2017 Final Report
In Support of Maintaining and Restoring Water Resources
Prepared by Claire Jantz and Antonia Price

EXECUTIVE SUMMARY

We report final activities on the WPF-funded project, "A land cover mapping, modeling, and monitoring system for the Delaware River Basin (DRB) in support of maintaining and restoring water resources." In this executive summary, we highlight major project management milestones and our key accomplishments. We also present a summary of challenges and obstacles encountered, modifications to the original scope of work, a description of unintended outcomes, and lessons learned so far. Following the executive summary is a detailed description of the progress made on each milestone and activity outlined in the original award agreement.

Some clarifying points:
- We use the terms 'DRB' and 'basin' to refer to the Delaware River watershed basin, and we use the term 'AOI', short for area-of-interest, to refer to the 43-county region that completely covers the DRB.
- Italicized text outlines the language used in the original award agreement

Project Management Milestones:
- At Shippensburg University (SU), Alfonso Yañez Morillo (Research Analyst) and Antonia Price (Project Coordinator) were both hired during the 4th month of the project.
- By the 6th month of the project, we agreed on the data development leads for key project components and reached an agreement with PASDA (The Pennsylvania Spatial Data Clearinghouse) to distribute final data products to the public free of charge.
- Developed outreach strategy by month 6 and began reaching out to county GIS coordinators to request data. Outreach strategy included email, website, social media, and an e-newsletter.
- In-person and web-based research team meetings were held in months 1, 2, 5, 7, 11, 12, 13, 15, 16, 18, and 21. Wrap-up calls to discuss remaining project commitments were held in months 29 and 30 with UVM and USGS collaborators.

Key accomplishments since last report:
- Our outreach plan is being successfully implemented.
  - Project website (http://drbproject.org/) was overhauled in June 2016. Project is housed at the Center for Land Use and Sustainability (http://centerforlanduse.org/) at Shippensburg University. Updates continue to be posted via Social Media on Twitter (https://twitter.com/ShipCLUS) and Facebook (https://www.facebook.com/ShipCLUS).
  - E-newsletters containing project updates were sent during months 8, 10, 13, 16, 19, 23, 25, and 29. A special data release newsletter was sent during month 27 to highlight DRB2070 version 1.0. Our mailing list currently includes 115 subscribers.
  - Our project was featured in the September 2015 DRWI newsletter, an online blog (http://paenvironmentdaily.blogspot.com/2015/10/delaware-river-watershed-land-use.

html), Winter 2016 Water Resources Association of the Delaware River Basin
Newsletter, in articles by Shippensburg University and the Academy of Natural Sciences
of Drexel University, and in mailings from the Coalition for the Delaware Watershed.
- ○ We have presented our work at a variety of venues, including the 2016 Science of
Sourcewater Workshop, 2016 and 2017 Pennsylvania GIS Conference, 2016 Central
Pennsylvania GIS Day, 2016 Delaware River Watershed Forum, 2016 Susquehanna River
Symposium, and International Association of Landscape Ecology (US Division) 2016 and
2017 annual meetings. We also plan to present at the Society for Social Work and
Research annual conference in January 2018.
- In 2015, SU and USGS completed analyses of land use and land cover change for the AOI, along
with analyses of socio-economic descriptors of the AOI and the DRB (i.e. employment hotspots,
economic characterization, population and housing unit trends). These results have been
presented at workshops and shared with the steering committee.
- Through a related project, UVM has completed state-wide tree cover datasets for Pennsylvania
and Delaware. The Pennsylvania state-wide product is available via PASDA, was featured in our
e-newsletter, and information about it was shared with our partners. The Delaware state-wide
product is available via Delaware's state GIS clearinghouse.
- Using SLEUTH, SU produced a baseline land use forecast for the entire AOI in March 2017
(DRB2070 version 1). A revised baseline and two alternative land use forecasts were produced
by SU in July 2017 (DRB2070 version 2). These products are available in the following formats:
  - ○ ArcGIS online application (https://arcg.is/1neLqS)
  - ○ Data files for GIS professionals: proportion developed for NHDPlus catchments (2001,
    2011, 2030, 2070) with ArcMap document (.mxd) for quick visualization of all three
    scenarios. (zip file: http://data.centerforlanduse.org/CLUS_DRB2070_v2.4.zip)
  - ○ Will be integrated with the Stream Reach Assessment Tool (SRAT) in August 2017.
- USGS produced a baseline scenario for the AOI using CBLCM in June 2017, and will be producing
two alternative scenarios through the Chesapeake Bay work in late Summer 2017.
- UVM has completed the high-resolution land cover data for all counties intersecting the
Delaware River Basin in Maryland, New York, and New Jersey. At the time of this report, the
data is available via PASDA, was featured in our e-newsletter, and shared through our partners.
UVM will be replacing the statewide data (below) with a basin-wide mosaic and clipped by
county in late Summer 2017:
  - ○ Delaware State data available via UVM SAL:
    letters-sal.blogspot.com/2016/03/delaware-high-resolution-land-cover.html
  - ○ Delmarva Penninsula and Maryland Counties available via Chesapeake Conservancy:
    chesapeakeconservancy.org/conservation-innovation-center/high-resolution-data/land-
    cover-data-project/
  - ○ New Jersey Counties available on PASDA:
    www.pasda.psu.edu/uci/DataSummary.aspx?dataset=3147
  - ○ Pennsylvania Counties available on PASDA:
    www.pasda.psu.edu/uci/DataSummary.aspx?dataset=3193
  - ○ New York Counties soon available on PASDA

Challenges and obstacles encountered:
- At SU, USGS, and UVM, our planned timelines were delayed by institutional contracting
procedures, which slowed the processing of our prime and sub-contract awards, and which
delayed the effective project start by nearly 4 months.

- We have also experienced some unexpected delays while acquiring data as responses and response times have varied widely from GIS departments among the 43 counties in the AOI.
- At UVM, problems were encountered with the PA LiDAR tiles. The original LiDAR data contractor deleted the original files, and it took some time to recover and reprocess those data. The shrub and wetland classes for NJ and NY also presented a challenge because of the different LiDAR acquisitions. New York data has been delayed because the new LiDAR that was supposed to be acquired did not occur. The UVM team had to rely on old LiDAR and aerial imagery to complete the product, which required a great deal of time-intensive manual interpretation to achieve the desired accuracy. Due to issues with LiDAR acquisitions or quality, UVM took longer to complete the land cover data than originally anticipated, and data dissemination continues.
- At SU, we neglected to submit for Institutional Review Board (IRB) approval prior to the DRB2070 workshops. This caused some stress as we prepared to submit for IRB approval on the Target End User Survey. However, we were able to retroactively apply to use the secondary data from the workshops without a problem and followed that application with an addendum.
- When we started the modeling process, we chose to use CCAP data, as it appeared to be most useful to professionals. However, as our project progressed, many users and SRAT began to utilize NLCD data. In order to ensure our data compatibility, we switched from CCAP to NLCD, requiring a reprocessing of our modeling input data. This caused a minor delay in calibrating SLEUTH for our modeling process.
- At USGS, funding was cut for the Land Change Science Program, which provided support for the development of the Chesapeake Bay Land Change Model (CBLCM). This presented a major obstacle for our collaborators, as deadlines related to CBLCM work for the Chesapeake Bay Program were moved up. They were unable to provide modeled land use for this project until July 2017 and plan to provide revised scenarios in late summer 2017.

Modifications to the original scope of work:
- UVM, the Chesapeake Bay Program/USGS, and the Chesapeake Conservancy undertook a similar high resolution, land cover mapping of the entire Chesapeake Bay Watershed. This initiative includes an expanded set of land cover classes including emergent wetlands, scrub/shrub, and impervious surfaces under tree canopy. Given that many counties intersect both the Delaware River Basin and the Chesapeake Bay Watershed, we decided to expand the land cover classes mapped within the Delaware River Basin to produce consistent data products that are comparable across the entire length of the shared watershed boundary.
- Because of the development of the SRAT, we processed our data to release the results for the same stream reach areas that are utilized in SRAT. We have provided the outputs of DRB2070 version 2 to ANS for inclusion in the Stream Reach Assessment Tool. We have also been in communication with Scott Haag about possible collaborations and future modeling work.
- Due to the delay in receiving CBLCM model outputs, a comparison of CBLCM and SLEUTH results is not yet complete and we were not able to provide a synthesized summary to our target end users of these two outputs by the project end date. Our future work through the Delaware Watershed Research Fund will include some modeling components, and we hope to provide a synthesis of these two model outputs by Fall 2017.
  - Preliminary comparisons highlight SLEUTH's dependence on existing urban centers
  - In PKC, satellite imagery shows development in some areas where CBLCM did not predict growth. It is likely that is due to not considering second home development or growth pressures related to factors outside of population and employment.
- Dr. Claire Jantz is serving on the advisory committee for Stroud's William Penn Foundation project to enhance Wikiwatershed.org toolkit, in order to provide input on the best way to

incorporate our models into Wikiwatershed. It is our understanding that at this time, they are exploring the *feasibility* of incorporating our buildout data, but they are not planning to implement the plans at this time. Questions remain between Stroud and ANS about calculating stream impacts on the fly (current approach in Model My Watershed) vs. pre-processing and delivering static results based on user queries (current approach in SRAT) when working with Basin-wide datasets. We are maintaining communication with these two research teams.

Unintended outcomes:
- The Center for Land Use and Sustainability at Shippensburg University joined the Coalition for the Delaware River Watershed. Learning about and making many other partnerships and networks has and will help spread the word about our project, and add credibility
- This project has demonstrated our capacity for research, which was recognized by Shippensburg University. This recognition prompted us to renew the Center for Land Use and Sustainability (CLUS), with institutional support. By connecting our project to the CLUS, we have an identifiable brand for our project and team. We are also able to reach a wider audience and rely on existing networks inside and outside the university.
- To model land use change effectively and realistically out to 2070, we learned that we need to explicitly consider climate change impacts (i.e. sea-level rise, increase in inland and coastal flooding). To keep to our project scope, we focused on existing data sets that could be used as a proxy for some of the potential impacts. We also modeled Sea Level Rise and Storm Surge risk for the AOI, a separate dataset that will be available on PASDA. To specifically study these impacts, we began work in January 2017 on a project funded by the Delaware Watershed Research Fund to better understand the effects of land use change and climate change on hydrology and forests. That project will tie in to this work and will eventually be made available to the same target end user group.
- Model my Watershed and the Stream Reach Assessment Tool developed in parallel with our project, and we have worked closely with those developers to ensure that our data can be easily integrated into these systems. This will greatly increase the adoption and utility of our work.
- This project emphasized the need for basin-wide data sharing and data storage protocols. We are actively contributing to the DRWI GIS working group to assist in the development of these protocols.
- SLEUTH is an urban growth model, and as such, does not perform well in areas where population and employment are not the drivers of growth. In the Poconos-Kittatinny Cluster, second home development and recreation accounts for the majority of growth. To better understand future development pressures, Pinchot Institute for Conservation supported customized modeling for the PKC region. Our team used similar methods from our basin-wide work to develop customized scenarios for PKC. This subcontract allowed us to have a pilot region to polish our models and supported the basin-wide work.

Lessons learned:
- Because of the relatively short time frame for a project of this scope we were concerned about our ability to disseminate final products effectively. This was a concern raised independently by participants in our workshops. On the one hand, multiple DRWI projects speak to the success and interest of multiple groups for the fate of the Delaware River Basin. On the other hand, we are concerned that stakeholders are beginning to express "start up fatigue," where many projects are announced and launched, but the final results are not effectively communicated back to the stakeholders. One workshop participant specifically requested that we report back instead of immediately moving on to a next project. It is extremely important for us to develop a

strong dissemination strategy for this project, and to collaborate with others to develop effective outreach and dissemination strategies for the DRWI as a whole.

- "Get comfortable with triage": This was an ambitious project to undertake in the allotted timeframe. To stay on track, our team was under pressure to make major modeling decisions quickly and confidently. We adopted a "triage" mentality to tag ideas that we could incorporate, and rule out those that would require a major investment of resources. We made informed decisions by reviewing similar modeling projects and scientific literature and then modified those approaches to fit our needs.
- "Imagining the future is difficult": For experts and non-experts alike, imagining major phase changes in land use trajectories is hard. An example we often use is Baltimore harbor- who would have guessed a thriving working harbor 100 years ago would go through a process of decline and rebirth to become a tourist center.
- "The process is as important as the products": The outreach and stakeholder engagement necessary to inform our model decisions was much larger than anticipated. We gathered a large amount of qualitative data, which we were able to effectively leverage into a quantitative survey instrument to build a framework to cooperatively write scenario narratives. While the outreach was time and labor intensive, we developed a deeper knowledge about the system we were modeling and were able to "pre-board" our users while customizing our products for faster uptake.
- With unlimited time and resources we may have been able to produce better products, but we would have missed our opportunity to support planning efforts. There are still some major gaps that the modeling and planning community needs to address in this region:
  - How to think about the future, especially with respect to emerging issues like energy
  - How to incorporate climate and land use change interactions such as flooding or storm severity, in addition to storm surge and sea level rise
  - How to continue to monitor Basin-wide land use/land cover change in the absence of a coordinated framework

MILESTONE 1
Throughout the project, target End-User Community informed and engaged in LiDAR collection, land cover and growth model development activities; End User Advisory Groups actively engaged in production, review, feedback and refinement of all project deliverables.

<u>Activities:</u>
1.1: With WPF/DRWI Coordinating Committee, identify Target and Steering Committee end-users. Target End-Users represent a potentially large and broad group of scientists and conservation practitioners who are identified as potential users. Steering Committee users are committed users who have a vested interest in the project outcomes for specific scientific or conservation applications. (months 1-2)
- A Target End User contact list was started during month 3 of the project. Including county GIS coordinators, this list currently has over 400 individuals.
- Steering Committee members were finalized during month 7 of the project. See Appendix 1 for a list of the 18 members and 3 back-ups members.

1.2: Conduct at least 4 Target End-User and 6 Steering Committee meetings over the project period
- Target End-User Meetings were held in Philadelphia, PA (month 10), Narrowsburg, NY (month 11), Reading, PA (month 13), Washington, NJ (month 14), Dover, DE (month 14), and Media, PA (month 22). See Appendix 2 and 3 for participant lists from our 2015 and 2016 workshops.

- Steering Committee Meetings were held via webinar (months 8,11, 14, 17, 20, 24). The final meeting was held in June 2017 (month 30). Meeting minutes can be found online: http://drbproject.org/about/steering-committee/

1.3: Present mapping and modeling plans and receive feedback (months 2-12)
- Project scope for mapping and modeling work was presented to the Steering Committee (month 8). Project timelines were presented to workshop groups (months 10 and 11).

1.4: Interview key Target End Users and Steering Committee users re: participation in Long Term Monitoring and Modeling (months 2-12)
- We began discussions with our Target End Users and Steering Committee regarding long-term participation and needs from the beginning of this project. See our feasibility study for more information.

1.5: Present basin-wide high resolution land cover; get feedback (months 13-24)
- Steering committee members had access to review and provide feedback on our land cover data products prior to our target end users.

1.6: Present basin-wide calibrated and validated CBLCM model; get feedback (months 4-9)
- Calibrated models for SLEUTH finished (month 12) and presented to the steering committee. Problems encountered with CBLCM work, which was delayed until 2017.

1.7: Solicit feedback on land use/land cover change scenarios (months 6-12)
- Feedback on drivers of land use change was collected from DRB2070 workshops (months 10-15). This information was compiled and shared via basin-wide land use survey (month 18).
- Draft land use change scenarios were completed at the DRB2070 scenario development workshop (month 22), which was informed by previous workshop and survey data.

1.8: Present; get feedback on land use/land cover change forecasts (months 9-15)
- Draft scenario themes were shared in the basin-wide land use survey (month 18). Draft baseline land use change forecast were presented in March 2017, followed by alternative forecasts.

1.9: Present; get feedback on long term monitoring and modeling draft plan (months 12-18)
- Baseline land use scenario finished for the DRB (month 27). Alternative futures and revised baseline available (month 31).

1.10: Present results of Feasibility Study for long term monitoring and modeling plan to WPF/DRWI Coordinating Committee (months 18-24)
- During our last steering committee meeting, we discussed long term monitoring and modeling needs in the Delaware River Basin. Their comments have been integrated into our recommendations and will be disseminated along with this final report.

MILESTONE 2
By December 2016, new high-resolution land cover produced, sustainably-housed and available to Target End User Community for ongoing use.

Activities:
2.1: Identify and collect relevant local digital data sets through End-Users. (months 1-6)
- We have an agreement in place with PASDA to freely distribute Basin-wide data sets
- We reached out to each of the GIS offices in the 43 counties that intersect the DRB

2.2: Data prep and processing (months 3-18)
- High-resolution leaf-on and leaf-off imagery was obtained for the entirety of the AOI and prepped for analysis.

- LiDAR was obtained for Delaware, Pennsylvania, and selected areas within New Jersey and New York. All available LiDAR was prepared for analysis. LiDAR datasets that cover the remaining gaps in New Jersey and New York were delivered by UVM in 2017.
- Supporting datasets provided by state and county organizations were prepared for analysis.

2.3: Data accuracy assessment and metadata production (months 18-20)
- UVM developed accuracy assessment protocols, choosing to mimic those being used for the Chesapeake Bay Watershed land cover project.

2.4: Land cover summarization (months 20-24).
- Land cover data is currently available by state for Delaware State (month 15), Pennsylvania (month 19), Maryland/Delmarva Peninsula (month 25), New Jersey (month 27), and New York (month 31). UVM will be releasing a mosaic of the entire AOI as well as clipped by county. This dataset will replace previous datasets and will be available via PASDA.

MILESTONE 3

By June 2016, land use/cover change modeling complete with minimum 10-year increments over a 30-year horizon. Results sustainably-housed and available to Target End User Community for ongoing use.

Activities:

3.1: Assemble required GIS data and complete model calibration and validation (months 1-6)
- We met with the USGS group to plan our work with the CBLCM (month 5)
- By the end of 2015, we had done some refining of the SLEUTH model to prepare for analysis. The required GIS data was mostly assembled for SLEUTH and CBLCM, but model calibration and validation was not complete.

3.2: Develop initial land use/cover change forecast (months 4-9)
- By the end of 2015, we had held two workshops to inform scenario development. Remaining stakeholder workshops, an on-line survey, and a scenario writing were completed by the conclusion of 2016, with an initial baseline forecast completed in March 2017.

3.3: Generate finalized future land use/cover change scenarios (months 9-18)
- Our three scenarios include: 1. "Baseline"- historical trends (revised), 2. "Corridors"- Climate induced westward expansion: the new frontier (sprawling population growth along corridors), and 3. "Centers"- Amenity driven development in urban centers (concentrated population growth in historic centers).
- Data is available through an ArcGIS online application (https://arcg.is/1neLqS) or as data files for GIS professionals: proportion developed for NHDPlus catchments (2001, 2011, 2030, 2070) with ArcMap document (.mxd) for quick visualization of all three scenarios. Download zip file: http://data.centerforlanduse.org/CLUS_DRB2070_v2.4.zip

MILESTONE 4

By December 2016, long term monitoring and modeling feasibility study completed and summary report presented to WPF/DRWI Coordinating Committee.

Activities:

4.1: Interview staff at state mapping offices, identify frequency of LiDAR mapping (months 1-6)
- While we did not conduct formal interviews with state mapping offices, we had the opportunity to converse with state, regional, and local experts regarding plans for LiDAR mapping. At this time, and to the best of our knowledge, LiDAR mapping across the DRB occurs as a highly ad hoc

and opportunistic process, driven largely by sporadic and limited funding opportunities, such as the USGS's 2015 Hurricane Sandy Supplemental Funding lidar and DEM acquisition plan.

- At the national level, the USGS has launched the 3D Elevation Program (3DEP) initiative. The primary goal of 3DEP is to collect LiDAR data for the conterminous United States, Hawaii, and U.S. territories, with data acquired over an 8-year period. The USGS provides cost-share funds for local, regional, and state agencies to acquire LiDAR data. We note that this effort is intended to create a nationwide LiDAR-based elevation data set using data that is not more than 8 years old. On-going LiDAR funding and acquisition plans have not yet been set.
- With DRWI researchers at ANS, we are exploring how the DRWI can participate in the National Map 3D Elevation Project (http://nationalmap.gov/3DEP/), a USGS program that coordinates and partially funds the production of LiDAR acquisition and mapping efforts.

4.2: Interview Target End Users re: needs for ongoing high-resolution land cover; modeling interface and tools (months 1-12)

- There is a high demand for high-resolution land cover. Once the baseline data is completed, there will be a need for regular updates, ideally on a 1 - 5 year time cycle. Likewise, for the land change model, there will be a need for iterative refining once the initial forecasts are released. Future modeling work is appropriate at 5 - 10 year intervals. It is worth noting that land change modeling technology is currently in a phase of rapid development, so it will be important to consider data compatibility in future work.

4.3: Interview Target End Users re: participation interest in long term monitoring plan (months 1-12)

- Our team has been gathering anecdotal information from our target end users on long term monitoring and modeling needs throughout this project. In our DRB2070 workshop registration, we gathered information from stakeholders on their view of the regional identity and thinking about the entire watershed. This information is included in the feasibility study.

4.4: Develop draft long term monitoring and modeling plan and budget (months 10-18)

- Our recommendations for a long term plan can be found in the feasibility study.

4.5: Prepare final plan and feasibility report (16-24)

- See the feasibility study.

Appendix 1- Steering Committee List

List of steering committee members that served from 2015-2017 for the DRB Project.

Member	Title	Organization
Claire Jantz	Lead Investigator	Shippensburg University, Geography and Earth Science
Scott Drzyzga	Co-investigator	Shippensburg University, Geography and Earth Science
Jarlath O'Neil-Dunne	Co-investigator	University of Vermont, Spatial Analysis Laboratory
Peter Claggett	Co-investigator	US Geological Survey, Chesapeake Bay Program
Clare Billett	Project Sponsor	William Penn Foundation, Watershed Protection
Robert Cheetham	President/CEO	Azavea
Chad Pindar*	Supervisor	Delaware River Basin Commission, Watershed Planning and Compliance
Jessica Rittler Sanchez*	Basin Planner	Delaware River Basin Commission, Planning and Information Technology
Karen Reavy	GIS Coordinator	Delaware River Basin Commission, Planning and Information Technology
Carol Collier	Senior Advisor	Academy of Natural Sciences, Delaware River Watershed Initiative, Watershed Management and Policy
Scott Haag	Database Administrator	Academy of Natural Sciences, Delaware River Watershed Initiative
Chris Linn	Manager	Delaware Valley Regional Planning Commission, Office of Environmental Planning
Kathy Commisso	GIS Specialist	National Parks Service, Delaware Water Gap National Recreation Area
Kristina Heister	Superintendent	National Parks Service, Upper Delaware Scenic and Recreational River
Jamie Myers*	Biologist	National Parks Service, Upper Delaware Scenic and Recreational River
Megan Boatright	Manager	Natural Lands Trust, GIS and Cartography Services
Diane Rosencrance	Senior Director	Natural Lands Trust, Landscape Planning
Abigail Weinberg	Director of Research	Open Space Institute
Barry Evans	Senior Research Associate	Penn State University, GIS Support Center
Stephanie Pendergrass Dalke	Project Director	Pinchot Institute for Conservation/ Common Waters Partnership
Charles Dow	Director	Stroud Water Research Center, Information Services
Sarah Johnson	Conservation GIS Analyst	The Nature Conservancy (PA), Freshwater Conservation Team
Eric Olsen	Project Director	The Nature Conservancy (NJ), Delaware River and Bay Whole System
Su Fanok	Senior Conservation Scientist	The Nature Conservancy (PA), Freshwater Conservation Team
Kathy Klein	President	Water Resources Association of the Delaware River Basin

* Alternative member for organization

Appendix 2- DRB2070 Workshop Attendees in 2015

This lists indicates the 2015 workshop attendees in Philadelphia, PA (P) or Narrowsburg, NY (N).

Attendee	Title	Organization	P/N
Carol Collier*	Senior Advisor, Watershed Management and Policy	Academy of Natural Sciences of Drexel University	P
Scott Haag*	Database Manager	Academy of Natural Sciences of Drexel University	P
Lin Perez	GIS Manager and Stormwater Specialist	Academy of Natural Sciences of Drexel University	P
Paul Faeth	Director, Energy, Water and Climate	CNA	P
Kim Beidler	Director	Coalition for the Delaware River Watershed	P
Karen Reavy	GIS Specialist	Delaware River Basin Commission	P
Fred Stein	Citizen Action Coordinator	Delaware Riverkeeper Network	P
Patty Elkis	Director, Division of Planning	Delaware Valley Regional Planning Commission	P
Katie Bartolotta	Southeastern PA Outreach Coordinator	PennFuture	P
Charles Dow*	Director of Information Services	Stroud Water Research Center	P
John Jackson	Senior Research Scientist	Stroud Water Research Center	P
Buck Moorhead	Partner	Building Consensus for Sustainability	P/N
Jeff Dexter	Township Supervisor	Damascus Township	N
Tyson Robb	Environmental Planner Technician	Delaware County Planning	N
Bethany Keene	Outreach Coordinator	Delaware Highlands Conservancy	N
Jim Serio	Broker	James Serio Real Estate	N
Carla Hahn	Park Ranger, Management	National Park Service	N
Kristina Heister*	Superintendent	National Park Service	N
Jamie Myers*	Biologist	National Park Service	N
Eric Roberts	Assistant Steward	Orange County Land Trust	N
Steve Schwartz	PKC Cluster Coordinator	Pinchot Institute for Conservation	N
Freda Eisenberg	Commissioner	Sullivan County Division of Planning and Environmental Management	N
Tina Spangler	Board Member	Town of Tusten ZBA	N
Ed Jackson	Chairman	Tusten Planning Board	N
Travis O'Dell	Resource Specialist	Upper Delaware Council	N
Cindy Odell	Secretary	Upper Delaware Council	N
Laurie Ramie	Executive Director	Upper Delaware Council	N
Autumn Sylvester	Agricultural Resource Specialist	County of Sussex	N

* Steering Committee Member

Appendix 3- DRB2070 Workshop Attendees in 2016

This lists indicates the 2016 workshop attendees in Reading, PA (R), Washington/Harmony, NJ (W), Dover, DE (D), or Media, PA (M).

Attendee	Title	Organization	R/W/D/M
Beth Burkovich	GIS Analyst	Berks County Planning Commission	R
Michael Griffith	Education and Watershed Specialist	Berks Nature	R
Madeline Urbish	Director	Coalition for the Delaware River Watershed	R
Brad Shirey	GIS Manager	County of Berks - IS Department	R
Jason Miller	CAD Designer/GIS Analyst	Great Valley Consultants	R
Joseph Hebelka	Hydrogeologist	PA Department of Environmental Protection	R
Nicholas Maziekas	Assistant Planner	Schuylkill County	R
Susan Smith	Planning and GIS Director	Schuylkill County	R
Ashton Hogarth	Environmental Specialist	SSM Group, Inc.	R
Mike Shanahan	Conservation Coordinator	The Nature Conservancy	R
Eli Bracken	GIS Specialist	Wildlands Conservancy	R
Angela Wenger	Chief Operating Officer	Center for Aquatic Sciences	W
Steven Rinker	GIS Coordinator/Manager	Monroe County Planning Commission	W
Kathy Commisso*	GIS Specialist	National Park Service	W
Nathan McLean	GIS Manager	NJ Highlands Council	W
Kathryn Semmens	Science Director	Nurture Nature Center	W
Kate Hutelmyer	Watershed Institute Coordinator	Stony Brook-Millstone Watershed Association	W
Sylvia Kovacs	Founder	Sustainable Highlands	W
Chris Ross	Senior Resource Management Specialist	NJ Highlands Council, Water Protection and Planning	W
Autumn Sylvester	Principal Planner	County of Sussex	N/W
Seung Ah Byun	Senior Planner for Water Resources	Brandywine Conservancy	D
Mary Raley	Project Planner	Delaware Department of Transportation	D
Mark Biddle	Environmental Scientist	Delaware Department of Natural Resources and Environmental Control, Watershed Assessment	D
Jimmy Kroon	Planner/GIS Coordinator	Delaware Department of Agriculture	D
Christie Bonniwell	Wetland Scientist	Delaware Department of Transportation	D
Naomi Bates	GIS/LiDAR Analyst	Delaware Geological Survey	D
Rose Ozbay	Research Assistant Professor	Department of Agriculture and Natural Resources	D

* Steering Committee Member

Appendix 3- Workshop Attendees (continued)

This lists indicates the 2016 workshop attendees in Reading, PA (R), Washington/Harmony, NJ (W), Dover, DE (D), or Media, PA (M).

Attendee	Title	Organization	R/W/D/M
James Gregory	GIS Specialist	Delaware Department of Natural Resources and Environmental Control	D
Anne Mundel	Hydrologist	Delaware Department of Natural Resources and Environmental Control	D
Brittany Sturgis	Watershed Planner	Delaware Department of Natural Resources and Environmental Control	D
Stephen Wright	Engineer IV	Delaware Department of Natural Resources and Environmental Control, Watershed Stewardship	D
John Inkster	Senior Application Support Specialist	Delaware Department of Natural Resources and Environmental Control, Watershed Stewardship	D
Sharon Dutton	Lab and Field Technician	Environmental Lab Section, Division of Water, Delaware Department of Natural Resources and Environmental Control	D
Sari Rothrock	Watershed Planning Specialist II	Partnership for the Delaware Estuary	D
Kathy Klein*	President	Water Resources Association of the Delaware River Basin	D, M
Karen Reavy*	GIS Coordinator	Delaware River Basin Commission	M
Melissa Andrews	Environmental Planner	Delaware Valley Regional Planning Commission	M
Steven Schwartz	Pocono/Kittatinny Cluster Coordinator	DRWI Cluster: Pocono/Kittatinny; Pinchot	M
Ryan Walker	Conservation Easement Program Manager/Municipal Planning Specialist	Natural Lands Trust	M
Rob Altenburg	Director, Energy Center	PennFuture	M
Kelly Anderson	Sourcewater Protection Program	Philadelphia Water Department	M
Molly Hesson	Sourcewater Protection Program	Philadelphia Water Department	M
Charles Dow*	Director of Information Services	Stroud Water Research Center	M
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