Proposal

Temperature and Dissolved Oxygen Information for Trout Management in the Quittapahilla Creek

Submitted for funding consideration to the

Pennsylvania Fish and Boat Commission

by

Lebanon Valley College

September 27, 2016

Partners:

Quittapahilla Watershed Association
Doc Fritchey Chapter of Trout Unlimited
Lebanon County Conservation District

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INTRODUCTION

Overview

The Quittapahilla Creek (The Quittie) in Lebanon County, Pennsylvania is situated in a limestone valley where groundwater is plentiful and springs are common. The Quittie is a stocked trout stream classified as TSF[1] and MF[2]. Given these designations, the stream is expected to have temperature and dissolved-oxygen concentrations that will support trout through July 31 of each year. Essentially, the Quittie is managed as a "put-and-take" trout fishery. But, the Quittie could be so much more than a seasonal trout fishery. Given the availability of cold water, why is the Quittie not a year-round trout fishery with a thriving and self-reproducing wild trout population?

This proposal outlines a study to be conducted in the summer of 2017 to evaluate the suitability of the Quittapahilla Creek to support a year-round trout fishery. The study involves continuous monitoring of temperature and dissolved-oxygen (DO) concentrations throughout the hottest months of the year and comparison of those results with requirements for trout sustainability. The study would be conducted by summer intern students from Lebanon Valley College (LVC) with guidance from an LVC Biology faculty member and a seasoned environmental scientist. Results from the study would be shared with the Pennsylvania Fish and Boat Commission for formulating management strategies and used to guide stream-improvement measures to be undertaken by the Quittapahilla Watershed Association, the Doc Fritchey Chapter of Trout Unlimited, and the Lebanon County Conservation District.

[1]TSF *Trout Stocking*—Maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat.

[2]MF *Migratory Fishes*—Passage, maintenance and propagation of anadromous and catadromous fishes and other fishes which move to or from flowing waters to complete their life cycle in other waters.

Background

Other Pennsylvania streams in limestone valleys have excellent wild trout populations. Examples would include Big Spring Creek in Cumberland County, Yellow Creek in Bedford County, and Piney Creek in Blair County. These three streams and several other Class A wild trout streams are in rural/agricultural areas. The Quittie is in an agricultural setting as well, but there is also a strong urban influence. Even so, there are other limestone streams in urban settings that support the Class A wild trout designation. Examples include Spring Creek in Centre County, Little Lehigh Creek in Lehigh County, and the LeTort Spring Run in Cumberland County. So, while the urban setting of the Quittie is a negative factor for trout, the urban character of the watershed should not prevent the stream from supporting a thriving trout population.

Anecdotal reports and the popular literature suggest that the Quittapahilla Creek is a legitimate cold-water stream throughout the year (Faulk, 1992; Wolf, 1999; Attardo, 2010; Henry, 1996). These reports are encouraging, but there is reason for skepticism about these glowing accounts. The Regional Biologist for the Pennsylvania Fish and Boat Commission, Kris Kuhn, states that he cannot recall ever seeing many small trout in the Quittapahilla Creek (personal communication, October 2013). Thus, natural reproduction must be very low. Also, interviews with several anglers who frequently fish the Quittapahilla Creek cannot recall catching any trout in the lower reaches of the stream in late summer. In 1999 a U.S. Geological Survey electrofishing effort in early fall near the mouth of the creek turned up lots of suckers, but no trout. Further, electrofishing surveys in late July 2004 found trout at three sampling stations in the upper reaches of the Quittie, but none at three sampling stations downstream from the town of Annville (Clear Creeks Consulting, 2006a). Thus, there is reason to believe that the stream is not all that it could be.

This apparent lack of trout in the lower reaches of the Quittie may be due to low dissolved-oxygen concentrations and/or warm water temperatures. We already know that nutrient concentrations are high in the waters of the Quittapahilla Creek Watershed (Pennsylvania Department of Environmental Protection, 2000; Clear Creeks Consulting, 2006a). High nutrient concentrations promote heavy growths of attached algae and rooted aquatic plants. These plants undergo photosynthesis in the day supplying extra oxygen to the water. At night, when there is no sunshine to fuel photosynthesis, this oxygen pump shuts down. But plant respiration (which consumes oxygen) and whole-stream metabolism (which consumes oxygen) continue at night. This causes depressed dissolved-oxygen concentrations in the stream. Thus, a diel pattern of high daytime oxygen concentrations and low nighttime concentrations prevails (Figure 1).

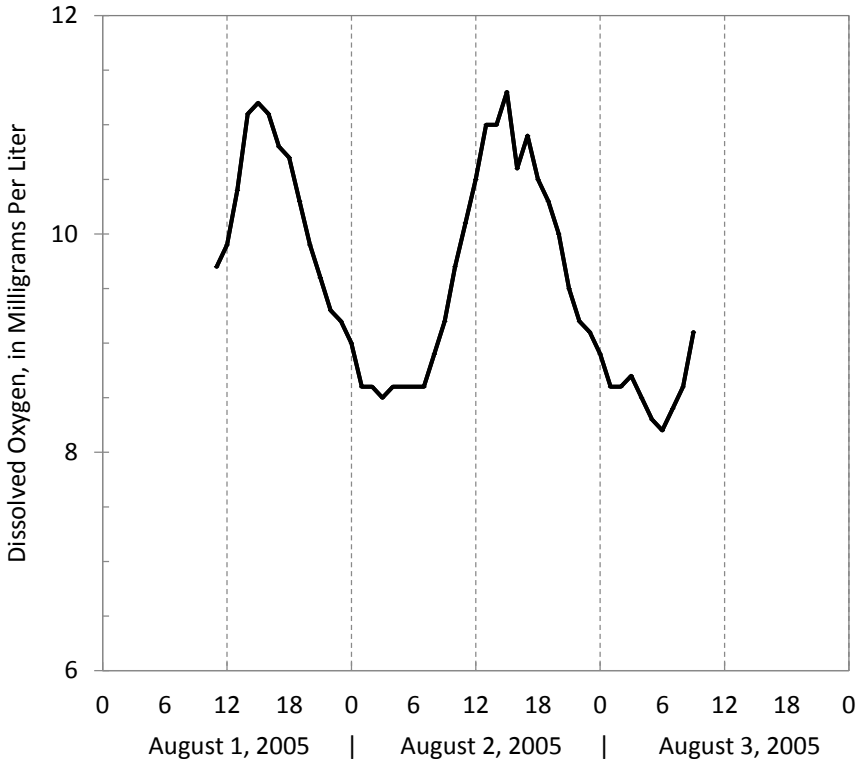

Figure 1. Diel changes in dissolved-oxygen concentrations, Quittapahilla Creek near Bellegrove, Pennsylvania, August, 2005, showing daytime maxima and nighttime minima. (Redrawn from Crawford and others, 2007).

Most streams get warmer as they flow downstream. In part, this is because the stream is wider allowing more sunlight to hit the water. Also, the influence of any cooling input from springs is dampened by the larger volumes of water in the stream. In 2004, Clear Creeks Consulting did a comprehensive water-quality study of the Quittapahilla Creek Watershed. Findings from that study indicate that for the Quittapahilla Creek, the water gets cooler in the downstream direction. This is because springs and cool tributaries enter the stream periodically along its length (Clear Creeks Consulting 2006a). But even with the cooler water downstream, temperatures in the hot summertime were marginal for trout survival.

A determination is needed to define the temperature and dissolved-oxygen regimes in the Quittapahilla Creek. If low dissolved-oxygen concentrations and/or high temperatures are found, then stream-improvement projects could be implemented to address the problems and management programs put in place to improve the fishing. On the other hand, if temperature and dissolved-oxygen regimes are suitable for trout survival and reproduction, then different management strategies (for example, special regulations or sediment control or habitat improvement) could be tailored to enhance the fishery. In addition, locations of cold-water and

warm-water inputs need to be identified. Then, projects could be formulated to protect cold inputs or remediate warm inputs.

Objectives and Scope

This proposal outlines a study to evaluate the temperature and dissolved-oxygen conditions in the Quittapahilla Creek throughout the hottest time of the summer. The study will determine the suitability of the stream to support a year-round cold-water trout fishery. Results of the study can be used to suggest remedial measures and management alternatives that would provide extended angling opportunities on this stream. The study is designed to be conducted in the summer by two college student interns, who would gain experience in conducting a research project. A faculty member from Lebanon Valley College (Dr. Rebecca Urban) would supervise the students and provide classroom instruction. An experienced aquatic scientist (Dr. Kent Crawford) would guide the study and serve as mentor for the students. Sponsorship and collaboration from the Lebanon Valley College (LVC), the Quittapahilla Watershed Association (QWA), the Doc Fritchey Chapter of Trout Unlimited (DFTU), and the Lebanon County Conservation District (LCCD) would provide support for the project.

Thus, the overall objectives of the proposed work are:

1. To provide credible scientific information on temperature and dissolved-oxygen concentrations that can be used for science-based management options to enhance the trout population of the Quittapahilla Creek,

2. To identify locations of cold-water inputs (tributaries and springs) and warm-water sources (tributaries, effluents, and runoff) for the Quittapahilla Creek, and

3. To provide training for college students in water-quality monitoring, scientific writing, and conducting scientific research.

The research would employ continuous temperature-monitoring devices during the hottest months of the year at several strategic locations throughout the Quittapahilla Creek Watershed (Figure 2). Four dissolved-oxygen monitors would be deployed, primarily at locations downstream from Annville. Two synoptic surveys of dissolved oxygen and temperature would be conducted, one in the wee hours of the morning and one during the hottest part of the day. These synoptic surveys would include multiple sampling locations, all sampled within a two-hour time frame with the objective of identifying cold-water and warm-water influences. A seven-month study period is suggested, from June 2017 through December 2017.

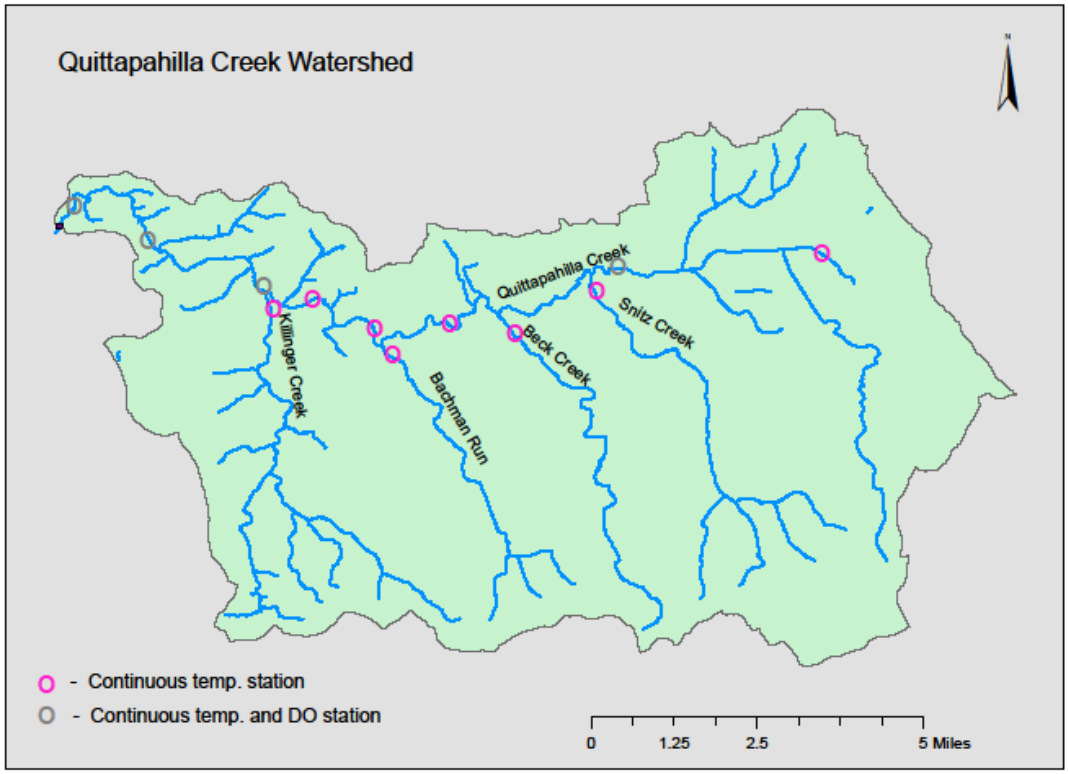

Figure 2. Map of the Quittapahilla Creek Watershed showing locations for proposed temperature and dissolved oxygen monitoring stations.

APPROACH

Continuous Temperature Monitoring

Trout are cold-water fish. At a water temperature of 21° Celsius, trout begin to experience thermal stress (Coutant, 1977). Water temperatures higher than about 28° Celsius (80° Fahrenheit) are lethal. Therefore, the mid-summer to late-summer period is the most critical for stream temperatures. For example, consider the temperature profile for the West Branch of the Susquehanna River at Karthaus (Figure 3). During 2015, the highest temperatures occurred during July and August. This pattern is typical for streams in the Northern Hemisphere. But, while this general pattern holds for most streams, the exact period (week or day) of the highest temperatures changes from year to year. Furthermore, stream temperature varies over the course of a day. The highest temperature could occur at noon or at 2 p.m. or 4 p.m. So, a temperature study should measure temperature over the duration of a summer and at all times of the day. Hence, continuous temperature measurement is called for.

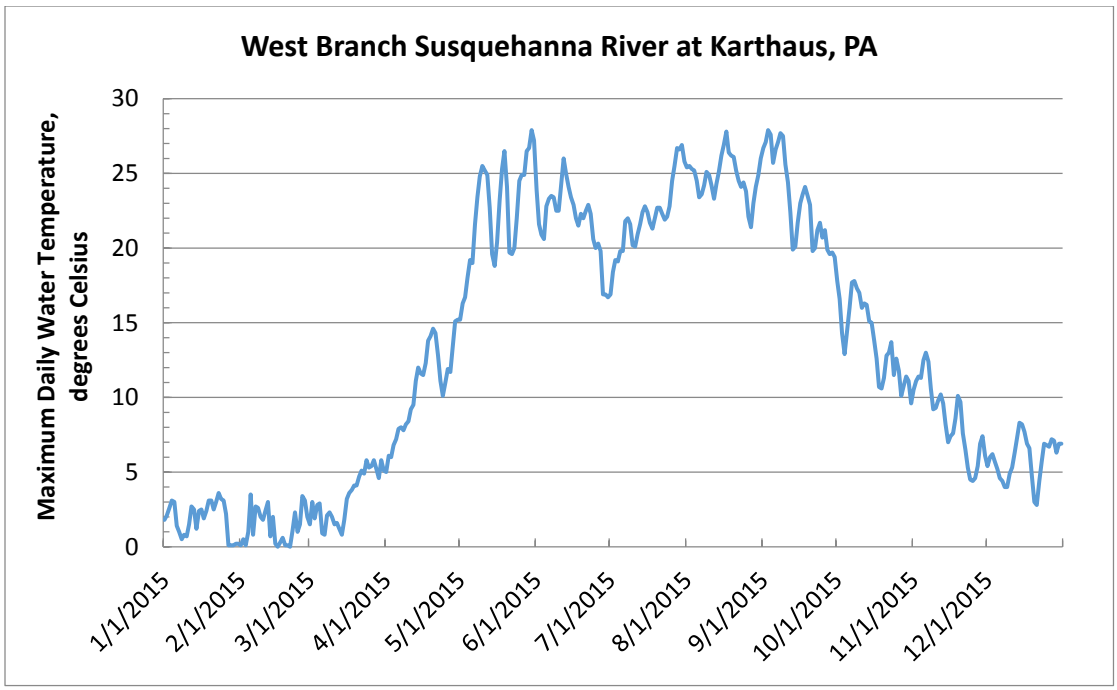

Figure 3. Daily maximum temperatures for the West Branch of the Susquehanna River at Karthaus, Pennsylvania, 2015. Data provided by the U.S. Geological Survey.

Further, there is evidence that summertime runoff from impervious areas can provide a spate of warm water to a receiving water body (Van Buren and others, 2000). For example, a thunder shower on a hot summer day may provide a flush of hot water from a large parking lot at a mall or a big box store or a downtown area. These temporary temperature spikes could be captured only with a continuous-monitoring approach.

Continuous temperature measurements can be collected easily with today's monitoring equipment. These devices are marketed by a number of different manufacturers (for example, Hydrolab, Eureka, Onset, YSI). A temperature monitoring device is simply placed in the stream a location of interest. The monitoring device remains in the stream and saves temperature measurements to an internal memory on a pre-determined schedule (for example, every 15 minutes or every hour). After a period of time (perhaps weeks or a month), the monitoring device is retrieved and the data are transferred from the internal memory to an external computer for storage and analysis.

This proposal calls for twelve continuous temperature recorders to be placed at critical locations in the Quittapahilla Creek (Table 1). These devices would provide a record of temperature for June, July, and August.

Continuous Dissolved-Oxygen Monitoring

Similarly, dissolved-oxygen monitoring should be done on a continuous basis. During daylight hours, dissolved oxygen concentrations in a stream increase because plants in the water are producing oxygen through photosynthesis. Photosynthesis cannot proceed without energy from the sun, so this dissolved oxygen source is inactive at night. But, plant respiration is a 24-hour phenomenon which consumes oxygen. In addition to plants, other organisms in the stream (fish, invertebrates, bacteria) are also respiring on a 24-hour basis and consuming oxygen all the while. Thus, dissolved-oxygen concentrations are lowered during the night. The result is a 24-hour cycle with higher concentrations in the day and lower concentrations at night. The daily minimum DO concentrations are expected to occur at the end of the night, just prior to sunrise. Continuous monitoring will capture these DO minima that occur around 5:00 a.m. Dissolved-oxygen concentrations may be especially critical for a stream like the Quittapahilla Creek because of the abundant plant life present and because the relatively low gradient of the stream limits reaeration.

Installation of four continuous dissolved-oxygen monitors is proposed. Each monitor would be capable of reading temperature and dissolved oxygen at pre-set (for example, hourly) intervals. These monitors would be deployed in mid-June and would remain in place through the end of August.

Like temperature monitors, continuous monitors for dissolved oxygen also are marketed by a number of manufacturers. One major difference between DO monitors and temperature monitors is the cost. DO monitors are more expensive. Therefore, we are proposing only four stream sampling sites for deployment of DO monitors (Table 1).

By deploying continuous monitors, temperature maxima and dissolved oxygen minima will be captured. Comparing the measured temperatures and dissolved-oxygen concentrations with the requirements for trout will allow an evaluation of whether the Quittapahilla Creek can support a year-round trout fishery. If temperatures that are too high or dissolved-oxygen concentrations that are too low are observed, then remediation measures and/or management alternatives can be suggested to address the problem(s).

Table 1. Proposed Quittapahilla Creek Watershed sampling locations for deployment of temperature and dissolved-oxygen monitors and for synoptic surveys.

	Station name	Continuous water temperature monitor?	Continuous dissolved oxygen monitor?	Temperature synoptic survey sampling site?	Dissolved oxygen synoptic survey sampling site?
1	Quittapahilla Creek at T395 (Metro Drive) (near the stream headwaters)	Yes	--	Yes	Yes
2	Quittapahilla Creek at Chestnut Street (downstream from the City of Lebanon)	Yes	Yes	Yes	Yes
3	Snitz Creek at LR38026 (Dairy Road) (near the mouth)	Yes	--	Yes	Yes
4	Lebanon WWTP effluent	--	--	Yes	Yes
5	Quittapahilla Creek at LR38026 (Dairy Road) (downstream from Snitz Creek, upstream from Beck Creek).	--	--	Yes	Yes
6	Beck Creek at T421 (Bricker Lane) (near the mouth)	Yes	--	Yes	Yes
7	Quittapahilla Creek at Quittie Nature Park footbridge (downstream from Beck Creek, upstream from Bachman Run).	Yes	--	Yes	Yes
8	Bachman Run at T431 Reigerts Lane) (near the mouth)	Yes	--	Yes	Yes
9	Quittapahilla Creek at US Route 422 (West Main Street) (d/s from Bachman Run, u/s from Annville WWTP effluent).	Yes	--	Yes	Yes
10	Annville WWTP effluent	--	--	Yes	Yes
11	Quittapahilla Creek at Clear Spring Road (downstream from Annville WWTP effluent).	Yes	--	Yes	Yes
12	Killinger Creek at T376 (upstream from WWTP, quarry)	--	--	Yes	Yes
13	Killinger Creek at the mouth (access from Syner Road)	Yes	--	Yes	Yes
14	Quittapahilla Creek at T4008 (Palmyra-Bellegrove Road) (downstream from Killinger Creek, d/s from Palmyra WWTP)	Yes	Yes	Yes	Yes
15	Quittapahilla Creek at LR38045 (Syner Road)	Yes	Yes	Yes	Yes
16	Quittapahilla Creek at LR38003 (Gravel Hill Road) (near the mouth)	Yes	Yes	Yes	Yes

Synoptic Surveys for Temperature and Dissolved Oxygen

A synoptic survey provides a broad areal overview of conditions at a particular point in time. That is, many sampling locations are sampled in the shortest amount of time possible. The intent is to provide a snapshot of conditions throughout an area, in this case, a watershed. For the Quittapahilla Creek study, two synoptic surveys are proposed, both during the heat of the summer. One synoptic survey would be conducted in the early morning (for example, 5 a.m.) when both temperature and dissolved oxygen would be at their very lowest, and one in the heat of the day (for example 3 p.m.) when temperature and dissolved oxygen would be at their very highest. Temperature and dissolved-oxygen concentrations would be measured at each site included in the synoptic survey. Specific conductance would also be measured, which could be used to identify spring sources and perhaps effluent sources.

These surveys would require four teams of two individuals each. Each team would visit four sampling stations in as rapid a progression as possible. Thus, a total of sixteen stations could be sampled within a short time period (perhaps two hours elapsed time). These synoptic surveys will allow identification of trouble spots in the watershed. That is, the synoptic surveys would pinpoint locations where high temperatures and/or low dissolved-oxygen concentrations are occurring. This information will be used to guide recommendations for remediation measures and management alternatives.

Our plan is for each of the two student interns, the Lebanon Valley College professor (Dr. Urban), and the project mentor (Dr. Crawford) to lead one of the four synoptic survey teams. This means that each team would have an individual trained in field measurements of temperature and dissolved oxygen. The second member of each team would be a volunteer who would be the driver, would serve as note taker, and would provide a safety factor for field activities. These volunteers would be recruited from the LVC, QWA, and/or DFTU.

Identification of Springs

By examining temperature data from the synoptic surveys, students will be able to identify locations where the stream gets colder or warmer. These locations will be examined further by walking the stream with temperature monitors to pinpoint the locations of cold-water inputs. Likewise, specific-conductance data from the synoptic surveys will be used to help identify spring inputs. Groundwater typically has a higher specific conductance than surface water, so increases in specific conductance may indicate a spring-water influence. Identification of springs will allow development of management options to protect and/or preserve these locations.

QUALITY ASSURNCE AND QUALITY CONTROL

We anticipate that temperatures and dissolved oxygen concentrations in the Quittapahilla Creek will be near or perhaps exceed critical values for supporting a trout population. Therefore, it is important that our measurements are accurate. Quality assurance and quality control will be stressed for all project activities.

Quality Assurance

The latest technology for field measurements will be used throughout the project. This includes using temperature-compensated barometers and dissolved-oxygen sensors having optical technology. A rugged notebook computer provided by Lebanon Valley College will be dedicated to the project.

Written protocols will be developed for both temperature dissolved-oxygen measurements. These protocols will allow for different individuals to collect the field measurements while using the exact same techniques. Classroom-type instruction will emphasize the importance of collecting quality data. Hands-on training will be provided for all field equipment. Field procedures will be demonstrated for all project personnel. Tests of proficiency will be employed to assure the students grasp the concepts and are comfortable with the equipment.

Instrument log books will be maintained for each instrument used in the project. These log books will document the performance of the instruments over the course of the study. Records in these books can be used to detect and correct instrument problems, if they occur.

Quality Control

Prior to being put into service, all field thermometers and thermistors will be standardized against a NIST-certified thermometer. The standardization will include checks at 0°, 25°, and 100° Celsius.

On the day of deployment, dissolved oxygen monitors will be calibrated in the lab using the DO saturation in air technique as recommended by the manufacturer (YSI, 2014). Additionally DO monitors will be checked against a zero DO solution prepared by adding sodium sulfite and cobalt chloride to water (Wilde and others, 1998). Performance of the monitors will be recorded in the log book for each individual instrument.

Once deployed in the field, bi-weekly maintenance of the dissolved-oxygen instruments will include downloading the data, cleaning the instrument, re-calibration and re-deployment. Maintenance every two weeks is not normally required for these instruments, but the need to collect the best quality data possible calls for extraordinary quality-control measures.

The raw dissolved-oxygen data that are downloaded from the monitors will be adjusted to account for instrument fouling and instrument drift. The final (adjusted) data will be stored on the project computer and will be backed up on USB flash drives and at Lebanon Valley College.

BENEFITS

Information gathered in this study will help to determine the suitability of the Quittapahilla Creek to sustain a year-round trout fishery. Sources of warm water to the stream will be pinpointed and cold-water springs and tributaries will be identified for protection and/or preservation. These data will be used to formulate management options.

Student interns will receive training and experience in study design and implementation, literature review, operation of field instruments, data collection, data management and analysis, report preparation, and oral presentations. The students will learn to calibrate, deploy, operate, and service continuous-monitoring instruments.

Results from this study will be used to guide water-quality improvement projects for the Quittapahilla Creek. If temperature and/or DO are found to present stressful conditions, then best management practices (BMPs) can be devised to address the problem(s). For example, low DO conditions would call for increased nutrient management or perhaps stream restoration measures to enhance reaeration. High temperatures would call for more shading or more diversion from surface runoff to groundwater. The long-term benefit would be improved management strategies for the Quittapahilla Creek, enhancing its viability as a trout stream, thereby providing improved recreational opportunities for the citizens of Lebanon County and beyond.

PRODUCTS

Several products are anticipated (table 2):

1. A database containing all temperature and dissolved-oxygen data collected for the project along with associated quality-control data will be prepared by the students in Microsoft Excel format. The database and associated metadata will be provided to the Quittapahilla Watershed Association for posting on their website, to the Biology Department at Lebanon Valley College, and to the Pennsylvania Fish and Boat Commission.
2. The students will present an oral briefing of their study to the Quittapahilla Watershed Association, the Doc Fritchey Chapter of Trout Unlimited, and the Lebanon County Conservation District in October, 2017.
3. The students will present a management-oriented presentation to appropriate staff of the Pennsylvania Fish and Boat Commission during the month of November, 2017.
4. A student-prepared final scientific report is anticipated. The report would include results from the study in both narrative and graphical formats, would summarize all findings, draw conclusions about the temperature and dissolved-oxygen regimes of the Quittapahilla Creek, and offer suggestions for management alternatives. This report will be due on December 31, 2017.

Table 2. -- Products anticipated from the temperature and dissolved-oxygen study.

Product	Targeted audience	Due date
Electronic database	QWA, LVC, PaFBC	September, 2017
Oral briefing	QWA, DFTU, LCCD	October, 2017
Management presentation	PaFBC	November, 2017
Written scientific report	LVC, QWA, PaFBC	December 31, 2017

SCHEDULE

Table 3.--Time lines for the proposed work.

Task	Calendar Year 2017											
	J	F	M	A	M	J	J	A	S	O	N	D
Project planning												
Student recruitment												
Equipment purchases												
Student training												
Continuous monitoring												
Synoptic sampling												
Data analysis												
Oral briefing for QWA, DFTU, LCCD												
Oral briefing for Penna. F&BC												
Report preparation												
Literature review												
Write draft report												
Prepare final report												
	J	F	M	A	M	J	J	A	S	O	N	D

BUDGET

We are requesting $34,371 from the Pennsylvania Fish and Boat Commission to complete the project. A breakdown of funds needed follows:

Category	Amount Needed	Unit Cost	Total, Calendar Year 2017
Salaries			
Student stipends	2	$4,200 each	$8,400
LVC professor stipend	12 weeks	$500 per week stipend	$6,000
Payroll tax		9% of wages and stipends	$1,296
Supplies and Equipment			
HOBO Water Temperature Pro v2 Data Logger (U22-001)	8	$150 each	$1,200
HOBO Diss. Oxygen Data Logger (U26-001)	4	$1,250 each	$5,000
HOBOware Pro Software	1	$100 each	$100
HOBO Waterproof Shuttle (U-DTW-1)	1	$250 each	$250
Multi-parameter field meter (In-Situ SmarTROLL)	2	$3,150 each	$6,300
Multi-parameter field meter -- rental (In-Situ SmarTROLL)	2	$650 each	$1,300
Field case for In-Situ SmarTROLL	2	$300	$600
Back-up ODO probe	1	$140	$140
Rebuild kit for pH probe	1	$120	$120
Calibration standards	pH buffers, sp. cond. stds.	Estimated costs	$600
DO calibration supplies	Sodium sulfite, cobalt chloride	Estimated costs	$400
Anchors for continuous monitors	12	Estimated costs	$400
NIST-certified thermometer	1	$400	$400
Batteries for field instruments			$25
Waders	2	$250 each	$500
Wading shoes	2 pair	$150 each pair	$300
Personal flotation device	2	$50	$100
Miscellaneous supplies: Labware, Kimwipes, gloves, first aid kit, hand sanitizer, anti-bacterial wipes, sun screen,		Estimated costs	$400
Mileage for student use of POV	1,000 miles	$0.54 per mile	$540
Total Direct Costs			$34,371
Indirect costs – Waived by Lebanon Valley College		45.4% of salaries, stipends and payroll taxes	$0
TOTAL FUNDING REQUESTED			**$34,371**

MATCHING CONTRIBUTIONS FROM PARTNERS

The Lebanon Valley College will provide summer housing for the students at no cost to the project. This applies only if the students elect to live on campus. Further, LVC will provide laboratory space, provide a computer dedicated to the project, and the intermittent services of College physical plant staff. In addition. LVC will waive all indirect costs for the project which are normally charged at 45.4 percent of salaries, stipends, and payroll taxes. For this project, indirect costs alone amount to $7,126. Dr. Crawford will donate his time and travel expenses needed for the project. Likewise, volunteers will donate time and travel expenses. In total, these contributions are valued at $23,402. See Attachment 1 for an accounting of these contributions.

PARTNERS

The project will be undertaken with support from LVC, QWA, LCCD, and DFTU. Lebanon Valley College will serve as the point of contact for the Fish and Boat Commission. The college will receive and distribute funds for the project, purchase equipment and supplies, pay students for their internships and travel costs. Both the Quittapahilla Watershed Association (Attachment 2) and the Doc Fritchey Chapter of Trout Unlimited (Attachment 3) will provide transportation, note-taking support, and a measure of safety during the synoptic surveys. The Lebanon County Conservation District (Attachment 4) will assist in identifying landowners for sampling stations and in obtaining access for conducting work on those properties. The QWA, DFTU, and LCCD will all be invited to listen to and critique a presentation of findings by the student interns as preparation for making a final presentation to the Pennsylvania Fish and Boat Commission.

COORDINATION

Frequent communications will be maintained among all partners and with the Fish and Boat Commission. The Lebanon County Planning Commission and the Lebanon County Commissioners will be informed of the project as a courtesy. At the beginning of the project, all partners will be included in establishing a date for the presentation of findings. Brief progress reports will be submitted to the funding agency on a monthly basis.

REFERENCES

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Attachment 1: Matching contributions for the project.

Project activity		Number of hours or miles	Cost per hour or mile or month	Value
Donated time for Dr. Crawford				
	Project planning	40	$ 50.00	$ 2,000
	Student training	80	$ 50.00	$ 4,000
	Synoptic surveys	20	$ 50.00	$ 1,000
	Management options	20	$ 50.00	$ 1,000
	Report preparation	40	$ 50.00	$ 2,000
Travel for Dr. Crawford				
	POV mileage			
	10 trips to LVC @30 miles per trip	300	$ 0.54	$ 162
	Daytime synoptic	50	$ 0.54	$ 27
	Nighttime synoptic survey	50	$ 0.54	$ 27
Travel for volunteer no. 1 for synoptic surveys				
	Daytime synoptic	50	$ 0.54	$ 27
	Nighttime synoptic survey	50	$ 0.54	$ 27
Travel for volunteer no. 2 for synoptic surveys				
	Daytime synoptic	50	$ 0.54	$ 27
	Nighttime synoptic survey	50	$ 0.54	$ 27
Contributions from Lebanon Valley College				
	Summer housing for student number 1[1]	12 weeks	$248	$ 2,976
	Summer housing for student number 2[1]	12 weeks	$248	$ 2,976
	Waiver of indirect costs			$ 7,126
	Total donated services			$ 23,402

[1] Housing costs will be provided at no charge to the project should the students decide to reside on campus.

Attachment 2: Letter of support from Quittapahilla Watershed Association.

Ms. Diana Day
Conservation Coordinator
Pennsylvania Fish and Boat Commission
1601 Elmerton Avenue
Harrisburg, PA 17110
26 September 2016

Dear Ms. Day,

This letter is sent in support of a proposal titled "Temperature and Dissolved Oxygen Information for Trout Management in the Quittapahilla Creek." This proposal has been submitted by Associate Professor of Biology Dr. Rebecca Urban at Lebanon Valley College to the Pennsylvania Fish and Boat Commission for funding consideration under the Tulpehocken and Quittapahilla Watershed Grant Program. The proposal calls for defining summertime high temperatures and low dissolved-oxygen concentrations. The Quittapahilla Watershed Association is a partner for the proposed work and fully supports the planned studies.

The Quittapahilla Creek is a cold-water stream that is not living up to its potential. This stream is managed as a put-and-take trout fishery, but with its cold water, why does it not support a wild trout population? A Total Maximum Daily Load (TMDL) evaluation completed by the Pennsylvania Department of Environmental Protection in 2000 identified sediment and nutrient loads as primary causes for impairments. However, that analysis did not evaluate summertime temperature maxima or dissolved-oxygen minima as potential stressors. This information gap needs to be filled in order to formulate rational fisheries management and watershed improvement strategies. The proposed work would provide that needed information.

The Quittapahilla Watershed Association has worked over the past years to improve conditions in the Quittapahilla Creek Watershed. Most recently, we have completed Phase I of a steam rehabilitation project in the Annville area of the Quittapahilla Creek. In July of this year, Phase II of that work was started and is now nearing completion. This work will provide stream narrowing, increased flow rates, streambank stabilization and habitat improvements for a half-mile section of the stream. We are confident these enhancements will improve the suitability of the Quittie for trout. But these projects cover only a small fraction of the stream. Are these problems significant impediments for the fish population? We do not know, and therefore support this effort to develop empirical information to answer this question.

The efforts of the QWA are paying off. Additional projects are planned, but more work is needed. The proposed research is a logical next step in building the informational data base needed to formulate the next Best Management Practices and future fisheries management plans.

The Quittapahilla Watershed Association is prepared to support the proposed project with our guidance and our time. Our members will be called upon to serve as a second member of four two-person sampling teams. We will provide transportation, note-taking services and an extra measure of safety during the proposed synoptic surveys. One of these proposed synoptic surveys will occur at night, and having a second person on a field team is a safety necessity.

Contributions from the QWA would be completely voluntary. No funds will accrue to the QWA as a result of our support.

Thank you for your consideration of the Lebanon Valley College application. We feel it is highly worthy of funding support.

Sincerely,

Dr. Michael J. Schroeder Co-President
Quittapahilla Watershed Association
8 East High Street
Annville PA 17003

Dr. David Lasky, Co-President
Quittapahilla Watershed Assocation
610 East Walnut Street
Annville PA 1703

cc:
Dr. Rebecca A. Urban, Associate Professor of Biology, Lebanon Valley College, 101 N. College Ave.. Annville PA 17003-1400
Dr. J. Kent Crawford, Environmental Scientist, 1115 Stonegate Road, Hummelstown PA 17036-9776

Attachment 3: Letter of support from Doc Fritchey Chapter of Trout Unlimited.

Trout Unlimited
Doc Fritchey Chapter
P.O. Box 6592
Harrisburg, PA 17112
www.dftu.org
E: rwarrencollins@gmail.com
P: 717-580-3958

1167 South Forge Road
Palmyra, PA 17078
September 20, 2016

Ms. Diana Day
Conservation Coordinator
Pennsylvania Fish and Boat Commission
1601 Elmerton Avenue
Harrisburg, PA 17110

Dear Ms. Day:

On opening day of trout season, the Quittapahilla Creek is abuzz with activity as anglers try their luck. The scene is quite amazing. Parking is at a premium and most anglers try to get to the stream early to get a choice spot. Lots of anglers catch trout and for most, it is a fun and exciting time. A big "Thank you" goes to the Pennsylvania Fish and Boat Commission for providing the stocking that results in this great outdoor experience.

But after opening day, things change. The crowds quickly diminish and an angler can frequently have long sections of the stream to himself or herself. The stocked fish are caught pretty quickly and those that are not caught apparently do not survive the hot summer. The Doc Fritchey Chapter of Trout Unlimited (DFTU) would like to see a change in management strategy for the Quittapahilla Creek to make it a year-round fishery that can sustain wild trout.

Therefore, DFTU is writing this letter in support of a proposal titled "Temperature and Dissolved Oxygen Information for Trout Management in the Quittapahilla Creek" This proposal has been submitted to the Pennsylvania Fish and Boat Commission for funding consideration under the Tulpehocken and Quittapahilla Watershed Grant Program. The proposal calls for defining summertime high temperatures and low dissolved-oxygen concentrations and has been submitted by Lebanon Valley College. The Doc Fritchey Chapter of Trout Unlimited is a partner for the proposed work and fully supports the planned studies.

The Quittapahilla Creek is a cold-water stream that is not living up to its potential. This stream is managed as a put-and-take trout fishery, but what prevents it from supporting a wild trout population? The Quittie is listed as an impaired waterway. Sediment and nutrients have been identified as the causative agents. But, from a trout management perspective, other problems may play a more important role. To our knowledge, there has never been a comprehensive evaluation of summertime temperature maxima or dissolved-oxygen minima as potential stressors. Are temperatures in the Quittie suitable for maintenance of a trout population? Do dissolved-oxygen concentrations in the Quittie cause stress among the trout? This information gap needs to be filled in order to formulate rational fisheries management and watershed improvement strategies. The proposed work would provide that needed information.

If the proposal is funded, the Doc Fritchey Chapter of Trout unlimited will be called on to provide support for the work. The proposal calls for two synoptic surveys for the stream. These surveys are designed to give a watershed-wide picture of conditions at a point in time. That means visiting many sampling locations in a short time period. DFTU volunteers stand ready and willing to assist with this task.

One of the basic approaches to conservation strategy of Trout Unlimited is to use the best science to drive conservation priorities. Please evaluate the proposal with that approach in mind.

Thank you for consideration of the LVC application. DFTU strongly supports the proposal and is willing to chip in with our time and talent.

Sincerely,

Russ Collins, President
Doc Fritchey Chapter of Trout Unlimited

cc: Dr. Rebecca A. Urban, Associate Professor of Biology, Lebanon Valley College, Lebanon, PA 17003-1400
Dr. J. Kent Crawford, Environmental Scientist, 1115 Stonegate Road, Hummelstown, Pa 17036-9776

Attachment 4: Letter of support from Lebanon County Conservation District.

LEBANON COUNTY CONSERVATION DISTRICT

2120 Cornwall Road * Suite 5 *Lebanon, PA 17042-9788
(717) 277-5275 FAX (717) 272-5314
www.lccd.org email: info@lccd.org

September 23, 2016

Diana Day
Conservation Coordinator
Pennsylvania Fish and Boat Commission
1601 Elmerton Avenue
Harrisburg, PA 17110

Dear Ms. Day:

The Lebanon County Conservation District (LCCD) has a long history of providing support to Lebanon County landowners in their efforts to protect and conserve natural resources. LCCD assists agricultural operators with manure management planning, developing erosion and sedimentation pollution control plans and installing best management practices. All tasks referenced are performed in an attempt to improve water quality in Lebanon County including but not limited to the Quittapahilla Creek.

Based on information provided within Lebanon Valley College's proposal, entitled "Temperature and Dissolved Oxygen Information for Trout Management in the Quittapahilla Creek", outcomes from the study are anticipated to guide water-quality improvement projects for the Quittapahilla Creek, thereby enhancing its viability as a trout stream while improving recreational opportunities along its reach. It is our hope that results of the study could be used not only by Pennsylvania Fish and Boat Commission but also to educate property owners within the Quittapahilla Creek watershed as incentive to encourage them to improve the quality of stormwater runoff from both agricultural and nonagricultural properties.

LCCD supports the proposal submitted by Lebanon Valley College and encourages the Pennsylvania Fish and Boat Commission to provide requested funding.

Sincerely,

Lynette J. Gelsinger
District Manager

Karl Kerchner
Assistant Manager

cc: Dr. Rebecca A. Urban, Associate Professor of Biology, Lebanon Valley College, Lebanon, PA 17003
Dr. J. Kent Crawford, Environmental Scientist, 1115 Stonegate Road, Hummelstown, Pa 17036

CONSERVING TODAY'S RESOURCES FOR TOMORROW