Model My Watershed:
A Tool for Water Resource Management

Webcast sponsored by EPA's Watershed Academy

EPA

Thursday, March 9, 2017
1:00pm – 3:00pm Eastern

Speakers:

- **Dr. Anthony Aufdenkampe**, Senior Environmental Scientist, LimnoTech
- **Dr. Barry M. Evans**, Senior Research Associate, Penn State University and Adjunct Faculty member at Stroud Water Research Center
- **Bill Brown**, Chief, TMDL Development Section, Pennsylvania Department of Environmental Protection

Wiki Watershed

Webcast Logistics

- **To Ask a Question**
  - Type your question in the "Questions" tool box on the right side of your screen and click "Send."
- **To Report any Technical Issues**
  - such as audio problems
  - Type your issue in the "Questions" tool box on the right side of your screen and click "Send" and we will respond by posting an answer in the "Questions" box.

2

Speakers

- **Dr. Anthony Aufdenkampe**, a Senior Environmental Scientist at LimnoTech in Minnesota. He serves as the project manager for *Model My Watershed* at Stroud Water Research Center.
- **Dr. Barry M. Evans**, a Senior Research Associate at Penn State University and Adjunct Faculty Member at Stroud Water Research Center. He is the author of the (MapShed) model that has been incorporated into the Model My Watershed online tool
- **Bill Brown**, who is Chief of the TMDL Development Section at Pennsylvania's Department of Environmental Protection

Overview of Today's Webinar

- WikiWatershed and the Model My Watershed Web App
  - Motivation & Vision
  - Delaware River Watershed Initiative (DWRI)
- "Site Storm Model" in Model My Watershed
  - Introduction and Micro Site Storm Model
  - Case Study A: Conservation Scenario vs. Development Scenario
  - Case Study B: Preliminary Conservation Planning
- "Multi-Year Watershed Model" in Model My Watershed
  - Introduction to MapShed (GWLF-E)
  - Incorporation of Core MapShed Components into Model My Watershed
  - Case Study C: Watershed Improvement Plan (WIP) Based on Prior TMDL Assessment
  - Case Study D: Simple MS4 Application
  - Case Study E: More Comprehensive MS4 Application
- WikiWatershed into the Future
  - Big Water Data: Visualization & Analytics for Everyone

Model My Watershed

Project Team

Anthony Aufdenkampe,
David Arscott, Melinda Daniels,
Steve Kerlin, Tara Muenz,
Barry Evans

Robert Cheetham, Matt McFarland,
Arianna Robbins

David Tarboton, Jeffrey S. Horsburgh,
Emilio Mayorga, Scott Haag,
Ali Shokoufandeh

Nanette I. Marcum-Dietrich, Millersville Univ.;
Carolyn Staudt, Concord Consortium

5

Model My Watershed

Project Support

William Penn Foundation

National Science Foundation
- grants DRL #0929763 & DRL #1418133

Stroud Water Research Center

Virginia Wellington Cabot Foundation

The Dansko® Foundation

Generous donations from Peter Kjellerup and
Mandy Cabot

6

The Future of Water Protection

- Information and knowledge are foundations of a functional democracy.
  - Informed citizenry is key to protecting watersheds, but …
  - It is presently nearly impossible to get a complete picture of information and data from the dozens of federal, state, municipal, academic and volunteer sources.
- Can we harness the power of Wikipedia, Facebook and Google Earth to bring people together to share information?

Wiki Watershed

A Web toolkit to support citizens,
conservation practitioners, municipal decision-makers, researchers, educators, and students

to collaboratively advancing knowledge and stewardship of fresh water.

Wiki Watershed — Three Programs

- **Model My Watershed®**– a watershed-modeling Web app to:
  - analyze real land cover, soil and other geospatial data,
  - model storm water runoff and water quality, and
  - compare conservation or development scenarios in your watershed
- **Monitor My Watershed®** – an new Web app (late 2017) for:
  - interactive map-based discovery, visualization, and sharing of data
  - from federal, state, academic and citizen sources; and
  - resources to assist citizens to monitor their watersheds using low-cost monitoring approaches based on sound science (EnviroDIY)
- **Manage My Watershed®** – a envisioned social networking Web app to support a community of practice for the protection of freshwater resources and to engage citizens with policy-makers.

9

Wiki Watershed — MMW Web Application

- Decision Support System for water conservation
  - Rapid visualization of watershed data
  - High-performance geospatial analysis capabilities
  - Science-based predictions of human impacts on stormwater runoff and water quality
- Intuitive user interface & satisfying user experience from any web browser
- Easy to share watershed-model scenarios, watershed-monitoring data
- Features for public and professional users alike

10

Delaware River Watershed Initiative

- A collaboration among >50 leading conservation organizations in DRB to:
  - protect tens of thousands of acres of land from development, restore streams,
  - test innovative approaches in ecologically significant places, and
  - monitor results over time.
- Funding: William Penn Foundation (WPF)
  - >$60M since 2014,
  - planning for a second phase

11

Introduction to Model My Watershed Data Visualization and Analysis

12

Web Demo

http://wikiwatershed.org

https://app.wikiwatershed.org

13

Introduction to Model My Watershed Site Storm Model

14

Site Storm Model: Core Components

- Simulates a hypothetical 24-hour storm
  - Total precipitation is variable
- Runoff model:
  - SLAMM: Source Loading and Management Model for Windows; urban small storm algorithms from Robert Pitts & WinSLAMM
  - TR55 for rural areas and large storms
- Water quality
  - EPA STEP-L: Spreadsheet Tool for Estimating Pollutant Load
- Compare Scenarios
  - Land cover change
  - Conservation practice / Best Management Practice (BMP) implementation

15

Case Study A: Scenarios for Conservation vs. Development Anytown, USA

16

Web Demo

http://wikiwatershed.org
https://app.wikiwatershed.org

17

Case Study B: Preliminary Conservation Planning at Cooch's Bridge

18

Web Demo

http://wikiwatershed.org
https://app.wikiwatershed.org

19

Questions?

WikiWatershed?
MMW Site Storm Model?
Case Study?

20

Overview of “Multi-Year Watershed Model” in Model My Watershed

Barry M. Evans, Ph.D.
Penn State University & Stroud Water Research Center

Bill Brown, Chief, TMDL Development Section,
Pennsylvania Dept. of Environmental Protection

21

Introduction to *MapShed* Desktop Application

22

Brief History

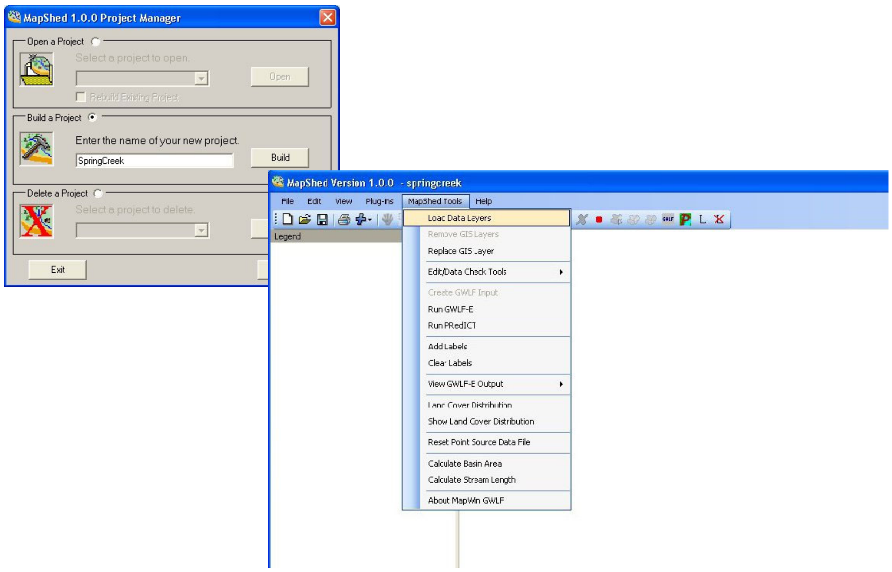
- *MapShed* is a "desktop" application that includes:
  - A GIS package for generating input parameters
  - The GWLF-E watershed simulation model
- Generalized Watershed Loading Function (GWLF) model
  - Substantially enhanced over 15 years to become GWLF-E
  - GWLF-E available within EPA BASINS model framework
- MapShed is an update of AVGWLF, which was:
  - Developed using ArcView 3.x software (AVGWLF)
  - Used by PA DEP and a number of other government and research organizations since 1999.
  - Efforts to re-configure to work in non-commercial GIS platform (MapWindow) began in 2010.
  - First "non-beta" version of *MapShed* released to public May 2012.

23

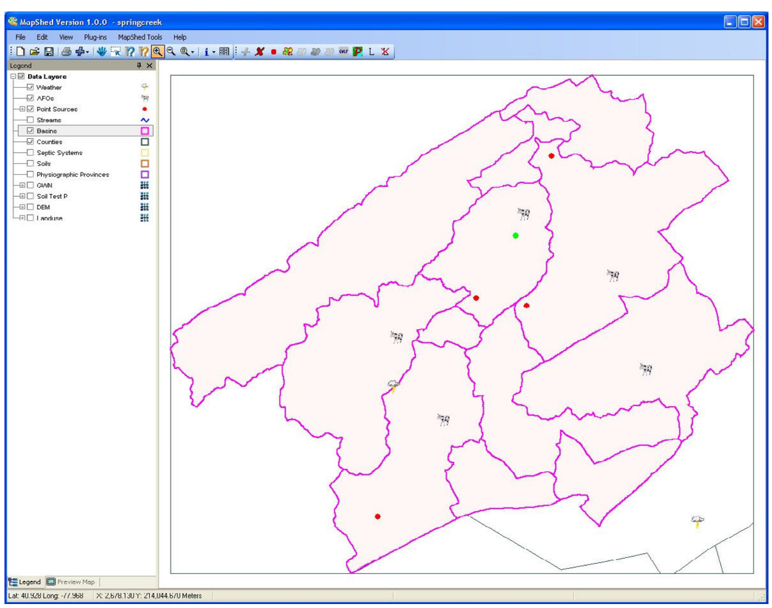
Core Components/Functions

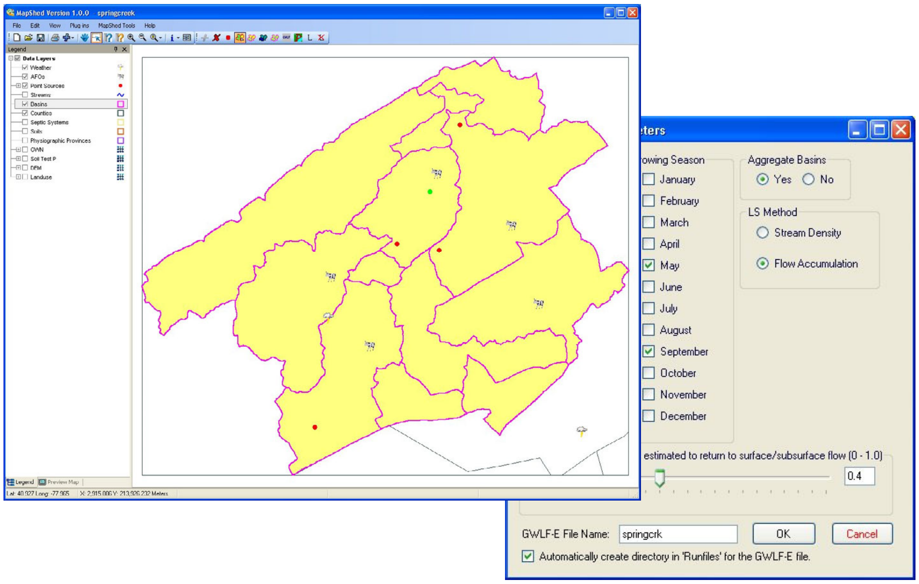
- Pre-processor
  - used to overlay and manipulate GIS layers, weather files, and other data for purpose of creating input files for the core watershed simulation model (GWLF-E)
- GWLF-E model
  - run with prepared input files to estimate nutrient (N and P), sediment, and pathogen loads for a given watershed (or watersheds)
- BMP simulator
  - a module for evaluating the potential benefits of BMP implementation
- Other tools
  - to visualize, evaluate and compare model output

24



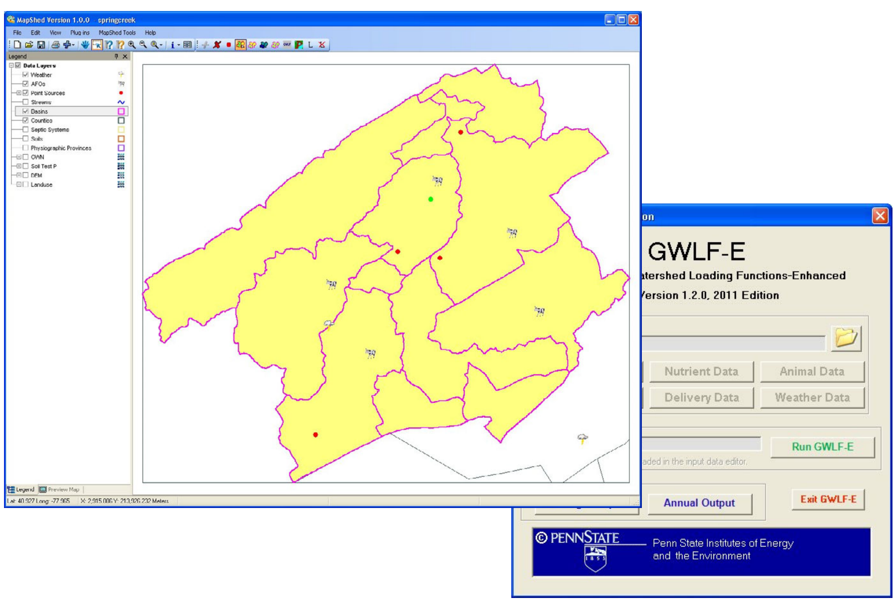
Use *MapShed* to create a project and load various data layers...





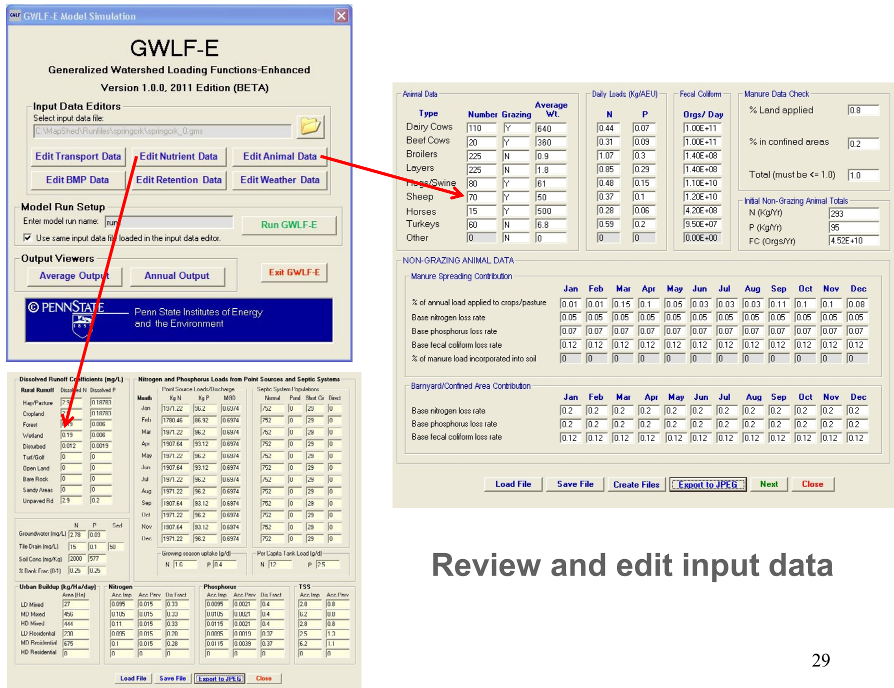
...then use *MapShed* to derive input data for the GWLF-E model

27



When input file has been prepared, open up the GWLF-E model

28

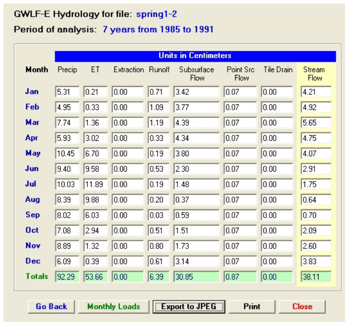


Review and edit input data

29

Run the GWLF-E model

30

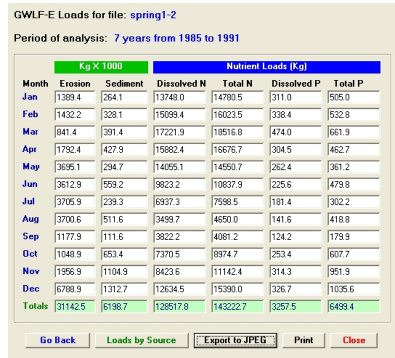


GWLF-E Hydrology for file: spring1-2

Period of analysis: 7 years from 1985 to 1991

Month	Precip	ET	Extraction	Runoff	Subsurface Flow	Point Src Flow	Tile Drain	Stream Flow
	Units in Centimeters							
Jan	5.31	0.21	0.00	0.71	3.42	0.07	0.00	4.21
Feb	4.95	0.33	0.00	1.09	3.77	0.07	0.00	4.92
Mar	7.74	1.36	0.00	1.19	4.39	0.07	0.00	5.65
Apr	5.93	3.02	0.00	0.33	4.34	0.07	0.00	4.75
May	10.45	6.70	0.00	0.19	3.80	0.07	0.00	4.07
Jun	9.40	9.58	0.00	0.53	2.30	0.07	0.00	2.91
Jul	10.03	11.89	0.00	0.19	1.48	0.07	0.00	1.75
Aug	8.39	9.88	0.00	0.20	0.37	0.07	0.00	0.64
Sep	8.02	6.03	0.00	0.03	0.59	0.07	0.00	0.70
Oct	7.08	2.94	0.00	0.51	1.51	0.07	0.00	2.09
Nov	8.89	1.32	0.00	0.80	1.73	0.07	0.00	2.60
Dec	6.09	0.39	0.00	0.61	3.14	0.07	0.00	3.83
Totals	92.29	53.66	0.00	6.39	30.85	0.87	0.00	38.11

Go Back | Monthly Loads | Export to JPEG | Print | Close

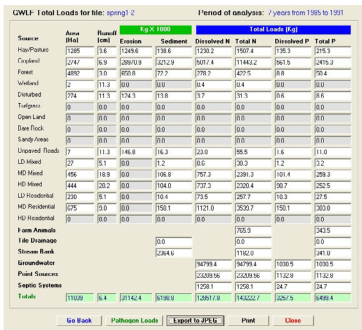


GWLF-E Loads for file: spring1-2

Period of analysis: 7 years from 1985 to 1991

Month	Erosion	Sediment	Dissolved N	Total N	Dissolved P	Total P
	Kg X 1000		Nutrient Loads (Kg)			
Jan	1389.4	264.1	13748.0	14780.5	311.0	505.0
Feb	1432.2	328.1	15099.4	16023.5	338.4	532.8
Mar	841.4	391.4	17221.9	18516.8	474.0	661.9
Apr	1792.4	427.9	15882.4	16676.7	304.5	462.7
May	3695.1	294.7	14055.1	14550.7	262.4	361.2
Jun	3612.9	559.2	9823.2	10837.9	225.6	479.8
Jul	3705.9	239.3	6937.3	7598.5	181.4	302.2
Aug	3700.6	511.6	3499.7	4650.0	141.6	418.8
Sep	1177.9	111.6	3822.2	4081.2	124.2	179.9
Oct	1048.9	653.4	7370.5	8974.7	253.4	607.7
Nov	1956.9	1104.9	8423.6	11142.4	314.3	951.9
Dec	6788.9	1312.7	12634.5	15390.0	326.7	1035.6
Totals	31142.5	6198.7	128517.8	143222.7	3257.5	6499.4

Go Back | Loads by Source | Export to JPEG | Print | Close



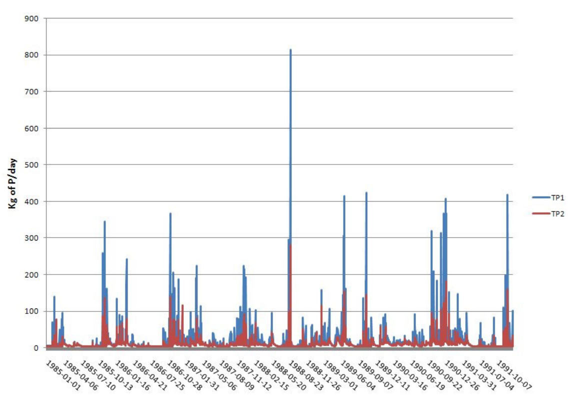
GWLF Total Loads for file: spring1-2 Period of analysis: 7 years from 1985 to 1991

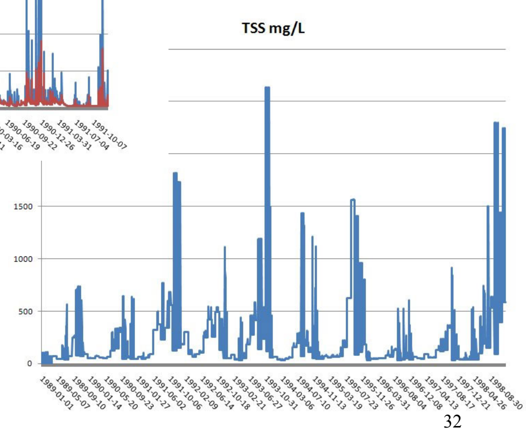
Source	Area (Ha)	Runoff (cm)	Erosion	Sediment	Dissolved N	Total N	Dissolved P	Total P
			Kg X 1000		Total Loads (Kg)			
Hay/Pasture	1285	3.6	1249.6	138.6	1230.2	1507.4	135.3	215.3
Cropland	2747	6.9	28970.9	3212.9	5017.4	11443.2	561.5	2415.3
Forest	4892	3.0	650.8	72.2	278.2	422.5	8.8	50.4
Wetland	2	11.3	0.0	0.0	0.4	0.4	0.0	0.0
Disturbed	274	11.3	124.3	13.8	3.7	31.3	0.6	8.6
Turfgrass	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Open Land	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bare Rock	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sandy Areas	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unpaved Roads	7	11.3	146.8	16.3	23.0	55.5	1.6	11.0
LD Mixed	27	5.1	0.0	1.2	0.6	30.3	1.2	3.2
MD Mixed	456	18.9	0.0	106.8	757.3	2391.3	101.4	259.3
HD Mixed	444	20.2	0.0	104.0	737.3	2320.4	98.7	252.5
LD Residential	230	5.1	0.0	10.4	73.5	257.7	10.3	27.5
MD Residential	675	9.0	0.0	150.1	1121.0	3539.7	150.1	303.0
HD Residential	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Farm Animals						765.9		343.5
Tile Drainage				0.0		0.0		0.0
Stream Bank				2364.6		1182.0		341.0
Groundwater					94799.4	94799.4	1030.5	1030.5
Point Sources					23209.56	23209.56	1132.8	1132.8
Septic Systems					1258.1	1258.1	24.7	24.7
Totals	11039	6.4	31142.4	6198.8	128517.8	143222.7	3257.5	6499.4

Go Back | Pathogen Loads | Export to JPEG | Print | Close

Various types of annual, monthly and daily output created

31



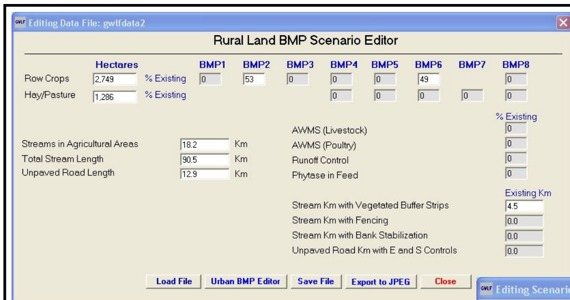


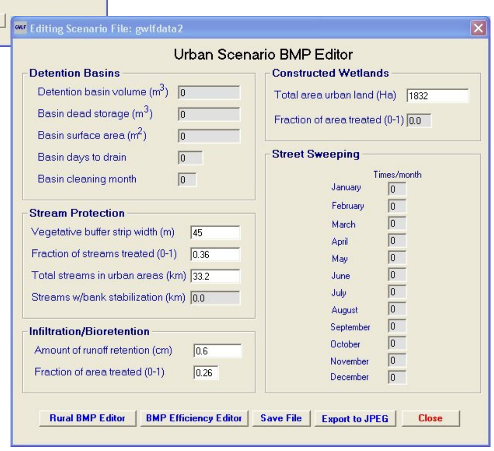
All output written to Excel files to provide additional control in management and display of data

32

Input can be edited to reflect BMP implementation levels

33





Specify various BMP settings for a given scenario, and then re-run GWLF-E to estimate potential load reductions….

GWLF Total Loads for file: springagg1-0 Period of analysis: 11 years from 1988 to 1998

Source	Area (Ha)	Runoff (cm)	Kg X 1000 Erosion	Sediment	Total Loads (Kg) Dissolved N	Total N	Dissolved P	Total P
Hay/Pasture	5581	5.5	9201.0	708.5	2290.4	3707.3	562.1	956.7
Cropland	7559	10.0	134067.2	10323.2	21845.8	42492.1	1386.4	7136.5
Forest	15777	4.6	3590.0	276.4	1382.4	1935.3	72.8	226.7
Wetland	48	15.7	2.2	0.2	14.3	14.7	0.8	0.9
				18.9	13.8	51.6	6.9	17.4
				8.1	257.8	274.0	19.0	23.5
				0.0	0.0	0.0	0.0	0.0
				0.0	0.0	0.0	0.0	0.0
				0.0	0.0	0.0	0.0	0.0
				35.1	4.2	74.4	0.2	19.8
				1.9	13.1	46.5	1.9	5.0
				201.7	1377.1	4419.9	189.6	488.9
				271.0	1850.9	5940.4	254.8	657.2
				42.0	286.8	1016.3	40.3	108.6
				550.1	3756.6	12056.6	517.2	1333.8
				2.5	16.9	54.1	2.3	6.0
						0.0		0.0
				0.0		0.0		0.0
				21937.8		10969.0		3055.0
					340394.0	340394.0	3772.9	3772.9
					0.0	0.0	0.0	0.0
					5769.2	5769.2	71.6	71.6
				34377.2	379273.4	429215.3	6898.8	17880.3

en Loads | Export to JPEG | Print | Close

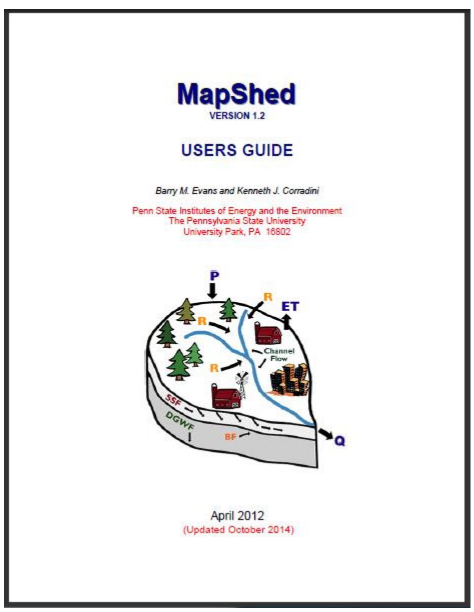
GWLF Total Loads for file: springagg3-0 Period of analysis: 11 years from 1988 to 1998

Source	Area (Ha)	Runoff (cm)	Kg X 1000 Erosion	Sediment	Total Loads (Kg) Dissolved N	Total N	Dissolved P	Total P
Hay/Pasture	5581	5.5	9201.0	708.5	2290.4	3707.3	562.1	956.7
Cropland	7559	10.0	134067.2	7123.0	14778.6	28745.8	664.3	3419.3
Forest	15777	4.6	3590.0	276.4	1382.4	1935.3	72.8	226.7
Wetland	48	15.7	2.2	0.2	14.3	14.7	0.8	0.9
Disturbed	362	19.1	245.3	18.9	13.8	51.6	6.9	17.4
Turfgrass	266	3.9	104.6	8.1	257.8	274.0	19.0	23.5
Open Land	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bare Rock	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sandy Areas	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unpaved Roads	14	15.7	456.0	35.1	4.2	74.4	0.2	19.8
LD Mixed	58	7.1	0.0	1.9	13.1	46.5	1.9	5.0
MD Mixed	1308	22.8	0.0	201.7	1377.1	4419.9	189.6	488.9
HD Mixed	1758	33.5	0.0	271.0	1850.9	5940.4	254.8	657.2
LD Residential	1267	7.1	0.0	42.0	286.8	1016.3	40.3	108.6
MD Residential	3568	12.8	0.0	550.1	3756.6	12056.6	517.2	1333.8
HD Residential	16	18.2	0.0	2.5	16.9	54.1	2.3	6.0
Farm Animals						2837.7		551.3
Tile Drainage				0.0		0.0		0.0
Stream Bank				19395.8		10038.0		2691.0
Groundwater					319675.3	319675.3	3572.5	3572.5
Point Sources					0.0	0.0	0.0	0.0
Septic Systems					5769.2	5769.2	71.6	71.6
Totals	37582.0	8.80	147666.3	28635.0	351487.5	396656.9	5976.2	14150.0

Go Back | Pathogen Loads | Export to JPEG | Print | Close

... and compare the results

35



Available at www.mapshed.psu.edu

36

Incorporation of Core *MapShed* Components into Model My Watershed

37

Key Activities

- Re-produce *MapShed* geoprocessing routines in Model My Watershed
  - Translate routines and formats from MapWindow to Geotrellis/GDAL/PostGIS
- Re-program GWLF-E from Visual Basic to Python
  - For multi-user processing on Linux and Apache Spark
- Use national GIS and weather data
  - Rather than state or regional
- Compare model output
  - Desktop MapShed vs. MMW on Amazon Cloud
  - Using same input data

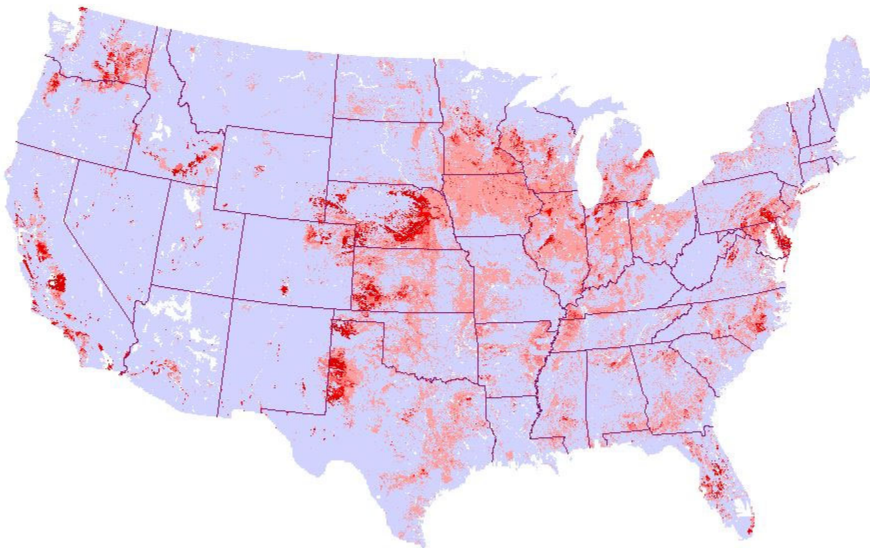
38

Additional Datasets for Watershed MultiYear Model (MapShed)

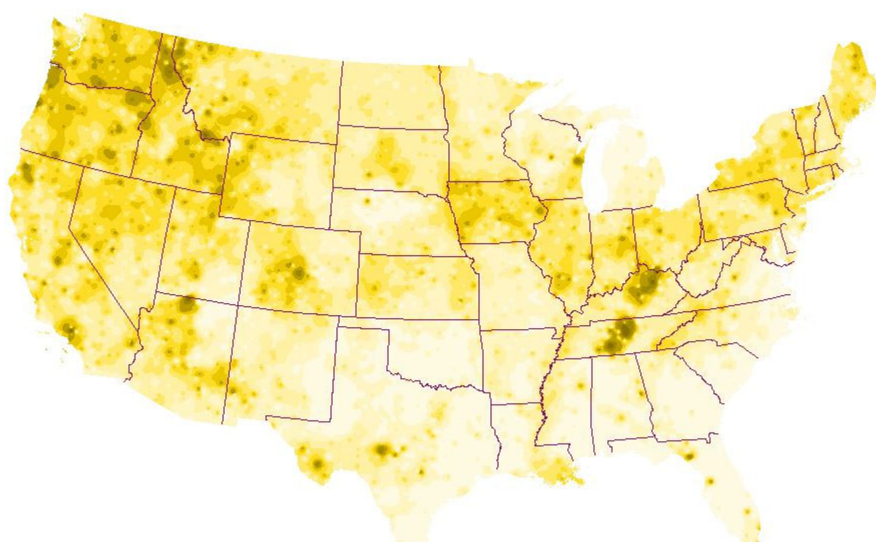
39

Weather Stations

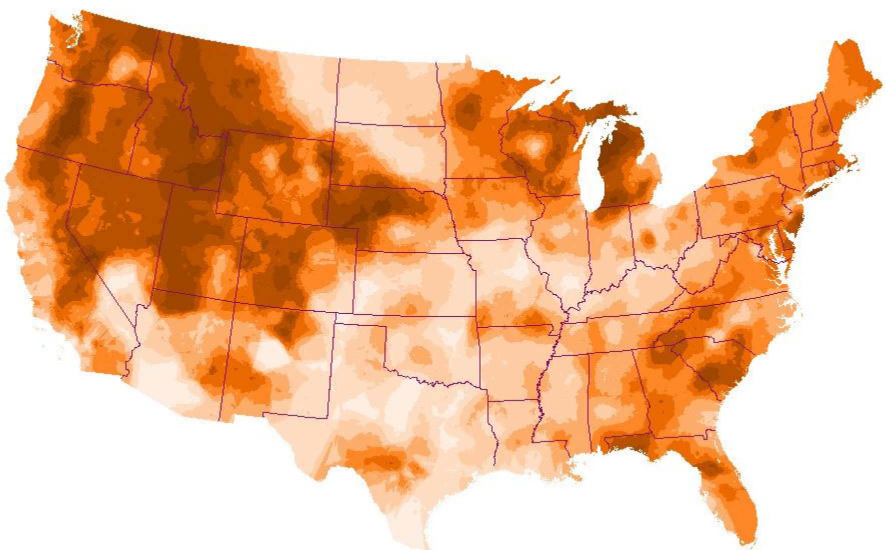
Groundwater Nitrogen Estimates



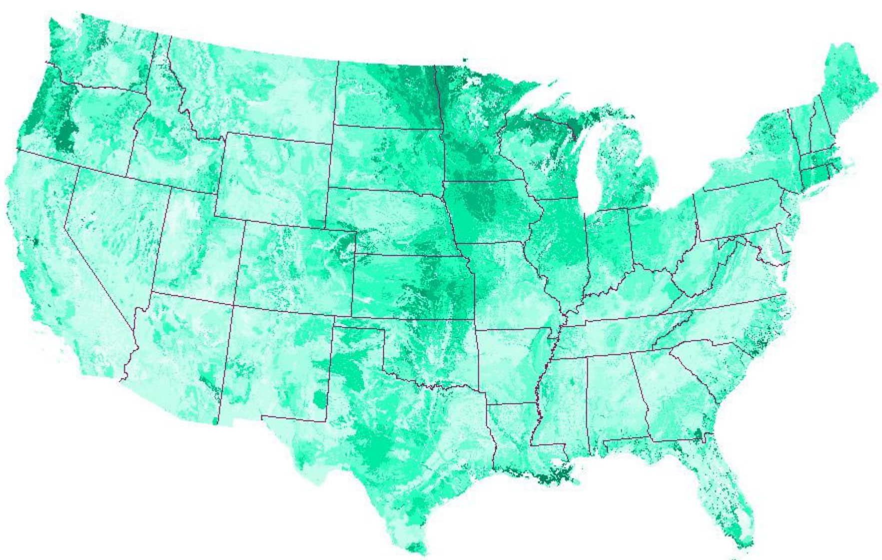
Soil P Estimates (Soon)



USGS Base Flow Estimates (Soon)

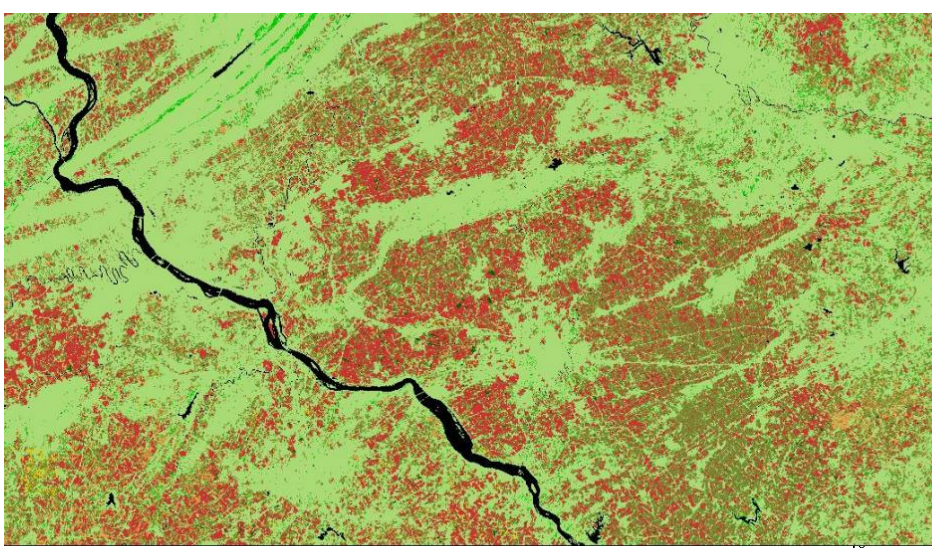


Soil Nitrogen Estimates (Soon)



New Weather Station Data (Soon)

USDA Cropland Layer (Soon)



Case Study C:
Watershed Improvement Plan (WIP) Based on Prior TMDL Assessment

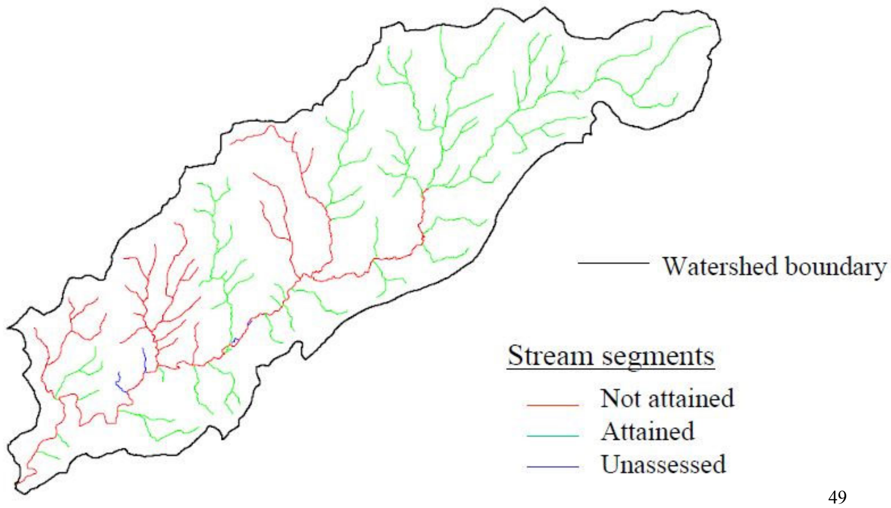
47

Basic Steps

- Run model to estimate pollutant loads from various sources for purpose of evaluating where focus should be with respect to future remediation efforts.
- Once loads have been identified and quantified, use MMW to simulate load reductions from various BMPs and remediation measures to assess potential load reductions that might be achieved.

48

Conestoga Creek Watershed in PA



49

TMDL Results

- Stream impairments primarily caused by siltation and nutrient enrichment from agricultural sources
- Analysis determined that Total P should be reduced by 38% and Sediment should be reduced by 44%
- Various assessments are now being made as to where BMP implementation may be most effective in achieving these reduction targets as part of an ongoing Watershed Improvement Plan (WIP)
- In recent past, MapShed has been used in Pennsylvania to simulate pollutant loads and potential reductions; but Model My Watershed can now be used to accomplish this.

50

Web Demo

http://wikiwatershed.org
https://app.wikiwatershed.org

51

BMP Simulation Results

- Prior TMDL determined that Total P should be reduced by 38% and Sediment should be reduced by 44%
- With MMW, mean annual TP and sediment loads were estimated to be 18,316 kg/yr and 7,648,782 kg/yr, respectively
- Given the above “current” loads, the reduced “target” loads should be about 18,316 * 0.62 = 11,356 kg/yr for TP, and 7,648,782 * 0.56 = 4,283,318 kg/yr for sediment
- Can also download the model input file created by MMW and do subsequent editing and model runs with “desktop” version of the GWLF-E model

52

Case Study C:
Simple MS4 Application

53

Background

- In Pennsylvania, all regulated areas (e.g., MS4s) are required to develop a "Pollutant Reduction Plan" to reduce sediment loads associated with their jurisdictions by at least 10% as part of the NPDES permit process
- Pollutant load estimates, including potential load reductions achieved via future BMP implementation, can be accomplished using MMW.

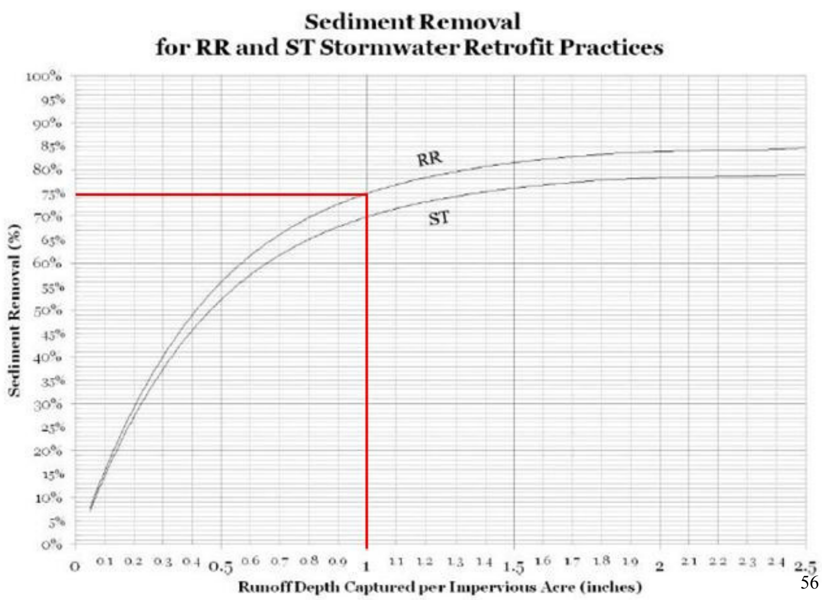
54

Basic Steps

- Use MMW to quantify distribution of land use/cover within a given MS4 (municipality or urban) area.
- Enter area values (e.g., acres) for each of the land use/cover categories in a given area into a spreadsheet (e.g., Excel).
- Apply Chesapeake Bay loading rates for N, P and sediment to the area values to generate estimates of total mean annual loads for each pollutant type for each land use/cover type.
- Estimate potential load reductions that might be possible with BMPs/remediation measures.
- In PA, BMP reduction coefficients must be based on “Performance Standard” approach.

55

Performance Standard Approach



56

Web Demo

http://wikiwatershed.org
https://app.wikiwatershed.org

57

Mean Annual Loads (lb/yr)

Land Use/Cover	Acres	Impervious Fraction	Total N	Total P	Sediment
Undeveloped	2198	----	21,983	725	515,721
Developed, Open	951	0.15	49,495	2,481	1,176,989
Developed, Low Intensity	593	0.32	12,727	771	455,657
Developed, Medium Intensity	208	0.65	4,615	369	267,252
Developed, High Intensity	109	0.90	2,481	232	182,756
Totals	**5456**		**91,300**	**4,578**	**2,598,376**

Loading Rates (lb/acre/yr)

	Total N	Total P	Sediment
Impervious Developed	23.06	2.28	1839
Pervious Developed	20.72	0.84	265
Undeveloped	10	0.33	235

Estimated Pollutant Reductions (Target = 10% reduction of sediment)

What if we captured 1 inch of runoff from all impervious surfaces (100%)?

Land Use/Cover	Total N	Total P	Sediment	Reduced N	Reduced P	Reduced Sed
Undeveloped	21,983	725	515,721	21,983	725	515,721
Developed, Open	49,495	2,481	1,176,989	19,798	744	294,247
Developed, Low Intensity	12,727	771	455,657	5,091	231	113,914
Developed, Medium Intensity	4,615	369	267,252	1,846	111	66,813
Developed, High Intensity	2,481	232	182,756	992	70	45,689
Totals	**91,300**	**4,578**	**2,598,376**	**49,710**	**1,881**	**1,036,385**
Percent Reduced				45.5	58.9	60.1

Reduction coefficient for TN: 0.60
Reduction coefficient for TP: 0.70
Reduction coefficient for Sediment: 0.75

Case Study E:
More Comprehensive MS4 Application

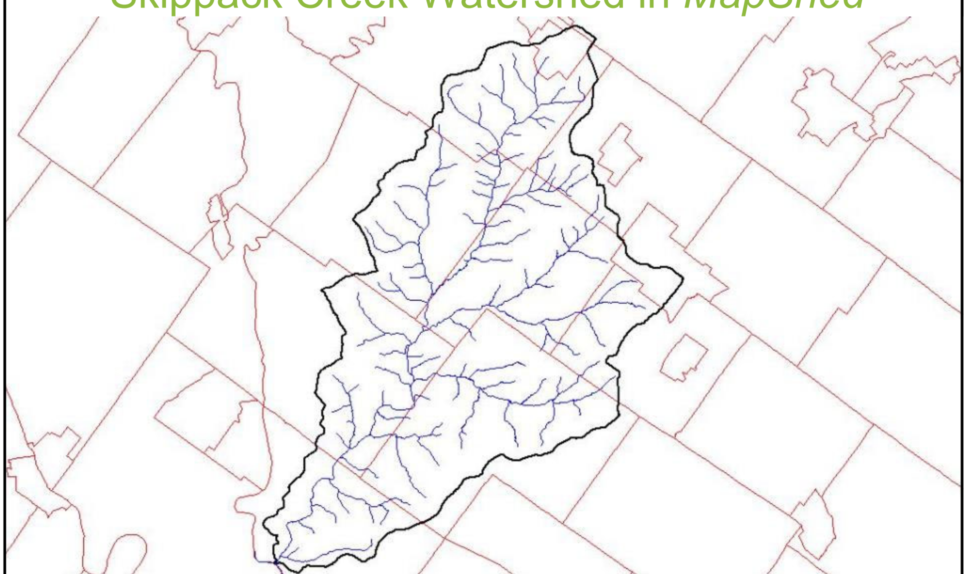
60

Basic Steps

- Use *MapShed* to estimate pollutant loads within a given watershed and the contribution of one or more "urban areas" to those loads.
- Use *MapShed* (GWLF-E model) to estimate potential load reductions within one or more "urban areas" based on use of future BMPs/remedial measures.
- This activity requires use of "Urban Area Tool" functions which currently do not exist in MMW, but will be implemented within a few months.

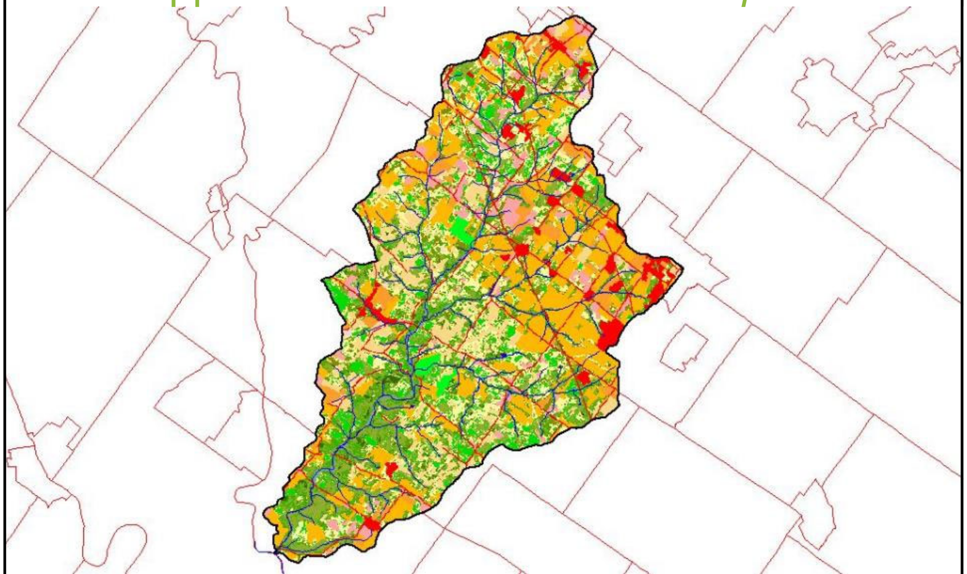
61

Skippack Creek Watershed in *MapShed*



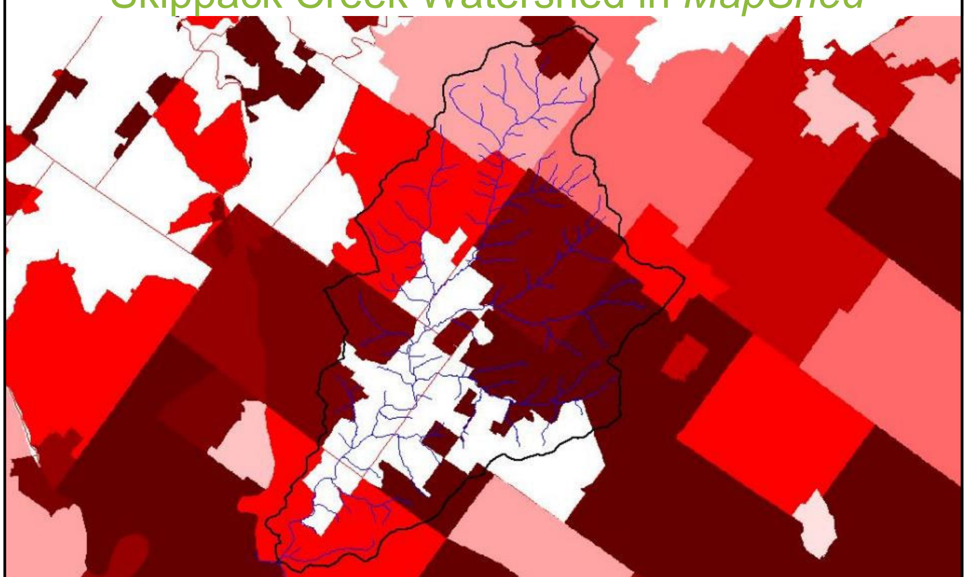
62

Skippack Creek Watershed in *MapShed*



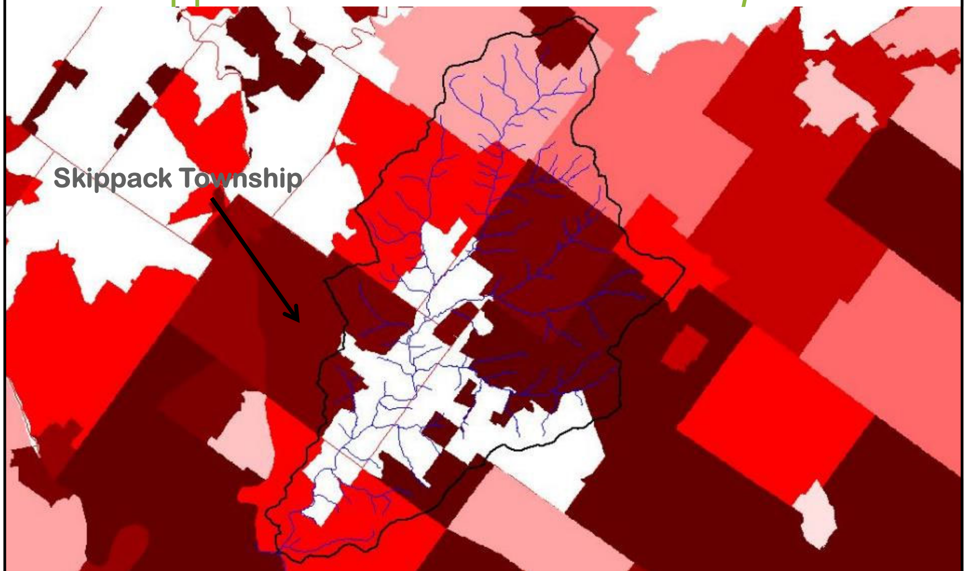
63

Skippack Creek Watershed in *MapShed*

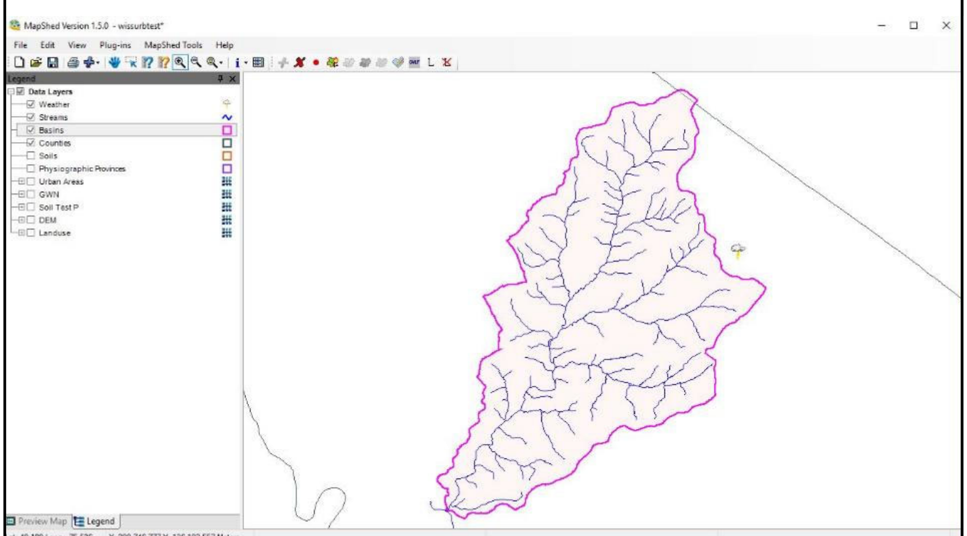


64

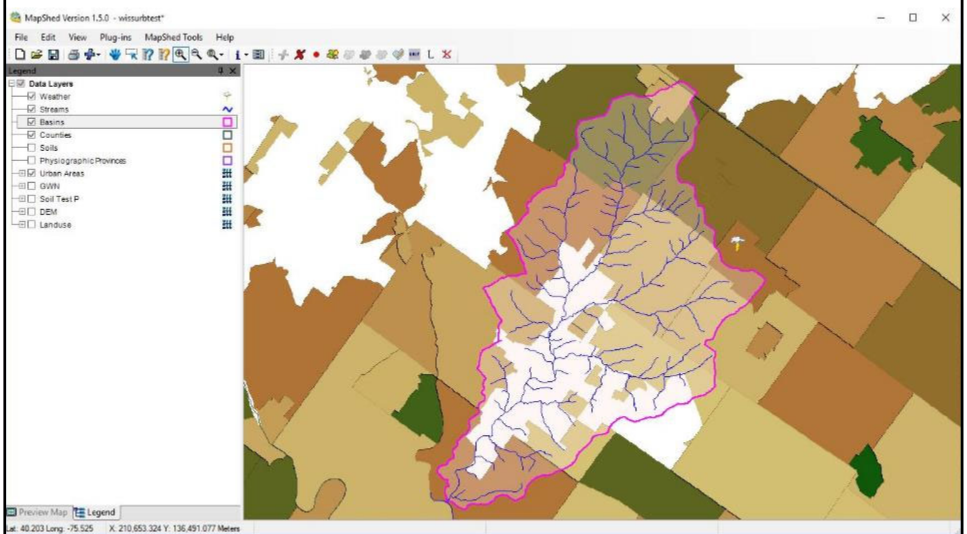
Skippack Creek Watershed in *MapShed*



Skippack Creek Watershed in *MapShed*



Skippack Creek Watershed in *MapShed*



67

Skippack Creek Watershed in *MapShed*

68

GWLF-E Urban Area Viewer - Version 1.1.3

Select input data file: C:\UrbanStormwater\PerformanceStandard\SkippackUrbTest\Output\skipnobmps-10_ua.csv

Watershed Totals | Municipality Loads | Regulated Loads | Unregulated Loads

GWLF-E Average Loads by Source for Watershed 10

		Sediment		Nitrogen		Phosphorus	
Source	Area (ac)	Total Load (lb)	Loading Rate (lb/ac)	Total Load (lb)	Loading Rate (lb/ac)	Total Load (lb)	Loading Rate (lb/ac)
Hay/Pasture	5903	258690.42	43.80	1608.82	0.27	404.55	0.07
Cropland	2266	1173696.99	518.00	6578.59	2.90	902.09	0.40
Forest	8357	23170.58	2.80	346.39	0.04	28.37	0.00
Wetland	257	132.28	0.50	46.34	0.18	2.49	0.01
Disturbed	2350	53594.38	22.80	173.13	0.07	62.06	0.03
Turfgrass	299	903.90	3.00	119.03	0.40	8.91	0.03
Open Land	0	0.00	0.00	0.00	0.00	0.00	0.00
Bare Rock	0	0.00	0.00	0.00	0.00	0.00	0.00
Sandy Areas	0	0.00	0.00	0.00	0.00	0.00	0.00
Unpaved Roads	0	0.00	0.00	0.00	0.00	0.00	0.00
LD Mixed	72	1190.50	16.50	27.23	0.38	2.93	0.04
MD Mixed	1584	109679.98	69.20	2315.87	1.46	263.34	0.17
HD Mixed	2824	195594.12	69.30	4129.54	1.46	469.58	0.17
LD Residential	2908	47950.54	16.50	1104.96	0.38	119.03	0.04
MD Residential	7477	517821.76	69.30	10932.61	1.46	1243.19	0.17
HD Residential	1339	92748.47	69.30	1958.19	1.46	222.67	0.17
Water	51.002488						
Farm Animals				0.0		0.0	
Tile Drainage		0.0		0.0		0.0	
Stream Bank		33569757.8		16783.8		4557.0	
Groundwater				180847.5		2628.2	
Point Sources				0.0		0.0	
Septic Systems				18626.7		0.0	
Totals	35687	36044932		245599		10914	

Print | Export to JPEG | Exit

69

GWLF-E Urban Area Viewer - Version 1.1.3

Select input data file: C:\UrbanStormwater\PerformanceStandard\SkippackUrbTest\Output\skipnobmps-10_ua.csv

Watershed Totals | Municipality Loads | Regulated Loads | Unregulated Loads

View loads for municipality: Skippack Twp (71016)

		Sediment		Nitrogen		Phosphorus	
Source	Source Area (ac)	Total Load (lb)	Loading Rate (lb/ac)	Total Load (lb)	Loading Rate (lb/ac)	Total Load (lb)	Loading Rate (lb/ac)
Hay/Pasture	240	10512.00	43.80	64.80	0.27	16.80	0.07
Cropland	178	92204.00	518.00	516.20	2.90	71.20	0.40
Forest	393	1100.40	2.80	15.70	0.04	0.00	0.00
Wetland	0	0.00	0.00	0.00	0.00	0.00	0.00
Disturbed	148	3374.40	22.80	10.40	0.07	4.40	0.03
Turfgrass	0	0.00	0.00	0.00	0.00	0.00	0.00
Open Land	0	0.00	0.00	0.00	0.00	0.00	0.00
Bare Rock	0	0.00	0.00	0.00	0.00	0.00	0.00
Sandy Areas	0	0.00	0.00	0.00	0.00	0.00	0.00
Unpaved Roads	0	0.00	0.00	0.00	0.00	0.00	0.00
LD Mixed	12	198.00	16.50	4.60	0.38	0.50	0.04
MD Mixed	111	7681.20	69.20	162.10	1.46	18.90	0.17
HD Mixed	222	15384.60	69.30	324.10	1.46	37.70	0.17
LD Residential	447	7375.50	16.50	169.90	0.38	17.90	0.04
MD Residential	203	14067.90	69.30	296.40	1.46	34.50	0.17
HD Residential	222	15384.60	69.30	324.10	1.46	37.70	0.17
Water	0						**Source Weighting**
Farm Animals				0.0		0.0	0.000
Tile Drainage		0.00		0.0		0.0	0.000
Stream Bank		2215647.76		1107.8		300.8	0.071
Groundwater				12116.8		176.1	0.067
Point Sources				0.0		0.0	0.000
Septic Systems				2868.5		0.0	0.154
Totals	2176	2382930.4		17981.4		716.5	

Print | Export to JPEG | Exit

70

Skippack Creek Watershed in *MapShed*

71

Web Demo

http://wikiwatershed.org

https://app.wikiwatershed.org

72

Questions?

MapShed?
MMW Multi-Year Watershed Model?
Case Studies?

73

WikiWatershed Web App into the Future

74

Big Water Data: for Everyone

- Scalable Cloud Infrastructure
  - Computation: Amazon EC2; Apache Spark
  - Data storage: Amazon S3 / Elastic Block Store
- 100% open-source software stack:
  - Geoprocessing: GeoTrellis
  - Data I/O: Python; PostGIS; PostgreSQL
  - Models: Python modules and/or wrappers
  - Web framework: Django Python

https://github.com/WikiWatershed

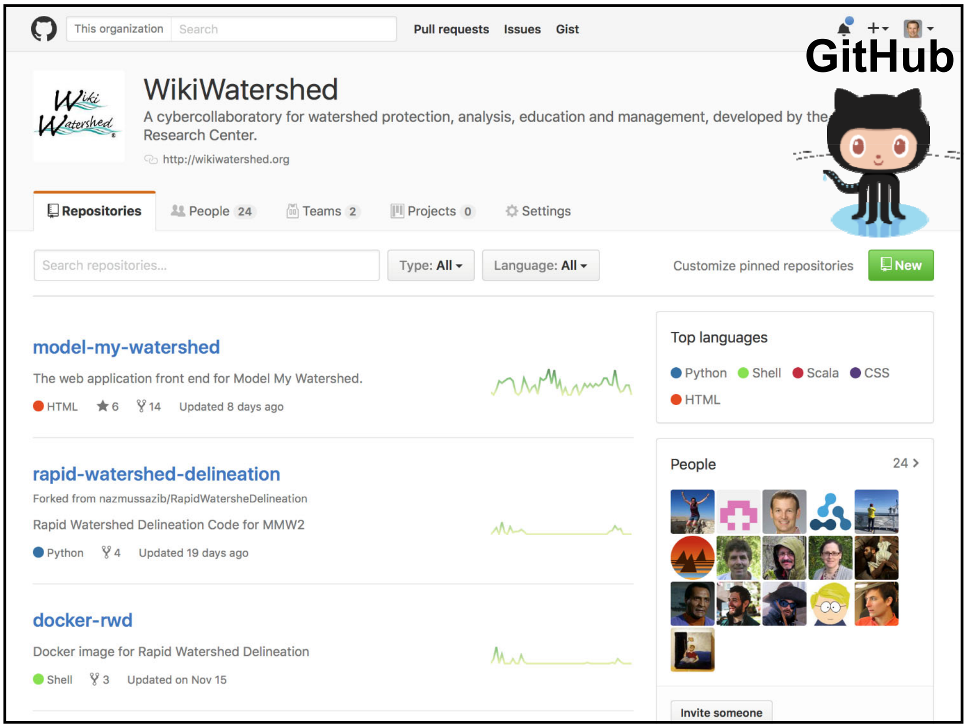
75

Big Water Data: for Everyone

Partnership between:

- Academic modelers, who:
  - Prototyped all code
  - Provided technical support for bug fixes
- Commercial software developers, who:
  - Led user experience (UX) design
  - Developed user interface (UI)
  - Implemented all code on Amazon cloud infrastructure

76



Future Developments: WPF Phase 2

- Enhance Model My Watershed
  - Import/Export
  - Better Share and Compare
  - Improve performance
- Develop Monitor My Watershed
  - Water data hub, via web-services from USGS, EPA, state and academic sources
  - Water data sharing, via EnviroDIY.org open-source data loggers
- Partnerships & Training in DRWI

EnviroDIY

78

Future Developments: Other Projects?

- Add new models?
  - HSPF?, SWAT?, SWMM?
  - Water Temperature?, Flooding?
  - Ecosystem services? / natural capital?
- Add new modeling features?
  - Detailed site design?, Customizable BMPs?
- Add enhanced data?
  - Future land-cover forecasts?
  - Localized data?, Global data?
- Add model output viewers/explorers?
  - National Water Model?
  - Calibrated model results for TMDL studies?

79

Thank You!

NSF

WILLIAM PENN FOUNDATION

80

Speaker Contact Information

Dr. Anthony Aufdenkampe
LimnoTech
Phone: (651-219-4076)
AAufdenkampe@limno.com

Dr. Barry M. Evans
Penn State University
Phone: (814-380-4779)
BME1@psu.edu

Bill Brown
Pennsylvania Department of Environmental Protection
Phone: (717-783-2951)
WillBrown@pa.gov

81

Next Watershed Academy Webcast: Please Visit Our Website

More Details to Come!

www.epa.gov/watershedacademy

82

Participation Certificate

If you would like to obtain participation certificates **type the link below into your web browser:**

- https://www.epa.gov/sites/production/files/2017-02/documents/watershed_academy_webcast_certificate.pdf

You can type each of the attendees names into the PDF and print the certificates.

83

Questions?

84