August 2018 Watershed Implementation Plan (WIP) for the Quittapahilla Watershed – Excerpts on Monitoring Program (pp. 209-217)

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VII. Monitoring Program

A. General

Monitoring will involve four separate programs. The first program will involve an evaluation of all subwatershed and mainstem restoration project reaches identified in the WIP. The second will involve an evaluation of all subwatershed restoration project reaches identified in the WIP. The third will focus on fixed points in the subwatersheds designated as representative of conditions over a broader subwatershed area. Because the mainstem Quittapahilla Creek includes a significant length of stream channel and watershed drainage area over which the QWA has no control, monitoring of the mainstem will not be included in Programs 2 and 3 outlined below. A fourth program will focus on evaluating progress along the mainstem.

B. Pre-Implementation and Post-Implementation Monitoring

1. Program 1 – Regulatory Monitoring

Restoration projects subject to federal permits are required to conduct a pre-implementation evaluation of the project stream reaches and post-construction monitoring for a five-year period of the restored reaches. The monitoring objectives include an evaluation of changes in channel cross-section; stream profile; channel stability; structural stability and condition; vegetation viability; and in-stream habitat.

The required monitoring typically includes topographic surveys of monumented cross- sections within the project area, visual field observations, photographic documentation, vegetation viability measurements, and identifies any necessary corrective measures. Additional information which demonstrates project success is included in annual monitoring reports. Typical monitoring components and frequency are described below and shown in Table 52.

The monitoring includes:

1. Evaluations of structural stability documenting changes in valley-wide cross sections across two structures in the re-located sections of stream channels. The representative cross-sections are monumented and shown in a graphical display which overlays previous cross-sections in annual reports.
2. Evaluations of structural stability by performing longitudinal profile surveys to document thalweg and water surfaces elevations. Longitudinal profiles are shown in a graphical display which overlays previous profiles in annual reports.
3. Evaluations of vegetation species richness and planted vegetation viability.
4. Evaluations of in-stream habitat quality using an assessment method such as EPA's

Rapid Bioassessment Protocol (RBP) high gradient stream habitat form. Results of the stream habitat assessment are shown for all monitoring years assessed, including preconstruction.

5. Photographic documentation of site conditions annually along the entire stream restoration project area. Photos of each top of riffle and constructed wetlands are required.

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6. Identification of any necessary corrective measures.

Table 52 – 404 Permit Monitoring Program				
Monitoring Components	**Pre- Construction**	**Year 1**	**Year 3**	**Year 5**
Geomorphic Assessment	**X**		**X**	**X**
Channel Cross-Sections	**Design**	**As-Built**	**X**	**X**
Longitudinal Profile	**Design**	**As-Built**	**X**	**X**
Vegetation Survey		**X**	**X**	**X**
Stream Habitat Assessment	**X**	**X**		**X**
Photo Documentation	**X**	**X**	**X**	**X**
Corrective Measures			**X**	**X**

This regulatory monitoring will be required of all projects in the subwatersheds and along the mainstem Quittapahilla Creek.

The pre-implementation monitoring will be conducted by the QWA's consultant during the design and permitting phase of each project. The cost of that effort has been incorporated into the design and permitting budget for all of subwatershed and mainstem restoration project reaches identified in the WIP. With the exception of Year 1, post-implementation monitoring will be conducted by QWA and Doc Fritchey Chapter of Trout Unlimited volunteers and/or college interns funded by QWA and Doc Fritchey Chapter of Trout Unlimited and trained by Clear Creeks Consulting. Year 1 documentation is provided by QWA's consultant and contractor.

Protocols for the assessments were developed to provide information that can be utilized to evaluate overall channel stability and in-stream habitat. The assessments included riffle pebble counts to assess riffle embeddedness; BANCS evaluations of eroding streambanks to estimate bank erosion rates and calculate sediment loadings; field measurements of representative riffle and pool baseflow and bankfull dimensions; and photo-documentation of existing conditions along the proposed project reaches.

2. Program 2 – WIP Subwatershed Project Reach Evaluations

The original field reconnaissance data utilized to identify problem areas and potential restoration projects in the subwatersheds is now fifteen years old. To document stream reach conditions and determine the continued need for restoration/stabilization along the subwatershed project reaches, QWA began conducting pre-implementation geomorphic assessments in 2017. These assessments were conducted by summer college interns funded by QWA and Doc Fritchey Chapter of Trout Unlimited and trained by Clear Creeks Consulting. The focus of the 2017 assessments was the restoration project reaches identified in the Snitz Creek subwatershed. Similar assessments were conducted during summer 2018 along Beck Creek subwatershed.

Protocols for the assessments were developed to provide information that can be utilized to evaluate overall channel stability and in-stream habitat. The assessments included riffle pebble counts to assess riffle embeddedness; BANCS evaluations of eroding streambanks to estimate bank erosion rates and calculate sediment loadings; field measurements of representative riffle and pool baseflow and bankfull dimensions; and photo-documentation of existing conditions along the proposed project reaches.

QWA intends to continue these pre-implementation geomorphic assessments along Bachman Run, Gingrich Run and Killinger Creek over the next few summers.

3. Program 3 – Subwatershed TMDL Monitoring Stations

Eight (8) long-term monitoring sites have been selected throughout the four major subwatersheds (Figure 25 and Table 53). The monitoring objectives include documenting baseline conditions, and determining and documenting progress towards meeting water quality and habitat improvement goals. This effort is not intended to replace the detailed monitoring and documentation conducted by PADEP. It will provide data that may indicate conditions have sufficiently improved to warrant PADEP's involvement with follow-up monitoring.

Pre-Implementation and Post-Implementation Monitoring will follow the Pennsylvania Improving Waters Program Guidelines (PADEP, 2016). The monitoring will utilize the field protocols outlined in the Water Quality Monitoring Field Manual for the Pennsylvania Senior Environment Corps (Nature Abounds and PADEP, 2013) or more rigorous methodologies where expertise is available. The monitoring will include geomorphic and in-stream habitat assessments, macroinvertebrate sampling and water quality sampling.

The pre-implementation geomorphic and in-stream habitat assessments will document stream reach conditions. They will include riffle pebble counts to evaluate riffle embeddedness, field measurements of representative riffle and pool baseflow and bankfull dimensions, evaluations of in-stream cover for fish, streambank condition, evaluation of streambank and riparian vegetation and photo-documentation of existing conditions. The pre-implementation geomorphic and in-stream habitat assessments will be conducted at each of the tributary monitoring stations. The assessments will be conducted annually for a minimum of three years prior to implementation and every two years post-implementation (Table 54). Once implementation of restoration projects begins in a given watershed, the annual monitoring will have entered the Post-Implementation phase for that subwatershed. These assessments will be conducted annually by college interns funded by QWA and Doc Fritchey Chapter of Trout Unlimited and trained by Clear Creeks Consulting. Data management for both phases will involve data analysis by Clear Creeks and data storage by QWA.

Pre-implementation biological surveys will provide baseline data characterizing the macroinvertebrate communities at the tributary monitoring stations. The macroinvertebrate surveys will be conducted annually for two to three years prior to implementation and every two years post-implementation (Table 54). Benthic macroinvertebrates will be collected at each of the eight sampling stations between October 1st and May 1st at the same time each year. Spring samples are preferred when one seasonal sample is collected since many immature aquatic insects are most developed prior to spring emergence. However, fall samples can provide an opportunity to collect fall-emerging aquatic insects that are often not collected in spring samples.

Samples will be collected using the 20-jab method. A standard D-frame aquatic net will be used to collect 20 separate samples from approximately one square foot of habitat throughout the sampling reach. These samples will be divided proportionally among the various habitats present within the sampling reach. Riffle samples will be collected with the aid of running water as with a kick seine, while pool and vegetation samples will be taken with a sweeping or jabbing

motion. All 20 samples will be combined into one composite sample for each sampling station. Sub-sampling is often employed in benthic macroinvertebrate studies, but full inventories of in-stream fauna are desired for this assessment. Samples with SAV and other debris will be fully inspected before discarding. Picked macroinvertebrates will be placed into labeled Nalgene jars with 70% ethyl alcohol (ETOH) for preservation. Alcohol preservative will be decanted and replaced with fresh ETOH after 24 hours to limit inadequate preservation due to introduced water and internal organism fluids. Macroinvertebrates will be sorted and identified using a zoom stereoscopic microscope and fiber-optic lighting. Final sorting of debris will also be accomplished and all organisms returned to fresh ETOH in labeled Nalgene jars for long-term storage and retention.

Taxonomic determinations will be made to the lowest practical taxonomic level, which for the purposes of this assessment are class for worms and family for molluscs and insects. While lower taxonomic determinations may provide additional ecological information, greater precision generally requires more intensive specimen preparation and examination.

The macroinvertebrate sampling will be conducted by Lebanon Valley College, Biology Department, with support from QWA and Doc Fritchey Chapter of Trout Unlimited volunteers trained by PADEP, Division of Water Quality. The taxonomic identification will be conducted by Lebanon Valley College, Biology Department. Data management will involve data analysis by Dr. Becky Urban, Lebanon Valley College and Clear Creeks Consulting and data storage by QWA. Biometrics will be developed to provide a water quality rating score for each station.

Pre-implementation water quality monitoring will provide baseline data characterizing the water quality along the tributary project stream reaches. Sample analysis will include pH, dissolved oxygen, specific conductance, total alkalinity, orthophosphate phosphorus, total phosphorus, nitrate, total Kjeldahl nitrogen, total nitrogen, sulfate, total dissolved solids, total suspended solids, turbidity, and fecal coliform. The water quality samples will be collected under storm flow conditions a minimum of six storms per year for a minimum of two years prior to implementation and every three years post-implementation (Table 54). Sample collection will be conducted by QWA and Doc Fritchey Chapter of Trout Unlimited volunteers at the tributary monitoring stations. Samples will be preserved and transported to PADEP, Division of Water Quality for analysis.

Hobo® Tidbit v2 Water Temperature Data Loggers will be installed at each of the tributary stations by Clear Creeks Consulting to record continuous temperature readings. The temperature data loggers will be maintained for a minimum of three years pre-implementation and minimum of ten years post-implementation. Data management will involve data downloading and analysis by Clear Creeks and data storage by QWA.

4. Program 4 – Mainstem WIP Monitoring Stations

Four (4) long-term monitoring sites have been selected along the mainstem Quittapahilla Creek (Figure 25 and Table 53). The monitoring objectives include documenting baseline conditions, and determining and documenting progress towards meeting water quality and habitat improvement goals. This effort is not intended to replace the detailed monitoring and documentation conducted by PADEP. It will provide data that may indicate conditions have sufficiently improved to warrant PADEP's involvement with follow-up monitoring.

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Pre-implementation monitoring will be conducted annually for two to three years. The Post-Implementation phase for the mainstem monitoring stations will begin three years after implementation begins on the MS4 projects upstream of the Q1 Station (downstream of Mill Street).

Pre-Implementation and Post-Implementation Monitoring will follow the Pennsylvania Improving Waters Program Guidelines (PADEP, 2016). The monitoring will utilize the field protocols outlined in the Water Quality Monitoring Field Manual for the Pennsylvania Senior Environment Corps (Nature Abounds and PADEP, 2013) or more rigorous methodologies where expertise is available. The monitoring will include geomorphic and in-stream habitat assessments, macroinvertebrate sampling and water quality sampling.

The pre-implementation geomorphic and in-stream habitat assessments will document stream reach conditions. They will include riffle pebble counts to evaluate riffle embeddedness, field measurements of representative riffle and pool baseflow and bankfull dimensions, evaluations of in-stream cover for fish, streambank condition, evaluation of streambank and riparian vegetation and photo-documentation of existing conditions. The pre-implementation geomorphic and in-stream habitat assessments will be conducted at each of the tributary monitoring stations. The assessments will be conducted annually for a minimum of three years prior to implementation and every two years post-implementation (Table 54). Once implementation of restoration projects begins in a given watershed, the annual monitoring will have entered the Post-Implementation phase for that subwatershed. These assessments will be conducted annually by college interns funded by QWA and Doc Fritchey Chapter of Trout Unlimited and trained by Clear Creeks Consulting. Data management for both phases will involve data analysis by Clear Creeks and data storage by QWA.

Pre-implementation biological surveys will provide baseline data characterizing the macroinvertebrate communities at the tributary monitoring stations. The macroinvertebrate surveys will be conducted annually for two to three years prior to implementation and every two years post-implementation (Table 54). Benthic macroinvertebrates will be collected at each of the eight sampling stations between October 1st and May 1st at the same time each year. Spring samples are preferred when one seasonal sample is collected since many immature aquatic

insects are most developed prior to spring emergence. However, fall samples can provide an opportunity to collect fall-emerging aquatic insects that are often not collected in spring samples.

Samples will be collected using the 20-jab method. A standard D-frame aquatic net will be used to collect 20 separate samples from approximately one square foot of habitat throughout the sampling reach. These samples will be divided proportionally among the various habitats present within the sampling reach. Riffle samples will be collected with the aid of running water as with a kick seine, while pool and vegetation samples will be taken with a sweeping or jabbing motion. All 20 samples will be combined into one composite sample for each sampling station. Sub-sampling is often employed in benthic macroinvertebrate studies, but full inventories of in-stream fauna are desired for this assessment. Samples with SAV and other debris will be fully inspected before discarding. Picked macroinvertebrates will be placed into labeled Nalgene jars with 70% ethyl alcohol (ETOH) for preservation. Alcohol preservative will be decanted and replaced with fresh ETOH after 24 hours to limit inadequate preservation due to introduced water and internal organism fluids. Macroinvertebrates will be sorted and identified using a

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Taxonomic determinations will be made to the lowest practical taxonomic level, which for the purposes of this assessment are class for worms and family for molluscs and insects. While lower taxonomic determinations may provide additional ecological information, greater precision generally requires relatively mature organisms and more intensive specimen preparation and examination.

The macroinvertebrate sampling will be conducted by Lebanon Valley College, Biology Department, with support from QWA and Doc Fritchey Chapter of Trout Unlimited volunteers trained by PADEP, Division of Water Quality. The taxonomic identification will be conducted by Lebanon Valley College, Biology Department. Data management will involve data analysis by Dr. Becky Urban, Lebanon Valley College and Clear Creeks Consulting and data storage by QWA. Biometrics will be developed to provide a water quality rating score for each station.

Pre-implementation water quality monitoring will provide baseline data characterizing the water quality along the tributary project stream reaches. Sample analysis will include pH, dissolved oxygen, specific conductance, total alkalinity, orthophosphate phosphorus, total phosphorus, nitrate, total Kjeldahl nitrogen, total nitrogen, sulfate, total dissolved solids, total suspended solids, turbidity, and fecal coliform. The water quality samples will be collected under storm flow conditions a minimum of six storms per year for a minimum of two years prior to implementation and every three years post-implementation (Table 54). Sample collection will be conducted by QWA and Doc Fritchey Chapter of Trout Unlimited volunteers at the tributary monitoring stations. Samples will be preserved and transported to PADEP, Division of Water Quality for analysis. Data management will involve data analysis by Clear Creeks and data storage by QWA.

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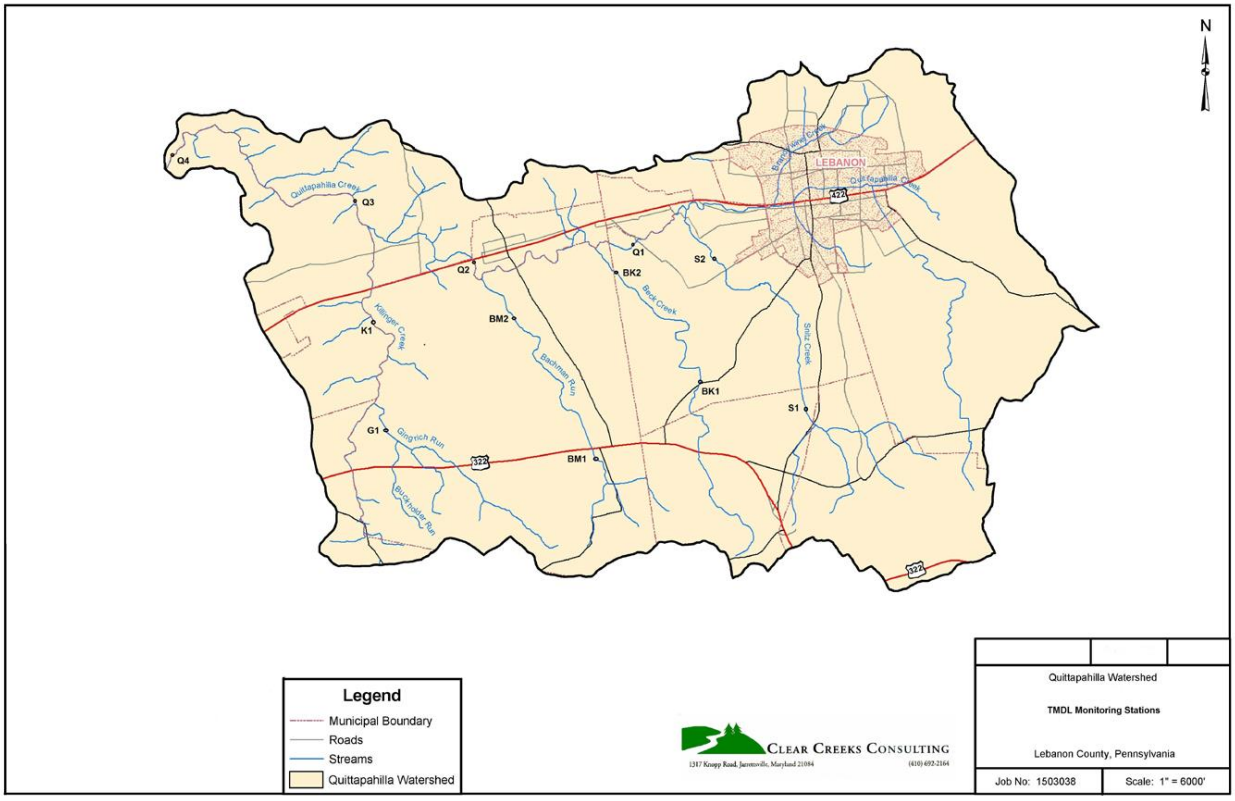

Figure 25 – TMDL Monitoring Station Locations

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Table 53 – TMDL Monitoring Station Locations					
Subwatershed	**Station ID**	**Location**	**Sampling Type**		
Bachman Run	BM1	UPS of Route 322	Geomorphic/In-Stream Habitat	Biological	Water Quality
	BM2	UPS of Copenhaver Lane	Geomorphic/In-Stream Habitat	Biological	Water Quality
Beck Creek	BK1	DS of Colebrook Road	Geomorphic/In-Stream Habitat	Biological	Water Quality
	BK2	UPS of Bricker Lane	Geomorphic/In-Stream Habitat	Biological	Water Quality

Gingrich Run	G1	UPS of Louser Road	Geomorphic/In-Stream Habitat	Biological	Water Quality
Killinger Creek	K1	UPS of Killinger Road	Geomorphic/In-Stream Habitat	Biological	Water Quality
Snitz Creek	S1	DS of Zinns Mill Road	Geomorphic/In-Stream Habitat	Biological	Water Quality
	S2	UPS of Walden Street	Geomorphic/In-Stream Habitat	Biological	Water Quality
Upper Mainstem	Q1	DS of Mill Street	Geomorphic/In-Stream Habitat	Biological	Water Quality
	Q2	UPS of Route 422	Geomorphic/In-Stream Habitat	Biological	Water Quality
Lower Mainstem	Q3	Palmyra-Bellegrove Bridge	Geomorphic/In-Stream Habitat	Biological	Water Quality
	Q4	Gravel Hill Road	Geomorphic/In-Stream Habitat	Biological	Water Quality

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Table 54 – TMDL Monitoring Schedule

Subwatershed	Station ID	Projects	Implementation Period	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
Snitz Creek	S1	1-16	2019-2025	X	X	X		X		X		X		X															
	S2	18-23	2025-2028						X	X	X		X		X		X		X										
Gingrich Run	G1	1-5	2019-2030	X	X	X		X		X		X		X		X		X		X									
Killinger Creek	K1	1-6	2019-2022	X	X	X		X		X		X			X		X		X		X								
Beck Creek	BK1	1-10	2023-2034				X		X				X		X		X		X		X		X		X				
	BK2	11-18	2023-2036				X	X									X	X	X		X		X		X				
Bachman Run	BM1	1-9	2025-2038								X		X	X		X		X		X		X		X		X		X	
	BM2	10-15	2027-2039								X		X			X		X		X		X		X		X		X	X
Upper Mainstem	Q1	SQ2-6	TBD	X	X	X	X		X		X			X															
	Q2	8-15	2019-2025	X	X	X	X		X	X		X			X														
Lower Mainstem	Q3	16-21	2025-2030					X	X		X		X	X		X		X		X									
	Q4	22-28	2030-2038												X	X	X			X		X		X		X		X	
			Total	5	5	5	4	5	5	5	5	4	5	5	5	5	5	5	4	5	3	3	2	3	2	3		3	1