50th Anniversary of the Delaware Water Resources Center

2015 Annual Meeting Newark, Del. April 17, 2015

Gerald J. Kauffman, Ph.D., Director University of Delaware Water Resources Center





Water

- 97-3-1
- Essential for life
- Most precious chemical (H₂0)
- Universal solvent
- Exists in nature as all three states of matter
- No economic substitute







Sea Level Rise

10,000 years ago

DRBC Compact 1961 AD





LYNDON B. JOHNSON XXXVI President of the United States: 1963-1969

461 - Statement by the President Upon Signing the Water Resources Research Act. July 17, 1964



THE Water Resources Research Act of 1964, which I have approved today, fills a vital need.

Abundant, good water is essential to continued economic growth and progress. The Congress has found that we have entered a period in which acute water shortages are hampering our industries, our agriculture, our recreation, and our industrial health and happeness.

Assuming a continuation of current practices, by the year noon there will not be enough unable water to meet the water requirements of parts of the States of Arizona, California, Colorado, Delaware, Idaho, Illinois, Indiana, Jowa, Kansas, Louissiana, Michigan, Minnesota, Montana, Nebraska, Nevada, New Jersey, New Messo, New York, North Dakota, Ohio, Oldahoma, Oregon, Fennybunia, South Dakota, Tenas, Utah, Wasconsin, and Wyoming.

This legislation will help us solve this problem. It will create local centers of water research. It will exist the intellectual power of universities and research institutes in a nationwide effort to conserve and utilize our water resources for the common benefit. The new centers will be concerned with municipal and regional, as well as with national water problems. Their ready accessibility to State and local officials will permit each problem to be attacked on an individual basis, the only way in which the complex characteristics of each water deficiency can be resolved. The bill contemplates a high degree of interstate cooperation, and I urge that this be encouraged.

In large measure, this legislation is a tribute to the vision and windom of Senator Clinton P. Anderson of New Mexico. He has long recognized the problems. He developed the program. He guided it through Congress. He has been in the forefront of the effort to see that adequate supplies of water are available in all parts of the Nation. Collection: Public Papers of the Presidents





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The Blue New, Newark, Del.: University of Delaware, 1965.





Delaware Water DWRO Resources Center ar the Conversity of Delayare DWRC Undergraduate Internships



BATTERITY College of Agriculture

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Delaware Water Resources Center (DWRC) interns

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The DWRC Internship Program

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Topics in water resources research and education of interest to the DWRC:

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How to Apply for a DWRC Internship

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Delaware Water Resources Center

Gendel J. Kouffman, Ph.D., Dourstor (2021 Annuel 2021 Academy York) Newark, 202 19725 Phone, 202-821-4929 F-mail: per-physiolatedu

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http://ag.udel.edu/dwrc/





The University of Delaware is fortuitously situated on campuses ideally suited by hydrology and geography to study water resources.





River Basin	Drainage Area (mi ²)	Nitrogen Load (ton/yr)	Unit N Load (ton/mi ² /yr)
Susquehanna	27,490	73,040	2.7
Delaware	11,819	50,525	4.3
Potomac	14,658	44,707	3.0
Hudson	13,363	28,711	2.1
James	10,339	17,482	1.7
Connecticut	11,261	17,236	1.5

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Sea Level Rise

Delaware Mean elev. 60 ft msl



10,000 years ago

Figure 1. Sea level rise and coastal flooding impacts in Delaware (NOAA Coastal Services Center)

Research Activities of the Delaware Water Resources Center



Creating a Floodplain Wetland to Protect Water Quality in the White Clay Creek National Wild and Scenic River Watershed UD Project Team: UD WATER (Watershed Action Team for Ecological Restoration)*

Watershed Management Practices College of Agriculture & Natural Resources Farm (2000-2011)



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Creating a Floodplain Wetland

Background: The Cool Run tributary of the White Clay Oreak drame land on the UD campus.

and in the City of Newark. If has long been negatively impacted by nonpoint pollution from urban, industrial, and aprecultural sources and is lasted by the Uh EPA as an impacted water body for mathematic datasabled ontriper, bacteria, and sedimentia. In 2006, the UD WATER team analyzed stormwater politiant loads in the Cool Run Watershell and recommended increasing the number and

Project: A section of loss quality parties non-removed from agricultural area to results a healthy. Fathetmenting Roodplain workland, thus coducing pollutant head to the White Clay Creek by filtering stornowater month. This welland, shong with others oreated on the farm, will also treate storneyater atorage, important to prevention of downstowam flooding. This project illustrates how the University partners with the City to manage land in the White Clay Creek watershed in a manner that improves water quality. Wellight halpitat will be created and enhanced, increasing the diversity of species in: the form and campus, at important component of UD efforts to be a more maximalile university FURITING: Provided by the UD Sustainability Fund, the College of Agriculture and Natural Resources, and the Department of National Resources and Environmental Control (ENREC)

acroage of wetlands in the watershed to improve scater quality and eccevision health.

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Wetland Construction and Status:

- « Wetlands ecological design developed by DNRIC
- Premits obtained from state and federal apencies.
- Land adjacent to stream channel escatated, lowering # and creating pockets with openings to the stream.
- * During stories, water closes higher in the stream channel and can now flots into the sucarated acreage and pond m the low areas . In this way, water is "stored", allowing it to ecaponate or indiffrante and than reducing storm flows downstream
- The combination of hummocks and pockets of differing depths also creates a varied habitat for wildlife. While some name flor's will be planted, the werfland will naturally fill in with native vegetation.









Stormwater Solutions for the University of Delaware's North Campus: Hydrologic Modeling in the Piedmont Watershed

Jillian Allen, Tim D'Agostino, Hannah Diehl UD Watershed Action Team for Ecological Restoration (UD WATER)

1. Introduction

Stormaster suroif is an accessing posterior for the health of eather quality and water supply in the Wele Clay Creek National Wells and Development Flow. The Land Language in the Phelineet, of the University of Delawage contains a supplement of region roots storer which regresses runtiff and publicat basic intravenues to the Wele Clay Creek (Fig. 1), Reduction of imperious storer through beel management practices such as can gardene and reformatation will reactive such as can gardene and informatation will reactive such as can gardene and reformatation will reactive the detimental impact of stormaster on the guality of Bhelic Clay Creek.



By 3 (Ball of signature and as could also be also a class proce

2. Research Objectives

To reduce needf and pollutert loads, develop a watertheid noole to determine how changes to the stormester system will improve water society and reduce floating in (1) Fartheid Ray, (2) Nas then Creek, (3) a gally cystem Hisdary to White Clay Devel

3. Methods

Each satershed are reached using an EPA hydrology/hydrackin program rathed SWMR (Storm Water Hamagameet Block). The SWMM model was developed according to the following methods:

Task 1 - Delivers the summaheds (Fig. 2) into appropriate sections according to topography (contexe lines) and the stormwater retrievely using GIS data. This may derive using GIS data and for time and convenience safe was proported for us.

Task 2 - Deale a liackdrap map for the DDMM model that excludes the autoatchrowers, pipes, and outfails that convey the stormwater randit

Task 3 - input nodes (manholiss) and outfails to enade the iterases if the SWMM model (Fig. 1)

Task 4 – Correct the nodes and outlide using triks (dominate prood) as depicted in Fig. 4.

Task 5 - Define and draw the calciforents on the map to complete the lastic material-excels (Figs. 5, 6, 7).



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4. Results



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Moving parameters

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Nodes 30

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4. Results

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Fail Barm Line (Hitten)

5. Future Work

- 1. Seguel solestial darks collected from the facilities run the
- I Watershed data such as ana, sipe diameter and longth.
- and invest elevation must be jud atto the model. 3 Run the model with attemate inputs (such as DMPs
- entailed)
- Expansion of the SWMM model to include the entire Chosenalty of Celevante compute and Newski.

6. Acknowledgements

We excit like to admonishing out memory Caratti Kauffman and Andone Homey for all of their help throughout the course of this propert. We would also like to their the WEA for the familing for this project.

WATERSHED ACTION TEAM FOR ECOLOGICAL RESTORATION

water

1. Introduction

Sustainable

Stormwater runnd has the ability to erode Earth's surface, creating channels to form along its path from impervious areas to streams, rivers, etc. Large channels, known as gallies, can be examined to determine the extent of the effects of stormwater. The resulting analysis can also provide insight into the implementation of appropriate stormwater management practices.

2. Objectives

- + For gallies located in a Piedmont watershed.
 - (1) Quantify total suspended solids loads received. ining time.
 - (2) Determine temporal probable peak flows.



over the support of the three publics being and tool within the study many

3. Methods

- Data representing Pre-1292 (completely forested). 1937, 1954, 1961, 1968, and 1992 land development and stocurwater management conditions were analyzed in this study. The three sites examined in this study are located near Newark. DE within the Christiana River Watershed and shown above.
- (c) Land use data generated by AreGIS was combined with anomal precipitation estimates and mean pollutant concentrations in the Simplified Method in order to determine the -day days bool textuiled shifts industry later watershed has experienced over time.
- E2) Within the TR-35 Hydrology Model, land use data was processed with time of concentration data to produce the expected is, so-, and sitoyear storm flows associated with each year and watershed being examined.

4. Key Results

Sub-Watershed Delineation Results

figure 4 anisi physicsphy Breek pergit kicks public. and input contributing for our water days delawsting for such polic cost until 10.04 plangraph matter due to bolk of regulation tract pair. Load raw

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· Significant basil use and shortowater mint warness development occurred between the years sugg and size?









Pollutant Load and Peak Flow Analysis Results







Rise in both TSS load and peak flow in 1992. represents to three are inwatershed broadary associated with Cally 2 day. to the installation of a sewar strikes and large parking lot depicted on 1000 acrial phonograph.

 Relatively large predicted. values for TES load and peak flow experienced by Gagly 1 ist consportions he is and a convergence of the size of its watershed. boundary in relation to three of Gallies 1 and 2.

5. Conclusions

Hydrologic Response from a

Developed Piedmont Watershed Kato Anienhach/, Virginia Thornton#, Luc Classowus?, Gerald Kanffman* "Culottate of Delaware, Department of Economical Engineering "Dates of the Inference Department of Dampy and Reviewanoutal Paley

(University of Delaware, Department of Geography) "Chiverstyne Delaware, Water Rawrenter Agency

> The results of this study demonstrate that

- (1) Because TSS loads and peak flows are functions of land une, graphical results for each parameter over time exhibit the same shape.
- (2) Severe increases in predicted. loading and flow can be resultant of.
 - (a) Increases in appearance of specific high mstriest-and/or high metal-containing land mar-O.e., agriculture, parking lota).
 - (b) Increases in sub-watershed size due to changes in flow patterns (i.e., totroduction of server system).

6. Future Work

- Ceadact field studies in order to:
- (1) Increase the accuracy of the models.
- (2) Compary model results to actual data.
- Perform spatial survey on mell gally to hopes of:
- (i) Classifying them further.
- (2) Obtaining data to serve as imput itata more advanced hydrologic modeling/prediction waters (i.e., HEC-RASI.

7. Acknowledgements

This project was funded by the University of Delaware's Watersheil Arthus Teasu for Emlogical Restoration through the Debrauer Water Resource Center and completed under the guidance of the entire UDM ATER team with special assistance from JournAler Pyle (EHS), and Andrew Honory (WRA).

WATERSHED ACTION TEAM FOR ECOLOGICAL RESTORATION

water

Assessment of Forest Quality Along an Urban-Rural Transition in a Piedmont Watershed

Megan R, Shaffer¹, Devika R Banarjee², Luc Claecoans¹, Gerald J. Kauffman⁴ Minipital Sciences Westmenet Roder "Devicement of Geopletis "Mater Researce Aprils"

1. Introduction:

Sustainable

The University of Delaware currently soms forests in the White Clay Creek State Park that protect the someonding watershed. This study strught to assess the forest quality and habitat health of these forests, which ones is a some of urbanmenal transition. These lands have previously leven used for agriculture but today have reviewed back to decideous and everypreen forest, presently shaped by urbanization and development.



2. Methods:

We conducted a field survey of the university several ferent and accorded ratings in a comparative fieldion of press, fair and good based on criteria provided by Kaddy and Drummond (1996) and the Delaware State Park Division of Parks and Rectwarden Trail Committee (Table 1). Maps based on our findings were constructed using GS and compared to forest types from previous land use data from Delaware DetaMIL. Areas were estimated from Geogle Tarth.

Table & Turnetauty of first painty uningence parts, internation, has able a deschafter of such table of feadly.

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1. Results:



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4. Conclusions

for future studies, a quartitative analysis of (1) tree diameter and height, (2) density of anderstory species, (2) density of canopy species, and (4) percentage of involve species per area would allow for a statistical comparison of the health of these forces regions assessed.

A future forest restoration plan is meeted and would not only allow for the return of those poor forest areas to healthy conditions, but also would preserve the good regime. Recommended activities for this plan include: controlling and sensoring insuive plants; planting rative vegetation in open spece; prening young trees to promate gestar tree health; and other apprepriate maintanance to allow optimal health of trees.



1. Acknowledgments:

We would like to thatk (2) WHTE and the Delaware like tensors (serve who provided bendyng in make the proper plaudie to all'thins, we would like to their (10 film) tank, full, beak further and blo, areafter Pale for their support and packness (antiga are small like to advantisely the other interns, longing, further, and an all the to advantisely for the intern storm, longing, and an all the to advantisely for the term storm, longing, and an and to the Datable.

6. References:

- Ben, M. and C. Horney, and A. Andrew, and S. M. Stranger, N. Stranger, and S. Sanger, S. Stranger, Nature 1997, Nature
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- international property of the local base of the second sec

watershed action team for ecological restoration



Reference Collection Categorized by Order and Family: Sampling completed by undergrad Bonnie McDevitt during the Summer of 2010

Order	Family		
Non Insects:			
Annelida	Hirudinea		
Basommatophora	Physidae		
Haplotaxida	Tubificidae		
Veneroida	Sphaeriidae		
Insects:			
Coleoptera	Dytiscidae		
Coleoptera	Scarabaeidae		
Coleoptera	Hydrophilidae		
Diptera	Chaoboridae		
Diptera	Stratiomyidae		
Diptera	Syrphidae		
Diptera	Chironomidae		
Diptera	Culicidae		
Diptera	Tipulidae		
Ephemeroptera	Baetidae		
Hempitera	Gerridae		
Hemiptera	Belostomatidae		
Hempitera	Corixidae		
Hemiptera	Veliidae		
Hemiptera	Mesoveliidae		
Hempitera	Notonectidae		
Odonata	Aeshnidae		
Odonata	Coenargrionidae		
Odenete	Liballulidaa		



Delaware Water Resources Center UD WATER Project 2010 – 2011 Melanie Allen Advisor: Dr. Judith Hough-Goldstein Area of Campus Studied: South Campus



UD WATER - Project Goals

The goals of the UD WATER project were - for the UD Campus:

- Identify major nonpoint sources of pollution in the Cool Run Subwatershed of the White Clay Creek (a wild and scenic river with tributaries on the campus)
- (2) Estimate, using USEPA methods and average pollutant concentrations in runoff, the annual pollutant loads to the Cool Run tributary from different land uses5
- (3) Develop recommendations to improve stormwater management, reducing flooding and improving water quality in the White Clay creek watershed

Personal Project Goal:

- (1) Create a reference collection of the biodiversity of aquatic macroinvertebrates in the UD Experimental Watershed at Newark Research and Education Center of the University of Delaware College of Agriculture and Natural Resources from samples collected during the Summer of 2010. (credit to Bonnie McDevitt) for future interns to utilize as a baseline of data.
- (2) Complete a Winter sampling to add to the reference collection.

Locations of Sampling completed on March 2, 2011 by Melanie Allen

- Site 1: located on one of the Cool Run tributaries that travels through agricultural land containing dairy pastures and cropland
- Site 2: located along Old South Chapel Street near the intersection with Farm Lane.
- Site 3: located near the power transfer station where one of the Cool Run tributaries crosses under the Amtrak access road.
- Site 4 located next to the Amtrak tracks as Cool Run tributary enters UD property.
- Site 5: :located at the east end of the cattle pasture on the Webb Farm.
- Site 6 : located on the east side of Route 72 near the entrance to the Webb Farm.

Methodology:

I followed a protocol for sampling aquatic macroinvertebrates in freshwater wetlands developed by the Maine Department of Environmental Protection. When sampling, I used the dip net measured sweep, which is the primary method used to collect aquatic macroinvertebrates in wetlands. A micron D-frame net is swept against the bottom substrate three times to remove and collect organisms from the sediment, keeping sure that the net is submerged during the entire sweep. All of the collected material is transferred into a sieve bucket, where water is drained and materials were transferred into individual specimens containers filled with ethyl alcohol, where they would be preserved until identification.

Negative. Found little to no biological biodiversity.

This was potentially due to the time of year as well as low oxygen levels. The Protocol practiced by the Maine Department of Environmental Protection that I followed recommended completing sampling during June-July, however due to time restraints I was only able to get a sampling in early March when specimens were minute or dormant. During early summer, aquatic invertebrate are much more developed and easier to identify. Dissolved oxygen analysis measures the amount of gaseous oxygen (O2) dissolved in a water solution. Below is a comparison of Dissolved Oxygen levels measured in mg/L from the Summer of 2010 and March 2011 (Table 1). The oxygen levels for a majority of the sites was lower in March, influencing its ability to support life.

McCafferty, Patrick. Aquatic Entomology: The Fishermen's and Ecologists' Illustrated Guide to Insects and Their Relatives. Science Books International. Boston, Massachusetts. 1981

Dept. of Environmental Protection: State of Maine. Protocols for Sampling Macroinvertebrates in Freshwater Wetlands: Division of Environmental Assessment Biological Monitoring Program

Table 1							
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	
lune	1.64	5.94	10.41	10.01	8.90	5.83	
luly	7.29	5.43	9.48	9.69	7.95	6.22	
August	7.88	6.82	9.57	10.12	10.59	7.77	
March	0.87	6.71	8.58	7.94	7.20	6.27	

What is "UD WATER"?

The UD WATER Project (Watershed Action Team for Ecological Restoration) was for med in early 2008 as a collaborative initiative with the long-term goal of meging and facilitating university-wide efforts to minimize the environmental impacts of storm water runoff from our campus. The UD WATER initiative is synergistic with the University's Path to Prominence strategic goal to become a Green Campus.

The UD WATER team brings together a consortium of faculty, staff, and students from various departments and disciplines across campus to work collaboratively to implement creative and innovative storm water management techniques in the most holistic and efficient manner achievable. The ultimate goal for this team is to reduce the quantity and increase the quality of storm runoff from campus properties, which will ultimately benefit our local waterways and is consistent with the mission of FPA regulations requiring the University and City of Newark to have a National Polatician Discharge Elimination Discharge Elimination of System (NPOES) permit. Membership on this team include faculty and staff from Occupational Health and Safey, Facilities Grounds Mainterance Services, Delabware Water Resources Agency within the Institute on Polic Adhitory and staff from Occupational Health and Safey, Facilities Grounds Mainterance Services, Delabware Water Resources Agency within the Institute on Polic Adhitory and to thore and the Discharge Elimination Occupational Health and Polic Policy, and the Newark. UD WATER has also funded Sinders City and a staff on exception and the staff and every and a staff on exception and the staff and every and a staff on exception and staff and every and a staff on exception and staff and every and staff and every and and staff and every and and staff and every and staff and every and and staff and every an

In the future, the UD WATER team hopes to add other faculty and students at UD with an interest in water resource management to participate in our efforts to use the UD campus as a storm water research laboratory for multiple disciplines. For more details, or to join the UD WATER team hopes to add other faculty and students at UD with an interest in water resources Center; Jisins@udel.edu), Jerry Kauffman (UD Water Resources Agency, jerryk@udel.edu] or Lesile York-Hubbard (Occupational Health and Safety; Jesileyh@udel.edu).





America's Founding Fish











Thank you Dr. J. Thomas Sims!

Second Director of the Delaware Water Resources Center (2000-2015)



Deputy Dean

T. A. Baker Professor of Soil and Environmental Chemistry College of Agriculture and Natural Resources University of Delaware

UD Water Conservation Campaign 1980s AD

