CHWA CESU Application –Stroud Water Research Center

A. Expression of desire to enroll in CHWA CESU as a new partner institution/organization.

Stroud Water Research Center is submitting the accompanying material to support an application to join the Chesapeake Watershed Cooperative Ecosystem Studies Unit (CHWA CESU) as a new nonfederal partner institution/organization. We believe that Stroud Water Research Center has a long history of collaborating with local, state and regional partners in support of initiatives that have similar goals and objectives of the CHWA CESU and its partners. We believe that these application materials will demonstrate our commitment to our mission to enhance knowledge and stewardship of freshwater resources that are synergistic with the goals and objectives of the CHWA CESU and the importance of collaborative partnerships in advancing basic research, education and outreach as it relates to federal CESU members.

B. Confirmation that institution/organization has read the CESU agreement and agrees to support the CESU mission and goals and fulfill the roles and responsibilities of a nonfederal partner, as described in the CESU agreement.

President and Executive Director, David B. Arscott, is supportive of this application. Through his endorsement he is providing assurance that Stroud Water Research Center is willing and able to meet the responsibilities and roles of a nonfederal partner and to support the CESU mission and goals. The primary contact, Dr. David B. Arscott, will also work with Stroud Center Principal Investigators and its technical staff to ensure that the Stroud Center meets these expectations while fulfilling the roles and responsibilities of a nonfederal partner.

C. Description of the institution/organization, its mission and the primary focus of collaborative activities to be supported through the CHWA CESU in in the context of the CESU mission.

Stroud Water Research Center (hereafter "the Stroud Center") was established in 1967 as a field station of the Academy of Natural Sciences of Philadelphia (until 1999) with a mission to understand how natural streams and rivers work in order to guide the cleanup and restoration of polluted streams and rivers. We are an independent 501(c) (3), not-for-profit, non-advocacy organization recognized worldwide for our freshwater research, environmental education, and watershed restoration. Our mission is to advance knowledge and stewardship of freshwater systems through global research, education, and watershed restoration. Information about the Stroud Center can be found at http://stroudcenter.org

The Stroud Water Research Center is a leading hybrid environmental institution. We conduct highly advanced, cutting-edge science focused on understanding how freshwater ecosystems function. We collaborate with academic institutions to teach undergraduate courses, mentor and teach graduate students, and train interns – all to help develop the next generation of scientists and environmental managers. We are a teaching institution, contributing to curriculum development and education of adults and students. We describe and curate biological specimens by housing one of the largest collections of aquatic insects in eastern North America. Similar to an environmental consulting firm we work with corporations, individuals, and government agencies (local, state, and federal) to solve environmental obstacles and help manage and protect our fresh water resource. We develop and

implement environmental restoration and mitigation projects that assist landowners, legislators, and environmental managers to improve water resource management practices to conserve, protect, and sustain clean fresh water for future generations.

During the past 50 years, the Stroud Center has influenced the focus and direction of freshwater science, education, and watershed restoration. Our original publication of the River Continuum Concept in 1980 remains the most cited and highly regarded foundational concept describing a stream's ecological functioning, worldwide. We are the new hosts of the Center for the North America Taxonomic Certification Program for identification of aquatic insects and other invertebrates, which underpins water-quality assessment in the United States. Our environmental education programs (like the Leaf Pack Network®, www.Wikiwatershed.org, and their curricula) are used throughout the United States and globally.

Stroud Water Research Center Principal Investigators and Senior Staff will develop proposals in response to solicitations through the CHWA CESU and other CESUs. If awarded competitive funding from these solicitations, Stroud Center staff will complete projects to support the missions of many different stakeholders – the federal partner, the CHWA CESU and the Stroud Center.

The Stroud Center is well situated to meet the mission of the CHWA CESU. There are dedicated staff committed to increasing the knowledge in their fields of expertise while engaging, mentoring, and training students, teachers, and natural resource professionals, and other practitioners various skills related to freshwater science, management, and ecological restoration techniques. While not all staff have previous experience partnering with a federal agency, all have established research, education and restoration programs that would contribute to the research interests and needs of different partners. We are located within the geographic region served by the CHWA CESU and are in close proximity to both the Susquehanna and Delaware Rivers and we are situated nearly midway between Baltimore and Philadelphia (between Washington D.C. and New York City, and between Philadelphia and Harrisburg). The Stroud Center is proud of its history of conducting novel research in freshwater systems while also mentoring interns, graduate students, and postdoctoral fellows that lead to various paid and unpaid positions at federal, state, and local governmental agencies.

These past actions and the strength of Stroud Center staff coupled with our location and commitment to our state and region position us as a strong partner for federal and nonfederal partners in the CHWA CESU. We also believe that our strengths would position us to work well with federal partners from other CESUs.

D. Description or list of the primary programs, departments, or other institutional divisions of the relevance to federal land management, environmental, and research agencies that will be engaged in CHWA CESU activities.

Stroud Water Research Center departments that will be available to participate in CHWA CESU programs/activities include:

- Research Groups: a Ph.D.-level scientist leads and organizes each research group that has one-to-many technical assistants, interns, graduate students, and/or postdoctoral associates and field and laboratory resources that facilitates their research program.
    - Fluvial Geomorphology - https://stroudcenter.org/groups/fluvial-geomorphology/
        - The Fluvial Geomorphology Group studies the movement of water, sediment, organic matter, nutrients and other molecules through watersheds to better understand

watershed hydrology, geomorphology, and biogeochemistry. We also investigate how watershed land use and river channel restoration practices influence hydrologically mediated processes such as surface-groundwater interaction, sediment transport, and channel evolution.

  - Biogeochemistry and Ecosystem Ecology- https://stroudcenter.org/groups/biogeochemistry/
    - The main focus of the Biogeochemistry Group is to investigate major elemental cycles in streams and their watersheds, particularly carbon, nitrogen, and phosphorus pools and fluxes. We are especially interested in quantifying and characterizing the rich array of organic molecules that exist in stream ecosystems, and serve as the main food source to microorganisms and consequently to all biological communities. Throughout the watershed, water is found in many places beyond stream channels, including aquifers, soils, and sediments. Our biogeochemistry laboratory has the capabilities to perform a wide range of chemistry analyses in water samples from all these places.
  - Microbial and Molecular Ecology - https://stroudcenter.org/groups/microbiology/
    - Microbial life such as bacteria, fungi, and algae are integral to a naturally functioning aquatic ecosystem. By applying comprehensive molecular approaches, this laboratory is focused on characterizing the composition and distribution of microbial communities, and determining the functional roles as well as their interactions with environments.
  - Fish Ecology - https://stroudcenter.org/groups/fish-ecology/
    - The Fish Ecology Group works to determine why fish in streams have the distributions they do. Our research includes field studies of fish movement, species composition and productivity; genetic studies of population structure; laboratory studies of tolerance limits to chemical, physical and biological factors; as well as mathematical modeling of population dynamics.
  - Aquatic Entomology https://stroudcenter.org/groups/entomology/
    - The Entomology Group studies factors that affect the distribution and abundance of aquatic invertebrates, the functional role of invertebrates in stream and river ecosystems, and how these invertebrate communities respond to human activities in temperate and tropical watersheds.
- Education Department - https://stroudcenter.org/education/
  - The education department interprets the research of our scientists and other research on freshwater systems. Our programs are multidisciplinary and oriented to a wide audience. Our aim is that through exposure to our programs and information, people will be motivated to become responsible stewards of freshwater resources. Our educators have developed extensive resources for educating adults and students grades 4 and up about watersheds and their importance. On-site and off-site school and scout programs, professional development workshops, and community and family programs are just some of the available options.
- Citizen Science Program
  - The Stroud Center's Citizen Science Program sits institutionally at the interface between Research, Education, and Restoration. Two full time facilitators help deliver programs, workshops, technical advice, and coordination services to develop and enhance volunteer monitoring, restoration, and land protection activities. This program utilizes several Stroud Center online resources provided in https://wikiwatershed.org/. WikiWatershed is a web toolkit designed to help citizens, conservation practitioners, municipal decision-makers, researchers, educators, and students advance knowledge and stewardship of fresh water. The flagship resource at WikiWatershed.org is Model My Watershed, a watershed-modeling web app that enables citizens, conservation practitioners, municipal decision-makers, educators, and students to: analyze real land use and soil data in their neighborhoods and watersheds, model stormwater runoff and water-quality impacts using professional-grade models, and compare how different conservation or development scenarios could modify runoff and water quality.

Finally, our Citizen Science Program helps groups learn and deploy open source, real-time water quality monitoring devices (see, https://envirodiy.org/).

- Watershed Restoration Group - https://stroudcenter.org/restoration/
    - The Stroud Center's Watershed Restoration Group taps a wide range of public and private funds to help landowners make needed improvements to their agricultural lands. The group provides and links financing and technical knowledge together with willing landowners to implement projects that improve land management to benefit water quality and quantity. Programs offered by the U.S. Department of Agriculture provide the foundation for many of our restoration projects. It's an "alphabet soup" of programs and acronyms, and we help landowners secure the best program funding to suit their farms and properties. One such program deserves special mention is USDA's Resource Conservation Partnership Program (RCPP). The Stroud Center and many partner groups and agencies have secured over $20 million dollars through RCPP to support agriculture conservation and restoration projects on farms in the Delaware and Chesapeake Bay watersheds.

E. A list of and brief description of the staff or faculty with the expertise in disciplines and subject areas of relevance to federal land management, environmental and research agencies (do not submit CVs).

David B. Arscott, Ph.D., President, Executive Director, Research Scientist. – His research focuses on fish ecology, aquatic primary production, distribution and diversity of aquatic macroinvertebrates, ecohydrology, and the ecology of rivers and flood plains. Additional interests include riverine landscape ecology and dynamics, aquatic food web structure and dynamics, habitat conservation, and land-water interactions. Arscott co-leads the fish ecology group with Dr. Jackson and also contributes to Education and Citizen Science activities at the Stroud Center

Melinda Daniels, Ph.D., Associate Research Scientist, Fluvial Geomorphologist. – Her research program focuses broadly on the fluvial geomorphology, hydrology, and stream ecosystem ecology of both "natural" and human-modified river systems from reach to watershed scales. These interests include fields such as river restoration, watershed management, stream ecosystem science, the examination of how people perceive river environments and the process of communicating science to river managers and stakeholders.

Charles L. Dow, Ph.D., Director of Information Services and Research Scientist. – His research interests primarily involve land use/land cover impacts and effects on water quality and quantity.

Matt Ehrhart, M. Eng., Director of Watershed Restoration. – His work is focused primarily on water quality, watershed restoration, agricultural conservation and preservation, and the associated policy and implementation issues.

John K. Jackson, Ph.D., Senior Research Scientist, Aquatic Entomology – His research interests span a variety of applied and basic subjects, including population and evolutionary ecology of stream insects, the role of abiotic and biotic processes in determining the structure and function of stream assemblages, energy and nutrient exchange within streams and between streams and their surrounding watersheds, and benthic monitoring and water quality assessment.

Jinjun Kan, Ph.D., Associate Research Scientist, Microbial Ecologist and Molecular Genetics. – His research focus' on environmental microbiology and molecular microbial ecology of aquatic ecosystems, particularly freshwater and estuaries, with focus on algal, bacterial, archaea, and viral population dynamics, and interactions with local environments, including trophic interactions, nutrient cycling, and biogeochemistry.

Steven Kerlin, Ph.D., Director of Education. – His education and research interests are in environmental and

science education, technology to enhance and extend outdoor education, educator professional development, and inquiry-based teaching and learning.

Diana Oviedo-Vargas, Ph.D., Assistant Research Scientist, Biogeochemist. – Her research seeks to improve our knowledge about the elemental cycles in streams, rivers, and estuaries and how they are linked to each other, to the water cycle, and to the terrestrial ecosystem at the surface and the subsurface level. Some of my current research interests include the nitrogen and phosphorus transport and transformation in fluvial systems and how human activities such as agriculture and urbanization can affect these processes; the quantification and characterization of the multiple carbon pools and fluxes in aquatic ecosystems and their role in global climate change; and the effects of emerging contaminants, like pharmaceutical products and microplastics, on the health of streams and rivers.

Marc Peipoch, Ph.D., Assistant Research Scientist, Ecosystem Ecologist. – His research focus is on understanding sources, sinks, and transport of nutrients, energy, and pollutants in river ecosystems. He has conducted independent research on understanding mechanistic interactions among energy flow, nutrient processing, and biological communities across multiple spatial and temporal scales in streams, rivers, and floodplain ecosystems. His overarching research goal has been to understand how ecological processes at one scale are influenced by form and function at other scales of stream ecosystems.

F. For academic institutions, include a description of the student demographics and the instruction's status as a minority-serving institution (e.g., as defined by the U.S. Department of Education)

Not Applicable

G. Description or list of facilities, equipment, centers, or institutes that would provide support to the research, technical assistance, or educational activities of relevance to federal land management, environmental, and research agencies that will be engaged in CESU activities.

The Stroud Water Research Center (www.stroudcenter.org) is located on White Clay Creek, and housed in a 38,820-square-foot combined research and teaching/outreach facility. This includes the new 14,000 sq. ft. LEED Platinum Moorehead Environmental Complex that opened in April 2012 that houses education facilities, Watershed Restoration offices, meeting spaces, administrative offices, and archival sample storage. Research laboratories occupy 12,130 sq. ft. of space and include a greenhouse and wet laboratories that are continuously supplied with stream water. These are complimented by an expansive meeting/conference room (2,400 sq. ft.), four meeting rooms, and two teaching laboratories.
The 800 ha White Clay Creek watershed upstream of the Stroud Center was designated by NSF as an Experimental Ecological Reserve in 1981 and an LTREB site in 1998, and the entire White Clay Creek and Brandywine Creek form the previously NSF-funded 1400 km^2 Christina River Basin Critical Zone Observatory. Much of the land in the LTREB and CZO watersheds is protected in perpetuity by conservation easements. The 3rd-order LTREB watershed has extensive field infrastructure including: electric power along the third-order section of the stream, a series of wells (shallow and deep), tension lysimeters and piezometers are installed along 5 transects that run from the stream to the uplands. The stream is gauged, with a continuous discharge dataset since 1969. Precipitation, air, and water temperature are continuously monitored. The site is protected so that equipment and installations can be left unattended.

Education department teaching facilities and resources. - The Education Department has two indoor teaching laboratories. One is equipped with a smart board and a digital microscope that students use to identify macroinvertebrates. The second classroom is a wet laboratory where students can evaluate water samples. In addition, the White Clay Creek watershed serves as an outdoor research site where students

collect water samples and biological specimens for analysis. Three outdoor learning stations are located in different environments (meadow, young riparian forest, and mature forest) of the watershed. A tree planting and conservation farming practices demonstration area is also located on the property. The LEED Platinum Morehead Environmental Complex and surrounding grounds are used as a learning demonstration site about how to "get the water right" with conservation practices that minimize runoff and promote infiltration as well as conservation of energy. The education department maintains and uses scientific equipment in K-12, college, citizen science, and professional development programs focused on macroinvertebrates, stream habitat assessments, water chemistry, watershed restoration, and other related topics.

Research Labs
The Entomology Laboratory, overseen by J. Jackson, specializes in taxonomic identification, community and population structure, genetic studies, and tolerance limits to chemical, physical, and biological factors of freshwater invertebrates. See instrumentation list below.

The Fish Ecology Laboratory, overseen by D. Arscott and J.K. Jackson, specializes in field studies of fish movement, species composition and productivity; genetic studies of population structure; laboratory studies of tolerance limits to chemical, physical and biological factors; as well as eDNA detection and mathematical modeling of population dynamics. See instrumentation list below.

The Organic and Isotope Geochemistry Laboratory, overseen by Dr. D. Oviedo-Vargas, specializes in the analysis of stable isotopes of many forms of carbon, nitrogen and oxygen, in addition to characterizing the solid inorganic matrix of soils and sediments. See instrumentation list below.

The Environmental Wireless Sensor laboratory, overseen by Dr. D. Arscott and staffed by full time electrical engineer Shannon Hicks, started in 2010 to serve the CRB-CZO but now serves an increasingly wide range of projects serving research scientists, citizen scientists, and students. The Stroud Center sensor lab has developed its wireless sensor system based on the Arduino open source electronics platform in combination with XBee ZigBee wireless radio modules (http://www.envirodiy.org).

The Microbiology laboratory, overseen by Dr. J. Kan, is equipped with necessary molecular microbial ecology facilities. Specific equipment includes two fume hoods, a biological safety cabinet, autoclave, anaerobic glove box, incubator with adjustable temperatures, ultra-low freezer (-80 ºC), Microcentrifuge, Milli-Q water, digital oven, pH meter, filtration system, PCR thermal-cycler, gel-electrophoresis, UV transluminator, SpeedVac, Nano-drop, Denaturing Gradient Gel Electrophoresis, and imaging system with GelCompar II, fluorescence in situ hybridization oven, three epifluoresence microscopes, an Olympus BX61 with differential interference contrast and automated stage, coupled to a computer with image analysis software; a Zeiss Universal with Phase optics and Nomarski optics; 23 dissecting microscopes and two Nikon Eclipse E400 compound microscopes.

The Fluvial Geomorphology Laboratory, overseen by Dr. M. Daniels, specializes in routine and stormflow hydrologic monitoring and analyses, studies of stream hydraulic habitats, suspended sediment, seston and stream nutrient dynamics, experimental stream nutrient and conservative tracer additions, and stream geomorphic assessments. The lab is also in the process of outfitting for thermal regime measurement and analysis.

The Biogeochemistry laboratory, overseen by Drs. D. Oviedo-Vargas and Peipoch, specializes in the analysis of dissolved organic carbon (DOC), biodegradable DOC (BDOC) and a wide array of nutrients, other anions and cations.

The Watershed Restoration team, overseen by M. Ehrhart, designs, installs, monitors, and manages watershed restoration projects on the Stroud Center experimental watershed and private farmland in surrounding counties.

The Greenhouse as a laboratory, is a communally managed facility and is available to all SWRC staff on an "as-needed" basis. The greenhouse can be supplied with White Clay Creek, ground/well water, or imported water and accommodates up to ten indoor streams (10' long x 18" wide x 10" deep) with adjustable slopes and individual pumps and reservoirs capable of working as flow through or recirculating systems (or partial flow through). Six custom-built algal farms stream White Clay Creek water continuously over 4x4-foot inclined planes that each accommodate 80 removable 23 x 6.4 x 0.16-cm acrylic culture plates, used to provide periphyton food to aquatic invertebrates. The greenhouse also houses a 720-L Minnow-Cool tank (Frigid Units, Inc.) with a 1 hp chiller and a 6KW heater to maintain temperature. Climate is controlled by a Wadsworth Envirostep system that controls heating, ventilation and shading.

The Wet Laboratories houses, among other infrastructure, a unique fish and aquatic invertebrate experimental laboratory with five separate recirculating water systems. Each recirculating system consists of 28 flow-through microcosms on a lower level designed for fish and 20 similar microcosms plus 6 troughs (for studying drift) designed for macroinvertebrate experimentation on the upper level. Each system has its own reservoir complete with the ability to supply White Clay Creek stream water, ground/well water or imported water. Each recirculating system is serviced by a biofiltration compartment, pump, bead filter, 6 kilowatt in-line electric water heater, heat exchanger (for cooling), and 50-watt UV sterilizer. The 5 heat exchangers share a closed-loop recirculating system with a 5-ton chiller that maintains a 0°C reservoir of ethylene glycol. In-line water heaters are regulated via an SCR panel. Heating and cooling is controlled with an Allen-Bradley Programmable Logic Controller (PLC) using a PC running RSLogix 5000 Enterprise Series software with a human-machine interface (HMI), InTouch-WindowViewer software. This system enables the control of temperature in all 5 systems independently to within plus or minus 0.05°C. Each system can be programmed to attain a precise temperature for any given time of day, with ramping rates up to 8°C/h in either direction. Simulated daylight is provided to experimental systems by 8-foot fluorescent "grow-lights" that are controlled by a programmable timer. Fish quarantine aquaria are housed in a wet lab consisting of six 120 gallon tanks with water recirculation system for quarantine/holding aquatic vertebrates and invertebrates.

In addition these indoor facilities, the Center maintains an outdoor artificial stream facility consisting of four streamside flumes, each 30 m long, 0.3 m wide and 0.3 m deep, lined with Hypalon. Stream gradients are individually adjustable to ~5%. Water is pumped from White Clay Creek to a header tank then fed into the channels at individually regulated flows of up to ~ 8 L/s. Streamwater passes through once and is returned to the stream, except that flume effluent can be temporarily diverted into two 1-m^3 tanks for treatment or recirculation if necessary.

Instruments and equipment shared by SWRC. -
Laboratory instrumentation at the Stroud Water Research Center support a wide array of biogeochemical and biological analyses, and include:

- Thermo-Delta V Plus Isotope Ratio Mass Spectrometer (IRMS) interfaced in continuous flow mode with a ConFlo IV to an OI Analytical Model 1030 DOC-DIC analyzer and a Thermo-Finnigan GasBench II automatic gas sampling and purification system;
- Thermo-Delta Plus XP Isotope Ratio Mass Spectrometer (IRMS) equipped with a dual inlet system and interfaced in continuous flow mode with a ConFlo III to a Costech 4010 CHNS-O Elemental Analyzer (EA);
- 5 Total Organic Carbon (TOC) analyzers – 2 Sievers 800, 1 Sievers 900, and OI Analytical model 1010 and model 1030 (used with IRMS);

- Dionex ICS-3000 ion chromatography system with Autosampler (AS), Dual Pumps (DP), Eluent Generator (EG), and Electrochemical Detector (ED) with Pulsed Amperometric Detection (PAD) and conductivity cells, and dual columns for simultaneous analysis using two methods (i.e. cations and anions) on the same sample;
- 2 Agilent 6890 series Gas Chromatographs (GC), one coupled to a 5973 series Mass Selective Detector (MSD) and the other to a Flame Ionization Detector (FID);
- Agilent 1100 series High Pressure Liquid Chromatograph (HPLC) with fluorescence detector;
- Micromeritics TriStar 3000 surface area and porosimetry analyzer;
- Bruker Tensor 27 Fourier Transform Infrared (FTIR) spectrometer with a Pike XY-Autosampler Diffuse Reflectance accessory;
- Mettler-Toledo DL50 Autotitrator optimized for alkalinity and Winkler oxygen analyses;
- Beckman LS-3801 liquid scintillation counter with a Packard 306 sample oxidizer;
- Perkin-Elmer Lambda 25* UV-Visible spectrophotometer;
- four Gilson respirometers.

Laboratory equipment shared by all at SWRC include:

- 3 microbalances, a Mettler UMX5, a Sartorius CP2P and a Cahn 25;
- 7 analytical balances, including Mettler models AE163 (2), XS205 Dual Range, H32, H16, P1200 and Fisher Scientific Accu-124D, and numerous top-loading balances;
- 2 refrigerated super speed centrifuges – a Sorvall Evolution RC* and a Sorvall RC2-B
- temperature controlled bioreactor room with flowing stream water
- Millipore Pelicon II Mini tangential flow ultrafiltration systems
- 3 Fisher Isotemp muffle furnaces
- Real Soft Pros portable Reverse Osmosis system, for the concentration of natural dissolved organic matter;
- Heat Systems - Ultrasonics W185 sonifier-cell disruptor and a Misonix S3000* Ultrasonic probe;
- Steris Amsco Renaissance model 3023 Autoclave*,
- 4 metabolism chambers with venturi flume inserts and new lids
- 2 water jackets supplied with stream water and halogen lamp illumination
- Miscellaneous equipment, including XAD-8 resin columns and pumps, two rotoevaporators, two Wiley mills, and laboratory and field pH, conductivity and oxygen meters, a Hettich Universal 32 centrifuge, Precision Scientific and Dubnofff waterbath shakers, numerous temperature controlled baths and incubators, two Hotpack sterilizing ovens, three Precision Scientific drying ovens, Rheem ultralow freezer, and numerous standard refrigerators and freezers.

Field instruments and equipment for stream monitoring, whole stream ecosystem metabolism estimates, and whole stream and chamber (in the field and laboratory) experiments include:

- 6 s::can in situ UV-Vis spectrophotometers (256 absorbance measurements from 220-720 nm) with con::cube field computers for data logging, process control and communication.
- Wireless sensor networks with dozens of logger nodes and hundreds of sensors, based on Arduino open-source electronics and XBee ZigBee wireless radio modules (http://www.stroudcenter.org/research/projects/czo/arduino.shtm).
- 10 YSI multi-parameter sondes (4 model 600XLM and 6 model 600XL) all equipped with with dissolved oxygen, temperature and conductivity probes, along with a custom data logger with interface for 4 sondes
- 7 ISCO 6700 series automated portable water samplers, for remote collection storm waters.
- LiCOR 1400 light meter, sensors for PAR in air and underwater and for total radiation in air
- Nikon NPL-332 Prismless Total Station with a TDS Trimble Nomad 800 handheld data collector for precision surveying
- 3 small boats: a 17 ft. Starcraft rated for 4 people, 532 lbs. and 45 HP; a 16 ft. MonArk (Brunswick) rated for 5 people, 690 lbs. and 30 HP; a 12 ft. Sea Nymph 1236LT rated for 3 people, 400 lbs. and

10 HP; and a 10 ft. inflatable Zodiac. Each of the first 3 have a dedicated trailer. 5 motors range from a 25HP 4-stroke Mercury to a 9.9 HP Evinrude.

Computing and data facilities.-
The computing and data facilities at the Stroud Center are structured around an array of 9 data and application servers in mirrored and RAID configurations and interconnected by an ultra-high bandwidth 1 Gbps managed switch. Data is backed up nightly or weekly (depending on data type) via an HP StorageWorks 1/8 autoloader with eight data cartridge slots and an HP Proliant DL100G2 Storage Network Access Storage (NAS). Backup tapes are regularly stored off site. Fiber Optic Internet Service (FIOS) provides 30 Mbps download and 15 Mbps upload bandwidth to the Internet, and Virtual Private Network (VPN) access from remote locations.

Stroud Center has a four-person Information Services group to oversee hardware, software and network functions, and to manage and analyze data. Data management and analysis is implemented primarily with SAS and more recently Python, using MS Excel and MS Access for data entry along with several multivariate analysis software packages to complement data analysis in SAS. Geographic Information Systems software (ESRI ArcGIS) is installed on a dedicated GIS computer as well as on several desktop machines with the Information Services section providing GIS data and analyses to others at the Stroud Center. We maintain a local Hydrological Information Systems (HIS) server developed by the Consortium of Universities for Advancement of Hydrologic Science Inc. (CUAHSI), for the organization, retrieval and electronic publishing of data using their Observations Data Model (ODM) and web services.

H. Description or list of past research, technical assistance and educational services supported through federal financial assistance awards that are of relevance to federal land management, environmental, and research agencies that will be engaged in CHWA CESU activities.

Stroud Water Research Center has conducted many activities with federal financial assistance awards in the form of competitive grants, contracts, and professional services. A complete list of federally funded projects occurring in fiscal year 2016-2017 is provided in section I below. Briefly, the Stroud Center has received funding or partnered with following federal agencies in the last 15 years: United States Department of Agriculture National Resource Conservation Service, U.S. Environmental Protection Agency, U.S. National Park Service, U.S. Department of Justice, the National Science Foundation, the U.S. Army Corps of Engineers, and the U.S. Forest Service. The Stroud Center has also had many grants and contracts with state entities that were providing federal funds through state administered programs. These agencies include: Pennsylvania Department of Environmental Protection, New Jersey Department of Environmental Protection, New York Department of Environmental Conservation. Stroud Center staff have also provided services supported by the Stroud Center at outreach events and national parks (i.e., National Water Gap, Valley Forge National Historic Park, First State National Historic Park) and at state parks throughout the Delaware and Susquehanna River watersheds.

I. Description or a list of current formal agreements and informal relationships with federal agencies that are of relevance to federal land management, environmental, and research agencies that will be engaged in CHWA CESU activities.

Stroud Water Research Center has many current and past grants and contracts with federal agencies. The following is a list of project titles, funding agency, a short project description, and a list of principal investigators (Stroud Center staff are in bold):

Improving Stream Water Quality and Reducing Runoff by Improving Farm Soil Health Through Permanent Cover Cropping
Funded by: U.S. Department of Agriculture
Scientists are studying how soil structure and soil ecosystem health improve farm fields over a three-year period after shifting from conventional tillage practices to cover cropping. They are also measuring changes in the amount of water, sediment, and nutrient runoff that result from the shift to cover cropping. At the conclusion of the project, watershed scaling models will be used to promote cover crops as a best management practice for mitigating pollution of streams and downstream estuaries.
Principal Investigator: Bernard W. Sweeney
Collaborators: Matthew J. Ehrhart, Anthony K. Aufdenkampe, and **David B. Arscott**

Land Use Effects on Stream Thermal Regime
Funded by: USDA Forest Service
Stream temperatures are dramatically affected by land use in the watershed and riparian zone. In this project, we measure stream temperatures throughout a series of small watersheds with land use ranging from very urbanized to completely forested to develop a predictive model of stream temperature changes.
Principal Investigators: Melinda D. Daniels and **Valérie Ouellet**

Delivering the National Fish and Wildlife Foundation Regional Conservation Partnership Program in Lancaster County, Pa.
Funded by: National Fish and Wildlife Foundation
This project provides outreach and technical assistance to farmers to ensure full implementation of funds provided by the U.S. Department of Agriculture's Regional Conservation Partnership Program for constructing ag best management practices (BMPs). The Stroud Center is NFWF's lead partner in this effort.
Project Lead: Matthew J. Ehrhart
Collaborators: USDA Natural Resources Conservation Service; National Fish and Wildlife Foundation; Red Barn Consulting, Inc.; TeamAg, Inc.; others

Demonstrating Low-Cost Methods for Reforestation
Funded by: National Fish and Wildlife Foundation
Four sites in New York, Pennsylvania, and Maryland demonstrated options for improving the cost-effectiveness of reforestation methods, including direct seeding, innovative fencing in lieu of tree shelters, live stakes, improved methods for managing herbivore competition, and more.
Project Lead: Bernard W. Sweeney
Collaborators: David S. Wise; Paul Salon (U.S. Department of Agriculture); Art Gover (private contractor); Andy Duncan (Pennsylvania Department of Conservation and Natural Resources); Natural Lands Trust

Whole-Farm Conservation Including Forested Buffers
Funded by: National Fish and Wildlife Foundation
This project expands the Farm Stewardship Program in Lancaster and Franklin Counties — the top two dairy counties in Pennsylvania. To address water-quality issues, whole-farm conservation with forested buffers is implemented. Farmers who install forested buffers receive incentives that can only be used to pay for other needed best management practices on the farm.
Project Lead: Matthew J. Ehrhart
Collaborators: Red Barn Consulting, Inc.; TeamAg, Inc.; others

Large Runoff Flux and Transformation of Particulate Nitrogen (PN) Following Large, Intense Storms: A Critical but Unexplored Component of N Cycling in Watersheds
Funded by: U.S. Department of Agriculture
Particulate nitrogen (PN) in stormwater runoff can increase dramatically with large storms, thus constituting a significant component of nitrogen cycling in watersheds. In this project, Stroud Center scientists apply a novel combination of approaches to monitor the flux and transformations of PN. The goal

is to produce a comprehensive model for PN fate and transport in watersheds, especially in agroecosystems subject to climate variability.
Principal Investigator: Jinjun Kan Collaborators: Shreeram Inamdar and Rodrigo Vargas (University of Delaware)

Characterizing Stream Connections and Physical, Chemical, Biological Influences on Downstream Navigable Waters
Funded by: U.S. Department of Justice
Drs. Dow and Arscott provided scientific expert services for the U.S. Department of Justice in the matter of Foster et al. v. EPA et al., No. 2:12cv-16744 (S.D.W.V.). The scope of work was to characterize and provide testimony on the physical, biological, and chemical relationships between certain headwater streams located in Wood County, West Virginia, and downstream waters connecting to the Little Kanawha River and eventually to the Ohio River.
Principal Investigator: David B. Arscott Collaborator: Charles L. Dow

CNH: Coupled Climate, Cultivation, and Culture in the Great Plains: Understanding Water Supply and Water Quality in a Fragile Landscape
Funded by: National Science Foundation
This collaborative project develops a model to predict the potential impact of climate variability, climate change, land use, and human activity on water resources across decades and centuries in the Central Great Plains of North America. It also identifies the most effective strategies to achieve sustainability and optimize policy.
Principal Investigator: Melinda D. Daniels Collaborators: Marcellus Caldas, Jessica Heirr-Stamm, Jason Bergtold, Aleksy Sheshukov, Martha Mather, and David Haukos (Kansas State University)

Collaborative Research: Coupled Geochemical and Geobiological Characterization of Dissolved Organic Matter Oxidation to Carbon
Funded by: National Science Foundation
As microbes process dissolved organic matter from leaves that fall into streams, they release CO2 into the atmosphere. Scientists are studying stream networks from two different climatic regions to identify which molecules release high rates of CO2 into the atmosphere from streams and rivers.
Principal Investigator: Louis A. Kaplan Collaborators: Rose Cory (University of Michigan); Patrick Hatcher (Old Dominion University)

Collaborative Research: Sediment Stabilization by Animals in Stream Ecosystems: Consequences for Erosion, Ecosystem Processes, and Biodiversity
Funded by: National Science Foundation
Caddisflies and other net-spinning macroinvertebrates attach gravels to one another within the streambed. These attachments result in more force required for flowing water to move the gravels, limiting erosion and creating a more stable habitat for biofilm and other macroinvertebrates. Researchers are running laboratory experiments in experimental streams, conducting field experiments and surveys, and modeling the landscape-scale effects of these tiny ecosystem engineers on stream-ecosystem processes.
Principal Investigator: Melinda Daniels

Integration of Physiological, Life-History, and Macro-Ecological Approaches for Understanding Thermal Limitation in Aquatic Insects: Implications for Freshwater Biodiversity in a Warming World
Funded by: National Science Foundation
In this project, we test the hypothesis that temperature limits the distributions of aquatic insects through its effect on resource allocation, and that warming decreases reproduction by shunting energy away from egg production to other metabolic processes.
Principal Investigators: Bernard W. Sweeney, **John K. Jackson**, and **David H. Funk**

Collaborators: David B. Buchwalter (North Carolina State University); Charles P. Hawkins (Utah State University); Goggy Davidowitz (University of Arizona)

Long-Term Research in Environmental Biology (LTREB): Trajectory for the Recovery of Stream Ecosystem Structure and Function During Reforestation
Funded by: National Science Foundation
Stream restoration in the United States is a multibillion-dollar industry. Yet long-term monitoring of its effectiveness is virtually nonexistent. Stroud Center scientists are studying restoration within White Clay Creek that involves the reforestation of meadows or pastures with native deciduous trees and the removal of invasive plant species. As the planted forest matures, researchers characterize the changes in the aquatic biological communities and their associated activity. Teachers are trained in the use of long-term environmental data as a means to enhance math skills, analytical abilities, and environmental knowledge of both students and teachers.
Principal Investigators: Bernard W. Sweeney, Anthony K. Aufdenkampe, **John K. Jackson**, **Jinjun Kan**, and **Melinda Daniels**
Collaborators: J. Denis Newbold, **David B. Arscott**, **Charles L. Dow**, **Steven C. Kerlin**, **Tara Muenz**, and Louis A. Kaplan

Metaecosystems and the Upstream Legacy: Influence of Dissolved Organic Matter on the Structure and Function of Streambed Bacterial Communities
Funded by: National Science Foundation DEB 1120717
Investigators explore how the quality of organic molecules changes with distance downstream and how those changes influence the composition of the communities of streambed microbes using that food resource. The research goals include advancing knowledge of stream ecosystems across drainage networks and forging a broad model of stream ecosystems in the global carbon cycle.
Principal Investigators: Louis A. Kaplan, **Jinjun Kan**, **Tara Muenz**, and Jennifer J. Mosher; Robert H. Findlay (University of Alabama)
Collaborator: David C. Richardson (SUNY New Paltz)

Restoring Flood Attenuation and Ecological Resiliency in the Mid-Atlantic Piedmont
Funded by: National Fish and Wildlife Foundation
For this project, scientists and watershed restoration professionals restore one headwater basin to reduce flooding downstream, improve water quality, and increase stream-ecosystem resilience so that it will once again support a breeding population of native brook trout and other coldwater fish. Pre- and post-project measures of water quality, hydrologic regime, and biological communities will determine the project's effectiveness.
Principal Investigator: Melinda D. Daniels
Collaborators: Bernard W. Sweeney, **David B. Arscott**, **Matthew J. Ehrhart**, **John K. Jackson**, **Tara Muenz**, and **Steven C. Kerlin**

Using Microbial Source Tracking (MST) to Identify Potential Bacterial Sources in White Clay Creek to Target Best Management Practices (BMPs) and implementation strategies
Funded by: White Clay Creek National Wild & Scenic River
Scientists monitored fecal indicator bacteria in White Clay Creek during summer and identified potential bacterial contamination by molecular microbial source tracking.
Principal Investigator: Jinjun Kan

Collaborative Research: Introducing Critical Zone Observatory (CZO) Science to Students and Teachers
Funded by: National Science Foundation
The Critical Zone encompasses the external or near-surface Earth extending from the top of the vegetation canopy down to and including the zone of freely circulating groundwater. This project engages college students and teachers in a summer research internship studying two observatories: the Christina River

Basin and the Susquehanna Shale Hills site. Participants engage in real-world, hands-on experiences examining and presenting on their particular research focus within the Critical Zone.
Project Leads: A.K. Aufdenkampe and **Tara Muenz**; Timothy S. White (The Pennsylvania State University)
Collaborators: David B. Arscott, **Jinjun Kan**, **Melinda D. Daniels**, and **Heather Brooks**; Holly Michael and Jim Pizzuto (University of Delaware)

Greening STEM Technologies: A Model for Advancing Do-It-Yourself (DIY) Environmental Sensing Networks to Support Citizen Science and Primary and Secondary Education
Funded by: U.S. Environmental Protection Agency
Stroud Center education and technical staff created STEM technologies to enhance public capabilities in citizen science. Partnerships with schools will lead to curricula and tools in 2017 and the installation of stream-monitoring stations.
Project Leads: David B. Arscott and **Tara Muenz**
Collaborators: Shannon Hicks, **Steven C. Kerlin**, and **Heather Brooks**

Learning to See, Seeing to Learning
Funded by: National Science Foundation
Stroud Center educators in collaboration with Carnegie Mellon University created and implemented a national survey of macroinvertebrate trainers and training programs. Education and entomology staff helped decide which 150 macroinvertebrates will be shown as gigapan images on Macroinvertebrates.org. Education staff continue to contribute to the development of the site.
Project Leads: Marti Louw (Carnegie Mellon University); **Tara Muenz**
Collaborators: Steven C. Kerlin, **John K. Jackson**, **Matthew J. Wilson**, **Michael C. Broomall**, and **Kelly C. McIntyre**; John Morse (Clemson University); Lauren Allen (Carnegie Mellon University); John Wenzel (Carnegie Museum of Natural History)

Teaching Environmental Sustainability — Model My Watershed
Funded by: National Science Foundation, Discovery Research K–12
Stroud Center educators and scientists are enhancing the Model My Watershed® application by integrating water-quality and terrain-analysis models. This work is being completed in partnership with the Concord Consortium, which will lead the curriculum development, and Millersville University of Pennsylvania, which will conduct research on learning. The geographic extent of this expansion will be the contiguous 48 states. Professional development for teachers will take place in California, Iowa, Kansas, Pennsylvania, and Virginia.
Project Leads: Melinda D. Daniels; **Steven C. Kerlin**; Nanette Marcum-Dietrich (Millersville University of Pennsylvania); Carolyn Staudt (Concord Consortium)
Collaborators: Anthony K. Aufdenkampe; Emilio Mayorga (University of Washington); Robert Cheetham (Azavea, Inc.)

Water SCIENCE
Funded by: National Science Foundation,
Innovative Technology Experience for Students and Teachers The Stroud Center's education department is collaborating with the Concord Consortium on a project to introduce middle school students to engineering practices for water resources. This project targets schools in Boston; Kennett Square, Pennsylvania; and Phoenix/Tempe, Arizona. Millersville University of Pennsylvania is also involved.
Project Leads: Carolyn Staudt (Concord Consortium); **Melinda D. Daniels**; Nanette Marcum-Dietrich (Millersville University of Pennsylvania)

J. Confirmation of the institution's/organization's willingness to accept a limited overhead rate of 17.5% and cost items to which the rate is applicable for activities conducted through the CESU, including research, technical assistance, and educational services (this overhead rate applies to the entire institution/organization for CHWA CESU activities).

President David B. Arscott supports this application and acknowledges that the maximum overhead rate for all work will be 17.5% and that there can be limitations on the cost items where the overhead rate can be applied. As part of Stroud Water Research Center's commitment to this partnership we consider the difference between this rate and our federally negotiated overhead cost rate (55% MTDC for Research and 44%MTDC for Education and Watershed Restoration activities; the National Science Foundation is the Stroud Center's federal cognizant agency) to be an in-kind contribution and supportive of the collaborative work that would be completed by Stroud Water Research Center staff, students, and/or interns.

K. Designation of a technical representative (with full contact information –name, title, full address, phone, fax, email) to serve on the CHWA CESU steering committee.

David B. Arscott, Ph.D. will serve as the technical representative for Stroud Water Research Center and serve as on the CHWA Steering Committee until March 1 when Scott Ensign, Ph.D. officially starts at the Stroud Center's Assistant Director. Their contact information follows:

David B. Arscott, Ph.D., President, Executive Director, Research Scientist, Stroud Water Research Center, 970 Spencer Road, Avondale, PA 19352, office phone: 610-268-2153 x278, cell phone: 484-885-5225, email: darscott@stroudcenter.org

Scott Ensign, Ph.D., Assistant Director, Stroud Water Research Center, 970 Spencer Road, Avondale, PA 19352, office phone: 610-268-2153 xTBD, cell phone: TBD, email: TBD

L. Participation in the CESU annual/semiannual partner meetings and facilitation of internal and external communication, promotion and response to CESU correspondence and administrative actions (e.g., announcement, new member applications, processing agreements/amendments, five-year reviews).

Stroud Water Research Center will attend and actively participate in partner meetings. We will relay all internal and external communications to the targeted groups and respond to correspondence and administrative actions from the CESU in a timely manner. The primary responsibility for ensuring that Stroud Center completes these tasks will be assumed by Scott Ensign after his hire date, but will be David Arscott until 1 March, 2018. Both Arscott and Ensign will work closely with other staff to ensure that there is appropriate dissemination of material between the CESU and Stroud Center stakeholders. Arscott and Ensign will also work closely with John D. Pepe, Controller at the Stroud Center, to ensure that any dissemination related to funded work is done so in a timely and correct manner.

M. Agree to relay agency-specific research, technical assistance and educational needs and associated funding opportunities to other institutional/organizational members (e.g., faculty, students)

As part of their responsibilities Drs. Arscott and Ensign will communicate information to appropriate stakeholder groups at Stroud Center. As part of the efforts to disseminate information about funding opportunities they will engage other staff listed above, members of the Stroud Center Senior Staff Leadership Team and the Controller's office and Grant Administration Support (Mr. John Pepe). Drs.

Arscott and Ensign will also work directly with staff at the Stroud Center to develop grant proposals in response to announcements of funding opportunities.

N. *Signature (or endorsement) from an appropriate official, with authority to commit institutional resources in a binding multi-year federal cooperative and joint venture agreement (e.g., president, executive director, chief financial officer, vice president for research, director of sponsored programs).*

President David B. Arscott has provided a letter of support and endorsement as part of this application. In his letter he expresses his enthusiasm for Stroud Center's membership as a means of contributing to the good work of the CHWA CESU and partner agencies.

O. *Letter(s) of support from one or more CESU federal agency partners sponsoring the new partner's application, including a description of successful past collaborative work supported through federal financial assistance awards.*

A letter of support for this application has been received from Ms. Laura J. Brown, Trial Attorney with the Environmental Defense Section of the Environment and Natural Resources Division of the U.S. Department of Justice. Ms. Brown's letter endorses the Stroud Center's application to the CHWA CESU and discusses the work completed by Drs. David Arscott and Charles Dow for a court case.

David B. Arscott, Ph.D.
Executive Director, Vice President, & Research Scientist
610-268-2153 x278 (o), 484-885-5225 (c)
darscott@stroudcenter.org

January 18, 2018

Daniel M. Filer, M.B.A., Ed.D.
University of Maryland Center for Environmental Science - Appalachian Laboratory
301 Braddock Road - Room 304
Frostburg, MD 21532

Dr. File,

I write to express my support for Stroud Water Research Center's application for membership in the Chesapeake Watershed Cooperative Ecosystem Studies Unit (CHWA CESU).

The Stroud Center would be honored to contribute to the network, assist partners, and provide technical services and research. Our staff have devoted their careers to pursuing knowledge and stewardship of freshwater and have a rich history of partnering with federal, state, local, and private organizations, institutions, and companies to achieve this mission. There is very strong overlap of the mission of the Stroud Center with the goals and priorities of this network. Membership in the CHWA CESU would be a great opportunity for our staff to make strong contributions to research, education, conservation and restoration of our landscapes in our region.

I am pleased to offer my full endorsement of this application for membership.

Sincerely,

David B. Arscott, Ph.D.
President, Executive Director, Research Scientist
Stroud Water Research Center

U.S. Department of Justice
Environment and Natural Resources Division

Environmental Defense Section
P.O. Box 7611
Washington, DC 20044

Telephone (202) 514-3376
Facsimile (202) 514-8865

January 19, 2018

Daniel M. Filer, M.B.A., Ed.D.
University of Maryland Center for Environmental Science
Appalachian Laboratory
301 Braddock Road - Room 304
Frostburg, MD 21532

Re: *Stroud Water Research Center*

Dear Dr. Filer:

I am writing in support of the application by Stroud Water Research Center to join the Chesapeake Watershed Cooperative Ecosystem Studies Unit (CHWA CESU). I am a trial attorney with the United States' Department of Justice. Stroud Water Research Center recently provided scientific expert witness services on behalf of the United States in one of my litigated cases, *Foster et al. v. United States Environmental Protection Agency et al.*, 2:14-cv 16744 (S.D.W.V.), which involved the enforcement of the Clean Water Act, 33 U.S.C. § 1311. The services were provided by Drs. David B. Arscott, Charles L. Dow. Drs. Arscott and Dow conducted field assessments, issued an expert report, provided deposition, and testified at trial.

These services demonstrate participation in a federal contract for which the Stroud Center provided services and received payment from a federal agency for these services. I recommend Stroud Water Research Center as a member of the CESU.

Sincerely,

Laura J. Brown
Trial Attorney
Environmental Defense Section
Environment and Natural Resources Division
United States Department of Justice
(202) 514-3376
Laura.J.S.Brown@usdoj.gov

WHITE CLAY CREEK
National Wild & Scenic River
Ours to Enjoy. Ours to Protect.

January 19, 2018

To Whom It May Concern:

I am writing in support of the application by Stroud Water Research Center to join the Chesapeake Watershed Cooperative Ecosystem Studies Unit (CHWA CESU). The White Clay Creek National Wild and Scenic River Program within the U.S. National Park Service has a long history of collaboration and shared funding with Stroud Water Research Center. In our early years, we partnered with the Stroud Center (Dr. John Jackson) with water quality monitoring program called Stream Watch. More recently, we have partnered with the Stroud Center for bacteria monitoring within the White Clay Creek Watershed with Dr. Jinjun Kan.

This partnership and the services provided by the Stroud Center demonstrate a successful partnership with a federal agency. I recommend Stroud Water Research Center as a member of the CESU.

Sincerely,

Shane Morgan

Shane Morgan
Management Plan Coordinator
White Clay Creek National Wild and Scenic River Program