Table 6. Lower Susquehanna River Subbasin Survey Streams Identified as Impaired Streams Requiring a TMDL on MDE's 2006 Draft Integrated 303(d) List

Basin Code	Basin Name	303(d) Listing Year	Impairment Category	Impairing Pollutant	Stations In Impaired Sections
2120201	Lower Susquehanna River	1996, 2002	Metals, Sediment, Toxics	Cadmium, Sediments, PCBs-fish tissue	
2120202	Deer Creek	2002, 2006	Biological	Unknown	
2120203	Octoraro Creek	2006	Biological	Unknown	
2120204	Conowingo Dam Susquehanna River	1996	Sediments, Nutrients	Sediments, Nutrients	
2120204	Conowingo Dam Susquehanna River (Conowingo Creek)	2002	Biological	Unknown	CNWG 1.8

RIDGE AND VALLEY ECOREGION

Penns Creek Watershed

Penns Creek Watershed is comprised largely of forested ridges and agricultural valleys and includes popular recreation areas for camping and fishing in Poe Valley State Park and Poe Paddy State Forest. The headwaters site (PENN 50.6) had nonimpaired biology, although the sites downstream (PENN 30.0 and PENN 5.0) were rated slightly impaired. The habitat was excellent at PENN 30.0, although the macroinvertebrate community was slightly impaired, possibly due to the heavy recreational use. The water quality was rated "middle" throughout the watershed mostly due to slightly high nutrient concentrations and, at the mouth of Penns Creek, slightly high temperature, which often is a problem on Penns Creek due to its slow-moving nature near the mouth.

The biological conditions varied at the tributaries to Penns Creek, ELKN 0.1, WPIN 0.8, and LRLN 0.8. Although they had similar water quality and habitat ratings, these tributaries differed with regard to water quality impacts and land uses. ELKN 0.1 and WPIN 0.8 drain agricultural areas in Penns Valley and have slightly high nutrient levels and, at WPIN 0.8, high total suspended solids (TSS). ELKN 0.1 was moderately impaired, while WPIN 0.8 was only slightly impaired, possibly due to a higher percentage of forested cover in Pine Creek Watershed. Laurel Run (LRLN 0.8) was sampled as it came off forested ridges and has low alkalinity and slightly high total phosphorus. This site had nonimpaired biological conditions.

Middle Creek Watershed

Middle Creek suffers from impairments that appear to be due to high total phosphorus concentrations. Each site in the watershed, MIDL 24.7, NMID 0.7, and MIDL 0.7, exceeded the level of concern for total phosphorus, and MIDL 0.7 had the highest total phosphorus level (0.902 mg/l) of all the sites in the Lower Susquehanna Subbasin (Table 4). Biological conditions in the Middle Creek Watershed were moderately or slightly impaired. The habitat in this watershed was designated supporting and partially supporting due to low ratings for instream parameters such as cover, substrate, and embeddedness and riparian habitat such as riparian vegetative zone. The habitat assessment at MIDL 24.7 also indicated that the sediment had an odor. Further study is needed on Middle Creek to determine the source of high total phosphorus. Possibilities include malfunctioning or outdated wastewater treatment plants, leaking septic systems, chemical fertilizers, animal waste, and soil erosion.

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Penns Creek.

Shamokin, Mahanoy, Mahantango, and Wiconisco Creek Watersheds

Shamokin, Mahanoy, Mahantango, and Wiconisco Creek Watersheds all contain sections that were impacted by abandoned mine drainage (AMD). Shamokin Creek at SHAM 2.7 exhibited the worst impacts from AMD with severely impaired biology, "lower" water quality, and partially supporting habitat. SHAM 2.7 also was impacted by high nutrient levels since this site not only exceeded levels of concern for alkalinity, iron, and manganese, but also nitrogen, orthophosphate, and total phosphorus. This site had the lowest alkalinity (2.6 mg/l) and highest manganese (2420 µg/l) of all the Lower Susquehanna Subbasin sites (Table 4). Little Shamokin Creek contributes good water quality conditions to Shamokin Creek and does not appear to be impacted by AMD.

Mahanoy Creek exceeded levels of concern for hardness, iron, magnesium, manganese, and sulfate. In fact, the levels of hardness (356 mg/l), magnesium (47.3 mg/l), and sulfate (304 mg/l) were the highest of all the sites in the Lower Susquehanna Subbasin (Table 4). The station at the mouth of Mahanoy Creek had "lower" water quality, moderately impaired biology, and excellent habitat. Coal fines and silt were noted in the stream, but the rest of the habitat scored well. The aquatic insect population was dominated by Chironomidae (midges); however, there were a couple mayflies (Baetis) and a stonefly (Perlesta) in the macroinvertebrate sample, and small fish were noted in the stream.

Mahantango Creek on the east side of the Susquehanna River included Pine and Deep Creeks that also were sampled in this survey. Biology was nonimpaired only on Pine Creek at Spring Glen (EPIN 12.7), which includes the headwaters along Broad Mountain. Slightly impaired conditions existed at Deep Creek and the mouth of Mahantango Creek (EMAH 0.2). Moderately impaired conditions existed at the mouth of Pine Creek and at Mahantango Creek in Klingerstown, Pa. The water chemistry was rated "middle" at all five sites, and the only indicator of possible AMD conditions on the ridges was low alkalinity at DEEP 1.2, EPIN 0.1, and EPIN 12.7. The biological community did not seem to be significantly impaired by AMD at any of these sites, except possibly EPIN 0.1 and EMAH 17.1, although the impairment could be due to other causes. There is an active treatment plant for AMD on Rausch Creek, a tributary to Pine Creek, which may be improving the water quality and biological conditions of these streams. Habitat was rated supporting at all sites, except for DEEP 1.2, which had excellent conditions.

Wiconisco Creek was sampled at the mouth and had slightly impaired biological conditions, although the water chemistry and habitat at the time of sampling were "higher" and excellent, respectively. Although this site had a fair number of mayflies, there was only one stonefly taxon, and the site received a low score for percentage of Chironomidae (midges). Small fish were observed during the time of sampling. The Wiconisco Creek Restoration Association has been working in this watershed to remediate the effects of AMD. It is possible that the one-time sample did not reflect usual water quality conditions, which may be worse than the water chemistry sample indicated, or that remediation efforts have improved water quality and the macroinvertebrate population is in the process of recovering. Other SRBC monitoring efforts indicated that water chemistry exceeds the Pennsylvania standards upstream of the AMD treatment.

West Branch and North Branch Mahantango Creek Watersheds

Sampling was conducted on the West Branch and North Branch Mahantango Creeks on the west side of the Susquehanna River. Both of these sites were nonimpaired and contained fairly similar macroinvertebrate populations. The water chemistry was similar also; however, WMHT 2.2 had total nitrate-n and total nitrogen values that slightly exceeded the level of concern, giving it a "middle" quality rating instead of "higher." The habitat ratings were similar except that NMHT 0.0 was assessed lower for embeddedness, sediment deposition, and channel alterations due to the remnants of a dam upstream of the sampling site.

Armstrong, Powell, Clarks, and Stony Creek Watersheds.

Armstrong Creek had a moderately impaired macroinvertebrate score, "lower" water quality, and partially supporting habitat. A majority of the watershed was cropland, and the water quality analysis indicated high total phosphorus and total suspended solids, and slightly elevated water temperature, total nitrate-n, and total nitrogen. The total suspended solids (204 mg/l) were the highest of all the Lower Susquehanna Subbasin sites (Table 4). The macroinvertebrate population was lacking stoneflies, which was another indicator of possible agricultural pollution.

Powell, Clarks, and Stony Creeks all had nonimpaired biological conditions. These watersheds were protected by forested ridges and state game lands. Powell Creek served as a reference site (Ecoregion 67b watersheds less than 100 square miles). Water quality was rated "middle" at all three sites, due to low alkalinity at Clarks and Stony Creeks and low alkalinity and slightly elevated total nitrate-n and total nitrogen at Powell Creek. The habitat was excellent at Stony Creek and supporting at Powell and Clarks Creeks. The lower habitat rating on Powell and Clarks Creeks was due mostly to channel disturbances, such as a concrete wall on Powell Creek and an upstream fish hatchery on Clarks Creek.

Sherman Creek Watershed

Sherman Creek demonstrated overall excellent watershed conditions and had the best water quality, biological and habitat conditions in the Lower Susquehanna Subbasin. The two sites on the mainstem and the tributary, Laurel Run, had nonimpaired biological conditions and excellent habitat ratings. The headwater site on Sherman Creek (SHRM 27.5) had "middle" water quality due to slightly elevated total nitrate-n and total nitrogen, and Laurel Run (LRSL 0.5) had low alkalinity, which is found often in forested ridge headwater streams. The site near the mouth of Sherman Creek (SHRM 2.0) was the only site in the Lower Susquehanna Subbasin Survey to have "higher" water quality, nonimpaired biology, and excellent habitat. All three sites sampled in this watershed (SHRM 2.0, SHRM 27.5, LRSL 0.5) served as reference sites for 67L, 67a, and 67cd, respectively.

Conodoguinet Creek Watershed

Most of the mainstem Conodoguinet Creek was impaired due to agriculture, according to the TMDL assessments (Table 5). The only site sampled that

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Kayaker on Sherman Creek.

was not in an impaired TMDL section was CONO 1.3. The subbasin survey results indicated that this site was moderately impaired, and the only site with nonimpaired biological conditions was CONO 51.8. The tributary sites sampled in this watershed were Middle Spring Run, Letort Spring Run, and Trindle Spring Run; all of these sites had moderately impaired biological conditions. The Conodoguinet Creek is a limestone-influenced stream with many spring sources. The tributaries mentioned above are true limestone streams and possibly should be assessed using protocol specific to limestone streams to comparatively determine level of impairment.

The mainstem Conodoguinet sites exceeded levels of concern for nitrate-n and total nitrogen with values ranging from 4.18 - 4.75 mg/l. This is a slow-moving valley stream that is wide and open in sections, so the temperatures exceeded the level of concern at all the sites except for the headwater site, CONO 66.0. The tributary sites also exceeded the levels of concern for total nitrate-n and total nitrogen with total nitrogen values ranging from 5.06 to 6.65 mg/l. Trindle Spring Run also exceeded the levels for sodium and acidity. TRDL 0.0 was downstream of residential, commercial, and industrial development. The habitat at all of the sites in the Conodoguinet Creek Watershed were rated supporting, except the headwater site, CONO 66.0, which was rated excellent. Abundant algae and aquatic vegetation were noted during the habitat assessment. The land use in this watershed was mostly agricultural and forested in the headwaters and mostly residential, commercial, and industrial uses toward the mouth.

Yellow Breeches Creek Watershed

Yellow Breeches Creek is a multi-use watershed that also serves as water supply for the surrounding area. The headwaters were rural, and state forest, state park lands, and agriculture were the primary land uses. As in the case of Conodoguinet Creek, the watershed becomes increasingly urbanized towards the mouth. However, this watershed was not as highly developed as the Conodoguinet Creek and was protected better by streamside vegetation. This is also a limestone-influenced stream, which was reflected in the macroinvertebrate population, especially at the headwater site, YLBR 25.7. This stream is a popular fishery and also is used for canoeing, kayaking, and tubing. Due to its multiple uses and interest to local residents, SRBC is conducting a Year-2 small watershed study on the Yellow Breeches Creek.

Two mainstem and two tributary sites were sampled on the Yellow Breeches Creek Watershed in the 2005 Lower Susquehanna Subbasin Survey. The two mainstem sites had "middle" water quality due to total nitrogen and nitrate-n values exceeding background levels. The biological condition at the headwater site (YLBR 25.7) was rated slightly impaired, although this may be due to it being a limestone-influenced stream. Further samples and study of this site would be necessary to determine level of impairment among other limestone-influenced streams. The site at the mouth was rated nonimpaired. The tributary sites, Mountain Creek and Cedar Run, represented two very different subwatersheds within the Yellow Breeches Watershed. Mountain Creek lies within the Michaux State Forest on the South Mountain sedimentary ridge and was dammed for recreational use as part of the Pine Grove Furnace State Park. Cedar Run is a limestone stream in an increasingly urbanized watershed that is heavily paved and developed. Both stream sample sites had "lower" water quality; however, Mountain Creek had high iron and total suspended solids concentrations and slightly elevated total nitrogen levels. The high iron was probably due to natural sources. This stream is listed on the TMDL 303(d) list due to atmospheric deposition. Limestone sand has been applied at select locations in the watershed to attempt to remediate the stream and raise the pH. Cedar Run contained high calcium, hardness, nitrate-n, total nitrogen, and sodium concentrations. Mountain Creek had nonimpaired biology and excellent habitat, while Cedar Run had moderately impaired biology and supporting habitat. The stream bed in Cedar Run was strewn with concrete, gravel, and asphalt pieces that embedded the substrate.

Paxton Creek Watershed

Paxton Creek Watershed is located in the urban and suburban Harrisburg, Pa., area. The lower stretches have been impacted due to outdated infrastructure, commercialization, and industrialization for decades.

J. Wilson

Paxton Creek Watershed includes highly urbanized and more natural settings.

A. Gavin

The upper stretches of the watershed have been developed more recently. Efforts are being made by the local watershed group, Paxton Creek Watershed and Education Association, to minimize the impact of new development. Unfortunately, the impacts of the development and urbanization in this watershed were evident in the severely and moderately impaired macroinvertebrate populations. The water chemistry performed may not have captured all of the impairments that exist in this watershed, but the parameters that did exceed levels of concern were nitrate-n, total nitrogen, and orthophosphate at PAXT 0.5, and sodium at both sites. Habitat was rated supporting and partially supporting at PAXT 8.4 and PAXT 0.5, respectively. Leeches and algae-covered substrate were noted at the sites, in addition to trash and litter. SRBC currently is conducting a stormwater, nutrient, and sediment study on the Paxton Creek Watershed with an emphasis on habitat remediation. This project was made possible through the support of the U.S. Environmental Protection Agency and the National Fish and Wildlife Foundation and will be implemented over the next three years.

Swatara Creek Watershed

An improvement in biological condition rating was evident at the Swatara Creek Watershed sites as the stream flowed from the headwaters to the mouth. The headwater site (SWAT 56.0) had a moderately impaired biological condition, which may have been due to the habitat, which was rated partially supporting. The area surrounding the stream was dominated by residential land use, and problems included an algae-covered bottom, low frequency of riffles, and high sediment deposition. The water chemistry analysis did not indicate that any parameters exceeded levels of concern. However, there were abandoned mine lands in the headwaters of Swatara Creek, which could have been a source of the impairment.

The biological and habitat conditions improved at the next site downstream, SWAT 39.0. Again, the water quality was rated "higher." Farther downstream (SWAT 21.7), biological and habitat conditions improved further; however, the water quality was rated "middle" due to elevated nitrate-n and total nitrogen. This increase in nitrogen may have been due to the influence of Little Swatara Creek, which enters Swatara Creek upstream of SWAT 21.7. Nitrate-n, nitrite-n, and total nitrogen were high at LSWT 0.6. The nitrite-n level (0.13 mg/l) was the highest recorded for the Lower Susquehanna Subbasin sites (Table 4).

Four tributary sites were sampled along Swatara Creek upstream of the site at the mouth. These tributaries were Quittapahilla, Manada, Spring, and Beaver Creeks. Water quality was rated "middle," and habitat was rated "supporting" on all these streams. MNDA 0.1 and BEAV 0.6 had slightly impaired biological conditions, while QUIT 0.3 and SPRG 0.0 were moderately impaired, most likely due to the high nutrient levels in each of these streams. QUIT 0.3 in particular exhibited very high nitrate-n (9.39 mg/l), total nitrogen (9.96 mg/l), orthophosphate (0.101 mg/l), and total phosphorus (0.119 mg/l) (Table 4). The site at the mouth of Swatara Creek had a nonimpaired macroinvertebrate community, although nutrient levels and sodium were elevated at the time of sampling, and habitat was rated partially supporting.

TRIASSIC LOWLANDS and TRAP ROCK and CONGLOMERATE UPLANDS ECOREGIONS

East Conewago and West Conewago Creeks Watersheds

A creek named Conewago Creek exists on both the east and west sides of the Susquehanna River south of Middletown near York Haven, Pa. Both creeks were located in agricultural areas and were impacted by nutrients. The eastern creek is much smaller and had slightly impaired biological conditions, "middle" water quality, and supporting habitat.

In this survey, West Conewago Creek contained five mainstem and four tributary sampling sites. All sites had "middle" water quality, mostly due to elevated nutrient levels. Biological conditions were either nonimpaired or slightly impaired, although the habitat ranged from excellent to partially supporting. The land use was mostly agriculture; however, most areas surrounding the stream had forested cover, and the lower section of Conewago Creek had a large percentage of natural vegetated area (Figure 3). The tributary Little Conewago Creek flowed through the northwestern part of suburban York, which may account for the five chemical parameters that exceeded levels of concern (Table 4); however, biological conditions were nonimpaired at the mouth. The other sites that had nonimpaired biological conditions were the two headwater Conewago Creek sites, the site at the mouth of Conewago Creek, and the site at the mouth of Bermudian Creek (BERM 1.2). One of the headwater sites, WCON 56.3, served as the reference site for group 64L. South Branch Conewago Creek was slightly impaired and was sampled near the Route 30 bridge in a developed area.

South Branch Codorus Creek.

S. Buda