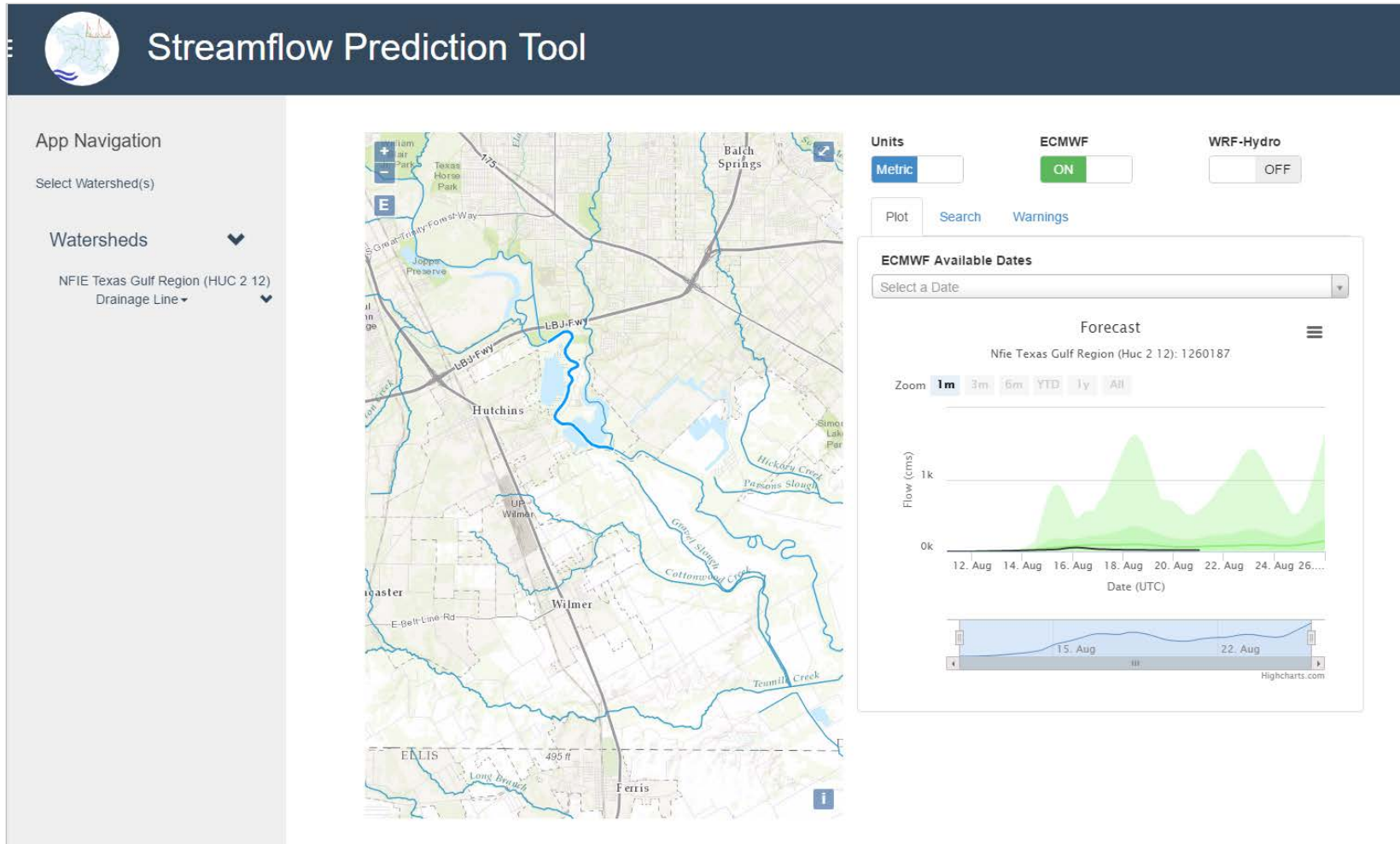
0 0.002 0.001

Max Flow: 32.47 cms

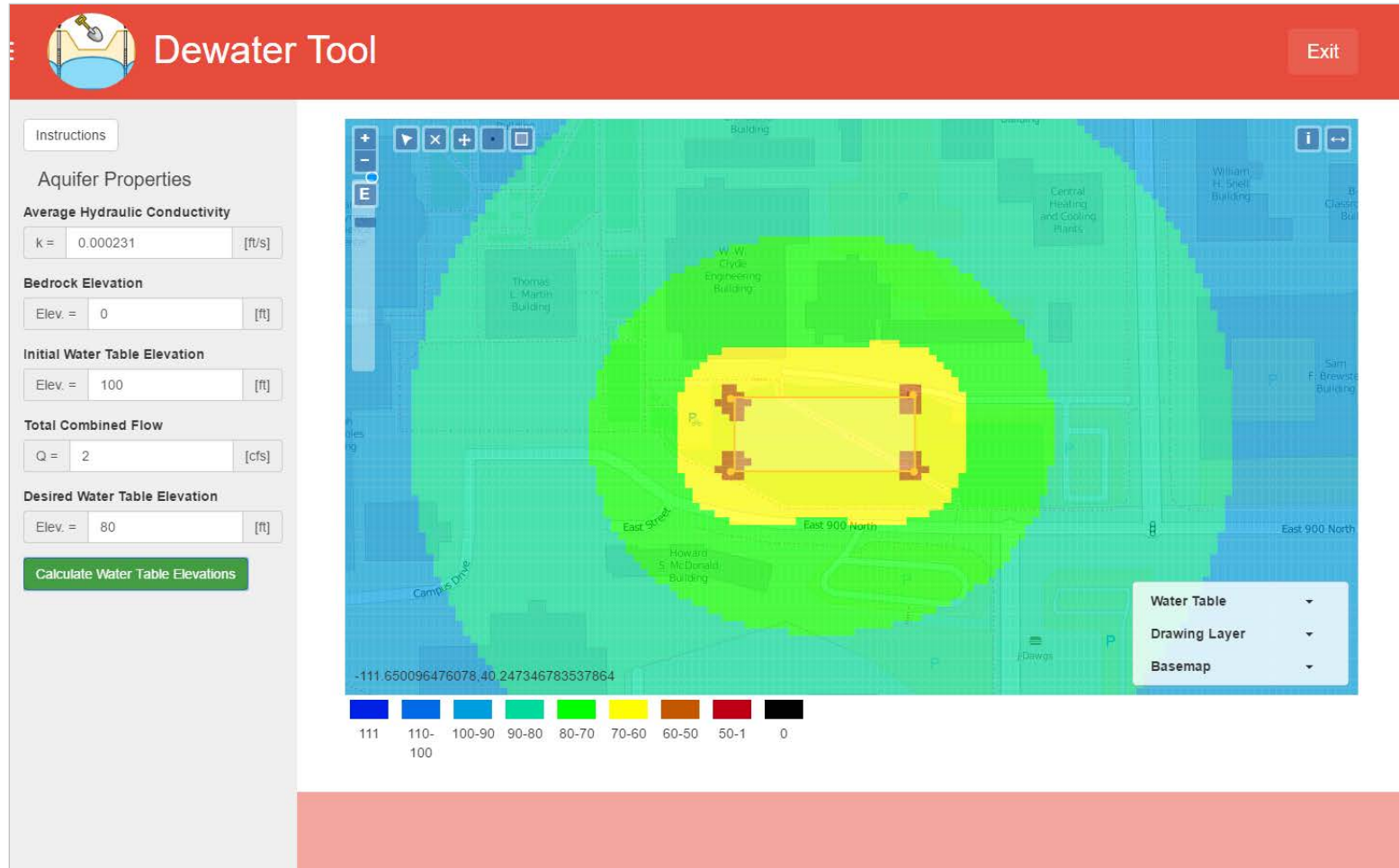


Note: Values shown in plot are normalized for easy comparison.

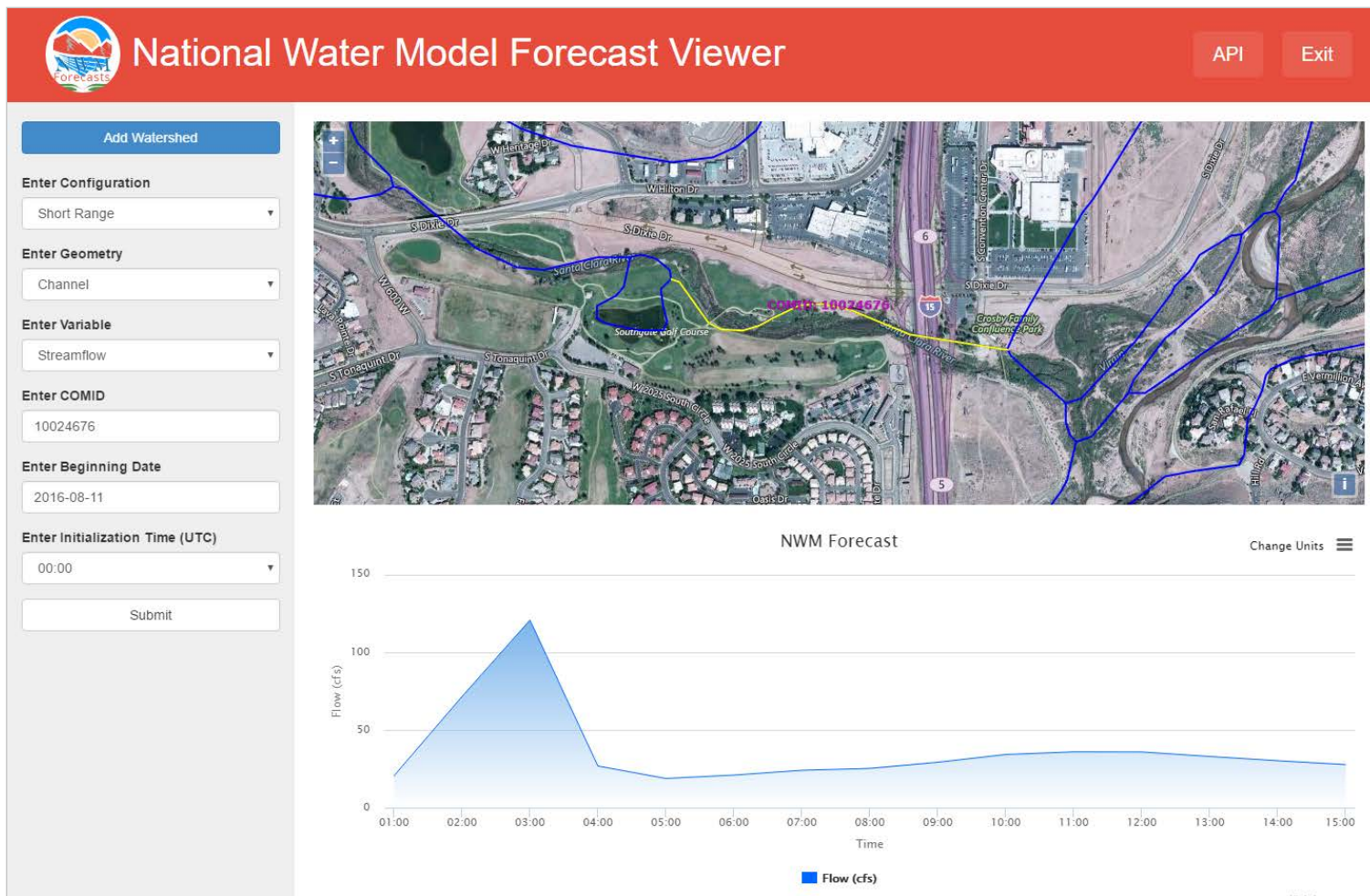




Tethys Platform Demo



Tethys Platform Demo





Contents lists available at ScienceDirect

Environmental Modelling & Software

journal homepage: www.elsevier.com/locate/envsoft



A new open source platform for lowering the barrier for environmental web app development



Nathan R. Swain ^{a,*}, Scott D. Christensen ^b, Alan D. Snow ^c, Herman Dolder ^a, Gonzalo Espinoza-Dávalos ^d, Erfan Goharian ^e, Norman L. Jones ^f, E. James Nelson ^f, Daniel P. Ames ^f, Steven J. Burian ^g

^a Aquaveo, LLC, Provo, UT, USA

^b Information and Technology Laboratory, United States Army Engineer Research and Development Center, Vicksburg, MS, USA

^c Coastal and Hydraulics Laboratory, United States Army Engineer Research and Development Center, Vicksburg, MS, USA

^d Department of Integrated Water Systems and Governance, UNESCO-IHE, Delft, The Netherlands

^e Department of Land, Air and Water Resource, University of California, Davis, CA, USA

^f Civil and Environmental Engineering, Brigham Young University, Provo, UT, USA

^g Civil and Environmental Engineering, University of Utah, Salt Lake City, UT, USA

ARTICLE INFO

Article history:

Received 12 February 2016

Received in revised form

2 August 2016

Accepted 8 August 2016

Keywords:

Tethys platform

Web app development

Environmental

Decision support

Hydrologic modeling

ABSTRACT

The interactive nature of web applications or “web apps” makes them a well-suited medium for conveying complex scientific concepts to lay audiences and creating decision support tools that harness cutting edge modeling techniques and promote the work of environmental scientists and engineers. Despite this potential, the technical expertise required to develop web apps represents a formidable barrier—even for scientists and engineers who are skilled programmers. This paper describes four hurdles that contribute to this barrier and introduces an approach to overcoming these hurdles. We present an open source implementation of this approach, a development and hosting environment for environmental web apps called Tethys Platform. Several case studies are provided that demonstrate how the approach, as implemented within Tethys Platform, successfully lowers the barrier to web app development in the environmental domain.

© 2016 Elsevier Ltd. All rights reserved.

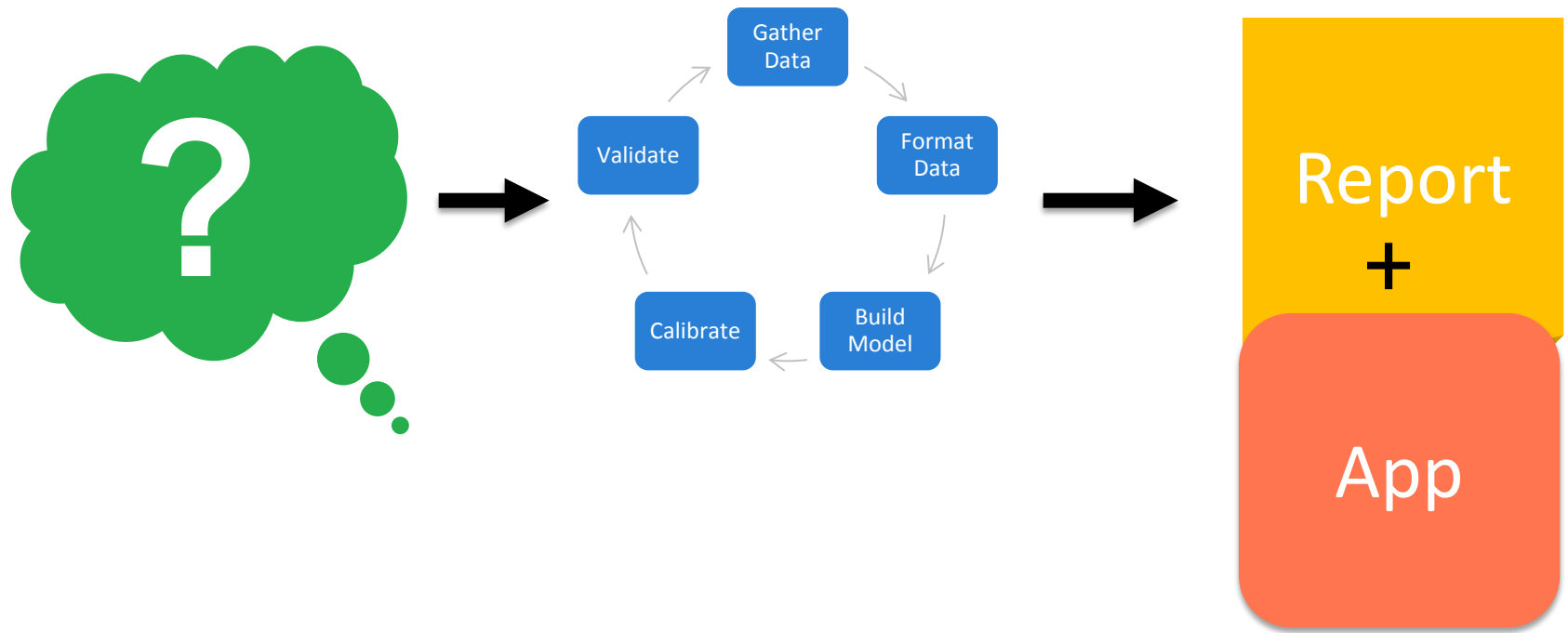


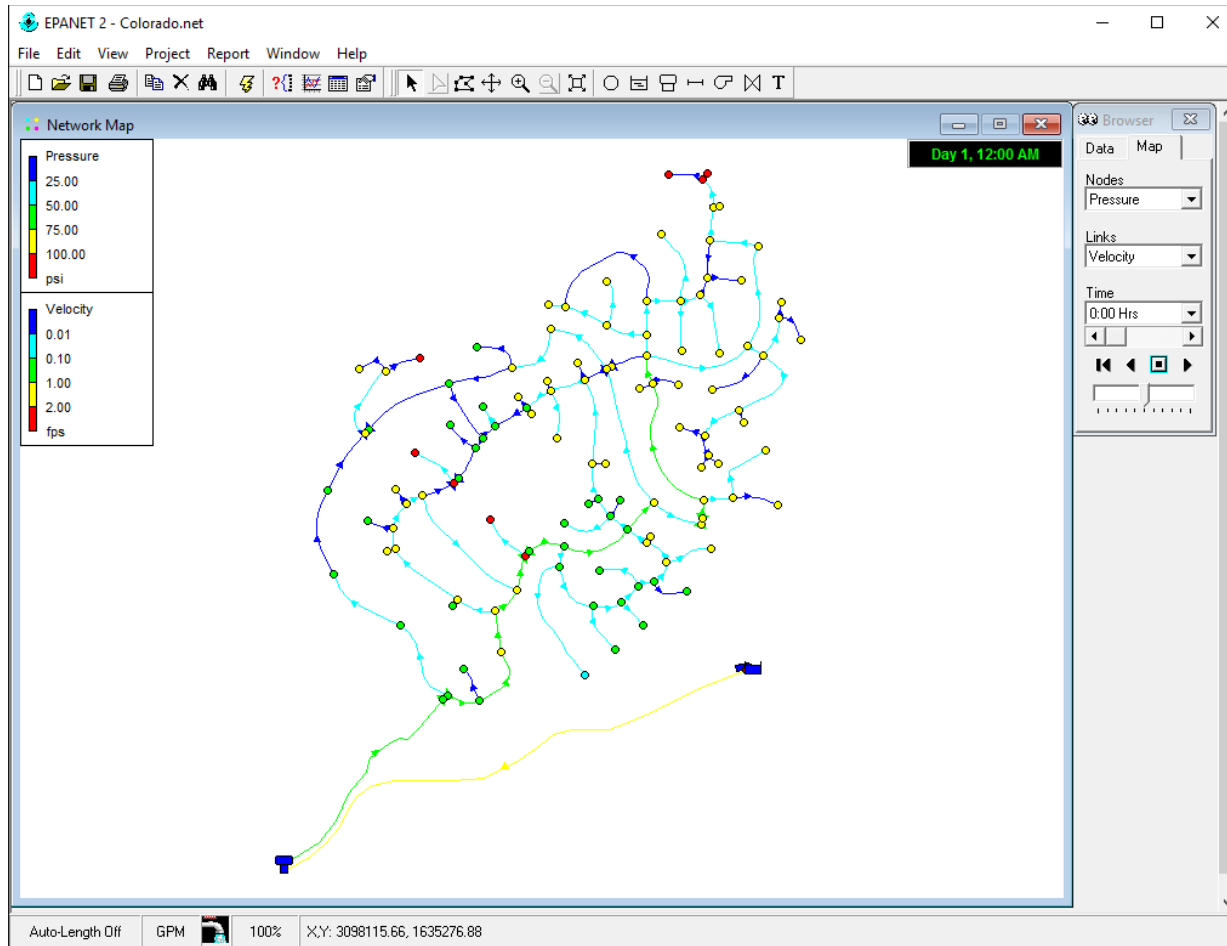
Theory to Practice



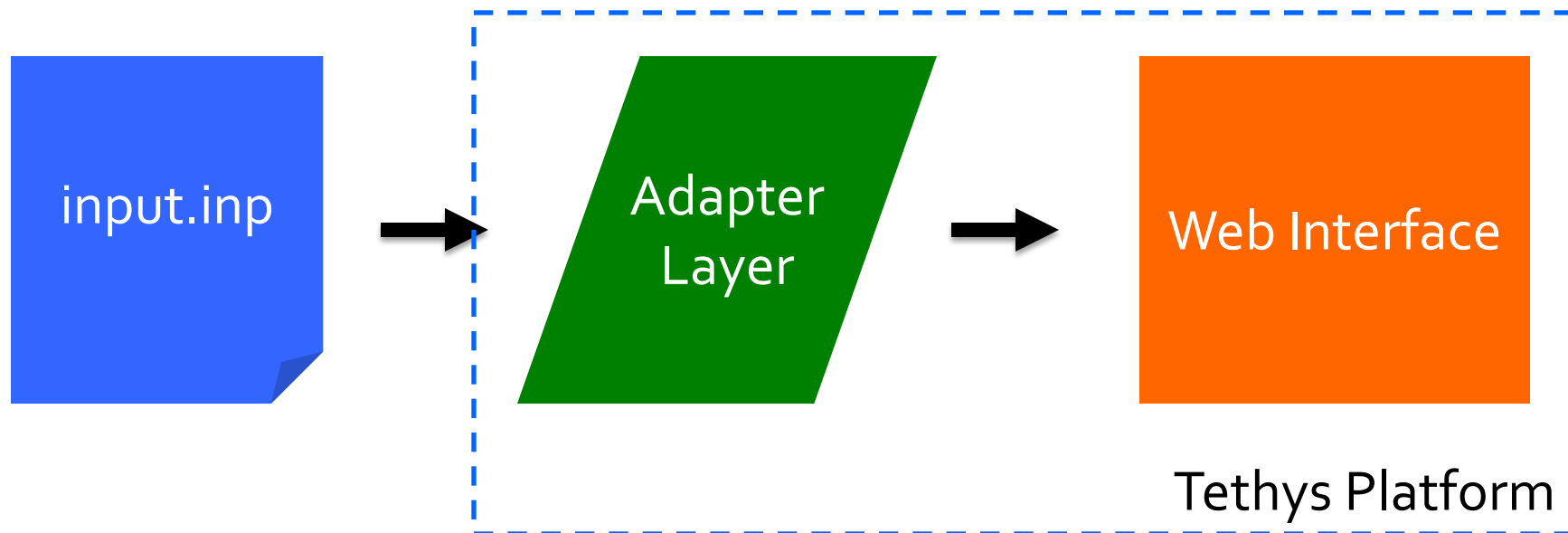
In theory, theory and practice are the same. In practice, they are not.

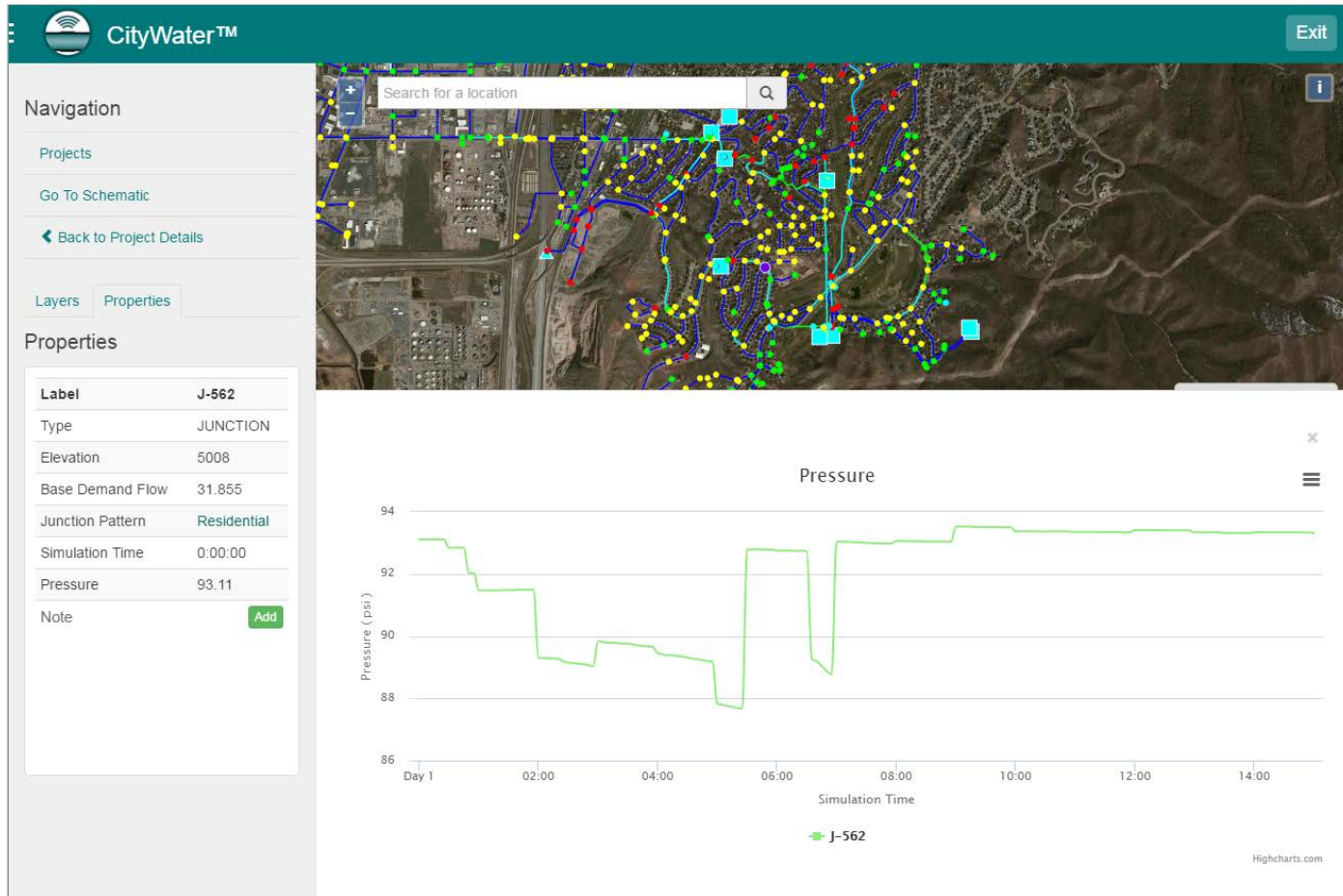
- Albert Einstein



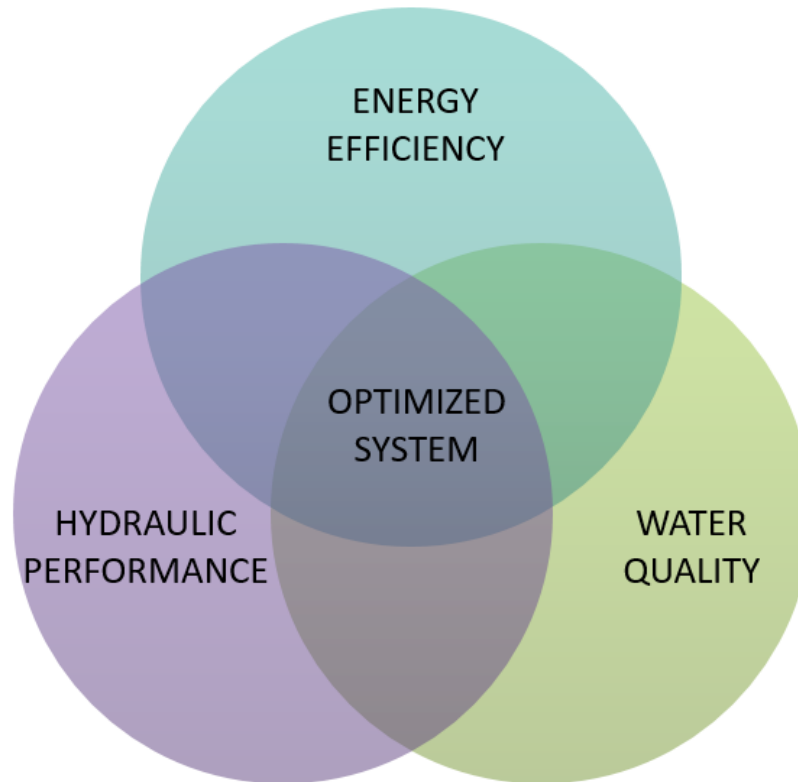


Adapting EPANET to Web





Water System Optimization (synergies, not tradeoffs)



Translating Theoretical Savings into Real Savings



Results

Water Utility	Annual Energy Savings
Jordan Valley Water	3,900,000 kWh (11%)
City of North Salt Lake	1,400,000 kWh (32%)
Logan City	900,000 kWh (32%)
Spanish Fork City	1,400,000 kWh (29%)
Granger-Hunter Improvement District	1,200,000 kWh (14%)



Tools

Hydraulic
Model

Mass
Balance

Energy Map

Equipment
Audit

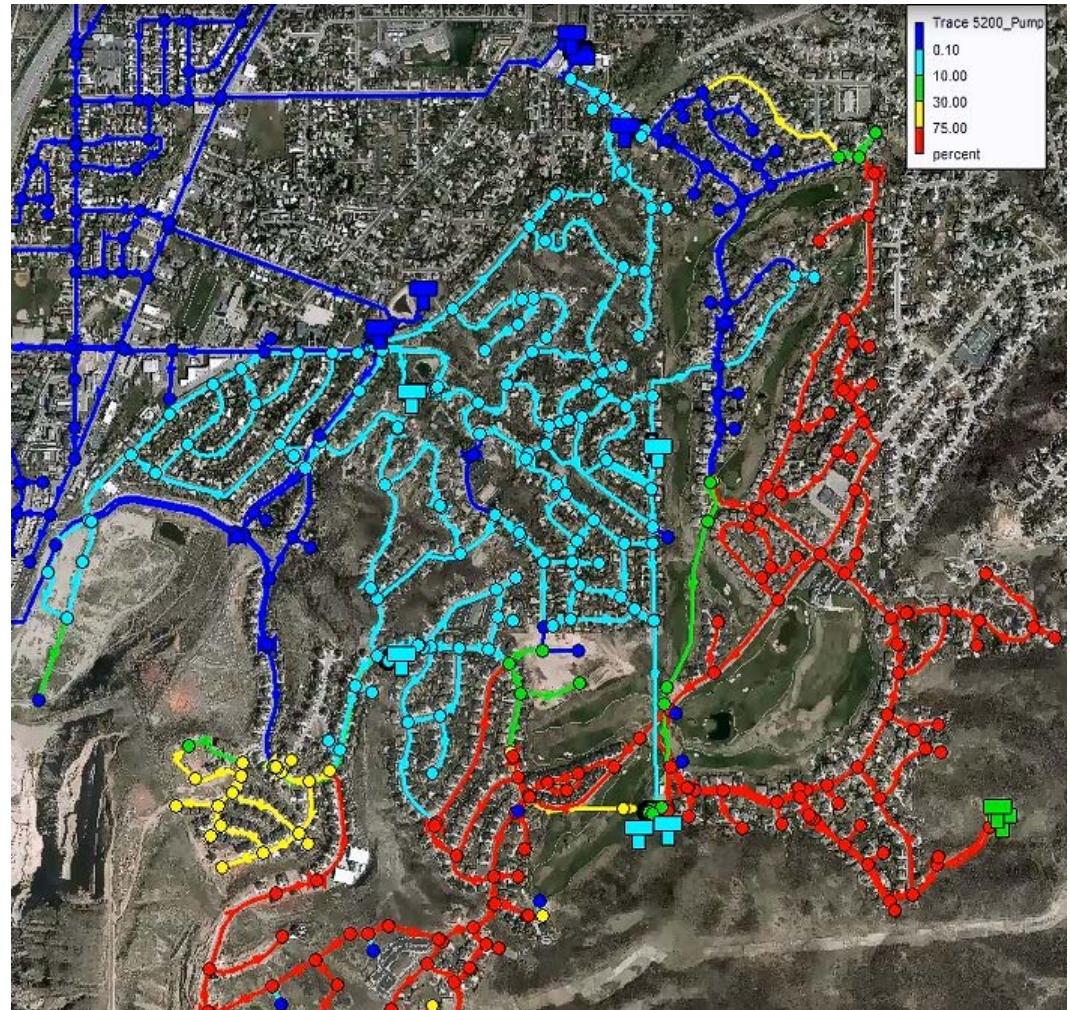
Operational
Practices

Training

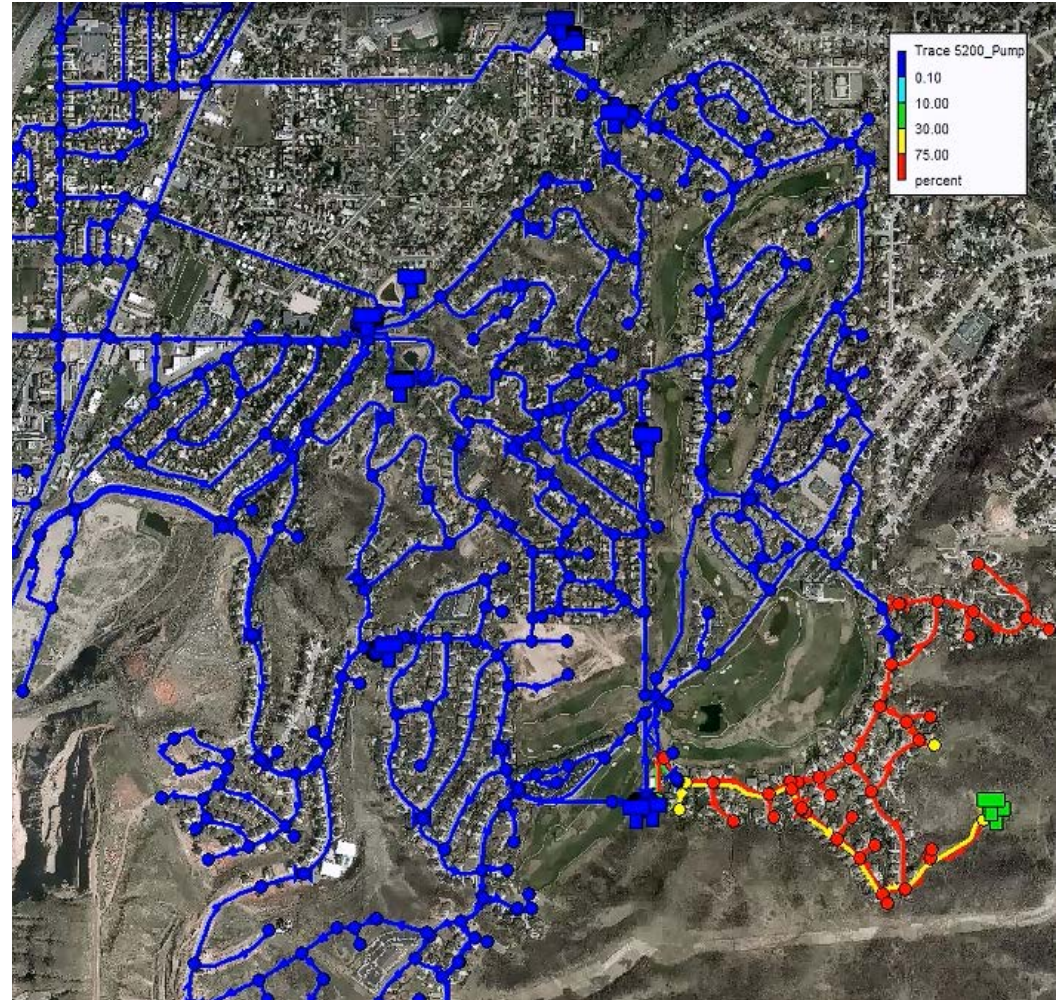


Water System Optimization

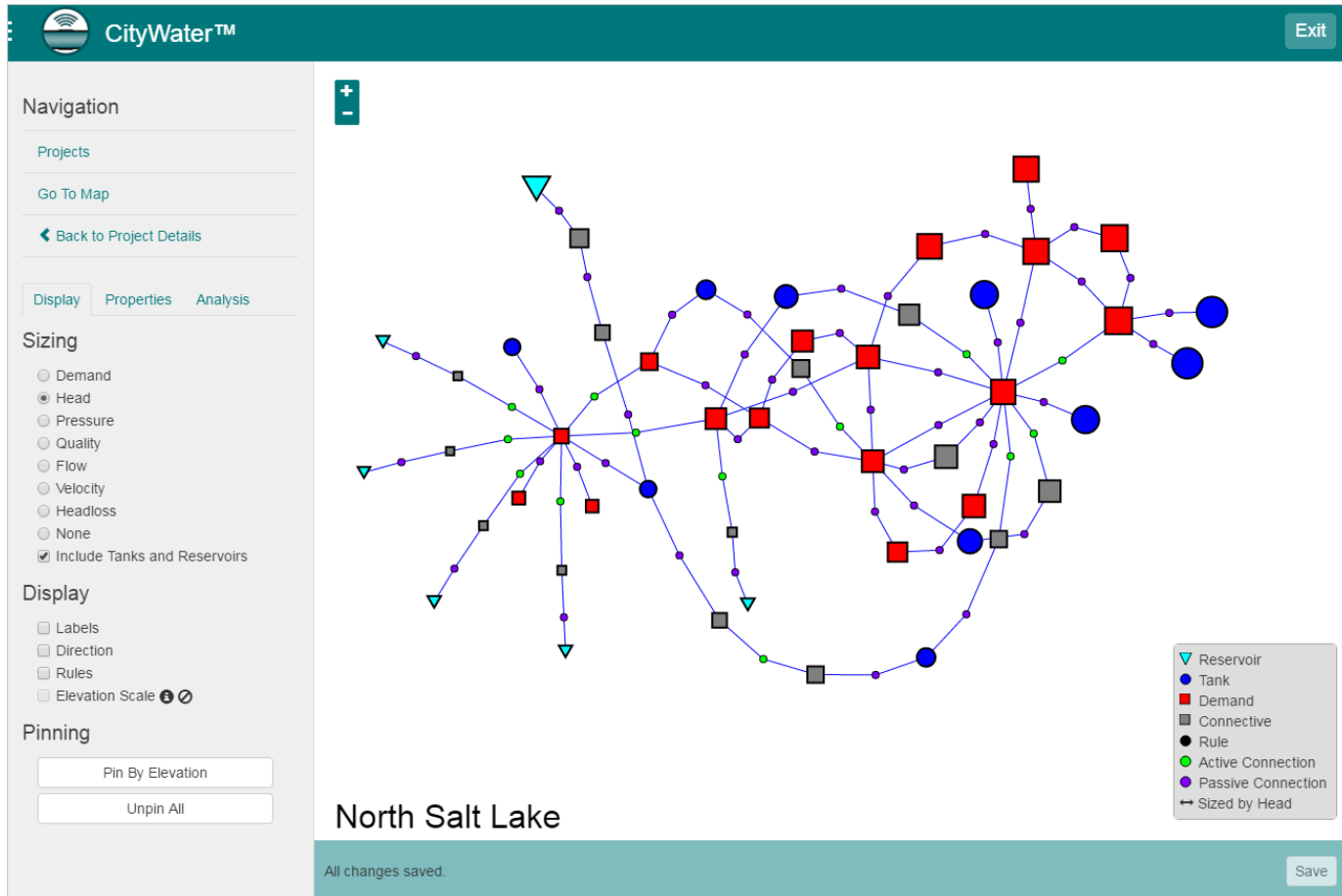
Pumping in Circles - Before



Pumping in Circles - After



Engineering SaaS Demo



Nathan Swain

nswain@aquaveo.com

Steven Jones

sjones@hansenallenluce.com



This material is based upon work supported by the National Science Foundation under Grant No. 1135482

