VIRGINIA STORMWATER RUNOFF CALCULATOR

PREPARED BY: JOHN L COLES
ADVISOR: CIBIN RAJ

GOAL

Develop a web-app which makes it extremely easy for a user to explore current stormwater runoff and pollution generated from an area of interest and to understand how changing landcover affects these values.

- The geographic extent for the web app will be the Commonwealth of Virginia
- Extremely easy to use means that user should not require specialized knowledge in Landcover types, soil classifications, or GIS.

1

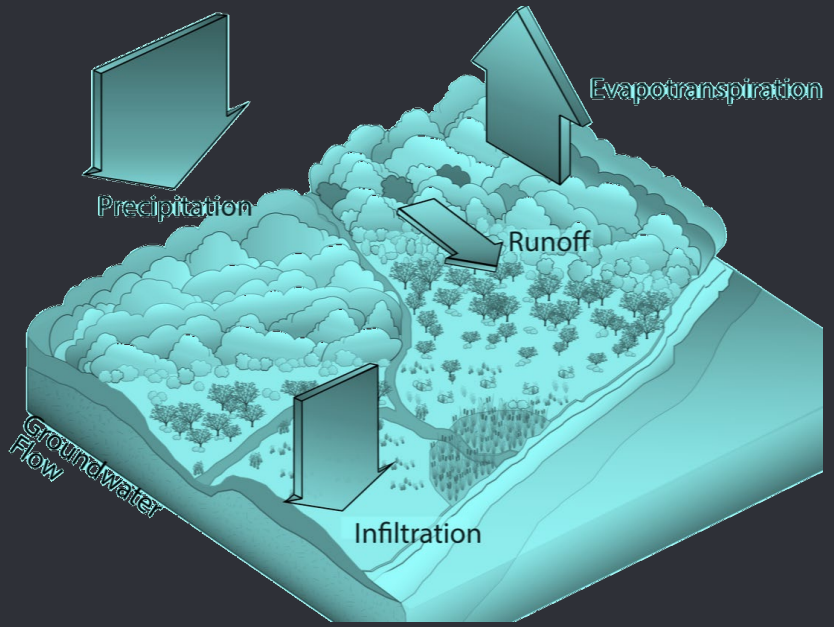
BACKGROUND

Why Stormwater Matters

WHEN RAIN FALLS…

When stormwater reaches the ground some of the water:

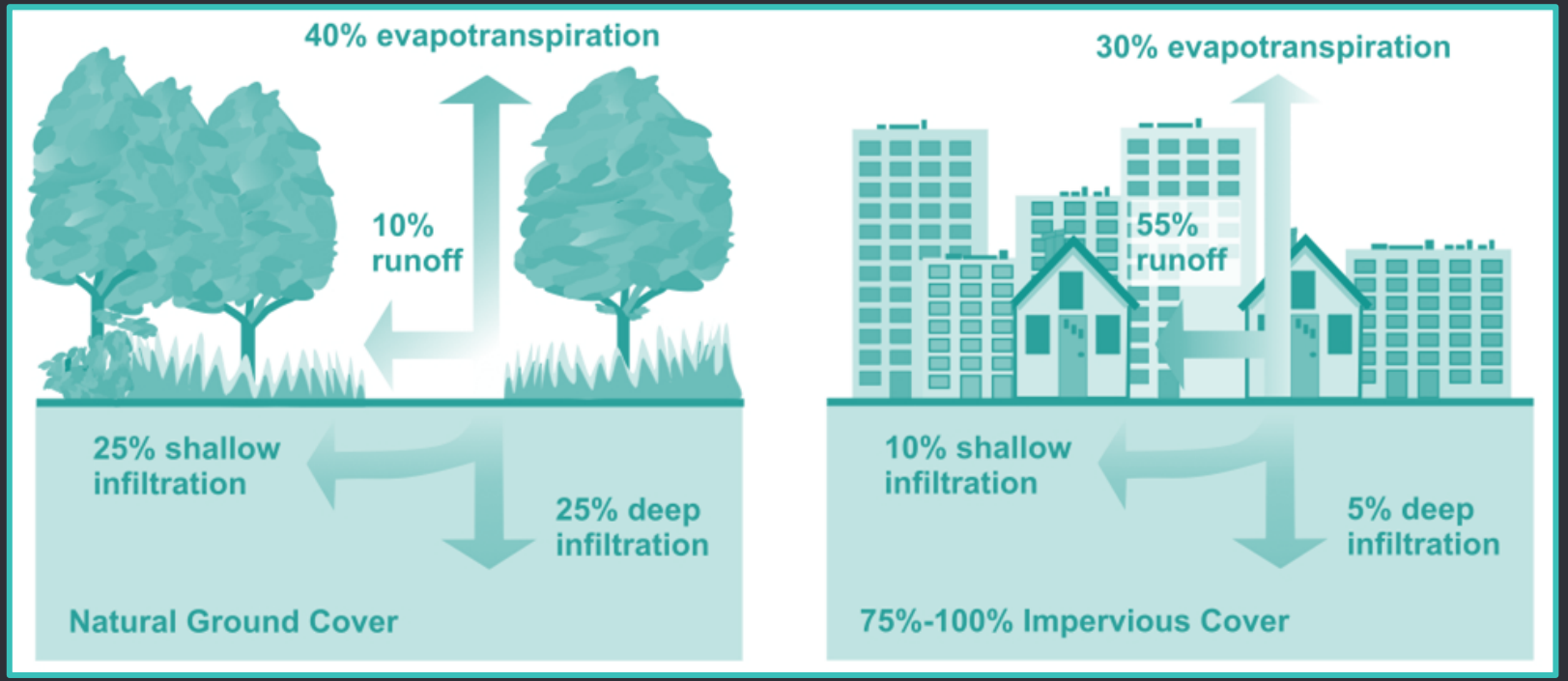
- Infiltration
- Evapotranspiration
- Runoff



STORMWATER RUNOFF

- Accumulates Pollutants
  - Soil Nutrients
  - Sediment
  - Litter
  - Pet Waste & Raw Sewage
  - Hydrocarbons (oil)
  - Pesticides & Herbicides

URBANIZATION



URBANIZATION IN CHESAPEAKE BAY WATERSHED

- Approx. 1 million new people per decade
- From 8.1 million in 1950 to estimated 19.4 million in 2030.
- 1990 – 2000 population increased by 10.3 %, but impervious cover increased by 41%.

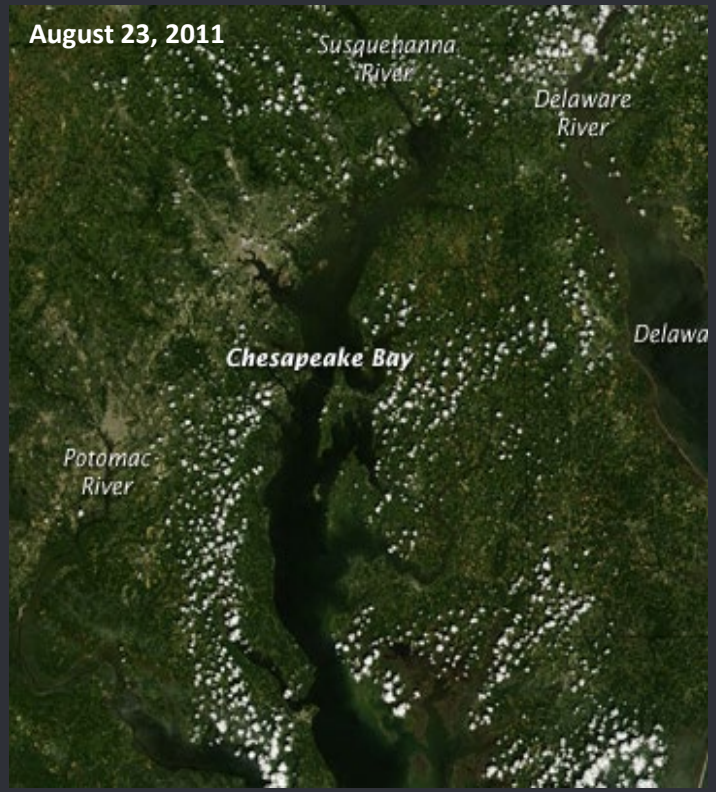
STORMWATER RUNOFF VOLUME

- Big Box Hardware Store = 352,000 gallons of runoff from 40-acre site.
- Shenandoah National Park = 32,000 gallons from 40 acres.

NUTRIENTS

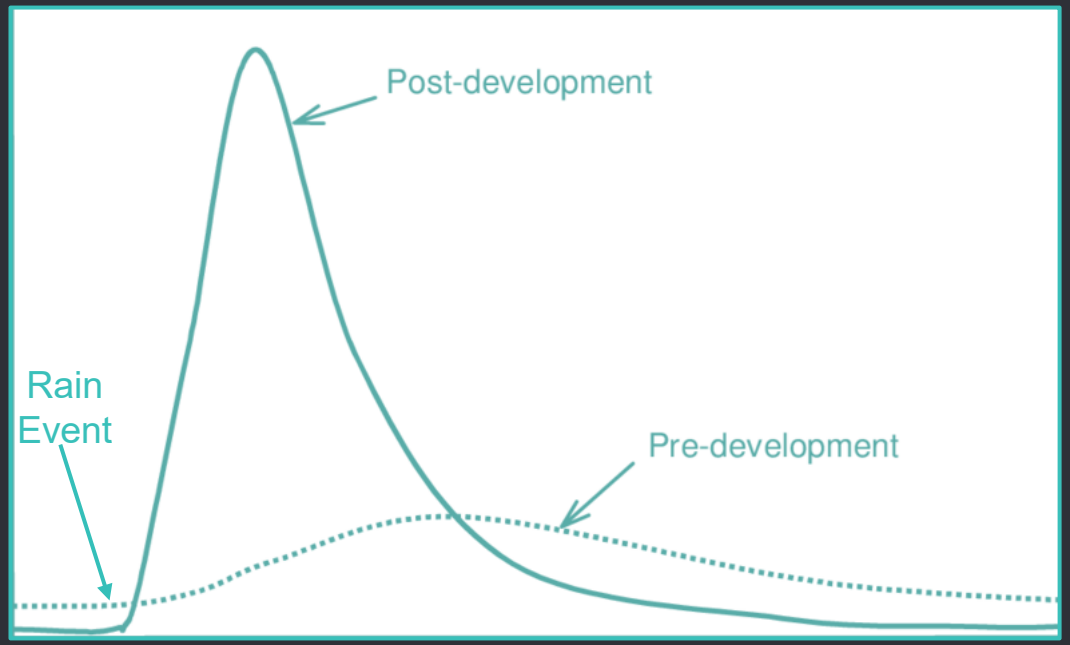
- Nitrogen & Phosphorus
- Over application of fertilizers
- Natural processes
  - Nitrogen Fixation
  - Breakdown of organic matter
- Increased algal blooms
- Decreased dissolved oxygen for other aquatic organisms

SEDIMENT


August 23, 2011
Susquehanna River
Delaware River
Delawa
Chesapeake Bay
Potomac River


September 13, 2011

PRE vs POST DEVELOPMENT



- Flooding
- Stream bank erosion
- Rising water temperatures
- Reduced Base Flow

2

STORMWATER BMPs

It's not all doom and gloom

STORMWATER BMPs

Practices and structures which capture and treat stormwater runoff, mimicking natural land cover

VIRGINIA RUNOFF REDUCTION METHOD (VRRM)

- Design standards exist for calculating the size of a stormwater management facility – e.g. biofilter:
  - Runoff Volume
  - Required Pollutant Removal
- In Virginia, the VRRM defines these calculations.

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EXISTING SYSTEMS

Evaluating what already exists

EXISTING CALCULATORS

VRRM Spreadsheet

Pros:

- Calculates sub-watersheds
- Calculations in form for submission to VA-DEQ

Cons:

- Complicated and Intimidating to use.
- User must supply their own land cover and soil data.
- Supporting Documentation is highly technical.

EPA National Stormwater Calculator

Pros:

- Automatically integrates landcover and soil data.
- User Friendly
- Includes existing BMPs in calculations

Cons:

- Calculates area of interest using circular buffer area
- No opportunity to explore how changes in land cover affect runoff volumes.

L-THIA – Perdue University

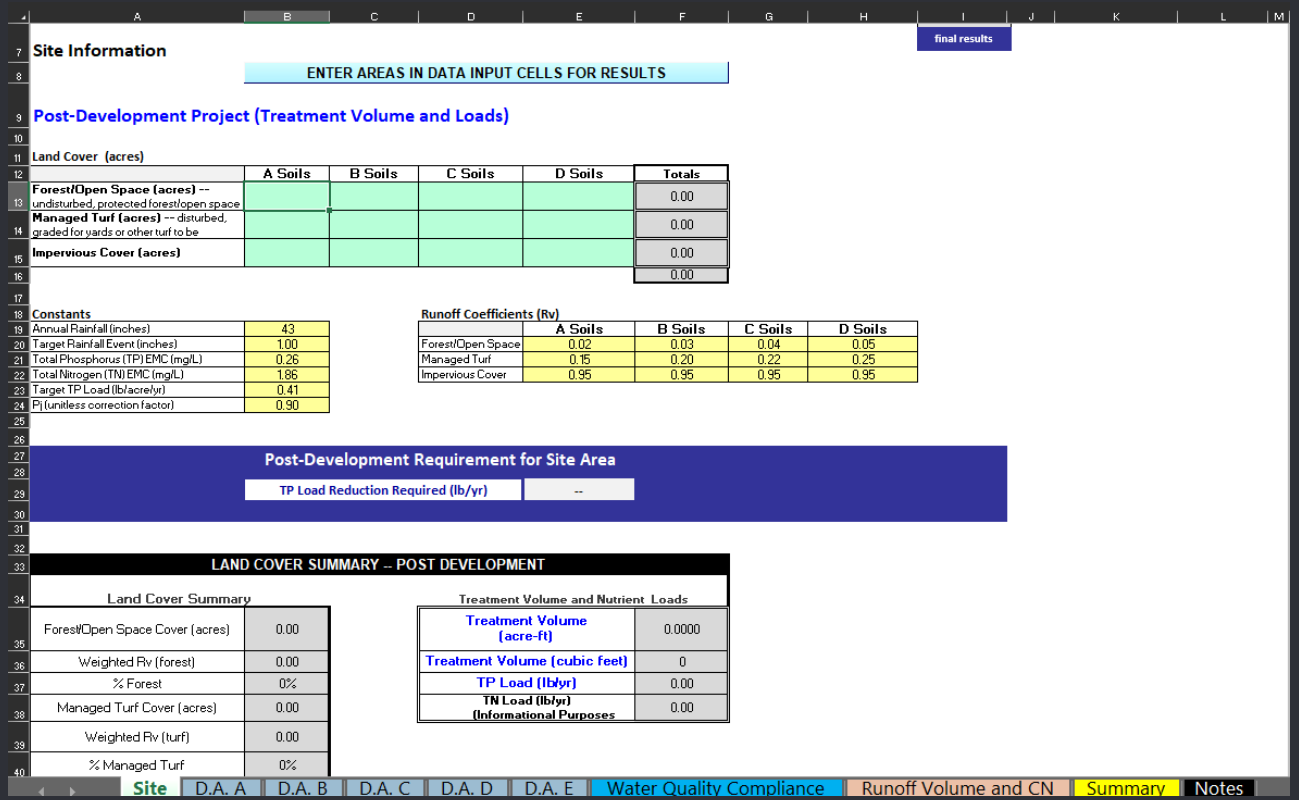
Pros:

- Calculates Quickly
- Offers users the opportunity to explore how changes in land use affect runoff volume

Cons:

- User must supply their own soil data
- Land cover is qualitative rather than quantitative

VRRM SPREADSHEET



final results

Site Information

ENTER AREAS IN DATA INPUT CELLS FOR RESULTS

Post-Development Project (Treatment Volume and Loads)

Land Cover (acres)

	A Soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space					0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be					0.00
Impervious Cover (acres)					0.00
					0.00

Constants

Annual Rainfall (inches)	43
Target Rainfall Event (inches)	1.00
Total Phosphorus (TP) EMC (mg/L)	0.26
Total Nitrogen (TN) EMC (mg/L)	1.86
Target TP Load (lb/acre/yr)	0.41
Pj (unitless correction factor)	0.90

Runoff Coefficients (Rv)

	A Soils	B Soils	C Soils	D Soils
Forest/Open Space	0.02	0.03	0.04	0.05
Managed Turf	0.15	0.20	0.22	0.25
Impervious Cover	0.95	0.95	0.95	0.95

Post-Development Requirement for Site Area

TP Load Reduction Required (lb/yr)	--

LAND COVER SUMMARY -- POST DEVELOPMENT

Land Cover Summary

Forest/Open Space Cover (acres)	0.00
Weighted Rv (forest)	0.00
% Forest	0%
Managed Turf Cover (acres)	0.00
Weighted Rv (turf)	0.00
% Managed Turf	0%

Treatment Volume and Nutrient Loads

Treatment Volume (acre-ft)	0.0000
Treatment Volume (cubic feet)	0
TP Load (lb/yr)	0.00
TN Load (lb/yr) (Informational Purposes	0.00

Site | D.A. A | D.A. B | D.A. C | D.A. D | D.A. E | Water Quality Compliance | Runoff Volume and CN | Summary | Notes

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EPA National Stormwater Calculator

Pros:

- Automatically integrates landcover and soil data.
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Cons:

- Calculates area of interest using a default circular buffer area.
- No opportunity to explore how changes in land cover affect runoff volumes.

L-THIA – Perdue University

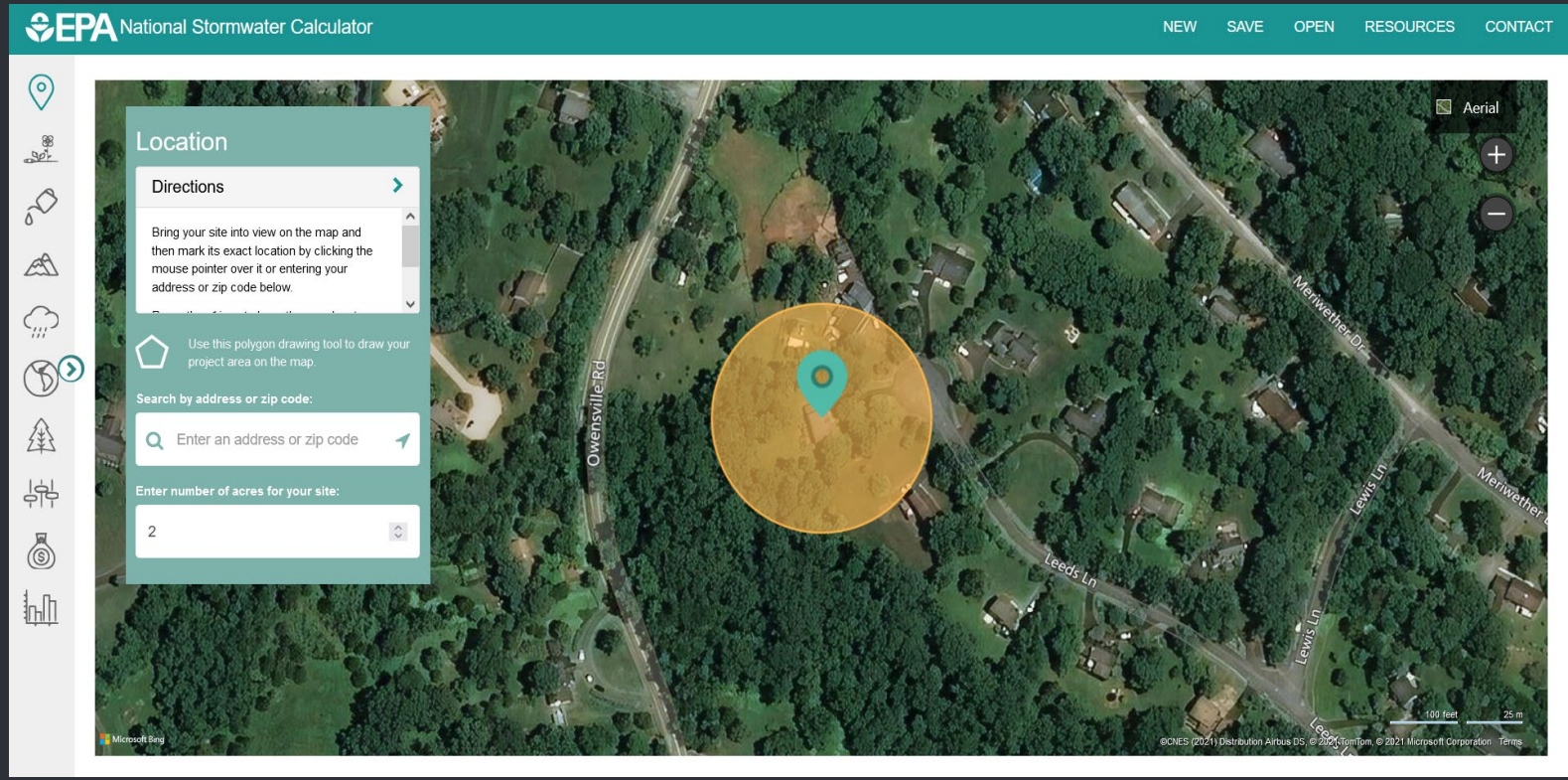
Pros:

- Calculates Quickly
- Offers users the opportunity to explore how changes in land use affect runoff volume

Cons:

- User must supply their own soil data
- Land cover is qualitative rather than quantitative

US EPA NATIONAL STORMWATER CALCULATOR



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- Automatically integrates landcover and soil data.
- User Friendly
- Includes existing BMPs in calculations

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- No opportunity to explore how changes in land cover affect runoff volumes.

L-THIA – Purdue University

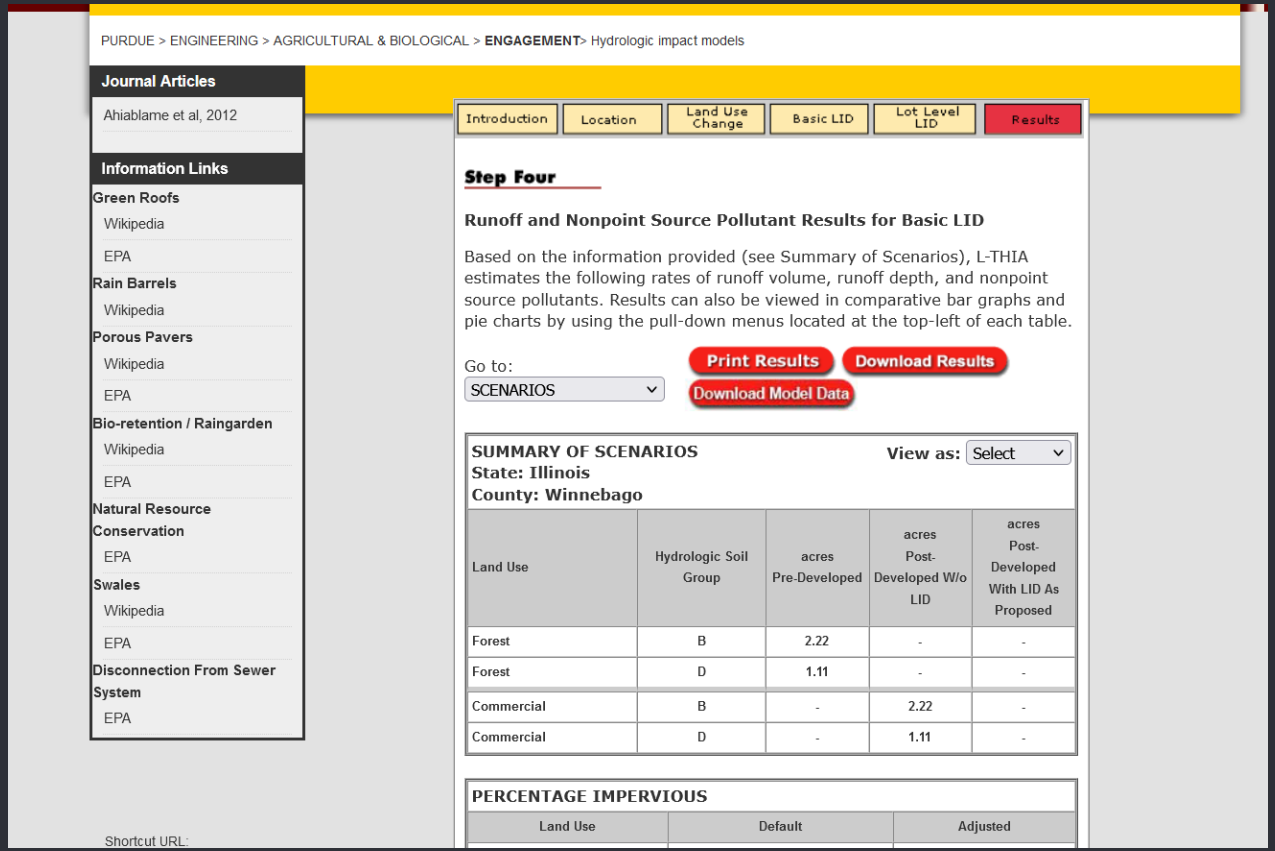
Pros:

- Calculates Quickly
- Offers users the opportunity to explore how changes in land use affect runoff volume

Cons:

- User must supply their own soil data (provided for great lakes region)
- Land cover is qualitative rather than quantitative
- Complex to use

L-THIA PERDUE UNIVERSITY



PURDUE > ENGINEERING > AGRICULTURAL & BIOLOGICAL > **ENGAGEMENT**> Hydrologic impact models

Journal Articles

Ahiablame et al, 2012

Information Links

Green Roofs
Wikipedia
EPA

Rain Barrels
Wikipedia

Porous Pavers
Wikipedia
EPA

Bio-retention / Raingarden
Wikipedia
EPA

Natural Resource Conservation
EPA

Swales
Wikipedia
EPA

Disconnection From Sewer System
EPA

Shortcut URL:

Introduction | Location | Land Use Change | Basic LID | Lot Level LID | Results

Step Four

Runoff and Nonpoint Source Pollutant Results for Basic LID

Based on the information provided (see Summary of Scenarios), L-THIA estimates the following rates of runoff volume, runoff depth, and nonpoint source pollutants. Results can also be viewed in comparative bar graphs and pie charts by using the pull-down menus located at the top-left of each table.

Go to: SCENARIOS

Print Results | Download Results | Download Model Data

SUMMARY OF SCENARIOS
State: Illinois
County: Winnebago

View as: Select

Land Use	Hydrologic Soil Group	acres Pre-Developed	acres Post-Developed W/o LID	acres Post-Developed With LID As Proposed
Forest	B	2.22	-	-
Forest	D	1.11	-	-
Commercial	B	-	2.22	-
Commercial	D	-	1.11	-

PERCENTAGE IMPERVIOUS

Land Use	Default	Adjusted

PROPOSED SYSTEM

- Intuitive to Use
- Requires no specialized skill in
  - Soil Science
  - GIS
- Only user input is AOI
- Remove barrier to entry for data and information about stormwater runoff calculations.

The design will *"assume the burden of complexity"* so the user doesn't have to.

Jackson Noel – Appcues Blog

4

METHODS

Design Considerations

OVERVIEW

Development

- Built using basic web scripting languages of HTML, CSS, & JavaScript
- Maps will be constructed using ArcGIS API for JavaScript
- Based on calculations specified in VRRM

Design

- Broken into 'bite-sized' actions to prevent users from becoming overwhelmed
- Only one user action per page
- Significant consideration to user experience.

Data Sources

Soil Hydrology

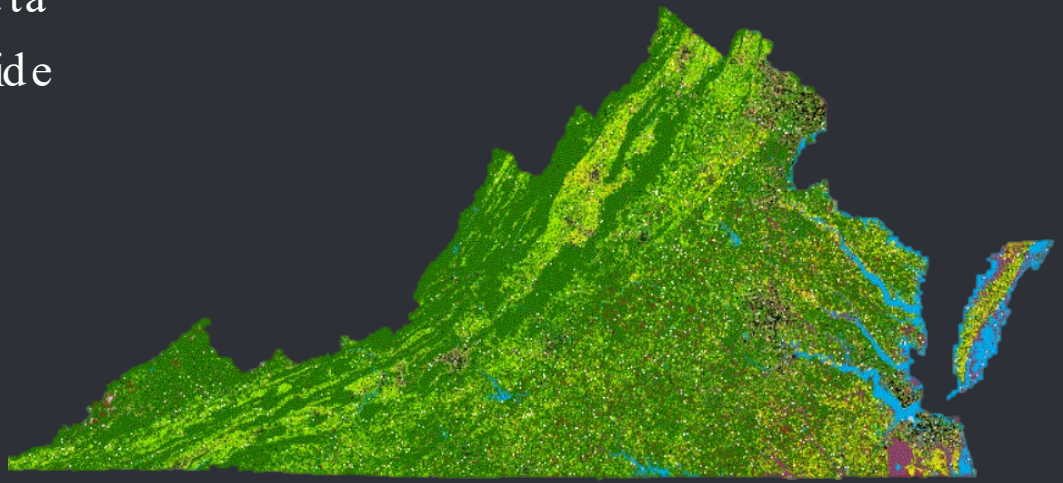
- USDA – NRCS Web Soil Survey – SSURGO
- Vector Data
- Nation Wide

Land Cover

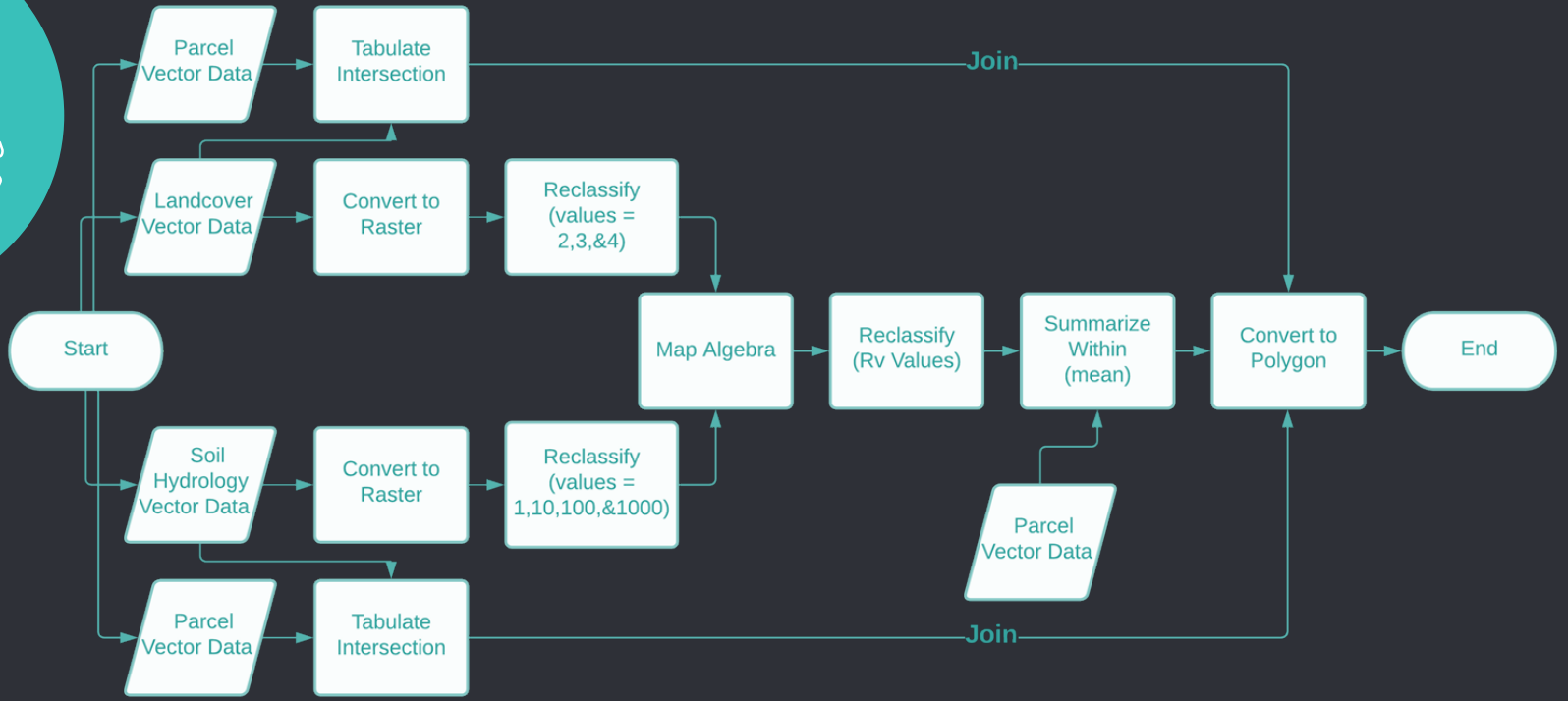
- VGIN
- Vector Data
- Statewide

Parcels

- VGIN
- Vector Data
- Statewide



GEOPROCESSING



Flow Chart: Created with Lucid Chart

GEOPROCESSING RECLASSIFY

		A	B	C	D
	Multiplier	1	10	100	1000
Forest/Open	2	2	20	200	2000
Managed Turf	3	3	30	300	3000
Impervious	4	4	40	400	4000

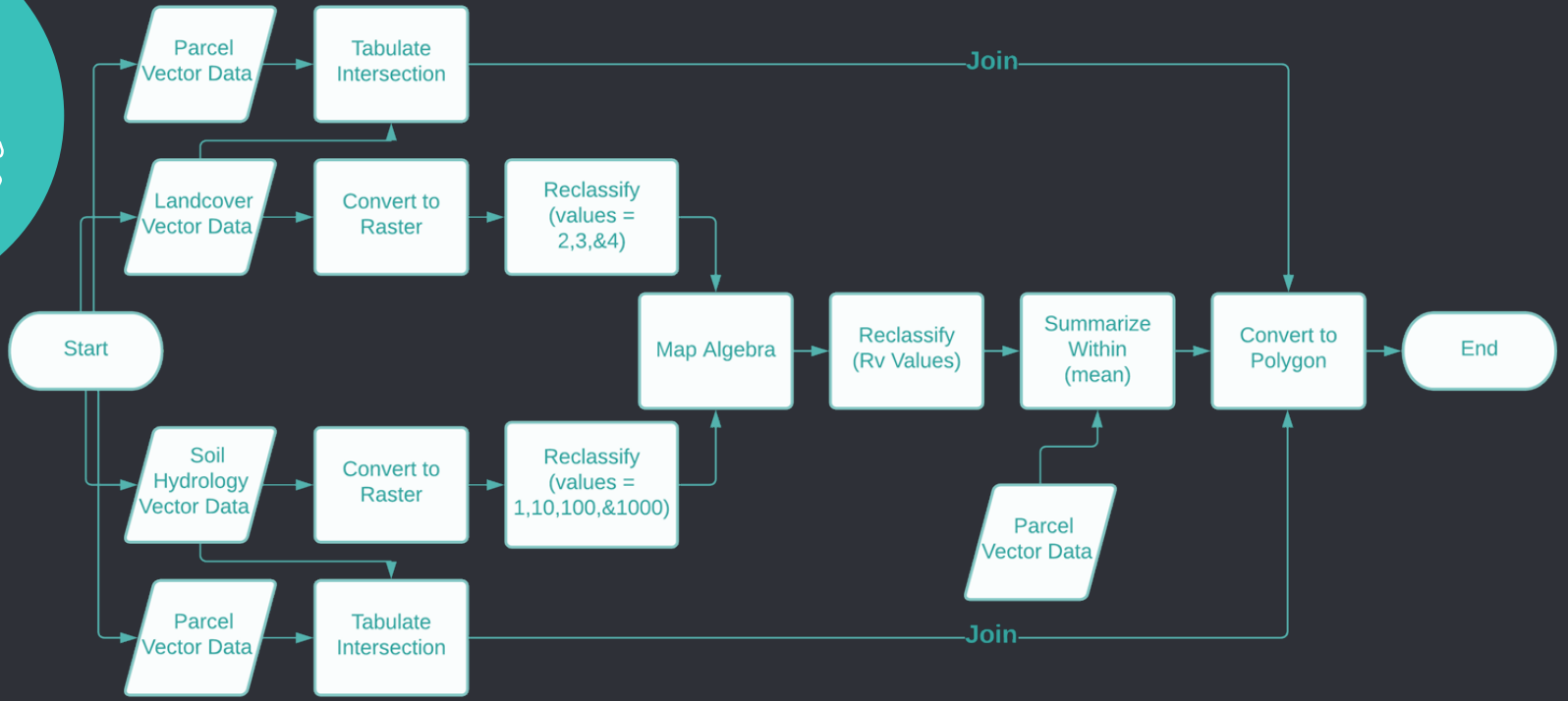
= Reclass Value

= Map Algebra Value

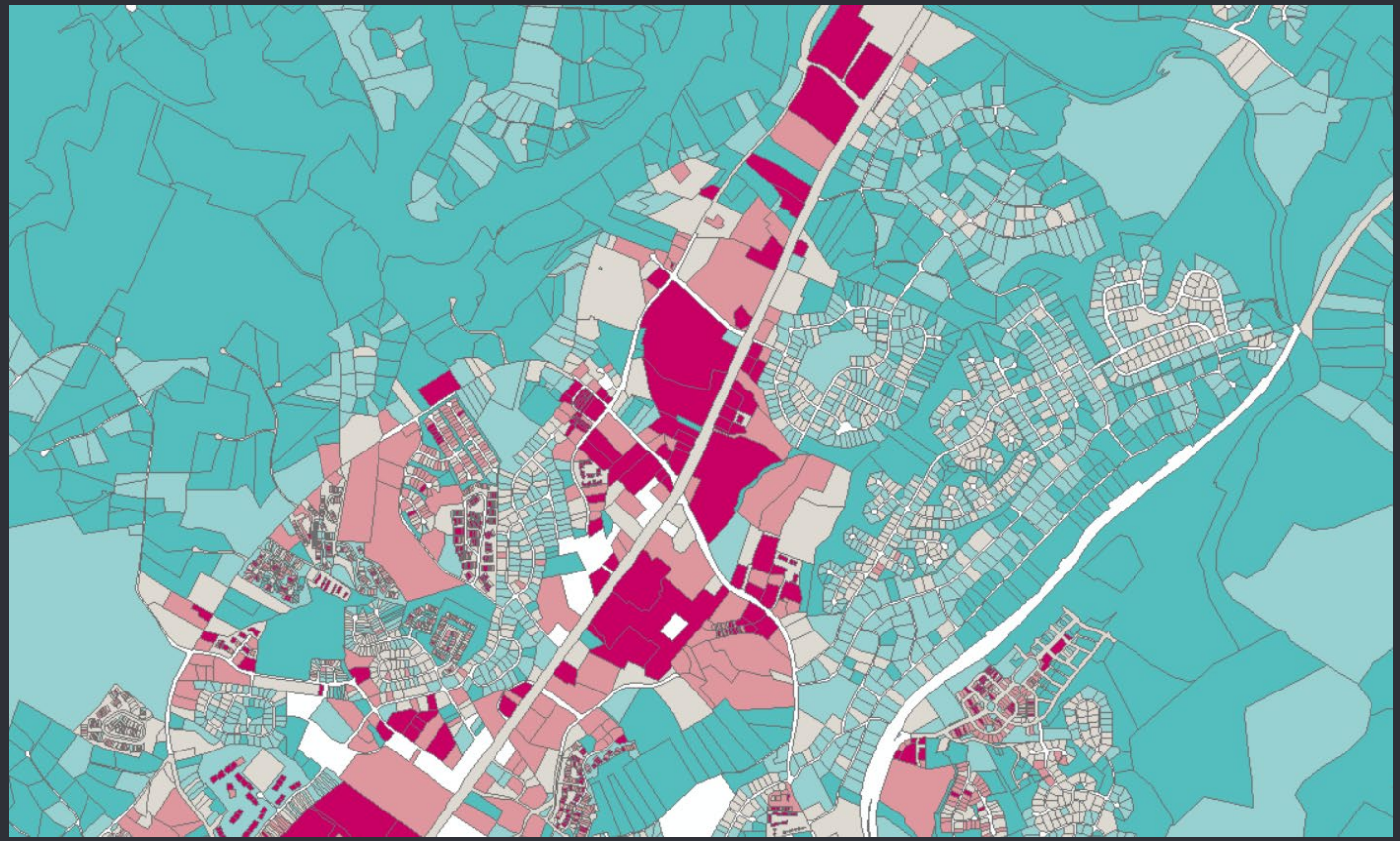
Reclass to ↓

R_v	A	B	C	D
Forest/Open	0.02	0.03	0.04	0.05
Managed Turf	0.15	0.20	0.22	0.25
Impervious	0.95	0.95	0.95	0.95

GEOPROCESSING

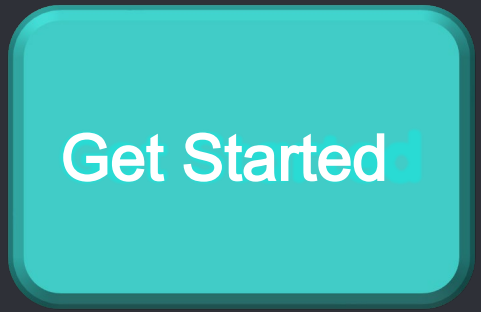


GEOPROCESSING PILOT STUDY

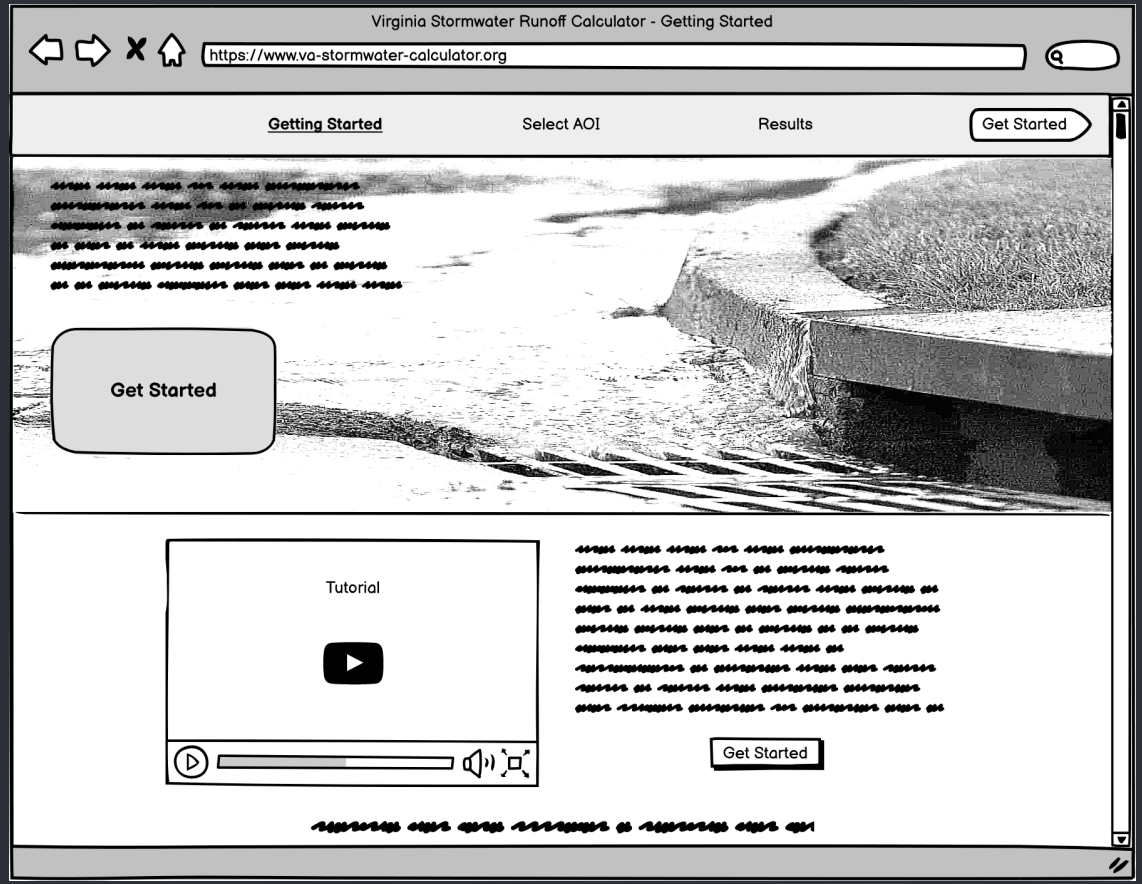


LANDING PAGE

- First page of application.
- Everything points towards “GET STARTED”
- Distraction Free
  - No external links
- Brief explanation of how application is useful
- Simple tutorial.



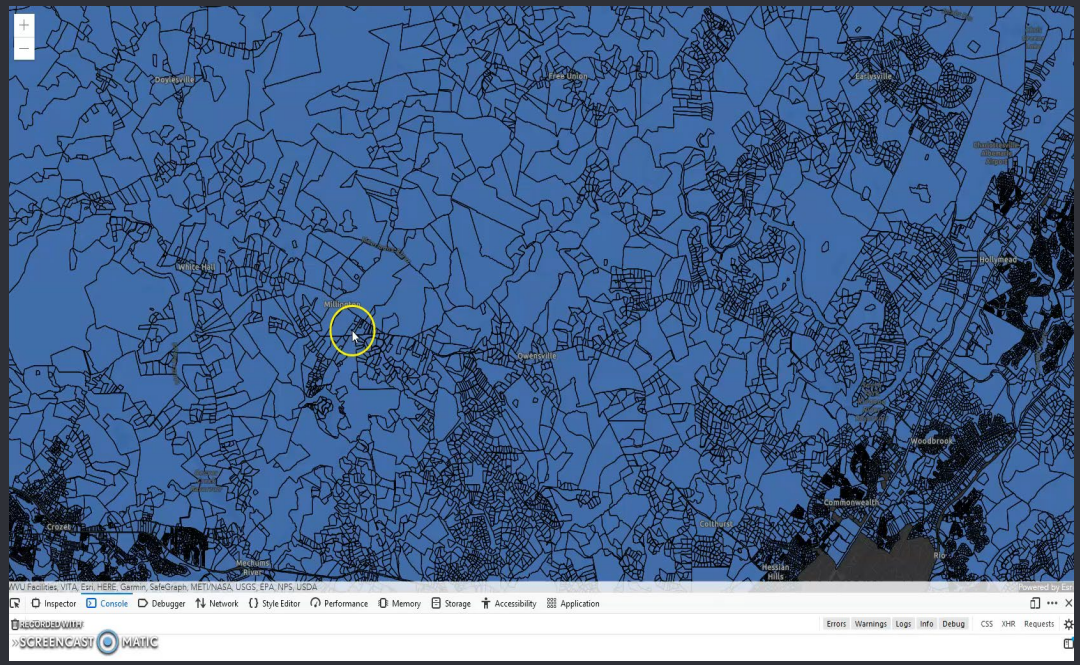
LANDING PAGE WIREFRAME



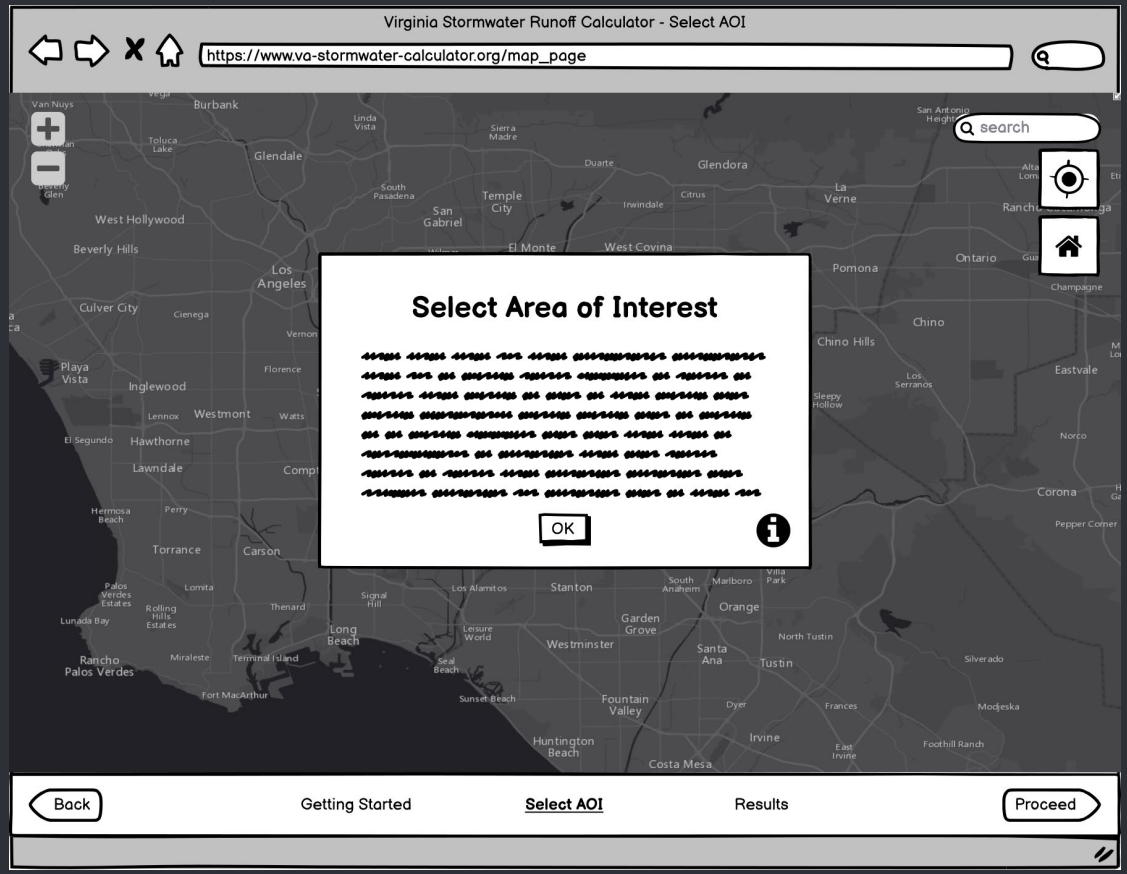
Created with Balsamic Cloud

MAP PAGE

- On the map page the user will select their Area-of-Interest (AOI)
- Uses ArcGIS API for JavaScript.
- MapView's HitTest property to select parcel.
- SessionStorage is used to temporarily save attributes to browser to pass to results page.



MAP PAGE WIREFRAME



Created with Balsamic Cloud

RESULTS PAGE

Column One Results

- Displays the Stormwater Runoff Values for the user's AOI
- Passed from map page via Session Storage
- In format matching VRRM Spreadsheet

Column Two Redevelopment

- Allows user to enter alternate values for landcover to explore how changing land cover affects stormwater.

Column Three Suggested BMP's

- Based on AOI properties, recommends
- Based on AOI size and land cover
- Includes links to get more information.

RESULTS PAGE CALCULATIONS

- Results populated from feature class attributes
- If user chooses to 'explore' how changes to land use affect runoff, values will be calculated using JavaScript

- Calculate Values include:
  - Weighted Runoff Coefficient
  - Runoff Volume
  - Phosphorus Load
  - Required Phosphorus Removal
  - Nitrogen Load
- Calculations are defined in VRRM Handbook & narrative proposal.

RESULTS PAGE: BMP RECOMMENDATION MATRIX EXAMPLES

Constructed Wetland: Site is greater than 300 acres AND Forest/Open is less than 100%

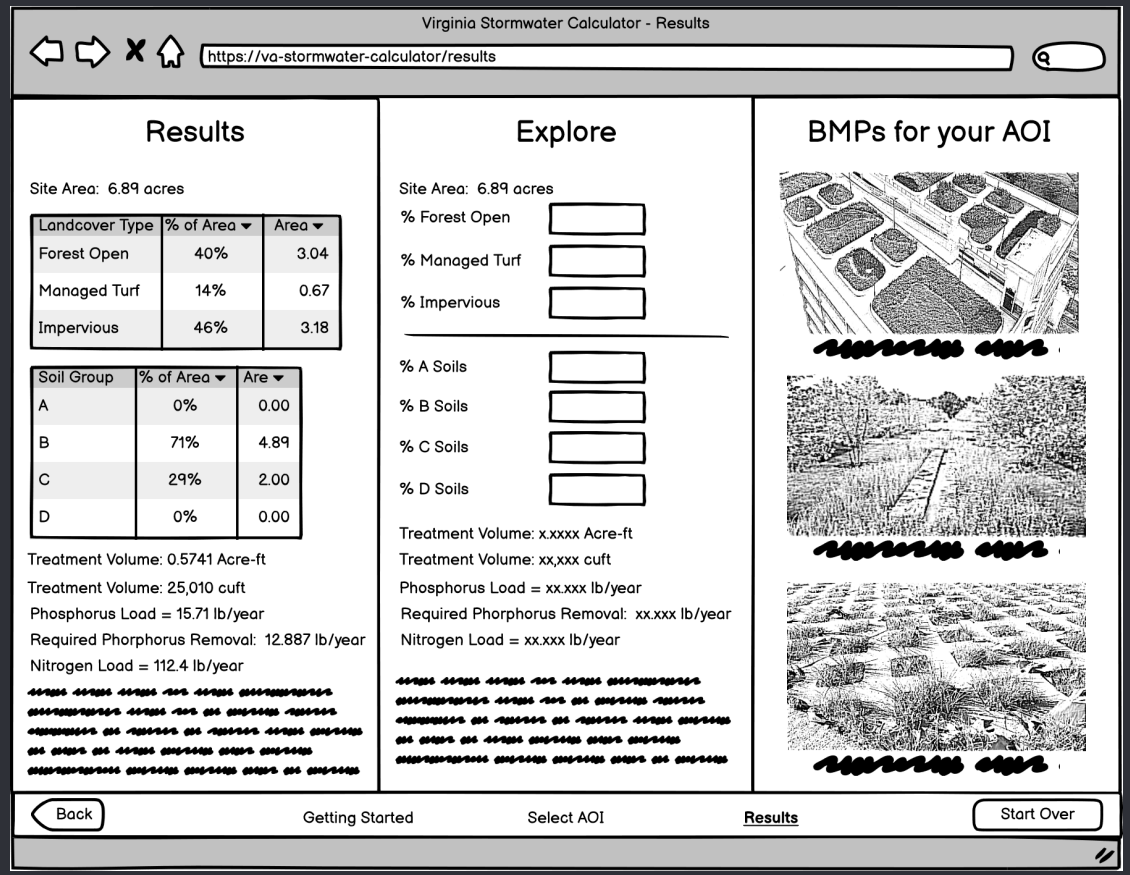
Wet Swale: Site is greater than 9 acres AND impervious cover is less than 50%

Porous Pavement: Impervious cover is greater than 0%

Conservation of Natural Areas: Recommended under all conditions

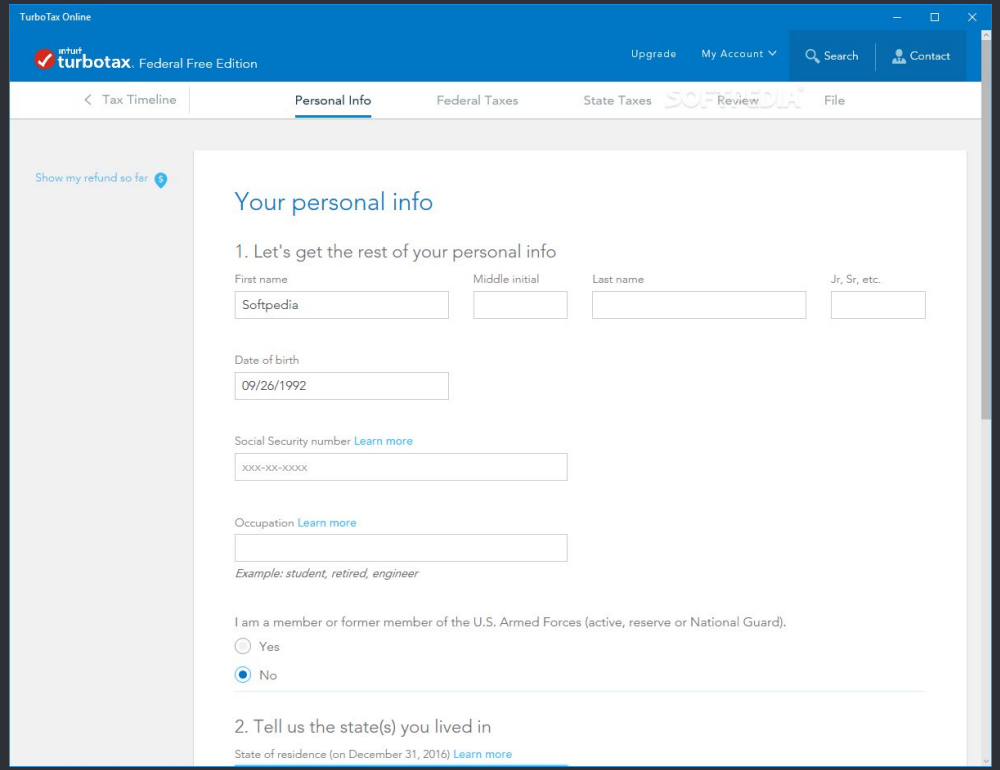
Based on Chapter 8 of Virginia Stormwater Management Handbook

RESULTS PAGE WIREFRAME



USER EXPERIENCE

- Turbo Tax
- Workflow broken into “bite-sized” pieces.
- Uncluttered
- Calming Colors
- Status indicator
- What’s Ahead
- Help & Tool Tips
- Consistent Theme across Application



USER TESTING

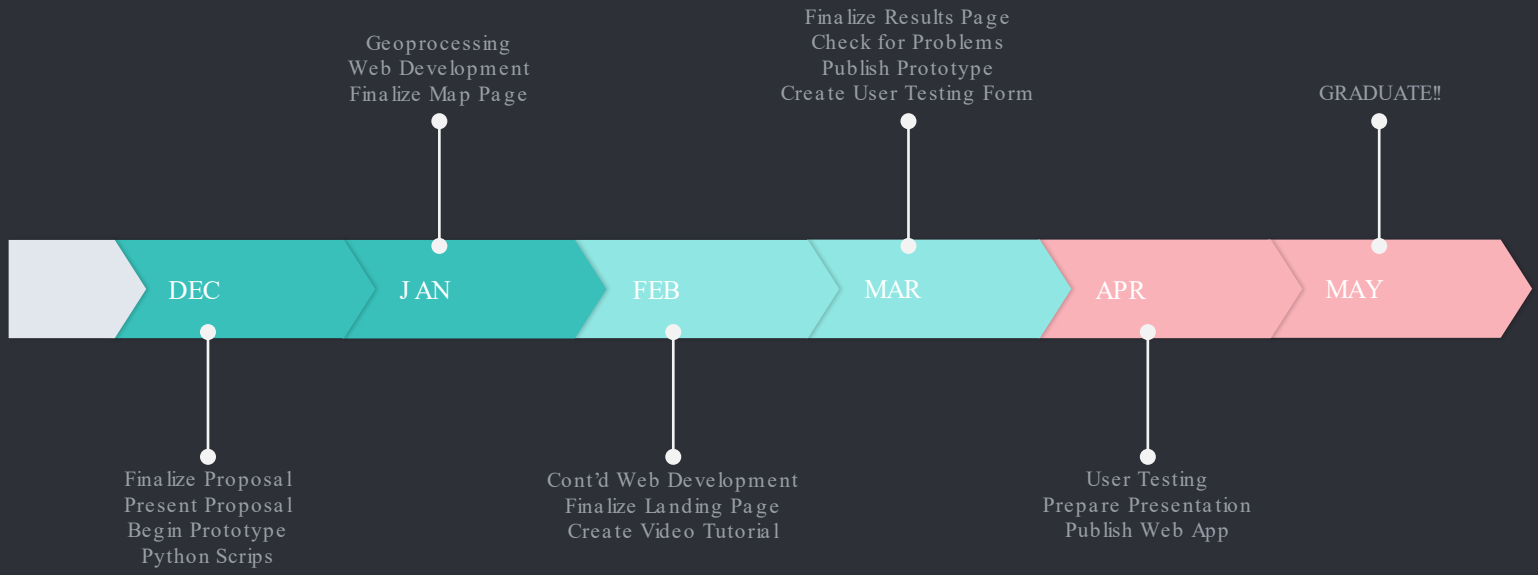
Upon completion of a functional prototype:

- Potential Users will be asked to 'test-drive' the system.
- Classmates, co-workers, industry professionals, friends, family.
- Given a task, then asked questions about experience
- Use free questionnaire gather feed back
- Iterative test, adjust process

Evaluation Questions

- User Information
  - Profession
  - Technology Proficiency
- Technical Issues
  - Device & Web Browser
  - Dead Links
  - Long Load Times
- Usability
  - Trouble using app
  - Buttons not where expected
  - Navigation issues
  - Tutorials/ Tooltips not helpful

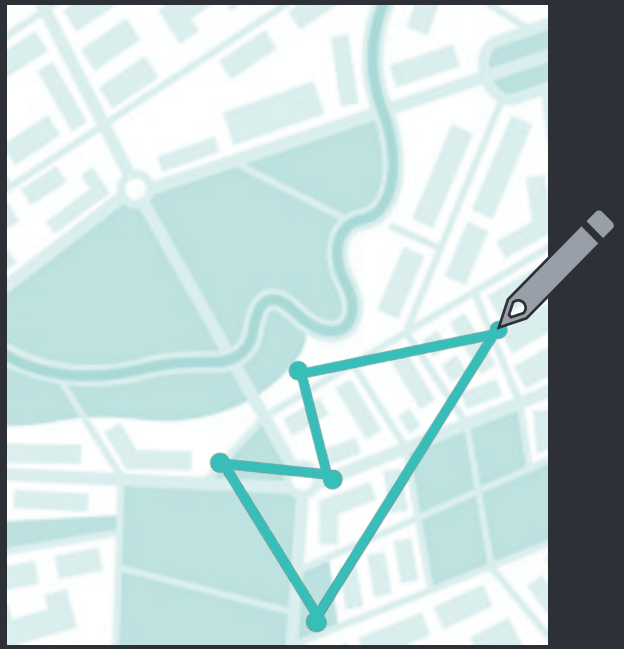
Timeline


DEC
J AN
FEB
MAR
APR
MAY
Finalize Proposal
Present Proposal
Begin Prototype
Python Scrips
Geoprocessing
Web Development
Finalize Map Page
Cont'd Web Development
Finalize Landing Page
Create Video Tutorial
Finalize Results Page
Check for Problems
Publish Prototype
Create User Testing Form
User Testing
Prepare Presentation
Publish Web App
GRADUATE!!

FUTURE WORK

- Mobile Compatibility

- Select AOI by Polygon



CONCLUSION

This proposal:

- Includes design instructions, processes, and considerations for building out the “Virginia Stormwater Runoff Calculator”
- Defines a system which is intuitive and easy to use.
- Includes steps for obtaining user feedback for continual improvement.
- Assumes the “burden of complexity” in making stormwater runoff calculations accessible to the lay user.

For full details please see the narrative proposal.

Thanks!

ANY QUESTIONS?

You can find me, John Coles at

jlc696@psu.edu