# Metals and pH TMDLs
# for the Cheat River Watershed, West Virginia

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Region 3
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# 1.0 Problem Understanding

The Cheat River is located in northeastern West Virginia and its approximately 1,420 square mile (908,796 acre) drainage area is represented by the Cheat River watershed (Figure 1-1). The majority of the watershed is located in Monongalia, Preston, Tucker, Randolph, and Pocahontas counties of West Virginia; approximately 80 square miles are in Fayette County, Pennsylvania and less than 1 square mile is located in Garrett County, Maryland. The headwaters of the Cheat River (Shavers Fork, Glady Fork and Laurel Fork) begin in Pocohontas and Randolph counties. The mainstem of the Cheat River flows north from the confluence of Shavers Fork and Black Fork of the Cheat River. The Cheat flows north for approximately 162 miles and discharges into Cheat Lake, near Morgantown, WV. From Cheat Lake, the water flows to the Monongahela River in Pennsylvania.

The watershed is dominated by forest and agricultural lands and common practices include coal mining, timber harvesting, recreational development, and agricultural activities. Many of the counties in the watershed contain active surface and deep mining operations. The majority of coal fields in the watershed contain abandoned coal mines, especially in the northern counties (Preston, Monongalia and Tucker). The watershed's population is widely distributed throughout small towns and rural unincorporated communities. The largest communities (less than 5,000 residents) in the watershed are Parsons and Kingwood (Chen and Herr, 2000).

Fifty-five waterbodies in the Cheat River watershed (Cheat watershed) have been included on West Virginia's 1998 303(d) list due to metals and/or pH impairments (Table 1-1). These listed waterbodies include part of the main stem of the Cheat River and 54 additional stream segments in the watershed. Appendix A provides more detailed maps depicting the impaired waterbody locations throughout the Cheat watershed. The pH and metals impairments, which include total iron, aluminum, manganese, and zinc have been attributed to mine drainage. The objective of this study was to develop TMDLs for the impaired waterbodies in the Cheat watershed. This report presents TMDLs for each of the 55 listed segments in the Cheat watershed.

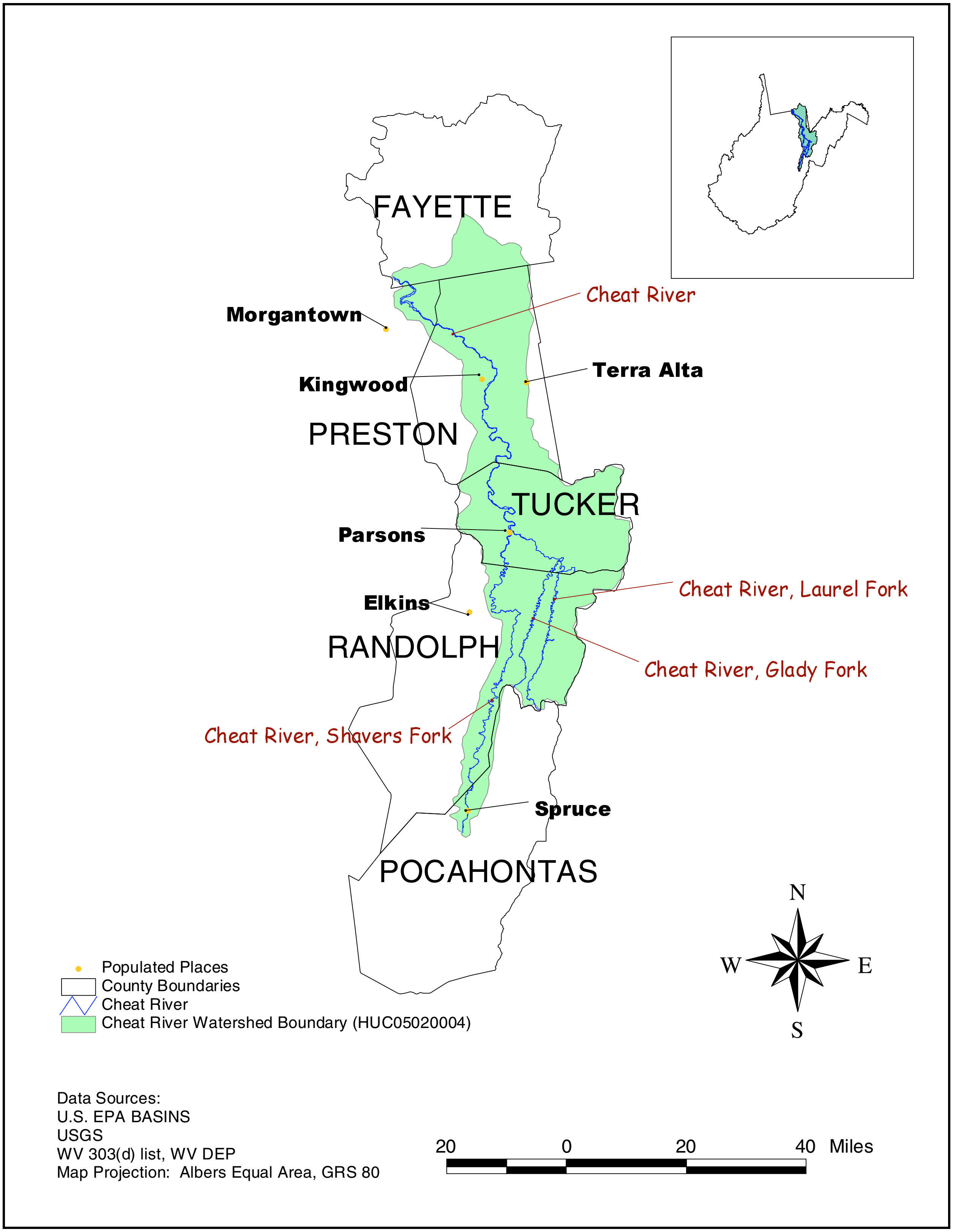


**Figure 1-1.** Location of the Cheat River watershed

**Table 1-1.** 303(d) listed waterbodies and corresponding impairments

| Stream Name | Listed Segment ID | Length (mi) | Trout Waters | pH | Al | Fe | Mn | Zn |
|---|---|---|---|---|---|---|---|---|
| Unnamed Tributary #1 to Cheat Lake | MC-? | 0 | | X | X | X | X | |
| Unnamed Tributary #2 to Cheat Lake | MC-? | 0 | | X | X | X | X | |
| Unnamed Tributary #3 to Cheat Lake | MC-? | 0 | | X | X | X | X | |
| Crammeys Run, tributary to Cheat Lake | MC-3 | 1.4 | | | X | X | X | |
| Bull Run, tributary to Cheat River | MC-11 | 6.2 | | X | X | X | X | |
| Middle Run, tributary to Bull Run | MC-11-A | 1.7 | | X | X | X | X | |
| Unnamed Tributary #1 to Bull Run | MC-11-.1A | 1.4 | | X | X | | | |
| Mountain Run, tributary to Bull Run | MC-11-B | 2.4 | | X | X | X | X | |
| Lick Run, tributary to Bull Run | MC-11-C | 1.5 | | X | X | X | X | |
| Unnamed Tributary #2 to Bull Run | MC-11-C-0.1 | 1.4 | | X | X | X | X | |
| Right Fork of Bull Run | MC-11-E | 1.8 | | X | X | X | X | |
| Big Sandy Creek, tributary to Cheat River | MC-12 | 19.0 | | X | X | X | X | |
| Unnamed Tributary to Big Sandy Creek | MC-12-? | 0 | | X | X | X | X | |
| Sovern Run, tributary to Big Sandy Creek | MC-12-0.5 | 14.0 | | X | X | X | X | |
| Little Sandy Creek, trib. to Big Sandy Creek | MC-12-B | 3.0 | X | X | X | X | X | |
| Webster Run, tributary to Little Sandy Cr | MC-12-B-0.5 | 7.4 | | X | X | X | X | |
| Beaver Creek, tributary to Little Sandy Cr | MC-12-B-1 | 2.8 | | X | X | X | X | |
| Glade Run, tributary to Beaver Creek | MC-12-B-1-A | 0 | X | X | X | X | X | |
| Unnamed Tributary #2 to Beaver Creek | MC-12-B-1-? | 4.6 | | X | X | X | X | |
| Hog Run, tributary to Little Sandy Creek | MC-12-B-3 | 3.0 | X | X | X | X | X | |
| Cherry Run, tributary to Little Sandy Creek | MC-12-B-5 | 5.6 | X | X | X | X | X | |
| Hazel Run, tributary to Big Sandy Creek | MC-12-C | 4.7 | | X | X | X | X | |
| Conner Run, tributary to Cheat River | MC-13.5 | 2.9 | X | X | X | X | X | |
| Greens Run, tributary to Cheat River | MC-16 | 8.2 | | X | X | X | X | |
| South Fork of Greens Run | MC-16-A | 4.3 | | | X | X | X | |
| Middle Fork of Greens Run | MC-16-A-.1 | 2.4 | | | X | X | X | |
| Muddy Creek, tributary to Cheat | MC-17 | 2.4 | X | X | X | X | X | |
| Martin Creek, tributary to Muddy Creek | MC-17-A | 15.6 | | X | X | X | X | |
| Fickey Run, tributary to Martin Creek | MC-17-A-0.5 | 2.6 | | X | X | X | X | |
| Glade Run, tributary to Martin Creek | MC-17-A-1 | 2.8 | | X | X | X | X | |
| Unnamed Tributary #1 to Glade Run | MC-17-A-1.1 | 3.6 | | X | X | X | X | |
| Unnamed Tributary #2 to Glade Run | MC-17-A-1.2 | 1.0 | | X | X | X | X | |
| Roaring Creek, tributary to Cheat | MC-18 | 1.2 | | X | X | X | X | |
| Morgan Run, tributary to Cheat River | MC-23 | 9.2 | | X | X | X | X | |
| Unnamed Tributary #1 to Morgan Run | MC-23-0.2-A | 4.6 | | X | X | | X | |
| Church Creek, tributary to Morgan Run | MC-23-A | 2.3 | | X | X | X | X | |
| Left Fork of Unnamed Trib. to Church Cr | MC-23-A-0.1-A | 4.0 | | X | X | X | X | |
| Right Fork of Unnamed Trib. To Church Cr | MC-23-A-0.1-B | 1.8 | | X | X | X | X | |
| Heather Run, tributary to Cheat River | MC-24 | 1.0 | | X | X | X | X | |

| Stream Name | Listed Segment ID | Length (mi) | Trout Waters | pH | Al | Fe | Mn | Zn |
|---|---|---|---|---|---|---|---|---|
| Unnamed Tributary #1 to Heather R | MC-24-A | 1.8 | | X | X | X | X | |
| Lick Run, tributary to Cheat River | MC-25 | 3.4 | | X | X | X | X | |
| Joes Run, tributary to Cheat River | MC-26 | 1.0 | | | X | X | X | |
| Pringle Run, tributary to Cheat River | MC-27 | 4.0 | | X | X | X | X | |
| Left Fork of Pringle Run | MC-27-A | 2.8 | | X | X | X | X | |
| Right Fork of Pringle Run | MC-27-B | 4.7 | | X | X | X | X | |
| Tub Run, tributary to Blackwater River | MC-60-D-2 | 4.0 | | X | X | X | X | |
| Finley Run, tributary to Blackwater River | MC-60-D-2.7 | 3.0 | | X | X | X | X | |
| North Fork of Blackwater River | MC-60-D-3 | 2.8 | | X | X | X | X | |
| Long Run, tributary to North Fork | MC-60-D-3-A | 0.7 | | X | X | X | X | |
| Middle Run, tributary to North Fork | MC-60-D-3-B | 4.0 | | X | X | X | X | |
| Snyder Run, tributary to North Fork | MC-60-D-3-C | 3.6 | | X | X | X | X | |
| Beaver Creek, tributary to Blackwater River | MC-60-D-5 | 13.8 | | X | X | X | X | |
| Hawkins Run, tributary to Beaver Creek | MC-60-D-5-C | 2.8 | | X | X | X | X | |
| Lower Blackwater River, trib. to Cheat R. | MC-60-D | 13.8 | X | | X | X | | |
| Cheat River (at Cheat Lake) | MC | 20.0 | | X | X | X | X | X |

All WV 303(d) listed stream segment identification numbers end in _1998.
All segment identification numbers are official WV stream codes for listed stream segments.

# 2.0 Water Quality Standards

West Virginia's *Requirements Governing Water Quality Standards* (WVSOS, 1999) have defined water quality criteria for surface waters as a numeric constituent concentration or a narrative statement representing a quality of water that supports a designated use or uses of the waterbody. Total aluminum, iron, manganese, zinc, and pH are given numeric criteria under the Aquatic Life and the Human Health use designation categories (Table 2-1). All listed waterbodies in the Cheat watershed have been designated as having an Aquatic Life and a Human Health use (WVDEP, 1998a). A number of waterbodies have also been identified as trout waters (Table 1-1). These waterbodies must meet the Aquatic Life B2 criteria.

**Table 2-1.** Applicable West Virginia water quality criteria

| POLLUTANT | USE DESIGNATION | | | | |
|---|---|---|---|---|---|
| | Aquatic Life | | | | Human Health |
| | B1, B4 | | B2 | | A [c] |
| | Acute [a] | Chronic [b] | Acute [a] | Chronic [b] | |
| Aluminum, Total (μg/L) | 750 | - | 750 | - | - |
| Iron, Total (mg/L) | - | 1.5 | - | 0.5 | 1.5 |
| Manganese, Total (mg/L) | - | - | - | - | 1.0 |
| pH | No values below 6.0 or above 9.0 | No values below 6.0 or above 9.0 | No values below 6.0 or above 9.0 | No values below 6.0 or above 9.0 | No values below 6.0 or above 9.0 |
| Zinc, dissolved (mg/L) | $(0.978)(e^{[(0.8473)(\ln[\text{hardness}\dagger]) + 0.8604]})$ | $(0.978)(e^{[(0.8473)(\ln[\text{hardness}\dagger]) + 0.7614]})$ | $(0.978)(e^{[(0.8473)(\ln[\text{hardness}\dagger]) + 0.8604]})$ | $(0.978)(e^{[(0.8473)(\ln[\text{hardness}\dagger]) + 0.7614]})$ | - |

Source: WVSOS, 1999; B1 = Warm water fishery streams, B4 = Wetlands, B2 = Trout waters, A = Water supply, public

[a] One hour average concentration not to be exceeded more than once every three years on the average,

[b] Four-day average concentration not to be exceeded more than once every three years on the average,

[c] Not to exceed

† Hardness as calcium carbonate (mg/L). The minimum hardness allowed for use in this equation shall not be less than 25 mg/l, even if the actual ambient hardness is less than 25 mg/l. The maximum hardness value for use in this equation shall not exceed 400 mg/l even if the actual hardness is greater than 400 mg/l.

# 3.0 Source Assessment

This section examines and identifies the potential sources of aluminum, iron, manganese, and zinc in the Cheat watershed. In general, the waterbodies in the Cheat watershed that are impaired due to pH, aluminum, iron, manganese, and zinc are heavily influenced by acid mine drainage (AMD).

## 3.1 Acid Mine Drainage (AMD)

AMD occurs when surface and subsurface water percolates through coal bearing minerals containing high concentrations of pyrite and marcasite, which are crystalline forms of iron sulfide ($FeS_2$). It is these chemical reactions of the pyrite which generate acidity in water. A synopsis of these reactions is as follows: Exposure of pyrite to air and water causes the oxidation of pyrite. The sulfur component of pyrite is oxidized releasing dissolved ferrous ($Fe^{2+}$) ions and also hydrogen ($H^+$) ions. It is these $H^+$ ions which cause the acidity. The intermediate reaction with the dissolved $Fe^{2+}$ ions generates a precipitate, ferric hydroxide [$Fe(OH)_3$], and also releases more $H^+$ ions, thereby causing more acidity. Another reaction is one between the pyrite and generated ferric ($Fe^{3+}$) ions, in which more acidity ($H^+$) is released as well as $Fe^{2+}$ ions, which then can enter the reaction cycle. (Stumm and Morgan, 1996).

There are four chemical reactions that represent the chemistry of the formation of AMD. The first reaction includes the oxidation of pyrite. The second reaction is the conversion of ferrous iron to ferric iron. The third reaction involves the hydrolysis of iron resulting in the formation of iron hydroxide ($Fe(OH)_3$) and the final reaction involves the oxidation of additional pyrite by ferric iron from the first and second reactions.

## 3.2 Zinc in the Cheat River Watershed

The lower mainstem of the Cheat River (Pringle Run to Cheat Lake) is impaired due to high zinc concentrations. Instream water quality data from EPA's STORET database were analyzed to characterize potential sources of zinc within the entire Cheat watershed. Up-stream undisturbed areas or areas in which AMLs are present were shown to have low instream zinc concentrations. However, higher instream zinc concentrations were observed in mining areas or in areas down-stream of mining activities and where AMLs are present. Assuming that zinc behaves like other divalent metals (e.g. iron(II), aluminum, manganese, etc.), this increase in concentration could indicate that active mining activities and AMLs influence instream zinc concentrations in the Cheat watershed.

## 3.3 Point Sources

Point sources represent permitted discharges at discrete locations in the Cheat watershed; point sources can be classified into 2 major categories: permitted non-mining point sources and permitted mining point sources.

### *3.3.1 Permitted Non-Mining Point Sources*

Data regarding non-mining point sources were retrieved from EPA's Permit Compliance System (PCS). The non-mining point sources in the Cheat watershed typically do not discharge significant amounts of aluminum, iron, manganese or zinc (e.g. wastewater treatment plants, non-metal producing industries, etc.). Their discharge is also typically within an acceptable range for pH.

### *3.3.2 Permitted Mining Point Sources*

Mining related point source discharges, from both deep, surface, and other mines, typically contain low pH values and high concentrations of metals (particularly iron, aluminum, manganese and zinc). Consequently, mining related activities are commonly issued discharge permits for these parameters. However, mining facilities are not required to report zinc discharges. A spatial coverage of mining permit locations was provided by West Virginia Office of Mining and Reclamation (OMR). The coverage included both active and inactive mining facilities, which are classified by type of mine and facility status. The mines were classified into eight different types: coal surface mine, coal underground mine, haul road, coal preparation plant, coal reprocessing, prospect, quarry, and other. The haulroad and prospect categories represent mining access roads and potential coal mining areas, respectively. The permits were also classified by mining status (7 categories) describing the status of each permitted discharge. OMR provided a brief description regarding classification and associated potential impact on water quality. Mining types and status descriptions are shown Table 3-1.

**Table 3-1**. Classification of mining permit type and status

| Type of Mining | Status Code | Description |
|---|---|---|
| Coal surface mine<br>Coal underground mine<br>Haul road<br>Coal preparation plant<br>Coal reprocessing<br>Prospect mine<br>Quarry<br>Other | Completely Released | Completely reclaimed, re-vegetated, should not be any associated water quality problems |
| | Phase II Released | Sediment and ponding are gone, partially re-vegetated, very little water quality impact |
| | Phase I Released | Re-graded and re-seeded, initial phase of the reclamation process, could potentially impact water quality |
| | Renewed | Active mining facility, assumed to be discharging according to the permit limits |
| | New | Newly issued permit, could be currently active or inactive, assumed to be discharging according to permit limits |
| | Inactive | Currently inactive, could become active anytime, assumed to be discharging according to discharge limits |
| | Revoked | Bond forfeited, forfeiture may be caused by poor water quality, highest impact to water quality |

These sites have permits for loading of total iron, total manganese, total nonfilterable residue, and pH. However, limestone quarries don't have permits for loading of total iron, total manganese, total nonfilterable residue and aluminum discharges. They are also required to list total aluminum discharges. There are a total of 128 active mining discharge permits for the Cheat watershed. A complete listing of the active mining point source discharges is located in Appendix B.

### 3.4 Nonpoint Sources

In addition to point sources, nonpoint sources may also contribute to water quality impairments in the Cheat watershed. Nonpoint sources represent contributions from diffuse, non-permitted sources. The most critical nonpoint source in the Cheat watershed is abandoned mine lands (AML).

Historically, the Cheat watershed has been the site of both surface and deep mining activities, and as a consequence, numerous AML sites remain which produce AMD flows (WVDNR, 1982). AML locations were identified in the *Adaptation of WARMF to calculate TMDLs for the Acid Mine Impaired Cheat River, West Virginia* report. This report also identified other potential contributing nonpoint sources. Figure 3-1 presents potential nonpoint and point sources in the Cheat watershed.

The predominant land uses in the Cheat River watershed were identified based on the BASINS GIRAS Database (Chen and Herr, 2000). Twenty-two land use categories were reclassified into 9 categories that best describe the watershed conditions and dominant source categories. The 22 original land uses from the GIRAS coverage and the nine reclassified land uses are described in Table 3-2 and are shown in Figure 3-2. According to the BASINS land use data, the major land uses in the watershed are forest land, which constitutes approximately 73 percent of the watershed area and surface mines, which make up 4 percent of the watershed area (Chenn and Herr, 2000). The surface area and land uses are summarized by impaired subwatershed tributary in Table 3-3.

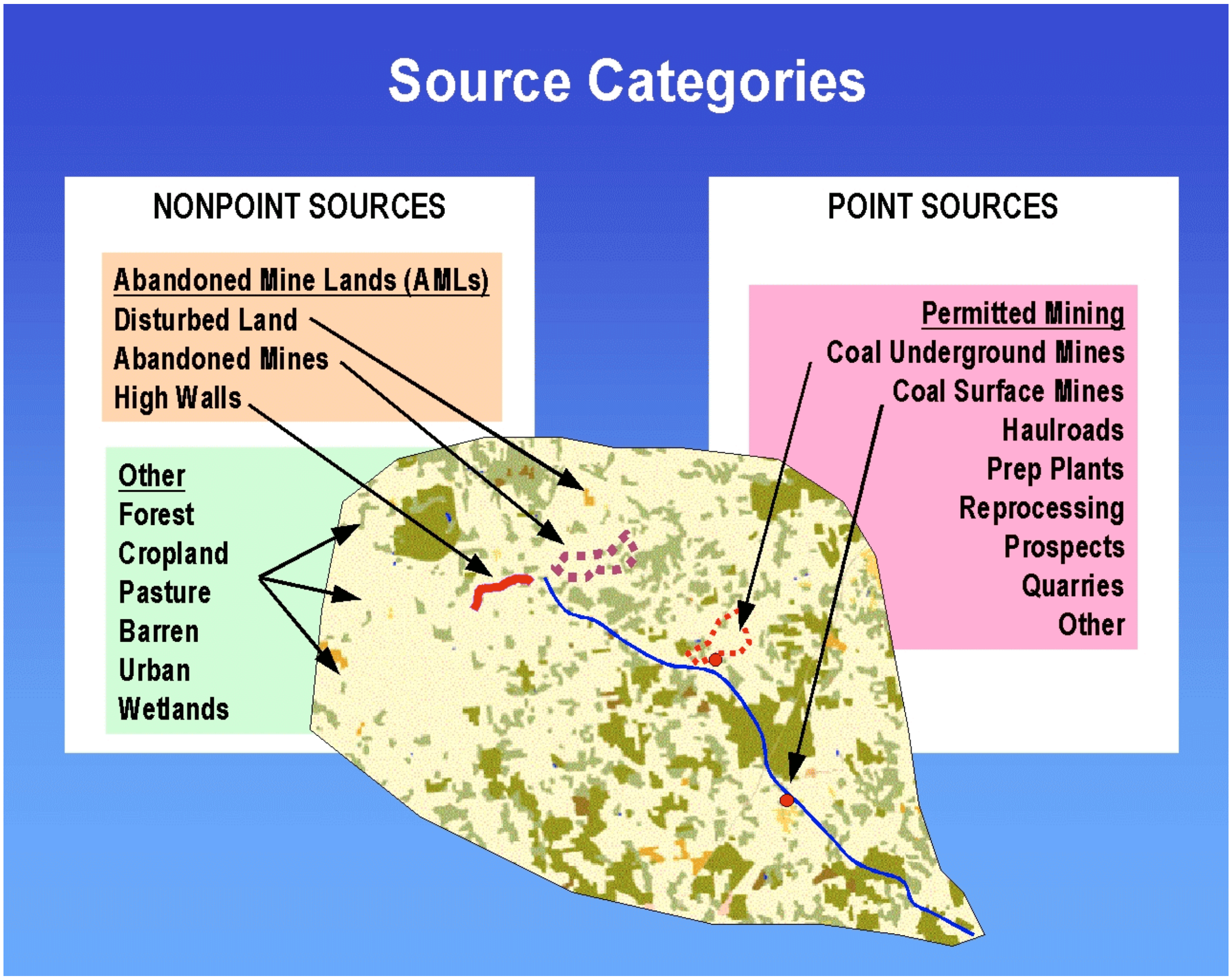


**Figure 3-1.** Potential sources contributing to impairments in the Cheat watershed

**Table 3-2.** WARMF land use categories

| Reclassified Land Use | BASINS (GIRAS) Land Use |
|---|---|
| Deciduous Forest | Orchards, Groves, Vineyards and Nurseries |
| | Deciduous Forest Lands |
| | Forested Wetlands |
| Mixed Forest | Mixed Forest Land |
| Coniferous Forest | Coniferous Forest Land |
| Grassland/Pasture | Cropland and Pasture |
| | Other Agricultural Land |
| | Shrub and Brush Rangeland |
| Marsh | Non Forested Wetlands |
| Strip Mines | Strip Mines, Quarries and Gravel Pits |
| Barren | Confined Feeding Operations |
| | Transitional Areas |
| Residential | Residential |
| Commercial/Industrial | Commercial Services |
| | Industrial |
| | Transportation, Communications |
| | Industrial and Commercial |
| | Mixed Urban or Built-Up Land |
| | Other Urban or Built-Up Land |

**Table 3-3.** Land use distribution and contributing area for each impaired stream

| No. | Name | Area ($mi^2$) | Decid. | Mixed | Conif. | Past. | Marsh | Mines | Barr. | Resid. | Com. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Unnamed Tributary #1 to Cheat Lake | 1.55 | 77.3% | 0.0% | 0.0% | 3.1% | 0.0% | 5.5% | 0.0% | 14.2% | 0.0% |
| 2 | Unnamed Tributary #2 to Cheat Lake | 0.82 | 69.4% | 0.0% | 0.0% | 13.5% | 0.0% | 17.1% | 0.0% | 0.0% | 0.0% |
| 3 | Unnamed Tributary #3 to Cheat Lake | 0.46 | 61.5% | 0.0% | 0.0% | 22.6% | 0.0% | 15.9% | 0.0% | 0.0% | 0.0% |
| 4 | Crammeys Run, tributary to Cheat Lake | 1.34 | 64.1% | 0.0% | 0.0% | 35.3% | 0.0% | 0.6% | 0.0% | 0.0% | 0.0% |
| 5 | Bull Run, tributary to Cheat River | 11.22 | 65.9% | 1.7% | 0.0% | 22.6% | 0.0% | 8.7% | 1.0% | 0.0% | 0.0% |
| 6 | Middle Run, tributary to Bull Run | 0.88 | 79.6% | 0.0% | 0.0% | 1.1% | 0.0% | 19.2% | 0.0% | 0.0% | 0.0% |
| 7 | Unnamed Tributary #1 to Bull Run | 0.83 | 98.2% | 0.0% | 0.0% | 0.0% | 0.0% | 1.8% | 0.0% | 0.0% | 0.0% |
| 8 | Mountain Run, tributary to Bull Run | 1.37 | 67.5% | 0.0% | 0.0% | 32.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 9 | Lick Run, tributary to Bull Run | 1.28 | 39.9% | 0.0% | 0.0% | 54.2% | 0.0% | 5.9% | 0.0% | 0.0% | 0.0% |
| 10 | Unnamed Tributary #2 to Bull Run | 1.05 | 70.0% | 0.0% | 0.0% | 20.9% | 0.0% | 9.1% | 0.0% | 0.0% | 0.0% |
| 11 | Right Fork of Bull Run | 1.51 | 53.2% | 0.0% | 0.0% | 19.7% | 0.0% | 19.5% | 7.6% | 0.0% | 0.0% |
| 12 | Big Sandy Creek, tributary to Cheat River | 206.27 | 57.0% | 12.0% | 3.6% | 25.2% | 0.0% | 1.3% | 0.5% | 0.1% | 0.3% |
| 13 | Unnamed Tributary to Big Sandy Creek | 1.82 | 78.6% | 0.8% | 0.0% | 7.1% | 0.0% | 11.9% | 0.0% | 0.0% | 1.5% |
| 14 | Sovern Run, tributary to Big Sandy Creek | 5.35 | 44.3% | 9.0% | 0.0% | 42.0% | 0.0% | 4.6% | 0.0% | 0.0% | 0.0% |
| 15 | Little Sandy Creek, trib. to Big Sandy Ck | 52.96 | 33.1% | 24.0% | 0.5% | 37.7% | 0.0% | 2.7% | 1.4% | 0.0% | 0.6% |
| 16 | Webster Run, tributary to Little Sandy Ck | 4.19 | 55.5% | 3.0% | 0.0% | 34.9% | 0.0% | 6.6% | 0.0% | 0.0% | 0.0% |
| 17 | Beaver Creek, tributary to Little Sandy Ck | 12.6 | 25.0% | 30.6% | 0.9% | 40.1% | 0.0% | 1.1% | 1.9% | 0.0% | 0.4% |
| 18 | Glade Run, tributary to Beaver Creek | 2.44 | 40.2% | 0.0% | 0.0% | 59.8% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 19 | Unnamed Tributary #2 to Beaver Creek | 1.25 | 39.6% | 0.0% | 0.0% | 57.2% | 0.0% | 3.2% | 0.0% | 0.0% | 0.0% |
| 20 | Hog Run, tributary to Little Sandy Creek | 3.91 | 48.3% | 4.5% | 0.0% | 40.7% | 0.0% | 5.9% | 0.1% | 0.4% | 0.0% |
| 21 | Cherry Run, tributary to Little Sandy Ck | 4.33 | 47.6% | 20.4% | 0.0% | 27.9% | 0.0% | 4.0% | 0.0% | 0.0% | 0.0% |
| 22 | Hazel Run, tributary to Big Sandy Creek | 6.22 | 25.2% | 34.9% | 0.2% | 38.6% | 0.0% | 0.8% | 0.4% | 0.0% | 0.0% |
| 23 | Conner Run, tributary to Cheat River | 2.46 | 48.5% | 8.2% | 0.0% | 35.6% | 0.0% | 7.7% | 0.0% | 0.0% | 0.0% |
| 24 | Greens Run, tributary to Cheat River | 11.5 | 67.6% | 0.0% | 0.0% | 23.5% | 0.0% | 3.9% | 0.4% | 3.7% | 1.0% |
| 25 | South Fork of Greens Run | 3.74 | 69.9% | 0.0% | 0.0% | 14.8% | 0.0% | 2.4% | 0.0% | 9.9% | 3.0% |
| 26 | Middle Fork of Greens Run | 1.43 | 78.2% | 0.0% | 0.0% | 15.6% | 0.0% | 6.2% | 0.0% | 0.0% | 0.0% |
| 27 | Muddy Creek, tributary to Cheat River | 33.48 | 34.6% | 28.6% | 0.5% | 31.0% | 0.0% | 4.9% | 0.2% | 0.0% | 0.1% |
| 28 | Martin Creek, tributary to Muddy Creek | 7.24 | 46.6% | 0.0% | 0.0% | 39.4% | 0.0% | 13.2% | 0.0% | 0.2% | 0.6% |
| 29 | Fickey Run, tributary to Martin Creek | 1.68 | 49.9% | 0.0% | 0.0% | 33.6% | 0.0% | 16.5% | 0.0% | 0.0% | 0.0% |
| 30 | Glade Run, tributary to Martin Creek | 3.75 | 33.9% | 0.0% | 0.0% | 49.5% | 0.0% | 15.1% | 0.0% | 0.3% | 1.2% |
| 31 | Unnamed Tributary #1 to Glade Run | 0.46 | 49.0% | 0.0% | 0.0% | 34.2% | 0.0% | 16.8% | 0.0% | 0.0% | 0.0% |
| 32 | Unnamed Tributary #2 to Glade Run | 0.83 | 32.4% | 0.0% | 0.0% | 46.2% | 0.0% | 21.4% | 0.0% | 0.0% | 0.0% |
| 33 | Roaring Creek, tributary to Cheat River | 15.12 | 62.9% | 9.7% | 0.8% | 21.4% | 0.0% | 5.0% | 0.0% | 0.1% | 0.0% |
| 34 | Morgan Run, tributary to Cheat River | 7.98 | 71.2% | 0.0% | 0.0% | 15.3% | 0.0% | 8.8% | 0.0% | 3.1% | 1.6% |
| 35 | Unnamed Tributary #1 to Morgan Run | 1.81 | 58.6% | 0.0% | 0.0% | 24.6% | 0.0% | 0.0% | 0.0% | 9.7% | 7.0% |
| 36 | Church Creek, tributary to Morgan Run | 3.32 | 76.9% | 0.0% | 0.0% | 10.7% | 0.0% | 11.1% | 0.0% | 1.3% | 0.0% |
| 37 | Left Fork of Unnamed Trib. to Church Ck | 0.23 | 96.5% | 0.0% | 0.0% | 0.0% | 0.0% | 3.5% | 0.0% | 0.0% | 0.0% |
| 38 | Rt. Fork of Unnamed Trib. to Church Ck | 0.63 | 71.1% | 0.0% | 0.0% | 9.1% | 0.0% | 19.8% | 0.0% | 0.0% | 0.0% |
| 39 | Heather Run, tributary to Cheat River | 2.21 | 78.1% | 0.0% | 0.0% | 16.7% | 0.0% | 3.8% | 0.0% | 1.3% | 0.0% |
| 40 | Unnamed Tributary #1 to Heather Run | 0.5 | 64.0% | 0.0% | 0.0% | 27.0% | 0.0% | 9.0% | 0.0% | 0.0% | 0.0% |
| 41 | Lick Run, tributary to Cheat River | 4.93 | 85.7% | 0.0% | 0.0% | 12.8% | 0.0% | 0.9% | 0.0% | 0.6% | 0.0% |
| 42 | Joes Run, tributary to Cheat River | 2.45 | 94.0% | 0.0% | 0.0% | 0.6% | 0.0% | 5.5% | 0.0% | 0.0% | 0.0% |
| 43 | Pringle Run, tributary to Cheat River | 9.57 | 85.5% | 0.0% | 0.5% | 5.4% | 0.0% | 6.2% | 0.0% | 2.2% | 0.2% |
| 44 | Left Fork of Pringle Run | 1.59 | 92.6% | 0.0% | 0.0% | 2.9% | 0.0% | 4.5% | 0.0% | 0.0% | 0.0% |
| 45 | Right Fork of Pringle Run | 3.51 | 80.3% | 0.0% | 1.5% | 6.0% | 0.0% | 5.7% | 0.0% | 6.0% | 0.5% |
| 46 | Tub Run, tributary to Blackwater River | 1.95 | 0.0% | 92.3% | 0.0% | 0.0% | 0.0% | 7.7% | 0.0% | 0.0% | 0.0% |
| 47 | Finley Run, tributary to Blackwater River | 0.28 | 0.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 48 | North Fork of Blackwater River | 18.13 | 32.6% | 57.3% | 0.3% | 1.7% | 0.0% | 6.5% | 0.0% | 1.0% | 0.6% |
| 49 | Long Run, tributary to North Fork | 2.48 | 0.0% | 94.1% | 0.0% | 0.0% | 0.0% | 5.9% | 0.0% | 0.0% | 0.0% |
| 50 | Middle Run, tributary to North Fork | 0.88 | 0.0% | 91.8% | 0.0% | 0.0% | 0.0% | 8.2% | 0.0% | 0.0% | 0.0% |
| 51 | Snyder Run, tributary to North Fork | 4.74 | 10.5% | 79.8% | 0.0% | 0.0% | 0.0% | 9.7% | 0.0% | 0.0% | 0.0% |
| 52 | Beaver Creek, trib. to Blackwater River | 22.39 | 69.5% | 14.9% | 4.2% | 0.0% | 0.0% | 10.0% | 1.3% | 0.1% | 0.1% |
| 53 | Hawkins Run, tributary to Beaver Creek | 1.89 | 89.3% | 0.0% | 0.0% | 0.0% | 0.0% | 10.7% | 0.0% | 0.0% | 0.0% |
| 54 | Lower Blackwater River, trib. to Cheat R. | 136.9 | 50.2% | 32.0% | 1.0% | 5.6% | 6.6% | 3.5% | 0.2% | 0.1% | 0.6% |
| 55 | Cheat River (at Cheat Lake) | 1343.5 | 58.5% | 25.0% | 1.1% | 12.7% | 0.7% | 1.3% | 0.2% | 0.3% | 0.3% |

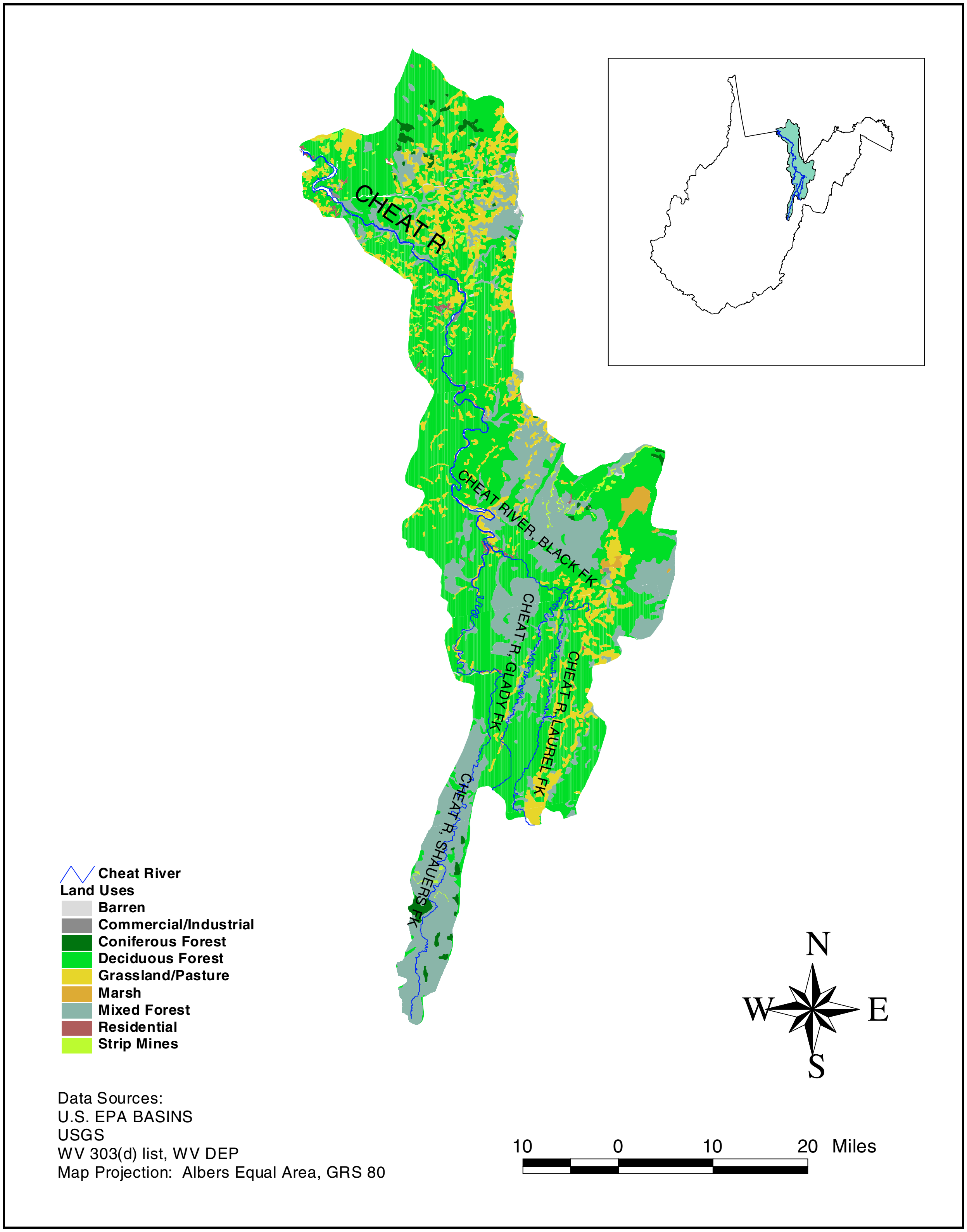


**Figure 3-2.** Land use coverage for the Cheat watershed

# 4.0 Technical Approach

Establishing the relationship between the in-stream water quality targets and source loadings is a critical component of TMDL development. It allows for evaluation of management options that will achieve the desired source load reductions. The link can be established through a range of techniques, from qualitative assumptions based on sound scientific principles to sophisticated modeling techniques. Ideally, the linkage will be supported by monitoring data that allow the TMDL developer to associate certain waterbody responses to flow and loading conditions. The objective of this section is to present the approach taken to develop the linkage between sources and in-stream response for TMDL development in the Cheat watershed.

## 4.1 Watershed Analysis Risk Management Framework (WARMF) Overview

WARMF was used to develop TMDLs for the Cheat watershed. WARMF is a decision support system designed for a watershed approach to TMDL calculation (Herr et al., 2000, Systech, 1998). The system consists of engineering, data, consensus, TMDL, and knowledge modules integrated into a Windows-based graphical user interface (GUI).

WARMF contains catchment, river, and reservoir models that use meteorology, air quality, managed flow, observed hydrology and water quality, and point source data to support TMDL development on a subwatershed basis. Refer to *Users' Guide to WARMF* (Herr et al., 2000) for a more detailed discussion of simulated processes and model parameters.

## 4.2 Model Configuration

*Adaptation of WARMF to Calculate TMDLs for the Acid Mine Impaired Cheat River, West Virginia* (Chen and Herr, 2000) describes the modeling approach for the Cheat watershed in detail. Configuration of the WARMF involved subdivision of the Cheat watershed into modeling units and continuous simulation of flow and water quality for these units using meteorological, land use, stream, mining, and pollutant-specific data. Pollutants that were simulated include metals, dissolved and suspended solids, carbon, nutrients, fecal coliform, dissolved oxygen, alkalinity, and pH.

## 4.3 Model Calibration

After the model was configured, calibration was performed at multiple locations throughout the Cheat watershed. Calibration refers to the adjustment or fine-tuning of modeling parameters to reproduce observations. Model calibration focused on two main areas: hydrology and water quality. Model calibration is also described in the report *Adaptation of WARMF to Calculate TMDLs for the Acid Mine Impaired Cheat River, West Virginia* (Chen and Herr, 2000).

# 5.0 Allocation Analysis

A TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards. TMDLs can be expressed in terms of mass per time or by other appropriate measures. TMDLs are comprised of the sum of individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving water body. Conceptually, this definition is denoted by the equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

In order to develop aluminum, iron, manganese, zinc, and pH TMDLs for each of the waterbodies in the Cheat watershed listed on the West Virginia 303(d) list, the following approach was taken:

- Define TMDL Endpoints
- Simulate Existing Conditions
- Estimate Point Source Contributions
- Determine the TMDL and Source Allocations

## 5.1 TMDL Endpoints

TMDL endpoints represent the instream water quality targets used in quantifying TMDLs and their individual components. Different TMDL endpoints are necessary for each impairment type (i.e., aluminum, iron, manganese, zinc, and pH). West Virginia's numeric water quality criteria for aluminum, iron, manganese, zinc, and pH (identified in Section 2) and an explicit Margin of Safety (MOS) were used to identify endpoints for TMDL development.

### *5.1.1 Aluminum, Iron, and Manganese*

The TMDL with the MOS endpoint for aluminum was selected as 712.5 ug/L (based on the 750 ug/L criteria for Aquatic Life minus a 5% MOS). The TMDL with the MOS for iron was selected as 0.475 mg/L (based on the 0.5 mg/L criteria for Aquatic Life—Trout Waters minus a 5% MOS) and 1.425 mg/L (based on the 1.5 mg/L criteria for Aquatic Life minus a 5% MOS). The TMDL with the MOS for manganese was selected as 0.95 mg/L (based on the 1.0 mg/L criteria for Human Health minus a 5% MOS).

Components of the TMDLs for aluminum, iron, manganese, and zinc are presented in terms of mass per time in this report.

*5.1.2 Zinc*

The TMDL with MOS endpoint for zinc was selected as 0.085 mg/L (based on the Aquatic Life criteria minus a 5% MOS). This was calculated using a hardness concentration (as $CaCO_3$) representative of the Cheat watershed.

*5.1.3 pH*

The water quality criteria for pH requires it to be equal to or above 6 and equal to or below 9. In the case of acid mine drainage, pH is not a good indicator of the acidity in a waterbody and can be a misleading characteristic. Water with near neutral pH (~7) but containing elevated concentrations of dissolved ferrous ($Fe^{2+}$) ions can become acidic after oxidation and precipitation of the iron (PADEP, 2000). Therefore, a more practical approach to meeting the water standards of pH is to use the concentration of metal ions as a surrogate for pH. Through reducing instream metals, namely aluminum and iron, to meet water quality criteria (or TMDL endpoints), it is assumed that a pH will result meeting the WQS. This assumption is based on application of MINTEQA2, a geochemical equilibrium speciation model, to aqueous systems representative of waterbodies in the Cheat watershed. By inputting into the model the dissolved concentrations of metals, a pH value can be predicted. See Appendix C for a more detailed discussion.

*5.1.4 Margin of Safety*

An implicit MOS was included in TMDL development through application of a dynamic model for simulating daily loading over a wide range of hydrologic and environmental conditions, and through the use of conservative assumptions in model calibration and scenario development. In addition to this implicit margin of safety, a 5% explicit MOS was used to account for uncertainty in the monitoring data. Long-term water quality monitoring data were used for model calibration, however these data were not continuous time series and may not have captured the full range of instream conditions that occurred during the simulation period.

## 5.2 Existing Conditions

The calibrated model provided the basis for performing the allocation analysis. The first step in this analysis involved simulation of existing conditions. Existing conditions represent current conditions in the watershed.

The calibrated model was run for the period October 1, 1989 through September 30, 1997 to represent existing conditions or current conditions in the watershed. This was the starting point for the allocation analysis. Predicted instream concentrations of aluminum, iron, manganese, and zinc for the impaired waterbodies in the Cheat watershed were compared directly to the TMDL endpoints. This comparison allowed evaluation of the expected magnitude and frequency of exceedances under a range of hydrologic and environmental conditions, including dry periods, wet periods, and average periods.

## 5.3 TMDLs and Source Allocations

A top-down methodology was followed to develop the TMDLs and allocate loads to sources. Impaired headwaters were first analyzed, because their impact frequently had a profound effect on down-stream water quality. The WARMF TMDL module was run in order to estimate the TMDL for each impaired segment. This module is described in *User's Guide to WARMF* (Herr et al., 2000).

Each TMDL represents the total load from all up-stream sources that are predicted to attain the water quality criteria for the entire modeling period (1989-1997). The TMDL endpoints were assigned the values designated in Section 5.1 when running the TMDL module. When appropriate, the averaging period was considered during these assessments (*e.g*., a four-day average was used for iron).

After running the TMDL module for headwaters, the module was then run for subsequent down-stream impaired waters. Therefore, when TMDLs were developed for down-stream impaired waterbodies, up-stream contributions that impact up-stream impaired waterbodies were represented under allocation conditions. Thus, impaired up-stream waterbodies were assumed to meet water quality criteria prior to calculation of TMDLs for down-stream waterbodies. Using this method, contributions from all sources were weighted equitably. In some situations, reductions in sources impacting unimpaired headwaters were required in order to meet down-stream water quality criteria. In other situations, reductions in sources impacting impaired headwaters ultimately led to improvements far down-stream. This effectually decreased required loading reductions from many potential down-stream sources.

The TMDL value provided by the WARMF Cheat watershed model represents the total TMDL for the impaired waterbody, however, it does not distinguish between WLAs and LAs. The total load derived from WARMF is designated as the total load available for allocation in the TMDL.

### *5.3.1 Wasteload Allocations (WLAs)*

The WARMF configuration of the Cheat watershed does not explicitly simulate contributions from all individual permitted sources in the watershed, therefore contributions from applicable permitted sources were estimated based on the available information on permitted facilities. This was required to support allocation to individual WLAs as required by TMDL regulations.

Because flow contributions from most permitted mining facilities in the watershed are directly related to hydrologic processes, it is assumed that their contributions will follow a similar pattern as the overall predicted watershed flow. The flow from each permitted mine was estimated as a percentage of its corresponding watershed's flow. The percentage was based on the ratio of the mine's area (presented in OMR's coverage of mining permit data) to the area of the watershed in which it is located. WLAs were made for all permitted facilities (for aluminum, iron and manganese) except for limestone quarries and those with a completely released or Phase 2 release classification. For TMDL purposes these point sources are assumed to be compliant with water quality criteria. Loading from revoked permitted facilities was represented as nonpoint source loading based on the lack of a permittee or permit. Individual zinc WLAs were not assigned because insufficient monitoring data were available throughout the Cheat watershed.

The proposed WLA for individual facilities was derived based on considering the magnitude of the estimated WLA relative to the estimated total TMDL load. The remaining load was compared to typical background loading to identify areas where remediation of abandoned mine lands was likely to be required, as part of achieving the LA. Assuming control of the nonpoint sources (LA), the remaining required controls were derived incrementally by reducing concentrations at permitted discharges until the TMDL was achieved. Each permitter was assigned a WLA (as a concentration) within a range of discharge concentrations, the minimum reflecting the instream water quality criteria and the maximum limit was derived using the EPA's *Technical Support Document for Water Quality-based Toxics Control* (USEPA, 1991) to find the monthly average discharge concentration. The ranges are as follows: Al: 0.75-4.3mg/L, Fe: 0.5 or 1.5 -3.2mg/L, Mn: 1.0-2.0 mg/L.

Tables 5-1 through 5-4 present the sum of the WLAs for each of the 55 impaired waterbodies. The WLAs for aluminum, iron, manganese, and zinc are presented as annual loads, in terms of pounds per year. Table D-5 presents the annual load by individual facility and the corresponding WLA concentration for each facility (for aluminum, iron and manganese). Loads are presented on an annual basis (as an average annual load), because they were developed to meet TMDL endpoints under a range of conditions observed throughout the year.

### *5.3.2 Load Allocations (LAs)*

Load allocations (LAs) were made as gross allotments including a combination of abandoned mine land, rural, and urban land uses.

Each of the 55 waterbody's LAs for aluminum, iron, manganese and zinc is presented in Tables 5-1 through 5-4. The LAs are presented as annual loads, in terms of pounds per year. They are presented on an annual basis (as an average annual load), because they were developed to meet TMDL endpoints under a range of conditions observed throughout the year.

**Table 5-1.** TMDLs, load, and waste load allocations for aluminum

| Aluminum | | | | | |
|---|---|---|---|---|---|
| **WV Stream Code** | **Stream Name** | **TMDL (lbs Al/yr)** | **ΣLAs (lbs Al/yr)** | **ΣWLAs (lbs Al/yr)** | **MOS** |
| MC-? | Unnamed Trib.# 1 To Cheat River Lake | 1,288 | 169 | 1,120 | Implicit |
| MC-? | Unnamed Trib.# 2 To Cheat River Lake | 725 | 725 | 0 | Implicit |
| MC-? | Unnamed Trib.# 3 To Cheat River Lake | 280.80 | 280.80 | 0.00 | Implicit |
| MC-3 | Crammeys Run, Trib. To Cheat Lake | 145.60 | 145.60 | 0.00 | Implicit |
| MC-11 | Bull Run, Trib. To Cheat River | 13,606.80 | 12,664.80 | 942.00 | Implicit |
| MC-11-A | Middle Run, Trib. To Bull Run | 1,400.80 | 689.60 | 711.20 | Implicit |
| MC-11-.1A | Unnamed Trib. #1 to Bull Run | 1,034.00 | 1,034.00 | 0.00 | Implicit |
| MC-11-B | Mountain Run, Trib. To Bull Run | 1,170.00 | 1,170.00 | 0.00 | Implicit |
| MC-11-C | Lick Run, Trib. To Bull Run | 3,124.60 | 3,124.60 | 0.00 | Implicit |
| MC-11-C-0.1 | Unnamed Trib. #2 to Bull Run | 885.10 | 885.10 | 0.00 | Implicit |
| MC-11-E | Right Fork of Bull Run | 2,175.00 | 2,175.00 | 0.00 | Implicit |
| MC-12 | Big Sandy Creek, Trib. To Cheat River | 100,327.30 | 72,305.40 | 28,021.90 | Implicit |
| MC-12-? | Unnamed Trib. To Big Sandy Creek | 555.20 | 55.80 | 499.40 | Implicit |

| Aluminum | | | | | |
|---|---|---|---|---|---|
| WV Stream Code | Stream Name | TMDL (lbs Al/yr) | ΣLAs (lbs Al/yr) | ΣWLAs (lbs Al/yr) | MOS |
| MC-12-0.5 | Sovern Run, Trib. To Big Sandy Creek | 1,136.20 | 1,136.20 | 0.00 | Implicit |
| MC-12-B | Little Sandy Creek, Trib. To Big Sandy Creek | 49,037.10 | 21,514.60 | 27,522.50 | Implicit |
| MC-12-B-0.5 | Webster Run, Trib. To Little Sandy Creek | 6,292.60 | 6,292.60 | 0.00 | Implicit |
| MC-12-B-1 | Beaver Creek, Trib. To Little Sandy Creek | 8,690.50 | 8,690.50 | 0.00 | Implicit |
| MC-12-B-1-A | Glade Run, Trib. To Little Sandy Creek | 573.70 | 573.70 | 0.00 | Implicit |
| MC-12-B-1-? | Unnamed Trib.#2 To Beaver Creek | 508.60 | 508.60 | 0.00 | Implicit |
| MC-12-B-3 | Hog Run, Trib. To Little Sandy Creek | 1,062.20 | 1,062.20 | 0.00 | Implicit |
| MC-12-B-5 | Cherry Run, Trib. To Little Sandy Creek | 1,690.60 | 1,690.60 | 0.00 | Implicit |
| MC-12-C | Hazel Run Trib. To Big Sandy Creek | 197.20 | 197.20 | 0.00 | Implicit |
| MC-13.5 | Conner Run, Trib. To Cheat River | 639.10 | 639.10 | 0.00 | Implicit |
| MC-16 | Greens Run, Trib. To Cheat River | 4,445.20 | 3,965.50 | 479.70 | Implicit |
| MC-16-A | South Fork of Greens Run | 2,399.70 | 2,399.70 | 0.00 | Implicit |
| MC-16-A-.1 | Middle Fork of Greens Run | 638.90 | 638.90 | 0.00 | Implicit |
| MC-17 | Muddy Creek, Trib. To Cheat | 7,531.80 | 7,147.00 | 384.80 | Implicit |
| MC-17-A | Martin Creek, Trib. To Muddy Creek | 3,967.40 | 3,582.60 | 384.80 | Implicit |
| MC-17-A-0.5 | Ficky Run, Trib. To Martin Creek | 1,322.40 | 937.60 | 384.80 | Implicit |
| MC-17-A-1 | Glade Run, Trib. To Martin Creek | 1,816.40 | 1,816.40 | 0.00 | Implicit |
| MC-17-A-1.1 | Unnamed Trib. #1 to Glade Run | 322.70 | 322.70 | 0.00 | Implicit |
| MC-17-A-1.2 | Unnamed Trib.#2 To Glade Run | 551.50 | 551.50 | 0.00 | Implicit |
| MC-18 | Roaring Creek, Trib. To Cheat | 6,767.40 | 6,767.40 | 0.00 | Implicit |
| MC-23 | Morgan Run Trib. To Cheat River | 4,319.30 | 4,319.30 | 0.00 | Implicit |
| MC-23-0.2-A | Unnamed Trib.#1 to Morgan Run | 73.90 | 73.90 | 0.00 | Implicit |
| MC-23-A | Church Creek, Trib. To Morgan Run | 3,122.70 | 3,122.70 | 0.00 | Implicit |
| MC-23-A-0.1-A | Left Fk of unnamed Trib. to Church Creek | 691.20 | 691.20 | 0.00 | Implicit |
| MC-23-A-0.1-B | Right Fork of unnamed Trib. To Church River | 404.80 | 404.80 | 0.00 | Implicit |
| MC-24 | Heather Run, Trib. To Cheat River | 1,590.90 | 1,590.90 | 0.00 | Implicit |
| MC-24-A | Unnamed Trib. #1 to Heather Run | 23.20 | 23.20 | 0.00 | Implicit |
| MC-25 | Lick Run, Trib. To Cheat River | 4,291.30 | 4,242.90 | 48.40 | Implicit |
| MC-26 | Joes Run, Trib. To Cheat River | 533.30 | 70.80 | 462.50 | Implicit |
| MC-27 | Pringle Run, Trib. To Cheat River | 6,440.80 | 6,440.80 | 0.00 | Implicit |
| MC-27-A | Left Fork of Pringle Run | 2,063.10 | 2,063.10 | 0.00 | Implicit |
| MC-27-B | Right Fork of Pringle Run | 1,046.10 | 1,046.10 | 0.00 | Implicit |
| MC-60-D-2 | Tub Run, tributary to Blackwater River | 398.30 | 398.30 | 0.00 | Implicit |
| MC-60-D-2.7 | Finley Run, tributary to Blackwater River | 217.30 | 217.30 | 0.00 | Implicit |
| MC-60-D | Lower Blackwater River trib. To Cheat River | 46,140.30 | 23,119.70 | 23,020.60 | Implicit |
| MC-60-D-3 | North Fork of Blackwater River | 5,600.50 | 4,686.80 | 913.70 | Implicit |
| MC-60-D-3-A | Long Run, tributary to North Fork | 804.70 | 422.30 | 382.40 | Implicit |
| MC-60-D-3-B | Middle Run, tributary to North Fork | 107.80 | 107.80 | 0.00 | Implicit |
| MC-60-D-3-C | Snyder Run, tributary to North Fork | 658.20 | 126.80 | 531.40 | Implicit |
| MC | Cheat River from Pringle Run to Cheat Lake | 277,222.40 | 211,897.60 | 65,324.80 | Implicit |

**Table 5-2.** TMDLs, load, and waste load allocations for iron

| Iron | | | | | |
|---|---|---|---|---|---|
| **WV Stream Code** | **Stream Name** | **TMDLS (lbs Fe/yr)** | **ΣLAs (lbs Fe/yr)** | **ΣWLAs (lbs Fe/yr)** | **MOS** |
| MC-? | Unnamed Trib.# 1 To Cheat River Lake | 2,355 | 644 | 1,710 | Implicit |
| MC-? | Unnamed Trib.# 2 To Cheat River Lake | 1,436 | 1,436 | 0 | Implicit |
| MC-? | Unnamed Trib.# 3 To Cheat River Lake | 554 | 554 | 0 | Implicit |
| MC-3 | Crammeys Run, Trib. To Cheat Lake | 85 | 85 | 0 | Implicit |
| MC-11 | Bull Run, Trib. To Cheat River | 23,886 | 22,002 | 1,884 | Implicit |
| MC-11-A | Middle Run, Trib. To Bull Run | 2,792 | 1,370 | 1,423 | Implicit |
| MC-11-.1A | Unnamed Trib. #1 to Bull Run | 1,965 | 1,965 | 0 | Implicit |
| MC-11-B | Mountain Run, Trib. To Bull Run | 1,828 | 1,828 | 0 | Implicit |
| MC-11-C | Lick Run, Trib. To Bull Run | 3,570 | 3,570 | 0 | Implicit |
| MC-11-C-0.1 | Unnamed Trib. #2 to Bull Run | 2,155 | 2,155 | 0 | Implicit |
| MC-11-E | Right Fork of Bull Run | 4,045 | 4,045 | 0 | Implicit |
| MC-12 | Big Sandy Creek, Trib. To Cheat River | 177,255 | 173,191 | 4,064 | Implicit |
| MC-12-? | Unnamed Trib. To Big Sandy Creek | 681 | 65 | 615 | Implicit |
| MC-12-0.5 | Sovern Run, Trib. To Big Sandy Creek | 788 | 788 | 0 | Implicit |
| MC-12-B | Little Sandy Creek, Trib. To Big Sandy Creek | 59,265 | 55,816 | 3,449 | Implicit |
| MC-12-B-0.5 | Webster Run, Trib. To Little Sandy Creek | 34,287 | 34,287 | 0 | Implicit |
| MC-12-B-1 | Beaver Creek, Trib. To Little Sandy Creek | 17,985 | 17,985 | 0 | Implicit |
| MC-12-B-1-A | Glade Run, Trib. To Little Sandy Creek | 263 | 263 | 0 | Implicit |
| MC-12-B-1-? | Unnamed Trib.#2 To Beaver Creek | 2,414 | 2,414 | 0 | Implicit |
| MC-12-B-3 | Hog Run, Trib. To Little Sandy Creek | 1,207 | 1,207 | 0 | Implicit |
| MC-12-B-5 | Cherry Run, Trib. To Little Sandy Creek | 604 | 604 | 0 | Implicit |
| MC-12-C | Hazel Run Trib. To Big Sandy Creek | 231 | 231 | 0 | Implicit |
| MC-13.5 | Conner Run, Trib. To Cheat River | 451 | 451 | 0 | Implicit |
| MC-16 | Greens Run, Trib. To Cheat River | 10,594 | 9,634 | 959 | Implicit |
| MC-16-A | South Fork of Greens Run | 5,693 | 5,693 | 0 | Implicit |
| MC-17-A | Martin Creek, Trib. To Muddy Creek | 8,759 | 7,990 | 770 | Implicit |
| MC-17-A-0.5 | Ficky Run, Trib. To Martin Creek | 2,632 | 1,862 | 770 | Implicit |
| MC-17-A-1 | Glade Run, Trib. To Martin Creek | 4,494 | 4,494 | 0 | Implicit |
| MC-17-A-1.1 | Unnamed Trib. #1 to Glade Run | 641 | 641 | 0 | Implicit |
| MC-17-A-1.2 | Unnamed Trib.#2 To Glade Run | 1,096 | 1,096 | 0 | Implicit |
| MC-18 | Roaring Creek, Trib. To Cheat | 6,623 | 6,623 | 0 | Implicit |
| MC-23 | Morgan Run Trib. To Cheat River | 10,541 | 10,541 | 0 | Implicit |
| MC-23-0.2-A | Unnamed Trib.#1 to Morgan Run | 126 | 126 | 0 | Implicit |
| MC-23-A | Church Creek, Trib. To Morgan Run | 8,201 | 8,201 | 0 | Implicit |
| MC-23-A-0.1-A | Left Fork of unnamed Trib. To Church Creek | 2,458 | 2,458 | 0 | Implicit |
| MC-23-A-0.1-B | Right Fork of unnamed Trib. To Church River | 1,717 | 1,717 | 0 | Implicit |
| MC-24 | Heather Run, Trib. To Cheat River | 2,822 | 2,822 | 0 | Implicit |
| MC-24-A | Unnamed Trib. #1 to Heather Run | 104 | 104 | 0 | Implicit |
| MC-25 | Lick Run, Trib. To Cheat River | 8,876 | 8,840 | 36 | Implicit |
| MC-26 | Joes Run, Trib. To Cheat River | 1,008 | 83 | 925 | Implicit |
| MC-27 | Pringle Run, Trib. To Cheat River | 13,594 | 13,594 | 0 | Implicit |
| MC-27-A | Left Fork of Pringle Run | 4,098 | 4,098 | 0 | Implicit |
| MC-27-B | Right Fork of Pringle Run | 2,929 | 2,929 | 0 | Implicit |
| MC-60-D-2 | Tub Run, tributary to Blackwater River | 154 | 154 | 0 | Implicit |
| MC-60-D-2.7 | Finley Run, tributary to Blackwater River | 543 | 543 | 0 | Implicit |
| MC-60-D-5 | Beaver Creek, tributary to Blackwater River | 6,626 | 2,265 | 4,362 | Implicit |
| MC-60-D-5-C | Hawkins Run, tributary to Beaver Creek | 1,030 | 1,030 | 0 | Implicit |
| MC-60-D | Lower Blackwater River trib. To Cheat | 46,551 | 28,431 | 18,120 | Implicit |

| Iron | | | | | |
|---|---|---|---|---|---|
| WV Stream Code | Stream Name | TMDLS (lbs Fe/yr) | ΣLAs (lbs Fe/yr) | ΣWLAs (lbs Fe/yr) | MOS |
| | River | | | | |
| MC-60-D-3 | North Fork of Blackwater River | 9,865 | 8,191 | 1,675 | Implicit |
| MC-60-D-3-A | Long Run, tributary to North Fork | 1,368 | 794 | 574 | Implicit |
| MC-60-D-3-B | Middle Run, tributary to North Fork | 81 | 81 | 0 | Implicit |
| MC-60-D-3-C | Snyder Run, tributary to North Fork | 4,192 | 3,091 | 1,101 | Implicit |
| MC | Cheat River from Pringle Run to Cheat Lake | 696,675 | 613,697 | 82,978 | Implicit |

**Table 5-3.** TMDLs, load, and waste load allocations for manganese

| Manganese | | | | | |
|---|---|---|---|---|---|
| WV Stream Code | Stream Name | TMDLs (lbs Mn/yr) | ΣLAs (lbs Mn/yr) | ΣWLAs (lbs Mn/yr) | MOS |
| MC-? | Unnamed Trib.# 1 To Cheat River Lake | 1,875 | 806 | 1,069 | Implicit |
| MC-? | Unnamed Trib.# 2 To Cheat River Lake | 1,011 | 1,011 | 0 | Implicit |
| MC-? | Unnamed Trib.# 3 To Cheat River Lake | 394 | 394 | 0 | Implicit |
| MC-3 | Crammeys Run, Trib. To Cheat Lake | 363 | 363 | 0 | Implicit |
| MC-11 | Bull Run, Trib. To Cheat River | 19,229 | 17,973 | 1,256 | Implicit |
| MC-11-A | Middle Run, Trib. To Bull Run | 1,865 | 916 | 948 | Implicit |
| MC-11-.1A | Unnamed Trib. #1 to Bull Run | 1,357 | 1,357 | 0 | Implicit |
| MC-11-B | Mountain Run, Trib. To Bull Run | 1,761 | 1,761 | 0 | Implicit |
| MC-11-C | Lick Run, Trib. To Bull Run | 4,324 | 4,324 | 0 | Implicit |
| MC-11-C-0.1 | Unnamed Trib. #2 to Bull Run | 1,523 | 1,523 | 0 | Implicit |
| MC-11-E | Right Fork of Bull Run | 3,344 | 3,344 | 0 | Implicit |
| MC-12 | Big Sandy Creek, Trib. To Cheat River | 80,691 | 66,075 | 14,616 | Implicit |
| MC-12-? | Unnamed Trib. To Big Sandy Creek | 1,127 | 307 | 820 | Implicit |
| MC-12-0.5 | Sovern Run, Trib. To Big Sandy Creek | 5,580 | 5,580 | 0 | Implicit |
| MC-12-B | Little Sandy Creek, Trib. To Big Sandy Creek | 44,032 | 30,236 | 13,796 | Implicit |
| MC-12-B-0.5 | Webster Run, Trib. To Little Sandy Creek | 7,714 | 7,714 | 0 | Implicit |
| MC-12-B-1 | Beaver Creek, Trib. To Little Sandy Creek | 11,283 | 11,283 | 0 | Implicit |
| MC-12-B-1-A | Glade Run, Trib. To Little Sandy Creek | 1,679 | 1,679 | 0 | Implicit |
| MC-12-B-1-? | Unnamed Trib.#2 To Beaver Creek | 1,392 | 1,392 | 0 | Implicit |
| MC-12-B-3 | Hog Run, Trib. To Little Sandy Creek | 2,824 | 2,824 | 0 | Implicit |
| MC-12-B-5 | Cherry Run, Trib. To Little Sandy Creek | 2,742 | 2,742 | 0 | Implicit |
| MC-12-C | Hazel Run Trib. To Big Sandy Creek | 1,520 | 1,520 | 0 | Implicit |
| MC-13.5 | Conner Run, Trib. To Cheat River | 2,856 | 2,856 | 0 | Implicit |
| MC-16 | Greens Run, Trib. To Cheat River | 5,957 | 5,318 | 640 | Implicit |
| MC-16-A | South Fork of Greens Run | 3,229 | 3,229 | 0 | Implicit |
| MC-16-A-.1 | Middle Fork of Greens Run | 889 | 889 | 0 | Implicit |
| MC-17 | Muddy Creek, Trib. To Cheat | 10,338 | 9,825 | 513 | Implicit |
| MC-17-A | Martin Creek, Trib. To Muddy Creek | 5,724 | 5,211 | 513 | Implicit |
| MC-17-A-0.5 | Ficky Run, Trib. To Martin Creek | 1,759 | 1,246 | 513 | Implicit |
| MC-17-A-1 | Glade Run, Trib. To Martin Creek | 2,869 | 2,869 | 0 | Implicit |
| MC-17-A-1.1 | Unnamed Trib. #1 to Glade Run | 429 | 429 | 0 | Implicit |
| MC-17-A-1.2 | Unnamed Trib.#2 To Glade Run | 733 | 733 | 0 | Implicit |
| MC-18 | Roaring Creek, Trib. To Cheat | 5,585 | 5,585 | 0 | Implicit |
| MC-23 | Morgan Run Trib. To Cheat River | 6,303 | 6,303 | 0 | Implicit |
| MC-23-0.2-A | Unnamed Trib.#1 to Morgan Run | 492 | 492 | 0 | Implicit |
| MC-23-A | Church Creek, Trib. To Morgan Run | 4,325 | 4,325 | 0 | Implicit |
| MC-23-A-0.1-A | Left Fork of unnamed Trib. To Church Creek | 1,108 | 1,108 | 0 | Implicit |
| MC-23-A-0.1-B | Right Fork of unnamed Trib. To Church River | 524 | 524 | 0 | Implicit |
| MC-24 | Heather Run, Trib. To Cheat River | 2,084 | 2,084 | 0 | Implicit |

| Manganese | | | | | |
|---|---|---|---|---|---|
| WV Stream Code | Stream Name | TMDLs (lbs Mn/yr) | ΣLAs (lbs Mn/yr) | ΣWLAs (lbs Mn/yr) | MOS |
| MC-24-A | Unnamed Trib. #1 to Heather Run | 61 | 61 | 0 | Implicit |
| MC-25 | Lick Run, Trib. To Cheat River | 6,494 | 6,471 | 23 | Implicit |
| MC-26 | Joes Run, Trib. To Cheat River | 692 | 75 | 617 | Implicit |
| MC-27 | Pringle Run, Trib. To Cheat River | 8,721 | 8,721 | 0 | Implicit |
| MC-27-A | Left Fork of Pringle Run | 2,741 | 2,741 | 0 | Implicit |
| MC-27-B | Right Fork of Pringle Run | 1,569 | 1,569 | 0 | Implicit |
| MC-60-D-2 | Tub Run, tributary to Blackwater River | 931 | 931 | 0 | Implicit |
| MC-60-D-5-C | Hawkins Run, tributary to Beaver Creek | 751 | 751 | 0 | Implicit |
| MC-60-D | Lower Blackwater River trib. To Cheat River | 62,290 | 48,317 | 13,973 | Implicit |
| MC-60-D-3 | North Fork of Blackwater River | 6,297 | 5,227 | 1,071 | Implicit |
| MC-60-D-3-A | Long Run, tributary to North Fork | 1,185 | 803 | 382 | Implicit |
| MC-60-D-3-B | Middle Run, tributary to North Fork | 208 | 208 | 0 | Implicit |
| MC-60-D-3-C | Snyder Run, tributary to North Fork | 2,929 | 2,241 | 688 | Implicit |
| MC | Cheat River from Pringle Run to Cheat Lake | 729,538 | 662,796 | 66,743 | Implicit |

**Table 5-4.** TMDLs, load, and waste load allocations for zinc

| Zinc | | | | | |
|---|---|---|---|---|---|
| WV Stream Code | Stream Name | TMDLs (lbs Zn/yr) | ΣLAs (lbs Zn/yr) | ΣWLAs (lbs Al/yr) | MOS |
| MC | Cheat River from Pringle Run to Cheat Lake | 102,804 | 102,804 | 0 | Implicit |

### *5.3.3 pH Modeling Results*

Aluminum, iron, and manganese concentrations were input into MINTEQA2 to simulate various scenarios including conditions with metals concentrations meeting water quality standards and conditions in proximity to mining activities. MINTEQA2 was run twice using the two different iron standards for aquatic life and trout waters. Based on the inputs (described in more detail in Appendix C), pH was estimated to be 7.74 for the aquatic life iron standard of 1.5 mg/L and 7.77 for the trout waters standard of 0.5 mg/L. For the scenario representative of mining areas, typical instream metals concentrations were used, and pH was estimated to be 4.38. Results from MINTEQA2 imply that pH will meet the West Virginia pH criteria of equal to or above 6 and equal to or below 9 if metals concentrations meet water quality criteria.

### *5.3.4 Seasonal Variation*

A TMDL must consider seasonal variation in the derivation of the allocation. For the Cheat watershed metals TMDLs, seasonal variation was considered in the formulation of the modeling analysis. By using continuous simulation modeling over a period of several years, seasonal hydrologic and source loading variability was considered. The metals concentrations simulated on a daily time step by the model were compared to the TMDL endpoints. An allocation which meets these endpoints throughout the year was developed. Water quality criteria for aluminum, iron and manganese does not vary seasonally, however it must be met throughout the year.

### *5.3.5 Future Growth*

This TMDL does not include specific future growth allocations to each subwatershed. Because of the general allocation philosophy used in this TMDL, such allocations would be made at the expense of active mining point sources in the watershed. However, the absence of specific future growth allocations does not prohibit new mining in the watershed. Future growth could occur in the watershed under the following scenarios:

1. A new facility could be permitted anywhere in the watershed, provided that effluent limitations are based upon the achievement of water quality standards end-of-pipe for the pollutants of concern in the TMDL.

2. Remining could occur without a specific allocation to the new permittee, provided that the requirements of existing State remining regulations are achieved. Remining activities are viewed as a partial nonpoint source load reduction from Abandoned Mine Lands.

3. Reclamation and release of existing permits could provide an opportunity for future growth provided that permit release is conditioned upon achieving discharge quality better than the wasteload allocation prescribed by the TMDL.

It is also possible that the TMDL may be refined in the future through remodeling. Such refinement may incorporate new information and/or to the redistribute pollutant loads. Trading may provide an additional opportunity for future growth, contingent upon the State's development of a statewide or watershed-based trading program.

### *5.3.6 Water Quality Trading*

This TMDL neither prohibits nor authorizes trading in the Cheat River watershed. Both the WVDEP and EPA generally endorse the concept of trading, and recognize that it may become an effective tool for TMDL implementation. However, significant regulatory framework development is necessary before large-scale trading in West Virginia may be realized. EPA will cooperate with the West Virginia Division of Environmental Protection in their development of a statewide or watershed-based trading program. Further, EPA supports program development assisted by a consensus-based stakeholder process.

Prior to the development of a formal trading program, it is conceivable that the regulation of specific point source to point source trades may be feasible under the framework of the NPDES program. EPA commits to cooperate with the WVDEP to facilitate such trades if opportunities arise and are proven to be environmentally beneficial.

## 6.0 Reasonable Assurance

Two primary programs are in effect which provide reasonable assurance for maintenance and improvement of water quality in the watershed. The WVDEP's efforts to reclaim abandoned mine lands, coupled with its duties and responsibilities for issuance of NPDES permits, will be the focal points in water quality improvement.

Additional opportunities for water quality improvement are both ongoing and anticipated. Historically, a great deal of research into mine drainage has been conducted by scientists at West Virginia University, the West Virginia Division of Natural Resources, the United States Office of Surface Mining, the National Mine Land Reclamation Center, the National Environmental Training Laboratory and many other agencies and individuals. Funding from EPA's 319 Grant program has been used extensively to remedy mine drainage impacts. This myriad of activity is expected to continue and result in water quality improvement.

### 6.1 Reclamation

Two distinct units of WVDEP reclaim land and water resources impacted by abandoned mines. The Office of Abandoned Mine Lands and Reclamation remedies eligible sites under Title IV of the Surface Mining Control and Reclamation Act of 1977. The Office of Mining and Reclamation's Special Reclamation Program remedies sites where operating permits and bonds have been revoked. Funding of the Office of Abandoned Mine Lands and Reclamation is derived from a federal tax on coal producers. The Special Reclamation Program is funded by the Special Reclamation Fund, which has primary sources of income from civil penalties, forfeited bonds, and a three-cent per ton fee on all coal produced.

A description of the operating procedures and accomplishments of each program follows.

#### *6.1.1 Office of Abandoned Mine Lands and Reclamation*

Title IV of the Surface Mining Control and Reclamation Act (Public Law 95-87) is designed to help reclaim and restore coal mine areas abandoned prior to August 3, 1977, throughout the country. The AML Program supplements existing state programs and allows the State of West Virginia to correct many abandoned mine related problems that would otherwise not be addressed.

The major purpose of the AML Program is to reclaim and restore abandoned mine areas so as to protect the health, safety, and general welfare of the public and the environment.

The AML Program corrects abandoned mine-related problems in accordance with the prioritization process specified in Public Law 95-87, Section 403 (a), 1-3.

Priorities:

- Priority 1 – The protection of public health, safety, general welfare, and property from extreme danger of adverse effects related to coal mining practices;

- Priority 2 – The protection of public health, safety, and general welfare from adverse effects related to coal mining practices; and

- Priority 3 – The restoration of the environment, including the land and water resources, that were degraded by adverse effects related to coal mining practices. This involves the conservation and development of soil, water (not channelization), woodland, fish and wildlife, recreational resources, and agricultural productivity.

Priority 1 and 2 problem areas include unsafe refuse piles, treacherous highwalls, pollution of domestic water supplies from mine drainage, mine fires, subsidence and other abandoned mine-related problems.

The AML Program is now also focused on Priority 3 problem areas and on treating and abating water quality problems associated with abandoned mine lands but is not required by law or any statutory authority to do so. By recognizing the need to protect, and in many cases, improve the quality of the state's water resources from the impacts of mine drainage pollution from abandoned coal mines, coordinated efforts are now being employed to deal with this nonpoint source pollution problem.

Although OAML&R has been actively involved in the successful remediation of mine drainage pollution, inadequate funding and the lack of cost-effective mine drainage pollution treatment and abatement technologies have limited water quality improvement efforts. In 1990, the Surface Mining Control and Reclamation Act was amended to include a provision allowing states and tribes to establish an Acid Mine Drainage Treatment and Abatement Program and Fund. States and tribes may set-aside up to 10% of their annual grant to begin to address abandoned polluted coal mine drainage problems. Money from the Acid Mine Drainage Treatment and Abatement Fund can be utilized to clean-up mine drainage pollution at sites where mining ceased prior to August 3, 1977, and where no continuing reclamation responsibility can be determined. In order to qualify and be eligible, qualified hydrologic units or watersheds must be identified and water quality must adversely impact biological resources. A plan must be prepared and presented to the Natural Resources Conservation Service for review and the Office of Surface Mining for approval. Plans that include the most cost-effective treatment and abatement alternatives, the greatest down-stream benefits to the ecosystem, and diverse cooperators and stakeholders, will be the highest priority for approval.

AML&R has created an Acid Mine Drainage Abatement Policy to guide efforts in treating and abating mine drainage pollution. The Policy acts to guide the expenditure of funds in order to achieve the maximum amount of mine drainage pollution treatment within the boundaries imposed by budgetary and statutory constraints. The goal is to utilize existing technologies and practical economic considerations to maximize the amount of treatment for dollars expended.

The policy includes a holistic watershed characterization and remediation procedure known as the Holistic Watershed Approach Protocol. The Protocol involves diverse stakeholders in the establishment of various sampling networks and subsequent water quality data generation that focus remediation efforts. The Protocol is first used to subdivide the watershed into focus areas. More specific data is then generated to allow identification of the most feasible pollution sources to address and the best available pollution abatement technology to apply. The Protocol also includes the establishment of post-construction sampling networks to assess the impacts of remediation efforts. The Protocol is iteratively implemented until all focus areas have been addressed and all feasible pollution abatement technologies have been applied. A detailed description of the Protocol is provided in Appendix F.

### *6.1.2 Special Reclamation Group*

When notice of permit revocation is received from the Director, a liability estimate is completed within 60 days of the revocation. The liability estimate notes any special health and safety characteristics of the site and calculates the cost to complete reclamation according to the permit reclamation plan. At sites where acid mine drainage is present, the permit is flagged for water quality characterization and a priority index assigned.

The reclamation plan at all sites includes the application of the best professional judgment to address the site specific problems including acid mine drainage. Any change or modification to the permit reclamation plan is done by or under the supervision of a Registered Professional Engineer. All construction requires application of best management practices to insure quality work and protect the environment.

Prioritization of bond forfeiture sites is consistent with the criteria used in the Abandoned Mine Land and Reclamation (AML&R) program. The criteria, as described below, have been used successfully for many years on abandoned mine areas with similar characteristics to bond forfeiture sites.

| Priority | Description |
|---|---|
| 1. | The highest priority sites are those that entail protection of public health, safety, general welfare, and property from extreme danger. There are relatively few of these types of bond forfeiture sites; however, they are unquestionably first order priorities and receive a ranking of 1. |
| 2. | Second order priority sites are those where public health, safety, welfare, and property values are judged to be threatened. Examples include sites with a high potential for landslides or flooding or the presence of dangerous highwalls, derelict buildings or other structures. |
| 3a. | Third order priorities comprise the bulk of bond forfeiture sites. Therefore, this ranking level is sub-divided into smaller groupings. The first sub-group is sites that are causing or have a high potential for causing off-site environmental damage to the land and water resources. Such off-site damage would most likely be from heavy erosion, or high loadings of acid mine drainage. |
| 3b. | The second sub-group would include sites that are of a lower priority, but are in close geographic proximity to first or second priority sites. It is more efficient and cost effective to "cluster" projects where possible. |

3c. The third sub-group includes sites near high-use public recreation areas and major thoroughfares.

3d. The fourth sub-group includes sites that are nearly fully reclaimed by the operator and only require monitoring of vegetative growth or other parameters. Sites which have a real potential for re-permitting by another operator or reclamation by a third party, will also be placed in this sub-group.

Reclamation construction contracts occur by submittal of a detailed Project Requisition to the State Purchasing Division. All state purchasing policies and procedures are applicable and the contract is awarded to the lowest qualified bidder. Special Reclamation personnel perform inspection and contract management activities through the life of the contract. When all reclamation work is satisfactorily completed, a one-year contract warranty period begins to insure adequate vegetative growth and drainage system operation. Upon completion of the contract warranty period and recommendation of the Regional Supervisor, the permit status is classified as “completed.” A completed status removes the liability of the forfeited site and terminates WVDEP jurisdiction and responsibility as a Phase III bond release.

### *6.2 Permitting*

NPDES permits in the watershed will be issued, reissued or modified by the Office of Water Resources in close cooperation with the Office of Mining and Reclamation. Both offices have adjusted permitting schedules to accommodate the State’s Watershed Management Framework, thus implementation of TMDL requirements at existing facilities will generally occur at the time of scheduled permit reissuance.

Future permitting actions will include implementation of the wasteload allocations specified for existing facilities. Permits for new facilities will be in accordance with the previously specified provisions for future growth. EPA approval is required of all permitting actions in the watershed, if the TMDL pollutants of concern are expected present in the discharge.

In accordance with the watershed approach, permits affected by new wasteload allocations in the Cheat River TMDL are scheduled to be reissued in 2001 and again in 2006.

Since the existing WARMF model is not configured to identify the portion of the instream load attributed to individual land uses or point sources in the watershed, and allocations were made outside of the model, the WVDEP has requested that action specific to implementation of lowering of existing wasteloads not be undertaken until such time that the WVDEP is provided with a version of the WARMF or similar model that will allow direct analysis of permitting effects within the model. EPA suggests that the WVDEP defer action on permit reissuances through a short-term administrative permit extensions in this watershed.

In the event that the newly developed model yields changes to point source allocations, WVDEP and EPA are prepared to modify the TMDL and pursue public notice and comment on the revised allocations if necessary.

## 7.0 Public Participation

Pursuant to 40 CFR 25, EPA policy is that there must be full and meaningful public participation in the TMDL development process. Each State must, therefore, provide for public participation consistent with its own continuing planning process and public participation requirements. As a result, it is the intent of the West Virginia DEP to solicit public input by providing meaningful opportunities for public comment and review of the draft TMDLs. The meetings and public meetings pertaining to the Cheat River watershed occurred as follows:

| | |
|---|---|
| January 25, 1999 | EPA provided a summary of the TMDL process, requirements of the consent decree, guidance for using HSPF, and outlined steps for the development of the TMDL |
| July 27, 1999 | Systech Engineering presented the WARMF model. |
| January 25, 2000 | Systech presented an 80 percent calibrated WARMF model for the Cheat watershed and a public meeting was held. West Virgina DEP was represented at the meeting. The Canaan Valley Institute and stakeholders of the Cheat watershed were also present. |
| February 14, 2000 | EPA representatives were present for a public meeting which involved discussion of stakeholder concerns. |
| October 12, 2000 | Public meeting presented by WVDEP, EPA, and Tetra Tech. |
| January 16, 2001 | Public hearing presented by WVDEP, EPA, and Tetra Tech. |

In addition to EPA's meetings with the public, the Canaan Valley Institute funded Evan Hansen from Downstream Strategies, as well as a technical committee, to review WARMF and its application the Cheat watershed. Mr. Hansen held many meetings, some of which EPA representatives attended, and provided written comments and recommendations from the Cheat TMDL Stakeholder Group to EPA regarding TMDL development and TMDL allocations in the watershed.

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# Appendix A

# Impaired Waterbodies in the Cheat Watershed

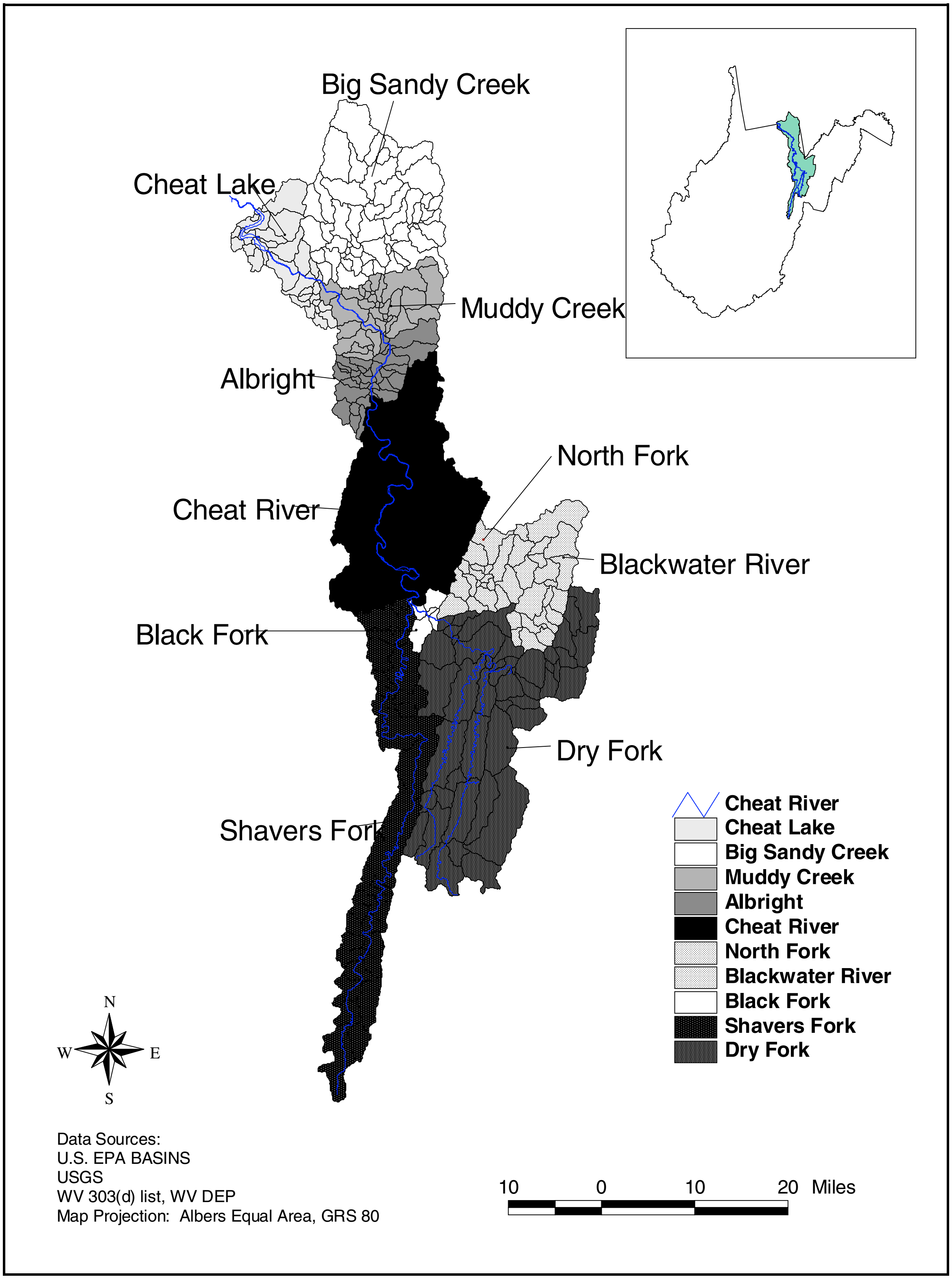



**Figure A-1.** The Cheat River watershed, its 10 major regions, and 351 modeled subwatersheds

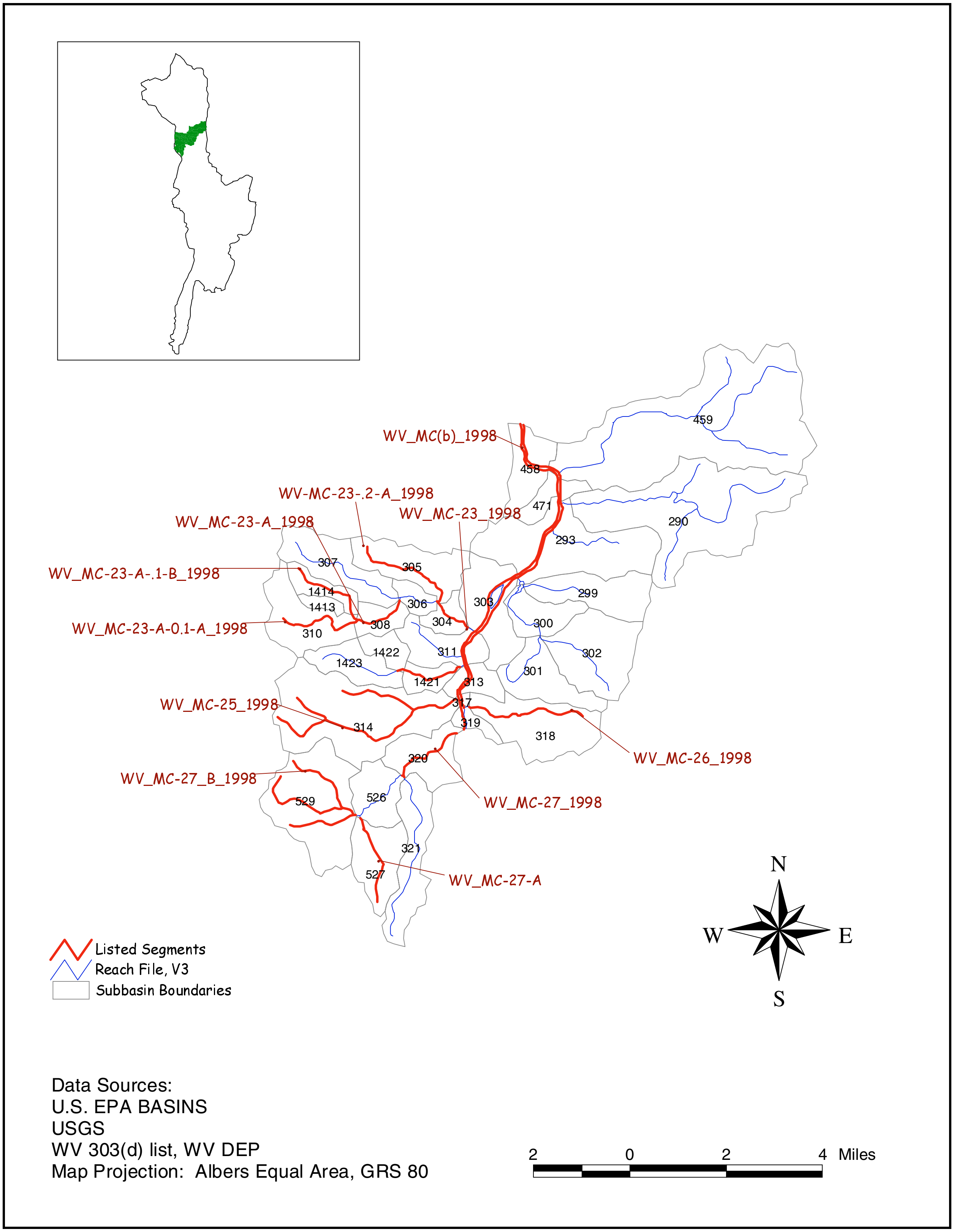



**Figure A-2.** Albright region - Preston County

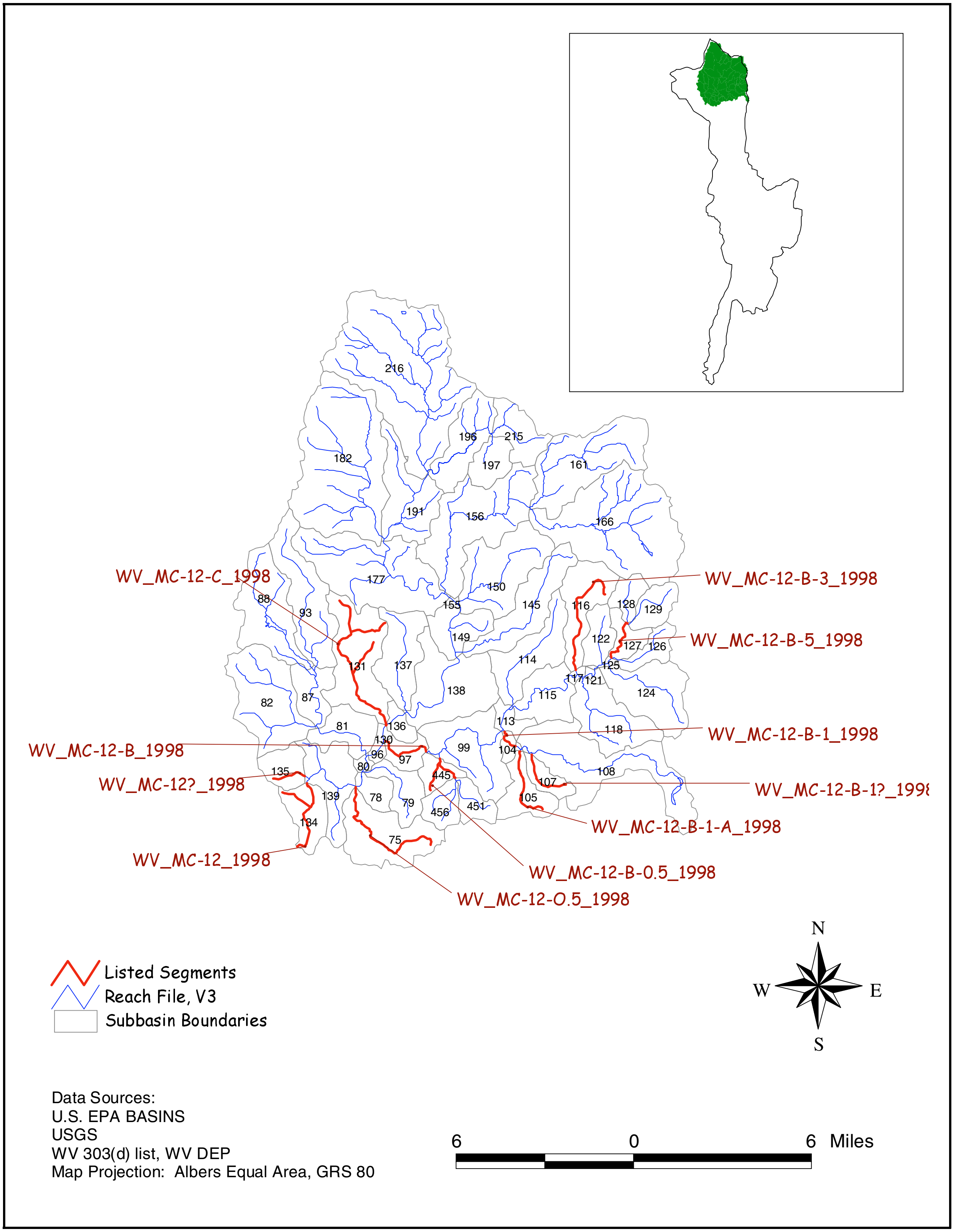



**Figure A-3.** Big Sandy Creek region - Preston and Fayette Counties

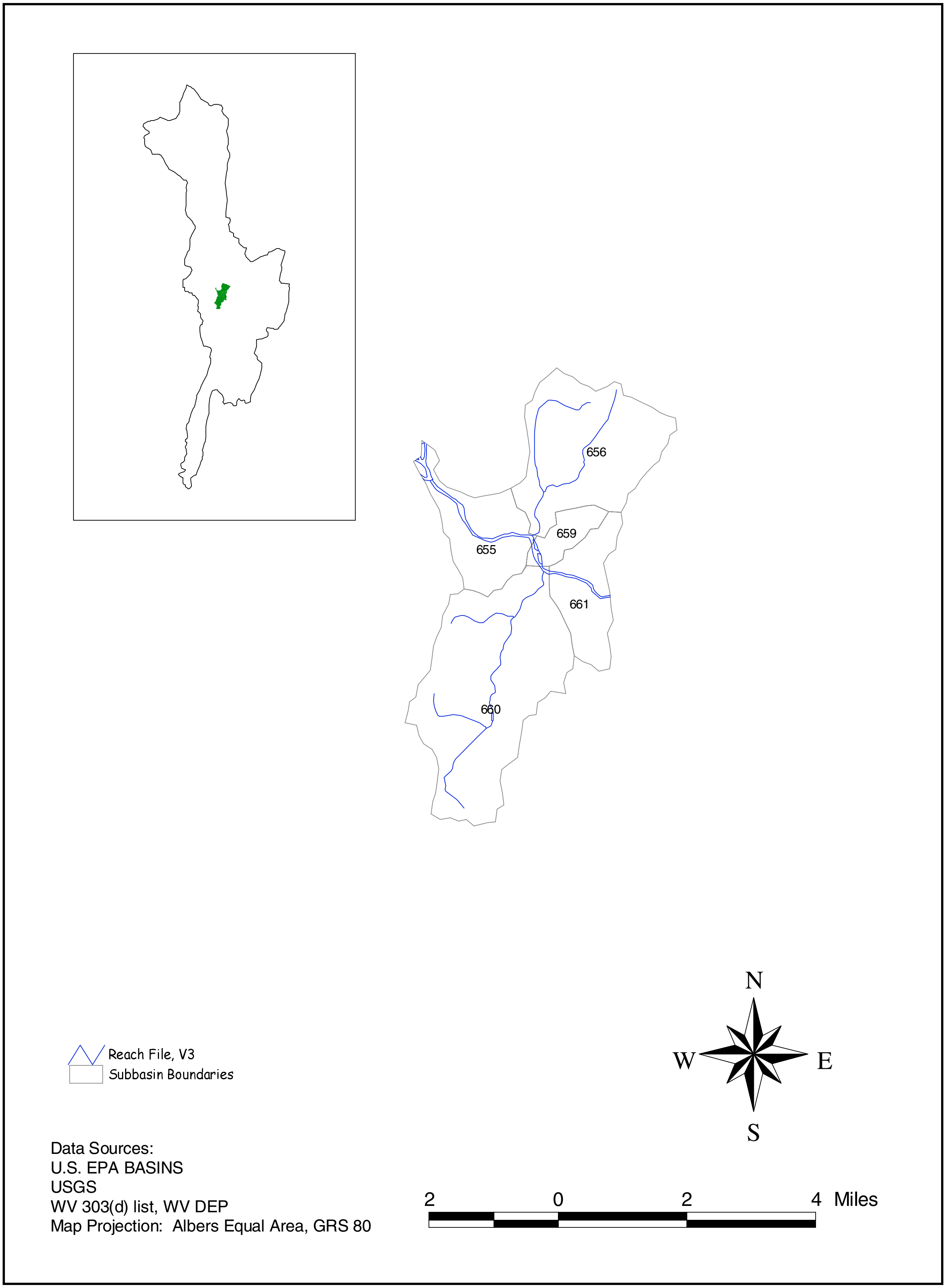



**Figure A-4.** Black Fork region - East of Parsons, no impaired waterbodies

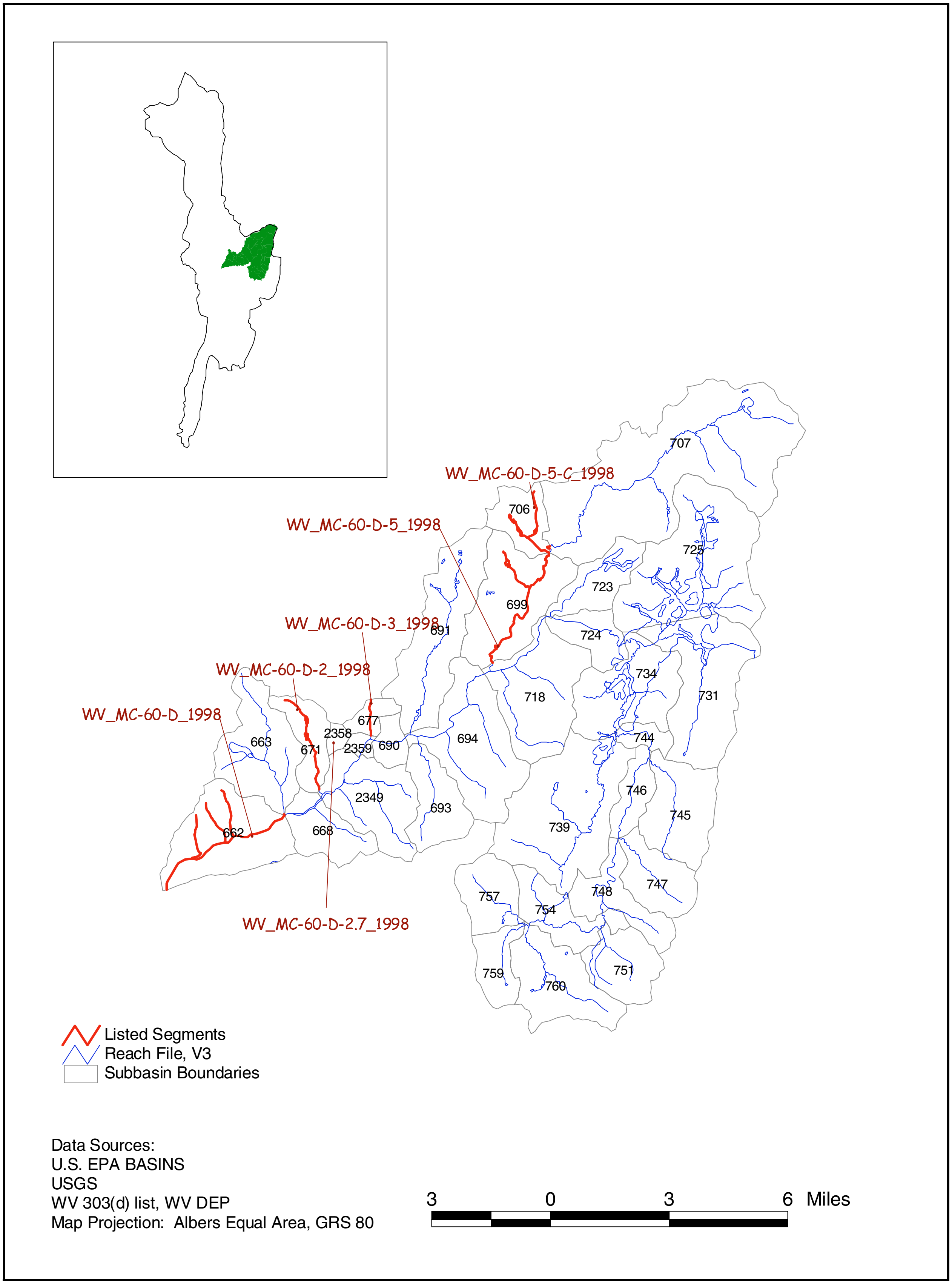



**Figure A-5.** Blackwater River region - East of Parsons, Tucker County

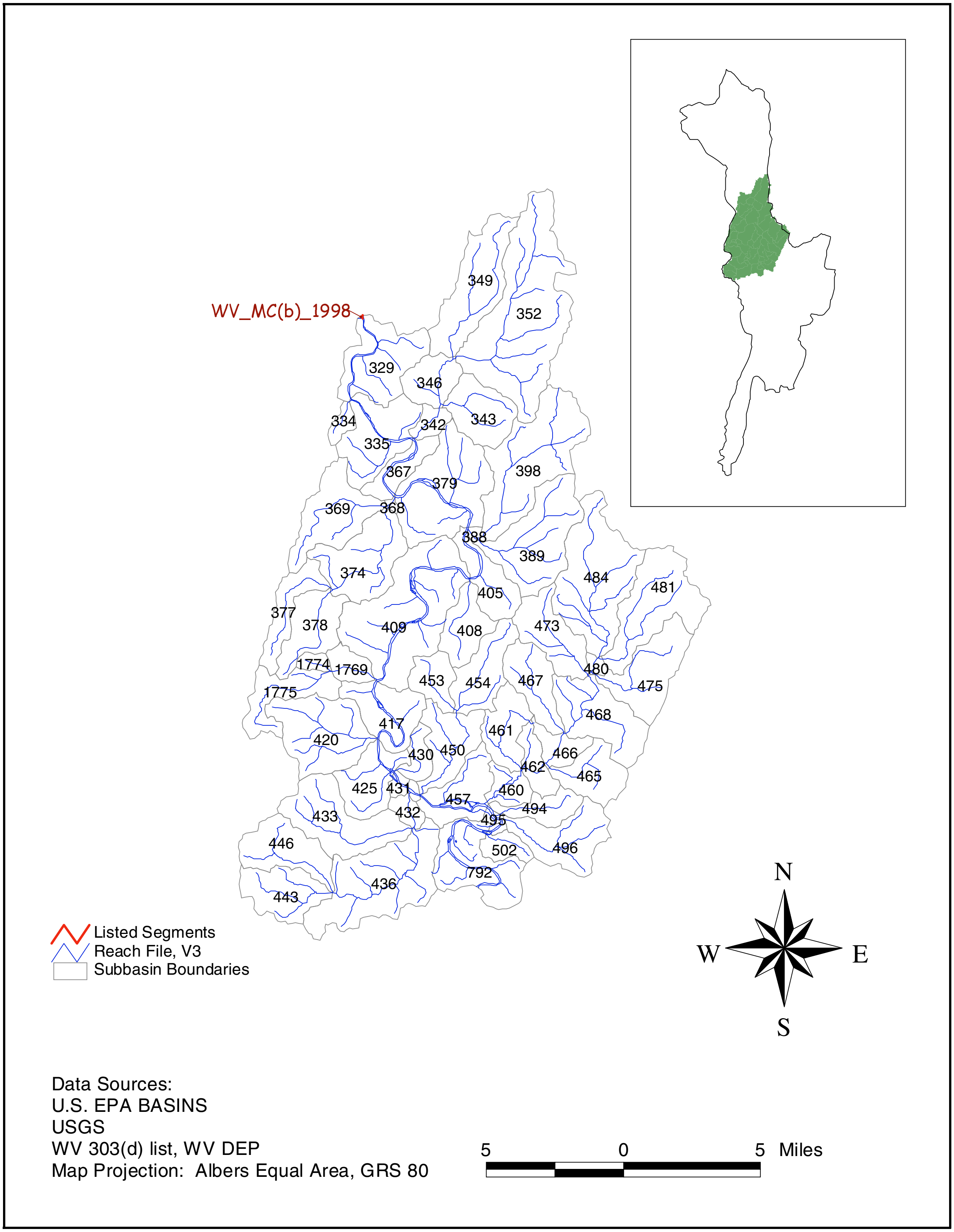



**Figure A-6**. Cheat River region - South of Terra Alta and North of Parsons

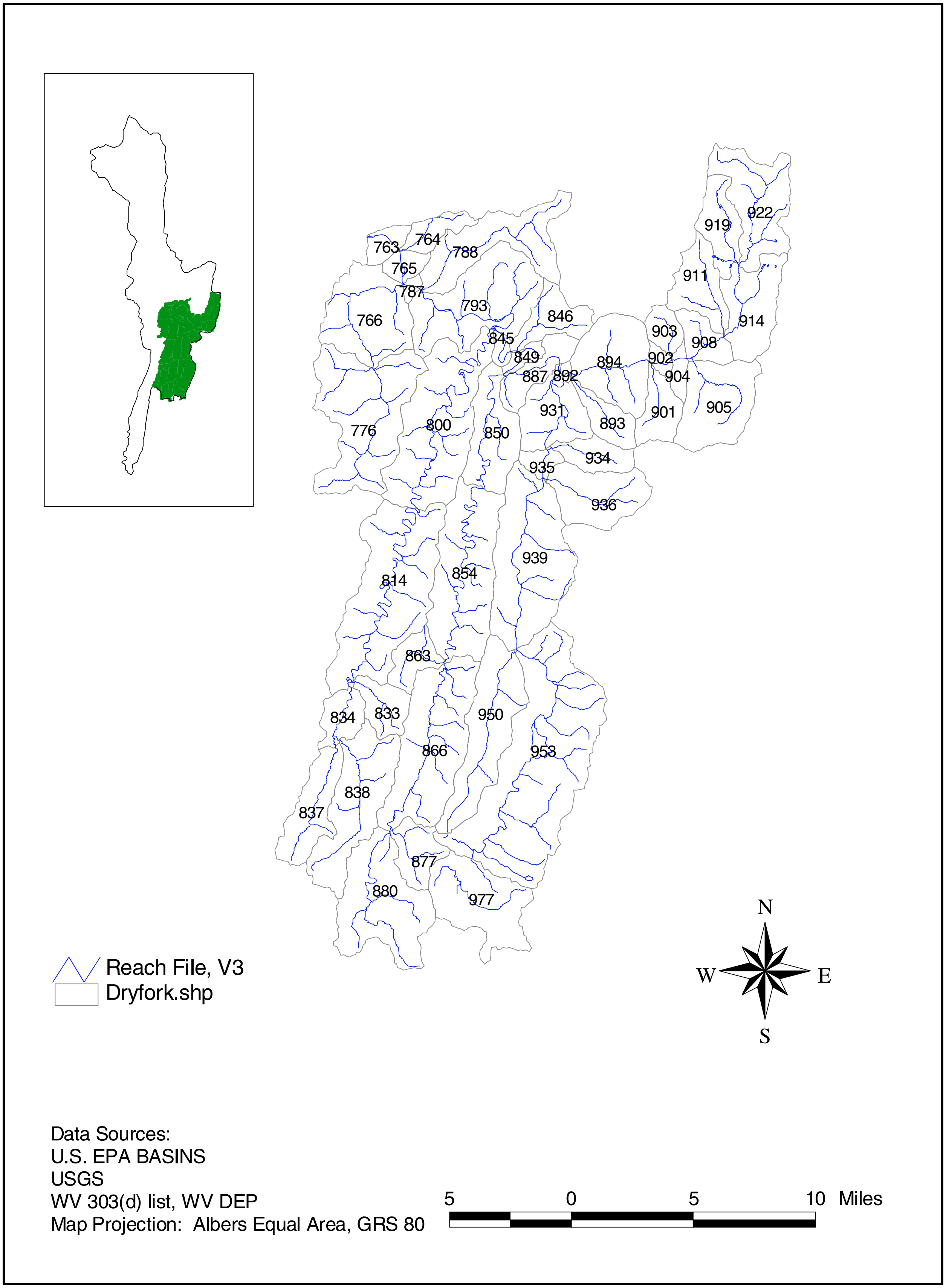



**Figure A-7.** Dry Fork region - East of Elkins, no impaired waterbodies

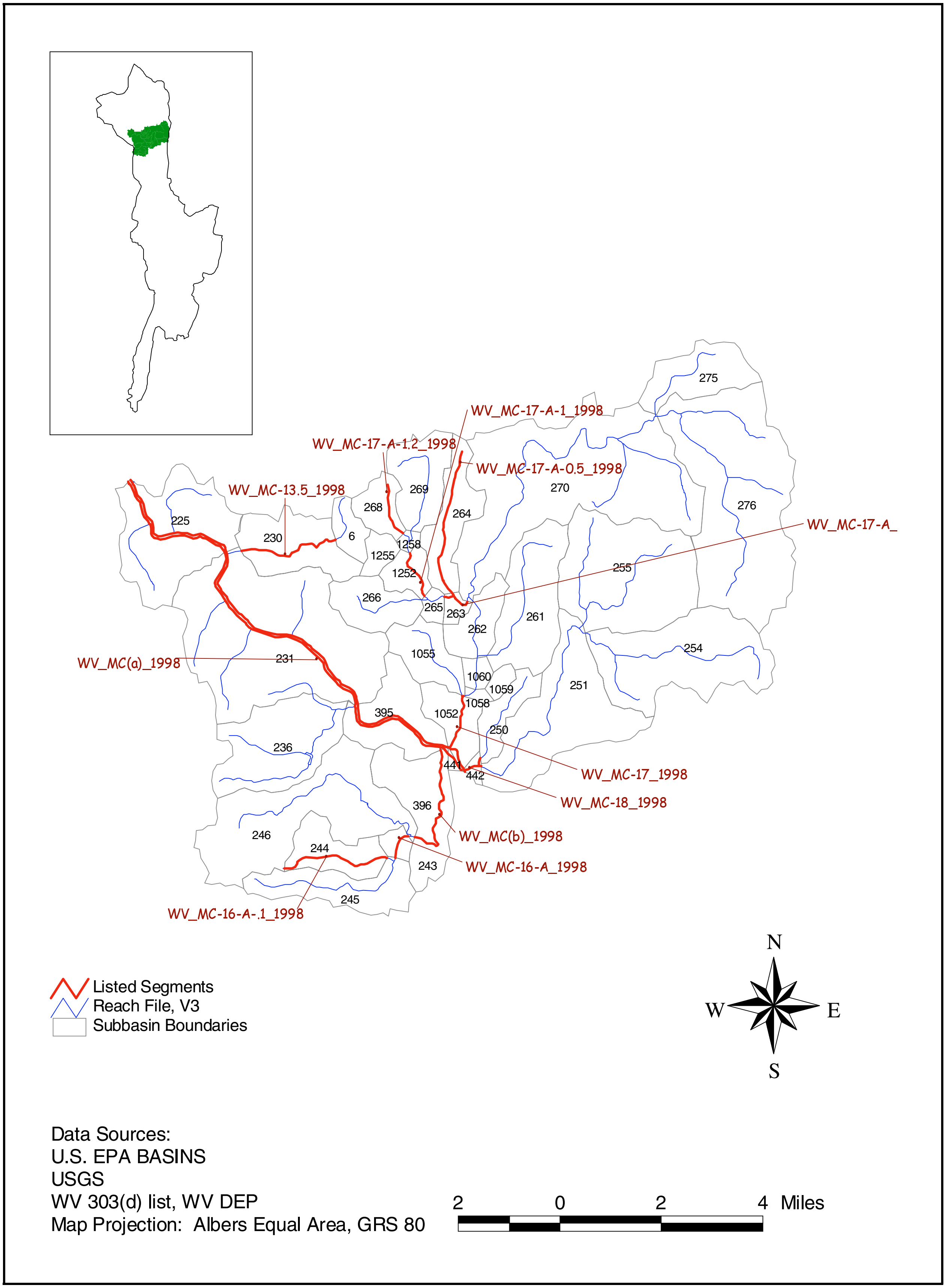



**Figure A-8.** Muddy Creek region - Cheat River, Preston County

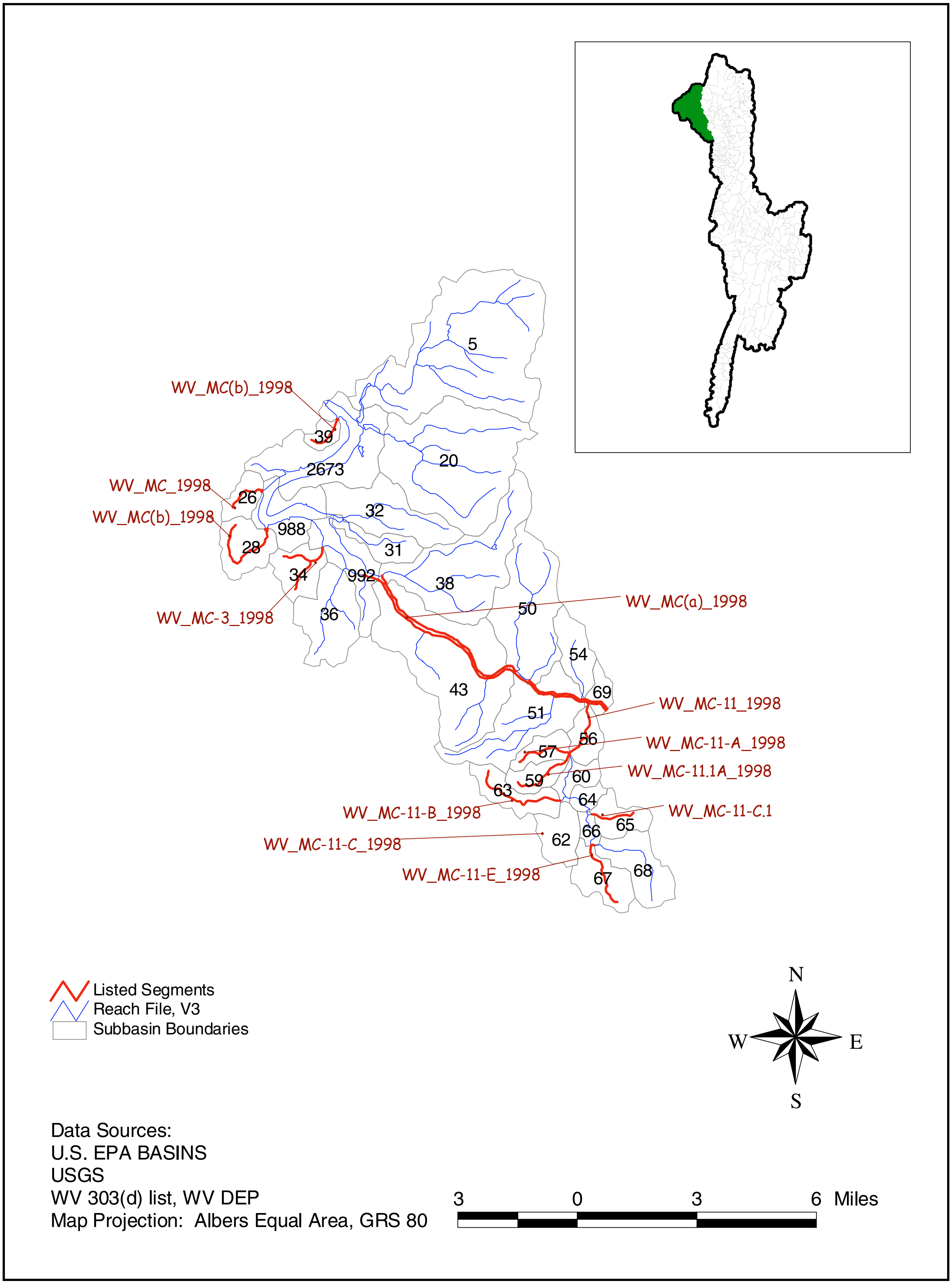



**Figure A-9**. Cheat Lake region - East of Morgantown

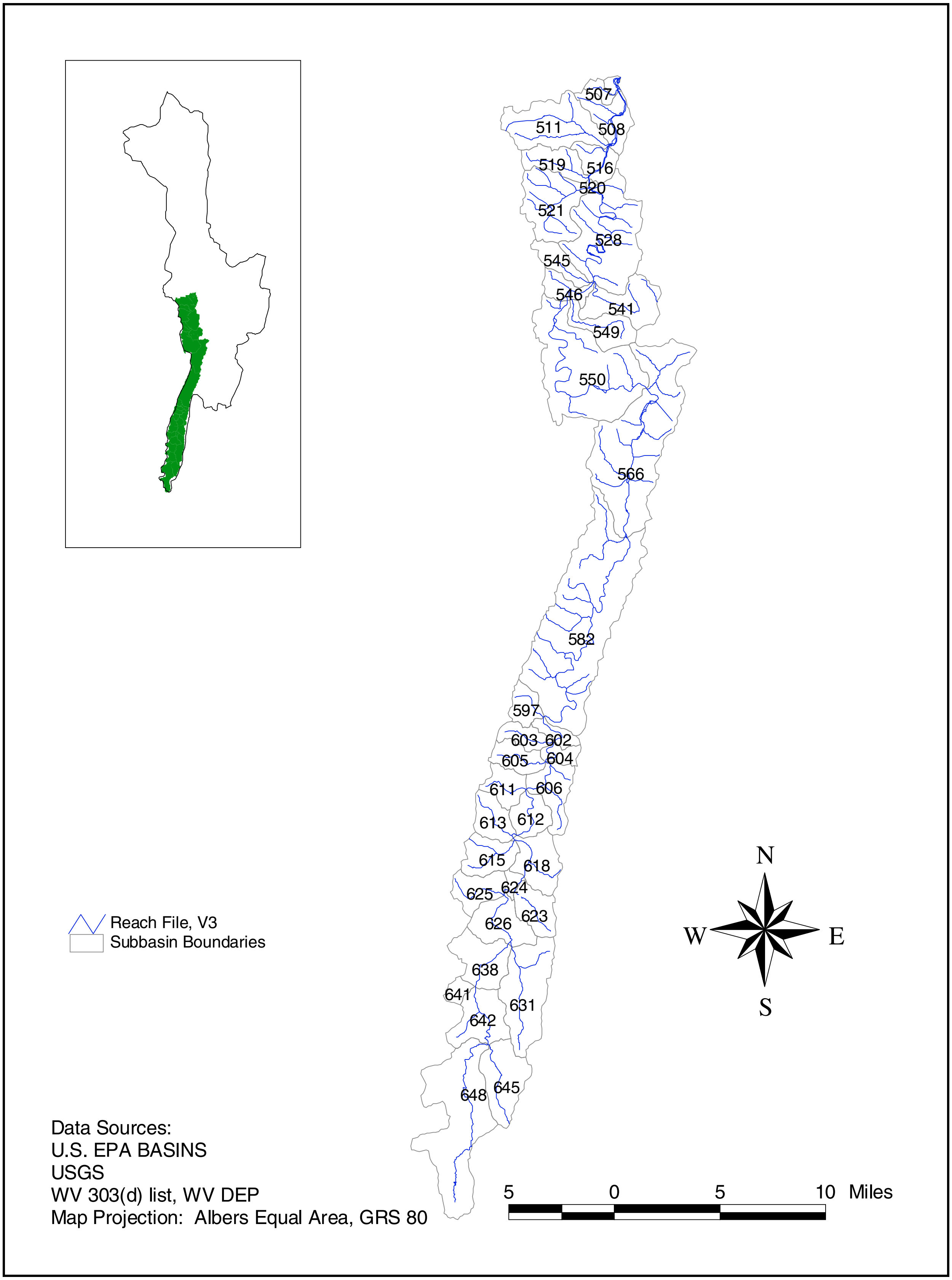



**Figure A-10**. Shavers Fork region - no impaired waterbodies, Randolph County, north of Spruce

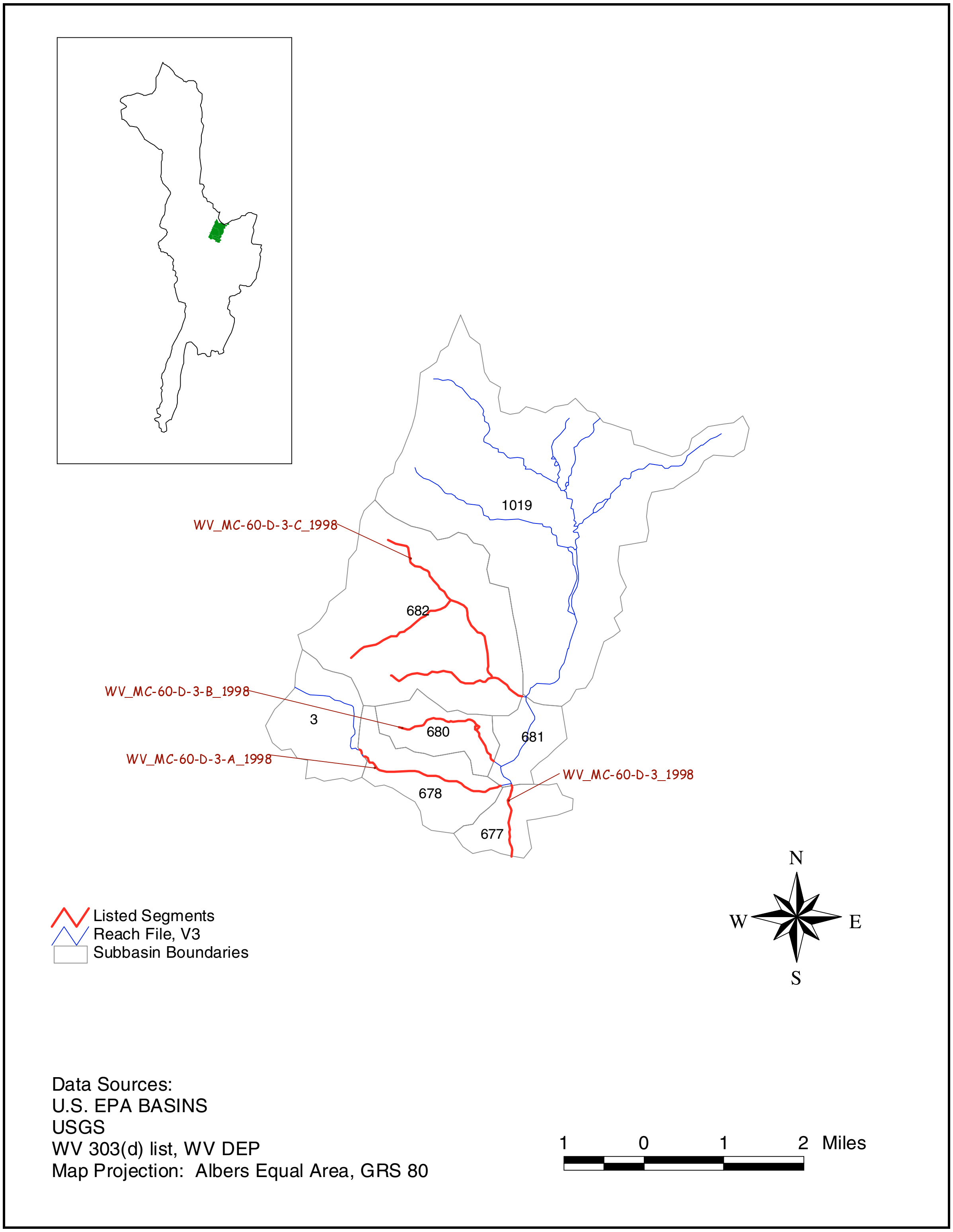



**Figure A-11.** North Fork region - Tucker County

# Appendix B

# Mining Permits in the Cheat Watershed

| Permit Id | Mine Type | Status Code | Facility Name | Original Area[A] | Current Area[B] | Watershed Id | NPDES ID | NPDES Status | County | Inspector |
|---|---|---|---|---|---|---|---|---|---|---|
| q002574 | Quarry | Renewed | Stanley Industries, Inc. | 74.0 | 74.0 | 3 | WV0092398 | 10/16/01 | Tucker | Deem |
| s007985 | Coal Surface | Revoked | Mary Ann Coal co | 26.0 | 0.0 | 5 | WV0098078 | Released 95 | Monongalia | - |
| s010582 | Coal Surface | Revoked | Rockville Mining co | 48.0 | 28.0 | 6 | WV0099139 | Revoked 97 | Preston | - |
| q015375 | Quarry | Renewed | Buckeye Stone Company | 66.0 | 66.0 | 20 | WV0047171 | Expired4/6/01 | Monongalia | - |
| q102890 | Quarry | Renewed | Buckeye Stone Company | 151.0 | 151.0 | 20 | WV0047171 | Expired 4/6/01 | Monongalia | - |
| z001881 | Coal Surface | Phase 1 Released | Preston County Coal and Coke Corporation | 100.0 | 36.0 | 28 | WV1006738 | Expired 4/09/03 | Monongalia | Hooton |
| s010285 | Coal Surface | Revoked | J & R Coal co | 12.0 | 0.0 | 28 | WV0098507 | Expired 11/15/90 | Preston | - |
| p001674 | Prospect | Revoked | Dumbarton Realty Inc | 3.0 | 0.0 | 32 | N/A | - | - | - |
| p005674 | Prospect | Revoked | Dumbarton Realty Inc | 3.0 | 0.0 | 32 | N/A | - | - | - |
| s005584 | Coal Surface | Revoked | Lakeview Coal co | 27.0 | 0.0 | 32 | WV0098357 | Revoked 1/23/97 | Monongalia | - |
| q006473 | Quarry | Renewed | Buckeye Stone Company | 15.0 | 15.0 | 38 | WV0047171 | Expired 4/6/01 | Monongalia | - |

| Permit Id | Mine Type | Status Code | Facility Name | Original Area[A] | Current Area[B] | Watershed Id | NPDES ID | NPDES Status | County | Inspector |
|---|---|---|---|---|---|---|---|---|---|---|
| s006483 | Coal Surface | Revoked | Sand Ridge Coal co | 160.0 | 0.0 | 43 | WV0067628 | Released 10/14/92 | Monongalia | Carico |
| s011280 | Coal Surface | Revoked | F & M Coal Co lp | 100.0 | 0.0 | 51 | WV1002805 | Released 10/9/95 | Preston | Deem |
| s007179 | Coal Surface | Revoked | Interstate Lumber Co Inc | 56.0 | 3.0 | 51 | WV1011421 | Released 7/31/95 | Preston | - |
| p100900 | Prospect | New | Coaltrain Corporation | 1.0 | 1.0 | 51 | N/A | - | - | - |
| s001485 | Coal Surface | Revoked | J & R Coal co | 9.0 | 25.0 | 51 | WV0068047 | Released 2/20/95 | Preston | - |
| s101487 | Coal Surface | Phase 1 Released | Ambrec Corporation | 137.0 | 137.0 | 54 | WV1006797 | Expired 4/27/01 | Preston | Hooton |
| s102887 | Coal Surface | Renewed | Sharon Coal co | 160.0 | 79.0 | 57 | WV1007009 | Expired 1/16/03 | Preston | Kromer |
| z001781 | Coal Surface | Revoked | Daugherty Coal Co Inc | 95.0 | 0.0 | 64 | NONE | - | - | - |
| s100986 | Coal Surface | Revoked | Daugherty Coal Co Inc | 50.0 | 0.0 | 65 | WV0099091 | Released 5/17/91 | Preston | - |
| s023776 | Coal Surface | Revoked | Rockville Mining co | 50.0 | 40.0 | 75 | WV0099180 | Released 1/12/94 | Preston | - |
| u102089 | Coal Undergr | Revoked | Bull Run Mining Co Inc | 10.0 | 20.0 | 75 | WV1007793 | Released 2/01/93 | Preston | - |

| Permit Id | Mine Type | Status Code | Facility Name | Original Area[A] | Current Area[B] | Watershed Id | NPDES ID | NPDES Status | County | Inspector |
|---|---|---|---|---|---|---|---|---|---|---|
| s100488 | Coal Surface | Renewed | Freeport Mining Corporation | 45.0 | 45.0 | 82 | WV1007289 | Expired 5/26/01 | Preston | - |
| z000781 | Coal Surface | Phase 1 Released | Primrose Coal, Inc | 190.0 | 58.0 | 108 | WV1006983 | Expired 1/28/01 | Preston | Kromer |
| u020400 | Coal Undergr | Revoked | Lobo Capital, Inc | 6.0 | 0.0 | 108 | NONE | - | - | - |
| s014879 | Coal Surface | Phase 1 Released | Patriot Mining Company, Inc. | 181.0 | 25.0 | 113 | WV1002791 | Expired 2/23/03 | Preston | - |
| s000981 | Coal Surface | Phase 1 Released | Patriot Mining Company, Inc. | 181.0 | 45.0 | 115 | WV1002791 | Expired 2/23/03 | Preston | Hooton |
| s006084 | Coal Surface | Revoked | Hidden Valley Coal co | 47.0 | 0.0 | 124 | WV0068497 | Released 8/20/98 | Preston | - |
| s006079 | Coal Surface | Revoked | Zinn Coal co | 75.0 | 0.0 | 129 | WV1002881 | Released 4/10/92 | Preston | - |
| s100595 | Coal Surface | New | Freeport Mining Corporation | 104.0 | 110.0 | 135 | WV1011588 | Expired 11/04/03 | Preston | Hooton |
| s100188 | Coal Surface Mine | Phase 1 Released | Patriot Mining Company, Inc. | 36.0 | 16.0 | 139 | WV1007270 | Expired 6/11/03 | Preston | Hooton |
| s000983 | Coal Surface | Revoked | Jones Coal, Inc | 46.0 | 128.0 | 145 | WV0095281 | Expired 2/05/95 | Preston | - |
| s103086 | Coal Surface | Revoked | Jones Coal, Inc | 23.0 | 0.0 | 145 | WV1002589 | Released 7/24/92 | Preston | - |

| Permit Id | Mine Type | Status Code | Facility Name | Original Area[A] | Current Area[B] | Watershed Id | NPDES ID | NPDES Status | County | Inspector |
|---|---|---|---|---|---|---|---|---|---|---|
| s015776 | Coal Surface | Revoked | Northwest Coal Co, Inc | 10.0 | 0.0 | 166 | NONE | - | - | - |
| s103586 | Coal Surface | Revoked | Rockville Mining co | 120.0 | 82.0 | 225 | WV0099180 | Released 1/12/94 | Preston | - |
| s006577 | Coal Surface | Revoked | Daugherty Coal Co Inc | 92.0 | 0.0 | 225 | NONE | - | - | - |
| s007383 | Coal Surface | Revoked | Daugherty Coal Co Inc | 44.0 | 0.0 | 225 | WV0099091 | Released 5/17/91 | - | - |
| s012479 | Coal Surface | Revoked | Daugherty Coal Co Inc | 87.0 | 0.0 | 225 | NONE | - | - | - |
| s018875 | Coal Surface | Revoked | Daugherty Coal Co Inc | 54.0 | 13.0 | 225 | NONE | - | - | - |
| s024674 | Coal Surface | Revoked | Daugherty Coal Co Inc | 69.0 | 0.0 | 225 | NONE | - | Preston | - |
| s004073 | Coal Surface | Revoked | Daugherty Coal Co Inc | 70.0 | 17.0 | 225 | NONE | - | Preston | - |
| u032100 | Coal Undergr | Revoked | Amanda Mining Inc | 6.0 | 0.0 | 231 | NONE | - | Preston | - |
| s100688 | Coal Surface | Revoked | F & M Coal Co lp | 95.0 | 0.0 | 231 | WV1007297 | Released 10/14/93 | Preston | - |
| s102687 | Coal Surface | Revoked | F & M Coal Co lp | 167.0 | 0.0 | 231 | WV1006941 | Released 9/03/93 | Preston | - |

| Permit Id | Mine Type | Status Code | Facility Name | Original Area[A] | Current Area[B] | Watershed Id | NPDES ID | NPDES Status | County | Inspector |
|---|---|---|---|---|---|---|---|---|---|---|
| s019277 | Coal Surface | Revoked | Daugherty Coal Co Inc | 60.0 | 0.0 | 231 | NONE | - | - | - |
| z004081 | Coal Surface | Revoked | Hallelujah Mining | 55.0 | 0.0 | 246 | WV0053911 | Released 9/24/92 | Preston | - |
| s101887 | Coal Surface | Revoked | *G & B Coal, Inc. | 41.0 | 0.0 | 246 | WV1006894 | Released 7/31/95 | Preston | - |
| s017677 | Coal Surface | Revoked | Interstate Lumber Co Inc | 110.0 | 176.0 | 251 | WV1002830 | Released 10/9/95 | Preston | - |
| u023500 | Coal Undergr | Revoked | Preston Energy Inc | 10.0 | 0.0 | 251 | WV1002651 | Expired 10/1/91 | Preston | Hooten |
| s100989 | Coal Surface | Phase 1 Released | Loyal G. Forman Jr Dba Loyal G Forman & Son | 60.0 | 60.0 | 261 | WV1007696 | Expired 4/04/01 | Preston | Dixon |
| e011300 | Coal Undergr | Revoked | T & T Fuels Inc | 2.0 | 0.0 | 262 | WV0030481 | Revoked 11/24/97 | Preston | - |
| s009185 | Coal Surface | Revoked | Rockville Mining co | 125.0 | 45.0 | 264 | WV0098442 | Released 1/29/96 | Preston | - |
| s105386 | Coal Surface | Revoked | Rockville Mining co | 32.0 | 64.0 | 264 | WV0099180 | Released 1/12/94 | Preston | - |
| u051900 | Coal Undergr | Phase 1 Released | Viking Coal Company | 9.0 | 10.0 | 264 | WV0091766 | In Renewal Draft | Preston | Hooton |
| r067300 | Other | Renewed | Coastal Coal-west Virginia, Llc | 57.0 | 139.0 | 264 | WV0063576 | Expired 1/12/01 | Preston | Hooton |

| Permit Id | Mine Type | Status Code | Facility Name | Original Area[A] | Current Area[B] | Watershed Id | NPDES ID | NPDES Status | County | Inspector |
|---|---|---|---|---|---|---|---|---|---|---|
| s006582 | Coal Surface | Revoked | Rockville Mining co | 475.0 | 281.0 | 266 | WV0099139 | Revoked 5/4/97 | Preston | - |
| u012583 | Coal Undergr | Revoked | T & T Fuels Inc | 14.0 | 0.0 | 266 | WV0099163 | Revoked 12/03/97 | Preston | - |
| u040800 | Coal Undergr | Revoked | Rock Bull Mining, Inc | 12.0 | 24.0 | 266 | WV0099139 (Rockville) | Revoked 5/04/97 | Preston | - |
| u042900 | Coal Undergr | Revoked | Preston Energy Inc | 5.0 | 0.0 | 269 | WV0069480 | Expired 4/9/89 | Preston | - |
| s002783 | Coal Surface | Revoked | *Crane Coal Co., Inc. | 8.0 | 0.0 | 269 | WV0098051 | Released 1/31/94 | Preston | - |
| u044900 | Coal Undergr | Revoked | New Coals, Inc | 10.0 | 0.0 | 270 | NONE | NONE | - | - |
| s101588 | Coal Surface | Phase 1 Released | Mary Ruth Corporation | 53.0 | 84.0 | 270 | WV1007386 | Expired 10/13/01 | Preston | Dixon |
| s004478 | Coal Surface | Revoked | F & M Coal Co lp | 70.0 | 0.0 | 270 | WV1007114 | Expired 6/22/93 | Preston | - |
| s100888 | Coal Surface | Revoked | Horizon Fuels Inc | 14.0 | 0.0 | 270 | WV1007351 | Released 3/28/94 | Preston | - |
| s000476 | Coal Surface | Revoked | Reckart Mining Co., Inc | 40.0 | 0.0 | 270 | NONE | - | - | - |
| s010375 | Coal Surface | Revoked | Reckart Mining Co., Inc | 35.0 | 0.0 | 270 | NONE | - | - | - |

| Permit Id | Mine Type | Status Code | Facility Name | Original Area$^{A}$ | Current Area$^{B}$ | Watershed Id | NPDES ID | NPDES Status | County | Inspector |
|---|---|---|---|---|---|---|---|---|---|---|
| s011077 | Coal Surface | Revoked | Reckart Mining Co., Inc | 20.0 | 0.0 | 270 | NONE | - | - | - |
| s100299 | Coal Surface | New | Ali Co. | 33.0 | 33.0 | 270 | WV1017331 | Expired 11/04/02 | Preston | Dixon |
| p059600 | Prep Plant | Inactive | Mepco, Inc. | 16.0 | 16.0 | 293 | WV0048739 | Expired 9/30/01 | Preston | Kromer |
| s004679 | Coal Surface | Revoked | F & M Coal Co lp | 130.0 | 0.0 | 293 | WV1006991 | Released 1/26/93 | Preston | - |
| s106386 | Coal Surface | Revoked | J.e.b., Inc | 56.0 | 42.0 | 305 | WV1002559 | Released 10/14/92 | Preston | - |
| s003781 | Coal Surface | Revoked | Bjorkman Mining co | 35.0 | 0.0 | 307 | NONE | - | - | - |
| s013180 | Coal Surface | Revoked | Bjorkman Mining co | 26.0 | 0.0 | 307 | NONE | - | Preston | - |
| s006284 | Coal Surface | Revoked | J.e.b., Inc | 40.0 | 0.0 | 308 | WV0068357 | Released 10/14/92 | Preston | - |
| o002082 | Other | Revoked | Pioneer Coal Sales, Inc | 5.0 | 0.0 | 310 | WV0057916 | Released 6/22/93 | Preston | - |
| p050400 | Prep Plant | Inactive | Patriot Mining Company, Inc. | 11.0 | 13.0 | 313 | WV0048887 | Expired 4/28/02 | Preston | Hooton |
| p102298 | Prospect | New | Nexus Mining Systems, Inc. | 2.0 | 2.0 | 314 | N/A | - | - | - |

| Permit Id | Mine Type | Status Code | Facility Name | Original Area[A] | Current Area[B] | Watershed Id | NPDES ID | NPDES Status | County | Inspector |
|---|---|---|---|---|---|---|---|---|---|---|
| u015482 | Coal Undergr | Revoked | Angela Mining Co Inc | 3.0 | 0.0 | 314 | NONE | - | Preston | - |
| s001483 | Coal Surface | Phase 1 Released | R. K. Company, Inc. | 100.0 | 78.0 | 318 | WV1007815 | Expired 9/20/01 | Preston | Dixon |
| s100197 | Coal Surface | New | R. K. Company, Inc. | 225.0 | 173.0 | 319 | WV1007815 | Expired 9/20/01 | Preston | Dixon |
| q101892 | Quarry | Renewed | Martin Marietta Materials, Inc. | 64.0 | 64.0 | 335 | WV0005151 | Expired 7/12/01 | Preston | Deem |
| s107386 | Coal Surface | Revoked | F & M Coal Co lp | 72.0 | 0.0 | 369 | WV1002791 | Expired 10/10/91 | Preston | - |
| q100295 | Quarry | Renewed | Laurel Aggregates, Inc | 284.0 | 192.0 | 369 | NONE | - | Preston | Deem |
| s102488 | Coal Surface | Revoked | Bolingreen Mining co | 21.0 | 21.0 | 395 | WV1007483 | Expired 11/19/01 | - | - |
| s100393 | Coal Surface | Renewed | Patriot Mining Company, Inc. | 13.0 | 13.0 | 396 | WV1007688 | Expired 7/14/01 | Preston | Hooton |
| s101389 | Coal Surface | Inactive | *Patriot Mining Co., Inc. | 47.0 | 54.0 | 396 | WV1007688 | Expired 7/14/01 | Preston | - |
| e006600 | Coal Undergr | Revoked | Bull Run Mining Co Inc | 7.0 | 0.0 | 451 | WV0036668 | Expired 6/28/94 | Preston | - |
| q013873 | Quarry | Renewed | Fairfax Materials, Inc. | 190.0 | 190.0 | 475 | WV0043613 | Expired 12/21/01 | Tucker | Deem |

| Permit Id | Mine Type | Status Code | Facility Name | Original Area[A] | Current Area[B] | Watershed Id | NPDES ID | NPDES Status | County | Inspector |
|---|---|---|---|---|---|---|---|---|---|---|
| q004078 | Quarry | Renewed | Stanley Industries, Inc. | 46.0 | 46.0 | 496 | WVG/2516 | Expired 9/17/00 | Tucker | Deem |
| p013185 | Prospect | Revoked | T & J Coal, Inc | 5.0 | 0.0 | 527 | N/A | - | - | - |
| p017785 | Prospect | Revoked | T & J Coal, Inc | 5.0 | 0.0 | 527 | N/A | - | - | - |
| q010874 | Quarry | Renewed | Sam G. Polino and Company | 34.0 | 34.0 | 550 | WVG/2503 | Expired 9/17/00 | Randolph | Meade |
| q010873 | Quarry | Renewed | Kermit Butcher Contractor | 16.0 | 16.0 | 550 | WVG/2513 | Expired 9/17/00 | Randolph | Meade |
| q200193 | Quarry | Renewed | Kermit Butcher Contractor | 45.0 | 45.0 | 550 | WVG/2513 | Expired 9/17/00 | Randolph | Meade |
| q203188 | Quarry | Renewed | Kermit Butcher Contractor | 15.0 | 15.0 | 550 | WVG/2513 | Expired 9/17/00 | Randolph | Meade |
| u070000 | Coal Undergr | Phase 1 Released | Mower Resources Inc. | 24.0 | 24.0 | 602 | WV0056227 | Expired 6/25/01 | Randolph | Dickinson |
| u072600 | Coal Undergr | Phase 1 Released | Mower Resources Inc. | 14.0 | 14.0 | 603 | WV0048909 | Expired 4/24/01 | Randolph | Dickinson |
| u048700 | Coal Undergr | Phase II Released | Mower Resources Inc. | 10.0 | 10.0 | 604 | WV0048909 | Expired 4/24/01 | Randolph | Dickinson |
| u070200 | Coal Undergr | Phase 1 Released | Mower Resources Inc. | 1.0 | 1.0 | 604 | WV0048909 | Expired 4/24/01 | Randolph | Dickinson |

| Permit Id | Mine Type | Status Code | Facility Name | Original Area[A] | Current Area[B] | Watershed Id | NPDES ID | NPDES Status | County | Inspector |
|---|---|---|---|---|---|---|---|---|---|---|
| h053800 | Haulroad | Phase II Released | Mower Resources Inc. | 17.0 | 17.0 | 612 | WV0052574 | Expired 5/28/01 | Randolph | Dickinson |
| h052100 | Haulroad | Phase II Released | Mower Resources Inc. | 17.0 | 17.0 | 618 | WV0052574 | Expired 5/28/01 | Randolph & Pocahontas | Dickinson |
| o006783 | Other | Phase 1 Released | Mower Resources Inc. | 28.0 | 28.0 | 618 | WV1003143 | Expired 6/25/01 | Randolph | Dickinson |
| o008882 | Other | Phase 1 Released | Mower Resources Inc. | 43.0 | 43.0 | 623 | WV0060925 | Expired 9/20/01 | Randolph | Dickinson |
| s200595 | Coal Surface | New | Buffalo Coal Company, Inc. | 64.0 | 64.0 | 682 | WV1013971 | Expired 2/06/01 | Tucker | Idleman |
| s200796 | Coal Surface | New | Buffalo Coal Company, Inc. | 10.0 | 10.0 | 691 | WV1014111 | Expired 5/21/01 | Tucker | Idleman |
| s201892 | Coal Surface | Phase 1 Released | Buffalo Coal Company, Inc. | 18.0 | 18.0 | 691 | WV0051616 | Expired 2/10/03 | Tucker | Idleman |
| s202392 | Coal Surface | Renewed | Buffalo Coal Company, Inc. | 57.0 | 57.0 | 691 | WV0051616 | Expired 2/10/03 | Tucker | Idleman |
| s000780 | Coal Surface | Inactive | Buffalo Coal Company, Inc. | 390.0 | 342.0 | 691 | WV0051519 | Expired 1/16/03 | Tucker | Idleman |
| s006185 | Coal Surface | Renewed | Buffalo Coal Company, Inc. | 70.0 | 70.0 | 691 | WV0098311 | Expired 4/27/01 | Tucker | Idleman |
| s007379 | Coal Surface | Phase 1 Released | Buffalo Coal Company, Inc. | 35.0 | 35.0 | 691 | WV0051501 | Expired 9/05/02 | Tucker | Idleman |

| Permit Id | Mine Type | Status Code | Facility Name | Original Area[A] | Current Area[B] | Watershed Id | NPDES ID | NPDES Status | County | Inspector |
|---|---|---|---|---|---|---|---|---|---|---|
| s007476 | Coal Surface | Renewed | Buffalo Coal Company, Inc. | 135.0 | 135.0 | 691 | WV0051616 | Expired 2/10/03 | Tucker | Idleman |
| o004583 | Other | Renewed | Buffalo Coal Company, Inc. | 3.0 | 3.0 | 691 | WV0051519 | Expired 1/16/03 | Tucker | Idleman |
| o200695 | Other | New | Buffalo Coal Company, Inc. | 28.0 | 28.0 | 691 | WV0051616 | Expired 2/10/03 | Tucker | Idleman |
| s014677 | Coal Surface | Renewed | Buffalo Coal Company, Inc. | 73.0 | 73.0 | 691 | WV0051616 | Expired 2/10/03 | - | Idleman |
| u003885 | Coal Undergr | Renewed | Buffalo Coal Company, Inc. | 66.0 | 66.0 | 707 | WV0091936 | Expired 6/04/01 | - | Idleman |
| p200499 | Prospect | New | Mettiki Coal Corporation (West Virginia) | 0.0 | 0.0 | 707 | N/A | - | - | - |
| p200500 | Prospect | New | Mettiki Coal (WV), LLC | 0.0 | 0.0 | 707 | N/A | - | - | - |
| i070000 | Coal Surface | Renewed | Island Creek Coal Company | 217.0 | 233.0 | 707 | WV0005541 | Expired 11/10/02 | - | Richard |
| o009783 | Other | Renewed | Buffalo Coal Company, Inc. | 100.0 | 101.0 | 707 | WV0060372 | Expired 2/18/03 | - | Idleman |
| s201888 | Coal Surface | Renewed | * Buffalo Coal Co., Inc. | 92.0 | 92.0 | 707 | WV0094871 | Expired 1/06/01 | - | Idleman |
| q201186 | Quarry | Renewed | Fairfax Materials, Inc. | 315.0 | 315.0 | 1019 | WV0043613 | Expired 12/21/01 | - | Deem |

| Permit Id | Mine Type | Status Code | Facility Name | Original Area[A] | Current Area[B] | Watershed Id | NPDES ID | NPDES Status | County | Inspector |
|---|---|---|---|---|---|---|---|---|---|---|
| s006578 | Coal Surface | Revoked | Rockville Mining co | 158.0 | 111.0 | 1255 | NONE | - | - | - |
| s005882 | Coal Surface | Revoked | Century Enterprises Inc | 58.0 | 0.0 | 1255 | WVG/1000 | Expired 10/31/94 | - | - |
| s002685 | Coal Surface | Revoked | *Wocap Energy Resources | 40.0 | 0.0 | 1413 | WV0067911 | Released 2/05/95 | - | - |
| s006182 | Coal Surface | Revoked | J.e.b., Inc | 18.0 | 8.0 | 1414 | NONE | - | - | - |
| e003200 | Coal Undergr | Revoked | *Borgman Coal Company | 5.0 | 5.0 | 1423 | WV0090832 | Released 10/14/92 | - | - |
| s104189 | Coal Surface | Revoked | Edward E. Thompson | 26.0 | 52.0 | 2673 | WV0095338 | Released 2/15/94 | - | - |
| s103488 | Coal Surface | Revoked | *GB Coal Company | 12.0 | 14.0 | 2673 | WV1007564 | Expired 11/05/01 | - | - |

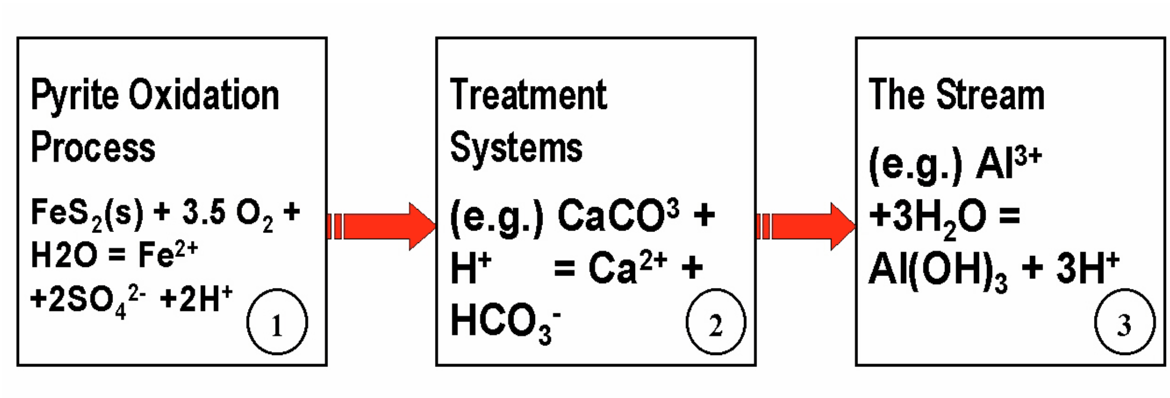
*NOTE: Facility Name has been changed to reflect the permittee rather than the operator
[A] Original Area - Surface disturbed area when mining permit was originally issued
[B] Current Area - Surface disturbed area of permitted mines (October 2000)

# Appendix C

# Modeling pH for TMDL Development

**Overview**

Streams affected by acid mine drainage often exhibit high metals concentrations (specifically for iron [Fe], aluminum [Al], and manganese [Mn]) along with low pH. The relationship between these metals and pH provides justification for using metals TMDLs as a surrogate for a separate pH TMDL calculation. The following figure shows three representative physical components that are critical to establishing this relationship.




Note: Several major ions comprise the water chemistry of a stream. The cations are usually $Ca^{2+}$, $Mg^{2+}$, $Na^+$, $K^+$, and $H^+$, and the anions consist of $HCO_3^-$, $CO_3^{2-}$, $NO_3^-$, $Cl^-$, $SO_4^{2-}$, and $OH^-$ (Stumm and Morgan, 1996).

Component 1 describes the beginning oxidation process of pyrite ($FeS_2$) resulting from its exposure to $H_2$ O and $O_2$. This process is common in mining areas. The kinetics of pyrite oxidation processes are also affected by bacteria (Thiobacillus ferrooxidans), pH, pyrite surface area, crystallinity, and temperature (PADEP, 2000). The overall stoichiometric reaction of the pyrite oxidation process is as follows:

$$FeS_2(s) + 3.75\ O_2 + 3.5\ H_2O \rightarrow Fe(OH)_3\ (s) + 2SO_4^{2-}\ +4H+$$

Lower pH and higher metals concentrations from Component 1 should be treated effectively with applicable systems. Component 2 presents an example chemical reaction occurring within a mining treatment system. Examples of treatment systems include wetlands, successive alkalinity producing systems, and open limestone channels. Carbonate and other bases (e.g., hydroxide) created in treatment systems consume hydrogen ions produced by pyrite oxidation and hydrolysis of metals, thereby increasing pH. The increased pH of the solution will precipitate metals as metal hydroxides. Treatment systems may not necessarily work properly, however, because the removal rate of metals, and attenuation of pH depends on chemical constituents of the inflow, the age of the systems, and physical characteristics of the systems (e.g., flow rate, detention rate) (West Virginia University Extension Service, 2000).

It is assumed that implementation of TMDLs in the Cheat watershed for aluminum, iron, and manganese will result in in-stream metals concentrations meeting the water quality criteria. This assumes that treatment systems are implemented properly and effectively increase pH, in order to precipitate and thus lower metals concentrations.

After treatment, the focus shifts to Component 3 and the relationship between metals concentrations and pH in the stream. The chemical process that needs to be considered is the hydrolysis reaction of metals in the stream. Component 3 presents an example of this reaction. In order to estimate pH resulting from chemical reactions occurring in the stream, MINTEQA2 (a geochemical equilibrium speciation model for dilute aqueous systems) was used.

## MINTEQA2 Application

MINTEQA2 is an EPA geochemical equilibrium speciation model capable of computing equilibrium aqueous speciation, adsorption, gas phase partitioning, solid phase saturation states, and precipitation-dissolution of metals in an environmental or lab setting. The model includes an extensive database of reliable thermodynamic data. The MINTEQA2 model was run using the following inputs:

| Species | Input Values (mg/L) |
|---|---|
| Ca | 43.2 |
| Mg | 14.5 |
| Na [a] | 6.3 |
| K [a] | 2.3 |
| Cl [a] | 7.8 |
| $SO_4$ | 86.6 |
| Fe [b] | 1.5 and 0.5 |
| Al [b] | 0.75 |
| Mn [b] | 1.0 |
| Zn [c] | 0.085 |
| Alkalinity | 18 (as $CaCO_3$) |

[a] source: Livingstone (1963)
[b] allowable maximum concentrations (TMDL endpoints)
[C] dissolved zinc concentration was calculated based on total hardness (as $CaCO_3$) using the equation (0.978)(e[(0.8473)(ln[hardness]) + 0.8604])

Input values for Fe, Al, Mn, and Zn were based on TMDL endpoints (maximum allowable limits). The alkalinity value was based on average in-stream concentrations for rivers relatively unimpacted by mining activities in the Cheat River watershed. Mean observation values were used for the remaining ions requiring input for MINTEQA2. Where observation data were not available, literature values were used for the chemical species. The model was additionally set to equilibrium with atmospheric $CO_2$. Based on the inputs presented, the resultant equilibrium pH was estimated to be 7.74 using the aquatic life standard (1.5mg/L total Fe) and 7.77 using the trout waters standard (0.5mg/L total Fe).

The model was also run using typical in-stream metals concentrations found in the vicinity of mining activities (10mg/L for total Fe, 10mg/L for Al, 5mg/L for Mn, 0.085 mg/L for Zn, and 3mg/L as $CaCO_3$ for alkalinity). These inputs resulted in an equilibrium pH of 4.38.

Results from MINTEQA2 imply that pH will be within the West Virginia criteria of above 6 and below 9, provided that in-stream metals concentrations simultaneously meet applicable water quality criteria.

**Assumptions**

The conclusions presented above assume that TMDLs are implemented properly, so that metals concentrations from point and nonpoint sources result in the stream meeting metals criteria (implying that pH from these sources has already been increased, in order to decrease metals). Additional assumptions (and facts) that were considered in this process are as follows:

*Iron (Fe)*

Ferric iron was selected as total iron based on the assumption that the stream will be in equilibrium with the atmospheric oxygen. Since iron exhibits oxidized and reduced states, the redox part of the iron reactions may additionally need to be considered. The reduced state of iron, ferrous iron, can be oxidized to ferric iron through abiotic and biotic oxidation processes in the stream. The first process refers to oxidation by increasing the dissolved oxygen because of the mixing of flow. The other process is oxidation by microbial activity in acidic conditions on bedrock (Mcknight and Bencala, 1990). Photoreduction of hydrous oxides also can increase the dissolved ferrous form. This reaction could increase pH of the stream followed by oxidation and hydrolysis reactions of ferrous iron (Mcknight, Kimball and Bencala, 1988). Since water quality data are limited, the concentration of total Fe was assumed to be constant at 1.5 mg/L, and it was assumed that total Fe increase by photoreduction would be negligent. (This assumption could ignore pH changes during daytime.)

*Sodium (Na), Potassium (K), and Chloride (Cl)*

The concentration of Na, K, and Cl can be higher in streams affected by acid mine drainage. These ions are conservative and are not reactive in natural water, however, so it is likely that the pH of the stream would not be affected.

*Calcium (Ca), Magnesium (Mg)*

These ions may have higher concentrations than the values used for the modeling in this study due to the dissolution of minerals under acidic conditions and the reactions within treatment systems. Increasing the concentrations of these ions in the stream, however, could result in more complex forms with sulfate in the treatment system and in the river. This should not affect pH.

*Manganese (Mn)*

Manganese oxide ($MnO_2$) can have a redox reaction with ferrous iron and produce ferric iron (Evangelou, 1998). This ferric iron can go through a hydrolysis reaction and produce hydrogen ions, thereby decreasing pH.

*Biological Activities*

Biological activities such as photosynthesis, respiration, and aerobic decay can influence the pH of localized areas in the stream. Biological reactions such as the one below:

$$1/6\ C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$$

will assimilate $CO_2$ during photosynthesis and produce $CO_2$ during respiration or aerobic decay. Reducing $CO_2$ levels will increase the pH and increasing $CO_2$ levels will lower the pH of the water (Langmuir, 1997). It is possible that as a result of these biological activities, the pH standards may be violated even though metals concentrations are below in-stream water quality standards.

*Kinetic Considerations*

The kinetic aspect of metal reactions in the stream is an important factor that also needs to be considered. For example, Fe and Mn can be oxidized very rapidly if the pH of the solution is 7.5 to 8.5; otherwise the oxidization process is much slower (Evangelou, 1995). Having a violation of metals concentrations, but no pH violation might be a result of the kinetic aspect of the reactions.

# Appendix D

# TMDL Components

This Appendix presents TMDLs for the impaired waterbodies in the Cheat Watershed. Tables D-1 through D-4 present the load allocations for nonpoint sources ( $\Sigma$LAs (kg/yr)) and the wasteload allocations for point sources ($\Sigma$WLAs (kg/yr)) for each impaired waterbody. The $\Sigma$LAs represents the total contribution from nonpoint sources, including abandoned mine lands and other nonpoint sources (forest, urban, etc.). For each waterbody, the $\Sigma$LAs represent all upstream contributions, i.e., the downstrean $\Sigma$LAs are larger than those upstream. The $\Sigma$WLAs represent all permitted facility contributions combined for the TMDL. These values are also cumulative. The contributing point sources column lists the permitted mines within the drainage area of each impaired waterbody.

In addition to the $\Sigma$WLAs for each impaired waterbody, individual WLAs are presented for each permitted mine (only for aluminum, iron, and manganese). The WLA for zinc was developed for the entire area contributing to the Cheat River impairment, not by individual permit. Individual WLAs are presented in Table D-5 along with their corresponding maximum discharge concentrations (mg/L for aluminum, iron, and manganese). These WLAs and corresponding concentrations are based on achieving the in-stream TMDL endpoint.

**Table D-1.** Aluminum allocation loadings for the Cheat River Watershed

| Aluminum | | | | |
|---|---|---|---|---|
| WV Stream Code | Stream Name | Contributing Point Sources | ΣLAs (lbs Al/yr) | ΣWLAs (lbs Al/yr) |
| MC-? | Unnamed Trib.# 1 To Cheat River Lake | z001881 | 168.5 | 1119.8 |
| MC-? | Unnamed Trib.# 2 To Cheat River Lake | | 725.0 | 0.0 |
| MC-? | Unnamed Trib.# 3 To Cheat River Lake | | 280.8 | 0.0 |
| MC-3 | Crammeys Run, Trib. To Cheat Lake | | 145.6 | 0.0 |
| MC-11 | Bull Run, Trib. To Cheat River | s102887 | 12664.8 | 942.0 |
| MC-11-A | Middle Run, Trib. To Bull Run | s102887 | 689.6 | 711.2 |
| MC-11-.1A | Unnamed Trib. #1 to Bull Run | | 1034.0 | 0.0 |
| MC-11-B | Mountain Run, Trib. To Bull Run | | 1170.0 | 0.0 |
| MC-11-C | Lick Run, Trib. To Bull Run | | 3124.6 | 0.0 |
| MC-11-C-0.1 | Unnamed Trib. #2 to Bull Run | | 885.1 | 0.0 |
| MC-11-E | Right Fork of Bull Run | | 2175.0 | 0.0 |
| MC-12 | Big Sandy Creek, Trib. To Cheat River | s100488,z000781,s014879, s000981, s100595, s100188 | 72305.4 | 28021.9 |
| MC-12-? | Unnamed Trib. To Big Sandy Creek | s100595 | 55.8 | 499.4 |
| MC-12-0.5 | Sovern Run, Trib. To Big Sandy Creek | | 1136.2 | 0.0 |
| MC-12-B | Little Sandy Creek, Trib. To Big Sandy Creek | z000781, s014879, s000981, s000684 | 21514.6 | 27522.5 |
| MC-12-B-0.5 | Webster Run, Trib. To Little Sandy Creek | | 6292.6 | 0.0 |
| MC-12-B-1 | Beaver Creek, Trib. To Little Sandy Creek | | 8690.5 | 0.0 |
| MC-12-B-1-A | Glade Run, Trib. To Little Sandy Creek | | 573.7 | 0.0 |
| MC-12-B-1-? | Unnamed Trib.#2 To Beaver Creek | | 508.6 | 0.0 |
| MC-12-B-3 | Hog Run, Trib. To Little Sandy Creek | | 1062.2 | 0.0 |
| MC-12-B-5 | Cherry Run, Trib. To Little Sandy Creek | | 1690.6 | 0.0 |
| MC-12-C | Hazel Run Trib. To Big Sandy Creek | | 197.2 | 0.0 |
| MC-13.5 | Conner Run, Trib. To Cheat River | | 639.1 | 0.0 |
| MC-16 | Greens Run, Trib. To Cheat River | s100393, s101389 | 3965.5 | 479.7 |
| MC-16-A | South Fork of Greens Run | | 2399.7 | 0.0 |
| MC-16-A-.1 | Middle Fork of Greens Run | | 638.9 | 0.0 |
| MC-17 | Muddy Creek, Trib. To Cheat | s100989, u051900, r067300, s101588, s100299 | 7147.0 | 384.8 |
| MC-17-A | Martin Creek, Trib. To Muddy Creek | u051900, r067300 | 3582.6 | 384.8 |
| MC-17-A-0.5 | Ficky Run, Trib. To Martin Creek | u051900, r067300 | 937.6 | 384.8 |
| MC-17-A-1 | Glade Run, Trib. To Martin Creek | | 1816.4 | 0.0 |
| MC-17-A-1.1 | Unnamed Trib. #1 to Glade Run | | 322.7 | 0.0 |
| MC-17-A-1.2 | Unnamed Trib.#2 To Glade Run | | 551.5 | 0.0 |
| MC-18 | Roaring Creek, Trib. To Cheat | | 6767.4 | 0.0 |
| MC-23 | Morgan Run Trib. To Cheat River | | 4319.3 | 0.0 |
| MC-23-0.2-A | Unnamed Trib.#1 to Morgan Run | | 73.9 | 0.0 |
| MC-23-A | Church Creek, Trib. To Morgan Run | | 3122.7 | 0.0 |
| MC-23-A-0.1-A | Left Fork of unnamed Trib. To Church Creek | | 691.2 | 0.0 |
| MC-23-A-0.1-B | Right Fork of unnamed Trib. To Church River | | 404.8 | 0.0 |
| MC-24 | Heather Run, Trib. To Cheat River | | 1590.9 | 0.0 |
| MC-24-A | Unnamed Trib. #1 to Heather Run | | 23.2 | 0.0 |
| MC-25 | Lick Run, Trib. To Cheat River | p102298 | 4242.9 | 48.4 |
| MC-26 | Joes Run, Trib. To Cheat River | s001483 | 70.8 | 462.5 |
| MC-27 | Pringle Run, Trib. To Cheat River | | 6440.8 | 0.0 |
| MC-27-A | Left Fork of Pringle Run | | 2063.1 | 0.0 |
| MC-27-B | Right Fork of Pringle Run | | 1046.1 | 0.0 |
| MC-60-D-2 | Tub Run, tributary to Blackwater River | | 398.3 | 0.0 |
| MC-60-5-C | Beaver Creek, tributary to the Blackwater | u003885, p200499, | 1301.8 | 2002.8 |

| Aluminum | | | | |
|---|---|---|---|---|
| WV Stream Code | Stream Name | Contributing Point Sources | ΣLAs (lbs Al/yr) | ΣWLAs (lbs Al/yr) |
| | river | p200500, o009783, s201888, s200398, h000463, h000499 | | |
| MC-60-D-5-C | Hawkins Run, tributary to Beaver Creek | | 533.5 | 0.0 |
| MC-60-D-2.7 | Finley Run, tributary to Blackwater River | | 217.3 | 0.0 |
| MC-60-D | Lower Blackwater River trib. To Cheat River | s200595,p200500, q002574, s200796, s201892, s202392, s000780, s006185, s0007379, s007476, o004583, o200695, s014677, u003885, p200499, o009783, s201888 | 23119.7 | 23020.6 |
| MC-60-D-3 | North Fork of Blackwater River | q002574, s200595 | 4686.8 | 913.7 |
| MC-60-D-3-A | Long Run, tributary to North Fork | q002574 | 422.3 | 382.4 |
| MC-60-D-3-B | Middle Run, tributary to North Fork | | 107.8 | 0.0 |
| MC-60-D-3-C | Snyder Run, tributary to North Fork | s200595 | 126.8 | 531.4 |
| MC | Cheat River from Pringle Run to Cheat Lake | see Footnote D-1 | 211897.6 | 65324.8 |

**Table D-2.** Iron allocation loadings for the Cheat River Watershed

| Iron | | | | |
|---|---|---|---|---|
| WV Stream Code | Stream Name | Contributing Point Sources | ΣLAs (lbs Fe/yr) | ΣWLAs (lbs Fe/yr) |
| MC-? | Unnamed Trib.# 1 To Cheat River Lake | z001881 | 644.2 | 1710.3 |
| MC-? | Unnamed Trib.# 2 To Cheat River Lake | | 1435.5 | 0.0 |
| MC-? | Unnamed Trib.# 3 To Cheat River Lake | | 553.6 | 0.0 |
| MC-3 | Crammeys Run, Trib. To Cheat Lake | | 84.5 | 0.0 |
| MC-11 | Bull Run, Trib. To Cheat River | s102887 | 22002.4 | 1884.0 |
| MC-11-A | Middle Run, Trib. To Bull Run | s102887 | 1369.7 | 1422.5 |
| MC-11-.1A | Unnamed Trib. #1 to Bull Run | | 1965.0 | 0.0 |
| MC-11-B | Mountain Run, Trib. To Bull Run | | 1828.1 | 0.0 |
| MC-11-C | Lick Run, Trib. To Bull Run | | 3570.4 | 0.0 |
| MC-11-C-0.1 | Unnamed Trib. #2 to Bull Run | | 2154.9 | 0.0 |
| MC-11-E | Right Fork of Bull Run | | 4045.1 | 0.0 |
| MC-12 | Big Sandy Creek, Trib. To Cheat River | s100488,z000781,s014879, s000981, s100595, s100188 | 173190.5 | 4064.2 |
| MC-12-? | Unnamed Trib. To Big Sandy Creek | s100595 | 65.4 | 615.3 |
| MC-12-0.5 | Sovern Run, Trib. To Big Sandy Creek | | 788.4 | 0.0 |
| MC-12-B | Little Sandy Creek, Trib. To Big Sandy Creek | z000781, s014879, s000981, s000684 | 55816.1 | 3448.9 |
| MC-12-B-0.5 | Webster Run, Trib. To Little Sandy Creek | | 34287.4 | 0.0 |
| MC-12-B-1 | Beaver Creek, Trib. To Little Sandy Creek | | 17984.6 | 0.0 |
| MC-12-B-1-A | Glade Run, Trib. To Little Sandy Creek | | 263.1 | 0.0 |
| MC-12-B-1-? | Unnamed Trib.#2 To Beaver Creek | | 2414.0 | 0.0 |
| MC-12-B-3 | Hog Run, Trib. To Little Sandy Creek | | 1207.0 | 0.0 |
| MC-12-B-5 | Cherry Run, Trib. To Little Sandy Creek | | 603.5 | 0.0 |
| MC-12-C | Hazel Run Trib. To Big Sandy Creek | | 231.2 | 0.0 |
| MC-13.5 | Conner Run, Trib. To Cheat River | | 451.1 | 0.0 |
| MC-16 | Greens Run, Trib. To Cheat River | s100393, s101389 | 9634.3 | 959.3 |
| MC-16-A | South Fork of Greens Run | | 5693.3 | 0.0 |
| MC-17-A | Martin Creek, Trib. To Muddy Creek | u051900, r067300 | 7989.7 | 769.6 |
| MC-17-A-0.5 | Ficky Run, Trib. To Martin Creek | u051900, r067300 | 1862.3 | 769.6 |
| MC-17-A-1 | Glade Run, Trib. To Martin Creek | | 4494.1 | 0.0 |
| MC-17-A-1.1 | Unnamed Trib. #1 to Glade Run | | 641.1 | 0.0 |
| MC-17-A-1.2 | Unnamed Trib.#2 To Glade Run | | 1095.5 | 0.0 |
| MC-18 | Roaring Creek, Trib. To Cheat | | 6622.5 | 0.0 |
| MC-23 | Morgan Run Trib. To Cheat River | | 10540.5 | 0.0 |
| MC-23-0.2-A | Unnamed Trib.#1 to Morgan Run | | 126.3 | 0.0 |
| MC-23-A | Church Creek, Trib. To Morgan Run | | 8201.1 | 0.0 |
| MC-23-A-0.1-A | Left Fork of unnamed Trib. To Church Creek | | 2458.3 | 0.0 |
| MC-23-A-0.1-B | Right Fork of unnamed Trib. To Church River | | 1717.2 | 0.0 |
| MC-24 | Heather Run, Trib. To Cheat River | | 2822.0 | 0.0 |
| MC-24-A | Unnamed Trib. #1 to Heather Run | | 104.0 | 0.0 |
| MC-25 | Lick Run, Trib. To Cheat River | p102298 | 8839.6 | 36.0 |
| MC-26 | Joes Run, Trib. To Cheat River | s001483 | 82.9 | 925.0 |
| MC-27 | Pringle Run, Trib. To Cheat River | | 13593.8 | 0.0 |
| MC-27-A | Left Fork of Pringle Run | | 4097.9 | 0.0 |
| MC-27-B | Right Fork of Pringle Run | | 2929.0 | 0.0 |
| MC-60-D-2 | Tub Run, tributary to Blackwater River | | 154.1 | 0.0 |
| MC-60-D-2.7 | Finley Run, tributary to Blackwater River | | 543.2 | 0.0 |

| Iron | | | | |
|---|---|---|---|---|
| WV Stream Code | Stream Name | Contributing Point Sources | ΣLAs (lbs Fe/yr) | ΣWLAs (lbs Fe/yr) |
| MC-60-D-5 | Beaver Creek, tributary to Blackwater River | u003885, p200499, p200500, o009783, s201888, s200398, h000463, h000499 | 2264.6 | 4361.8 |
| MC-60-D-5-C | Hawkins Run, tributary to Beaver Creek | | 1030.0 | 0.0 |
| MC-60-D | Lower Blackwater River trib. To Cheat River | s200595,p200500, q002574, s200796, s201892, s202392, s000780, s006185, s0007379, s007476, o004583, o200695, s014677, u003885, p200499, o009783, s201888 | 28431.2 | 18119.5 |
| MC-60-D-3 | North Fork of Blackwater River | q002574, s200595 | 8190.5 | 1674.8 |
| MC-60-D-3-A | Long Run, tributary to North Fork | q002574 | 794.3 | 573.6 |
| MC-60-D-3-B | Middle Run, tributary to North Fork | | 80.5 | 0.0 |
| MC-60-D-3-C | Snyder Run, tributary to North Fork | s200595 | 3091.1 | 1101.3 |
| MC | Cheat River from Pringle Run to Cheat Lake | see Footnote D-1 | 613696.9 | 82978.0 |

**Table D-3.** Manganese allocation loadings for the Cheat River Watershed

| Manganese | | | | |
|---|---|---|---|---|
| WV Stream Code | Stream Name | Contributing Point Sources | ΣLAs (lbs Mn/yr) | ΣWLAs (lbs Mn/yr) |
| MC-? | Unnamed Trib.# 1 To Cheat River Lake | z001881 | 806.0 | 1068.9 |
| MC-? | Unnamed Trib.# 2 To Cheat River Lake | | 1010.7 | 0.0 |
| MC-? | Unnamed Trib.# 3 To Cheat River Lake | | 393.5 | 0.0 |
| MC-3 | Crammeys Run, Trib. To Cheat Lake | | 362.9 | 0.0 |
| MC-11 | Bull Run, Trib. To Cheat River | s102887 | 17972.7 | 1256.0 |
| MC-11-A | Middle Run, Trib. To Bull Run | s102887 | 916.3 | 948.3 |
| MC-11-.1A | Unnamed Trib. #1 to Bull Run | | 1356.7 | 0.0 |
| MC-11-B | Mountain Run, Trib. To Bull Run | | 1760.6 | 0.0 |
| MC-11-C | Lick Run, Trib. To Bull Run | | 4324.3 | 0.0 |
| MC-11-C-0.1 | Unnamed Trib. #2 to Bull Run | | 1523.3 | 0.0 |
| MC-11-E | Right Fork of Bull Run | | 3344.2 | 0.0 |
| MC-12 | Big Sandy Creek, Trib. To Cheat River | s100488,z000781,s014879, s000981, s100595, s100188 | 66074.7 | 14616.1 |
| MC-12-? | Unnamed Trib. To Big Sandy Creek | s100595 | 307.0 | 820.4 |
| MC-12-0.5 | Sovern Run, Trib. To Big Sandy Creek | | 5579.6 | 0.0 |
| MC-12-B | Little Sandy Creek, Trib. To Big Sandy Creek | z000781, s014879, s000981, s000684 | 30236.3 | 13795.8 |
| MC-12-B-0.5 | Webster Run, Trib. To Little Sandy Creek | | 7713.7 | 0.0 |
| MC-12-B-1 | Beaver Creek, Trib. To Little Sandy Creek | | 11283.2 | 0.0 |
| MC-12-B-1-A | Glade Run, Trib. To Little Sandy Creek | | 1678.6 | 0.0 |
| MC-12-B-1-? | Unnamed Trib.#2 To Beaver Creek | | 1392.1 | 0.0 |
| MC-12-B-3 | Hog Run, Trib. To Little Sandy Creek | | 2824.4 | 0.0 |
| MC-12-B-5 | Cherry Run, Trib. To Little Sandy Creek | | 2741.5 | 0.0 |
| MC-12-C | Hazel Run Trib. To Big Sandy Creek | | 1520.0 | 0.0 |
| MC-13.5 | Conner Run, Trib. To Cheat River | | 2855.8 | 0.0 |
| MC-16 | Greens Run, Trib. To Cheat River | s100393, s101389 | 5317.6 | 639.6 |
| MC-16-A | South Fork of Greens Run | | 3228.8 | 0.0 |
| MC-16-A-.1 | Middle Fork of Greens Run | | 889.2 | 0.0 |
| MC-17 | Muddy Creek, Trib. To Cheat | s100989, u051900, r067300, s101588, s100299 | 9824.5 | 513.1 |
| MC-17-A | Martin Creek, Trib. To Muddy Creek | u051900, r067300 | 5211.3 | 513.1 |
| MC-17-A-0.5 | Ficky Run, Trib. To Martin Creek | u051900, r067300 | 1245.8 | 513.1 |
| MC-17-A-1 | Glade Run, Trib. To Martin Creek | | 2868.7 | 0.0 |
| MC-17-A-1.1 | Unnamed Trib. #1 to Glade Run | | 428.8 | 0.0 |
| MC-17-A-1.2 | Unnamed Trib.#2 To Glade Run | | 732.8 | 0.0 |
| MC-18 | Roaring Creek, Trib. To Cheat | | 5584.5 | 0.0 |
| MC-23 | Morgan Run Trib. To Cheat River | | 6302.6 | 0.0 |
| MC-23-0.2-A | Unnamed Trib.#1 to Morgan Run | | 491.7 | 0.0 |
| MC-23-A | Church Creek, Trib. To Morgan Run | | 4324.8 | 0.0 |
| MC-23-A-0.1-A | Left Fork of unnamed Trib. To Church Creek | | 1108.0 | 0.0 |
| MC-23-A-0.1-B | Right Fork of unnamed Trib. To Church River | | 523.7 | 0.0 |
| MC-24 | Heather Run, Trib. To Cheat River | | 2084.1 | 0.0 |
| MC-24-A | Unnamed Trib. #1 to Heather Run | | 60.8 | 0.0 |
| MC-25 | Lick Run, Trib. To Cheat River | p102298 | 6471.2 | 22.5 |
| MC-26 | Joes Run, Trib. To Cheat River | s001483 | 74.8 | 616.7 |
| MC-27 | Pringle Run, Trib. To Cheat River | | 8720.5 | 0.0 |
| MC-27-A | Left Fork of Pringle Run | | 2741.3 | 0.0 |
| MC-27-B | Right Fork of Pringle Run | | 1569.1 | 0.0 |
| MC-60-D-2 | Tub Run, tributary to Blackwater River | | 931.0 | 0.0 |
| MC-60-5-C | Beaver Creek, tributary to the | u003885, p200499, | 1610.0 | 5350.5 |

| Manganese | | | | |
|---|---|---|---|---|
| WV Stream Code | Stream Name | Contributing Point Sources | ΣLAs (lbs Mn/yr) | ΣWLAs (lbs Mn/yr) |
| | Blackwater river | p200500, o009783, s201888, s200398, h000463, h000499 | | |
| MC-60-D-5-C | Hawkins Run, tributary to Beaver Creek | | 750.8 | 0.0 |
| MC-60-D | Lower Blackwater River trib. To Cheat River | s200595,p200500, q002574, s200796, s201892, s202392, s000780, s006185, s0007379, s007476, o004583, o200695, s014677, u003885, p200499, o009783, s201888 | 48317.3 | 13972.9 |
| MC-60-D-3 | North Fork of Blackwater River | q002574, s200595 | 5226.6 | 1070.7 |
| MC-60-D-3-A | Long Run, tributary to North Fork | q002574 | 802.9 | 382.4 |
| MC-60-D-3-B | Middle Run, tributary to North Fork | | 207.6 | 0.0 |
| MC-60-D-3-C | Snyder Run, tributary to North Fork | s200595 | 2240.7 | 688.3 |
| MC | Cheat River from Pringle Run to Cheat Lake | see Footnote D-1 | 662795.5 | 66742.5 |

**Table D-4.** Zinc allocation loadings for the Cheat River Watershed

| Zinc | | | | |
|---|---|---|---|---|
| WV Stream Code | Stream Name | Contributing Point Sources | ΣLAs (lbs Al/yr) | ΣWLAs (lbs Al/yr) |
| MC | Cheat River from Pringle Run to Cheat Lake | see Footnote D-1 | 102,803.8 | 0 |

**Footnote D-1. Contributing point sources to main stem of the Cheat River from Pringle Run to Cheat Lake (WV Stream Code: MC)**

s100989, s101588, s100299, u102089, s100488, s100188, s100595, u051900, r067300, z001881, p102298, s001483, s100393, s101389, s102887, s200796, s201892, s202392, s000780, s006185, s007379, s007476, o004583, o200695, s014677, q201186, q002574, s200595, u003885, p200499, p200500, o009783, s201888, z000781, s014879, s000981, q006473, p100900, s101487, p059600, p050400, s100197, q101892, q100295, p068500, q013873, q004078, q010874, q010873, q200193, q203188, u070000, u072600, u048700, u070200, h053800, h052100, o006783, o008882

**Table D-5.** Allocation for permitted point sources

| | | Aluminum | | Iron | | Manganese | |
|---|---|---|---|---|---|---|---|
| Watershed ID | PERMIT ID | WLA (lbs Al/yr) | Concentration (mg Al/L) | WLA (lbs Fe/yr) | Concentration (mg Fe/L) | WLA (lbs Mn/yr) | Concentration (mg Mn/L) |
| 699 | h000463 | 71.1 | 1.1 | 154.8 | 1.5 | 189.9 | 1.8 |
| 699 | h000499 | 19.4 | 1.1 | 42.2 | 1.5 | 51.8 | 1.8 |
| 662 | o004583 | 56.8 | 4.3 | 44.7 | 3.2 | 34.5 | 2 |
| 699 | o009783 | 652.6 | 1.1 | 1505.3 | 3.2 | 1160.8 | 2 |
| 662 | o009783 | 1912.4 | 4.3 | 1421.4 | 1.5 | 1743.5 | 1.8 |
| 662 | o200695 | 530.2 | 4.3 | 417.3 | 3.2 | 321.8 | 2 |
| 314 | p102298 | 48.4 | 4.3 | 36.0 | 3.2 | 22.5 | 2 |
| 662 | p200499 | 0.0 | 4.3 | 0.0 | 3.2 | 0.0 | 2 |
| 699 | p200499 | 0.0 | 1.1 | 0.0 | 1.5 | 0.0 | 1.8 |
| 662 | p200500 | 0.0 | 4.3 | 0.0 | 3.2 | 0.0 | 2 |
| 699 | p200500 | 0.0 | 1.1 | 0.0 | 1.5 | 0.0 | 1.8 |
| 662 | q002574 | 1401.2 | 4.3 | 1102.9 | 3.2 | 850.5 | 2 |
| 678 | q002574 | 382.5 | 1 | 898.3 | 1.5 | 574.2 | 1 |
| 677 | q002574 | 490.1 | 0.75 | 573.7 | 1.5 | 382.5 | 1 |
| 264 | r067300 | 359.0 | 0.75 | 328.2 | 0.5 | 218.8 | 1 |
| 1052 | r067300 | 164.1 | 0.75 | 718.1 | 1.5 | 478.7 | 1 |
| 263 | r067300 | 359.0 | 0.75 | 718.1 | 1.5 | 478.7 | 1 |
| 662 | s000780 | 7384.6 | 4.3 | 5812.4 | 3.2 | 4482.3 | 2 |
| 134 | s000981 | 6827.6 | 0.75 | 990.3 | 1.5 | 3561.2 | 1 |
| 97 | s000981 | 9026.2 | 3.9 | 1131.1 | 0.5 | 4524.4 | 2 |
| 318 | s001483 | 462.6 | 0.75 | 925.2 | 1.5 | 616.8 | 1 |
| 662 | s006185 | 1325.4 | 4.3 | 1043.3 | 3.2 | 804.5 | 2 |
| 662 | s007379 | 662.7 | 4.3 | 521.6 | 3.2 | 402.3 | 2 |
| 662 | s007476 | 2556.2 | 4.3 | 2012.0 | 3.2 | 1551.6 | 2 |
| 662 | s014677 | 1382.2 | 4.3 | 1088.0 | 3.2 | 839.0 | 2 |
| 97 | s014879 | 9026.2 | 3.9 | 990.3 | 1.5 | 3561.2 | 1 |
| 134 | s014879 | 6827.6 | 0.75 | 1131.1 | 0.5 | 4524.4 | 2 |
| 134 | s100188 | 1358.0 | 0.75 | 197.0 | 1.5 | 708.3 | 1 |
| 1052 | s100299 | 39.0 | 0.75 | 77.9 | 0.5 | 51.9 | 1 |
| 396 | s100393 | 93.1 | 0.75 | 186.2 | 1.5 | 124.1 | 1 |
| 134 | s100488 | 1697.5 | 0.75 | 246.2 | 1.5 | 885.4 | 1 |
| 135 | s100595 | 499.5 | 1.2 | 601.8 | 1.5 | 2164.3 | 1 |
| 134 | s100595 | 4149.4 | 0.75 | 615.4 | 1.5 | 820.5 | 2 |
| 1052 | s100989 | 70.8 | 0.75 | 141.7 | 0.5 | 94.4 | 1 |
| 396 | s101389 | 386.7 | 0.75 | 773.3 | 1.5 | 515.6 | 1 |
| 1052 | s101588 | 99.2 | 0.75 | 198.3 | 0.5 | 132.2 | 1 |
| 57 | s102887 | 711.4 | 0.75 | 1422.7 | 1.5 | 948.5 | 1 |
| 56 | s102887 | 942.2 | 0.75 | 1884.4 | 1.5 | 1256.2 | 1 |
| 699 | s200398 | 239.1 | 1.05 | 520.7 | 1.5 | 638.7 | 1.8 |
| 677 | s200595 | 423.8 | 0.75 | 953.8 | 3.2 | 735.6 | 2 |
| 682 | s200595 | 531.5 | 1.5 | 776.9 | 1.5 | 496.6 | 1 |

| | | Aluminum | | Iron | | Manganese | |
|---|---|---|---|---|---|---|---|
| Watershed ID | PERMIT ID | WLA (lbs Al/yr) | Concentration (mg Al/L) | WLA (lbs Fe/yr) | Concentration (mg Fe/L) | WLA (lbs Mn/yr) | Concentration (mg Mn/L) |
| 662 | s200595 | 1211.8 | 4.3 | 1101.5 | 3.2 | 688.4 | 2 |
| 662 | s200796 | 189.3 | 4.3 | 149.0 | 3.2 | 114.9 | 2 |
| 662 | s201888 | 1742.0 | 4.3 | 1371.1 | 3.2 | 1057.4 | 2 |
| 699 | s201888 | 594.5 | 1.1 | 1294.7 | 1.5 | 1588.2 | 1.8 |
| 662 | s201892 | 340.8 | 4.3 | 268.3 | 3.2 | 206.9 | 2 |
| 662 | s202392 | 1079.3 | 4.3 | 849.5 | 3.2 | 655.1 | 2 |
| 662 | u003885 | 1249.7 | 4.3 | 983.6 | 3.2 | 758.5 | 2 |
| 699 | u003885 | 426.5 | 1.1 | 928.8 | 1.5 | 1139.3 | 1.8 |
| 263 | u051900 | 25.8 | 0.75 | 23.6 | 0.5 | 15.7 | 1 |
| 264 | u051900 | 25.8 | 0.75 | 51.7 | 1.5 | 34.4 | 1 |
| 1052 | u051900 | 11.8 | 0.75 | 51.7 | 1.5 | 34.4 | 1 |
| 134 | z000781 | 7167.1 | 0.75 | 1039.5 | 1.5 | 3738.3 | 1 |
| 97 | z000781 | 9475.1 | 3.9 | 1187.3 | 0.5 | 4749.4 | 2 |
| 28 | z001881 | 1120.0 | 2.1 | 1710.6 | 3.2 | 1069.1 | 2 |

# Appendix E

# Detailed Description of the TMDL Development and Source Allocation Approach

This Appendix presents a detailed description of the TMDL development and source allocation process. The process is demonstrated through Aluminum TMDL calculations for Snyder Run(MC-60-D-3-C), a tributary to North Fork. This impaired segment is located in the North Fork region of the Cheat Watershed.

Note: A “Definition of Parameters” table is located in the Appendix E-III.

## TMDL Endpoint

The TMDL endpoint for aluminum was selected as 712.5 ug/L (based on the 750 ug/L criterion, $WQ_{CRITERIA}$, for Aquatic Life minus a 5% MOS).

### WARMF Existing Conditions

After selecting the TMDL endpoint, the calibrated WARMF was run for subcatchment #682 for existing conditions. The modeling period was October 1, 1989 through September 30, 1997.

The WARMF estimated an average annual aluminum load of $TOTAL_{EXIST}$ = 4,942.2 lbs/yr (2,241.4 kg/year).

### WARMF TMDL Conditions

The WARMF TMDL module was then run for the same modeling period to represent water quality standard attainment during TMDL conditions. The 1989-1997 modeling period was assumed to represent all critical conditions because it covers a wide range of flow and meteorologic conditions, including low and high flow periods. As stated above, the TMDL endpoint was set to the criterion (minus a 5% MOS).

The WARMF estimated an average annual aluminum load of $TOTAL_{TMDL}$ = 658.2 lbs/yr (298.6 kg/year). This load represents the entire TMDL from both point (WLA) and nonpoint (LA) sources.

### TMDLs and Source Allocations

After estimating the TMDL using the WARMF, it was necessary to allocate loads to nonpoint sources (LAs) and individual point sources (WLAs). Because the WARMF was not configured to explicitly represent point sources, this analysis was performed outside of the WARMF.

*Source Assessment*

Potential sources in the drainage area contributing to impairments in Snyder Run include forest land and mines. Forest land was considered a nonpoint source and therefore required estimation of a LA. Mines were considered either as nonpoint sources (in the case of abandoned mine lands, limestone quarries, revoked mines and certain categories of released mines) or point sources (if mining permits were identified).

Four mining permits were identified within the Snyder Run drainage area (from West Virginia OMR's spatial coverage of mining permit locations):

| Permit ID | Name | Type | Status* | Expiration Date |
|---|---|---|---|---|
| s200595 | Buffalo Coal Company | coal surface mine | new | 1/31/2001 |
| u200389 | Buffalo Coal Company | coal underground mine | phase 2 released | 6/5/1999 |
| s002681 | Buffalo Coal Company | coal surface mine | completely released | 9/14/1992 |
| s002282 | Buffalo Coal Company | coal surface mine | completely released | 9/14/1992 |

* Status as of October, 2000

For allocation purposes, permits with a status of phase 2 released or completely released were not allocated explicit loads. These permits represent facilities at or near the end of reclamation and they are assumed to have very little or no water quality impact. Thus their contributions were considered as part of the nonpoint source allocation (LAs). Loading from revoked permitted facilities was also considered as a part of the nonpoint source allocation based on the absence of a permittee. In addition, permits representing limestone quarries typically do not contain limits for iron, aluminum and manganese. Thus, these permits were not allocated an explicit load. All other permits were allocated explicit loads (WLAs). As a result, only permit # s200595 was considered for explicit allocation for Snyder Run.

*Source Allocation Process*

In order to equitably assign WLAs to individual permits, it was necessary to estimate load contributions from different sources in the watersheds under existing conditions. The following sections describe the steps taken in the source allocation process.

### Permitted Load Estimate

First, the maximum permitted load from each point source was estimated. For permit # s200595, this estimate was made by multiplying the mine's daily flow by its permit limit (assumed to be $PSCONC_{PERMIT}$ = 6.0 mg/L for aluminum). Because the WARMF assumes that mine discharge is based on precipitation and nonpoint source processes, daily flow for the mine was estimated as a percentage of the immediate drainage area's estimated flow.

OMR's mining permit location coverage indicated that Permit # s200595 has an area of 64 acres ($AREA_{PS}$). The immediate drainage area to Snyder Run (subcatchment #682), as represented in the WARMF, was 3,086 acres ($AREA_{TOTAL}$ ). Thus, the average flow for permit # s200595's was estimated as;

$$FLOWps = \left( \frac{AREA_{PS}}{AREA_{TOTAL}} \right) \times FLOW_{TS} \qquad (1)$$

where $FLOW_{TS}$ represents the average flow for subcatchment #682. The average flow ($FLOW_{TS}$) was calculated based on the WARMF output for the entire modeling period.
The estimated average flow from permit #s200595 was then multiplied by 6.0 mg/L (and a conversion factor) to obtain the average annual load. The load was estimated to be $PSLOAD_{PERMIT}$ = 2,064.9 lbs/year (936.6 kg/year).

Note that this estimated permitted load is larger than the total TMDL, $TOTAL_{TMDL}$ (659.8 lbs/year), calculated by WARMF for the Snyder Run drainage area.

### Total Existing Nonpoint Source Load Estimate

The total existing nonpoint source load, $TOTALNPS_{EXIST}$,was estimated as the difference between the WARMF existing condition load estimate and the permitted condition load estimate described in the previous section. For Snyder Run, this calculation was as follows:

$$TOTAL_{EXIST} - PSLOAD_{PERMIT} = TOTALNPS_{EXIST} \qquad (3)$$

4,942.2lbs/yr - 2,064.9lbs/yr = <u>2,877.3 lbs/year</u>

### Abandoned Mine Land (AML) Area Estimation

The total nonpoint source load estimated above represents non-permitted contributions in the watershed, including AMLs, revoked and other nonpoint sources (reclaimed mines, forest, pasture, etc.). The distribution between AML loads (including revoked mines) and other nonpoint source loads was estimated in order to account for the following assumptions:

- Other nonpoint sources likely contribute significantly lower aluminum, iron, and manganese loads than AMLs and revoked mines.
- The attainable level of remediation for AMLs is expected to be different than the level for other nonpoint sources (which likely need no reductions to achieve water quality criteria for aluminum, iron, and manganese).

To estimate the distribution between AML and other nonpoint source loads, first the total nonpoint source aluminum unit area load, OUAL, was estimated for drainage containing impaired waterbodies. Thus, for Snyder Run, it was estimated as follows:

$$\frac{TOTALNPS_{EXIST}}{(AREA_{TOTAL} - AREA_{PS})} = OUAL \qquad (4)$$

$$\frac{2877.3(lbs/yr)}{3086(ac) - 64(ac)} = \underline{0.95(lbs/ac - yr)}$$

The total nonpoint source unit area loads for all of the drainage areas containing impaired waterbodies were calculated as above, and then ranked and compared to the total nonpoint source unit area load for a reference subcatchment representing only other nonpoint source areas (i.e. containing <u>no</u> AMLs or revoked mines). The drainage area for Horsecamp Run met the requirements. For this reference area, the total nonpoint source unit area load was estimated to be 0.128 lbs/ac-yr. The total nonpoint source unit area loads for all drainage areas containing impaired waterbodies in the Cheat Watershed ranged from as low as 0.07 lbs/ac-yr to as high as 170.3 lbs/ac-yr. Those acres with higher total nonpoint source unit area loads represented areas with a higher percentage of AMLs.

The percentage of the total area assumed to be AML, AML %, was then estimated for each impaired waterbody's drainage area. This estimate was made through a comparison to nonpoint source unit area loads for watersheds with known AML and revoked mine areas. Based on these estimated values, 5 ranges of AML % areas were developed. An average AML % area was assigned for each of these 5 ranges and ranged from 0.18% to 39% of the area. Each drainage area was then assigned to one of the five AML % ranges. Representative ranges were used because the AML % is an estimate based on nonpoint source unit area loads (the exact value is virtually unknown).

Based on its relatively low total nonpoint source unit area load, Snyder Run fell into the category with the smallest AML % area (0.18%).

### Allowable AML Load Estimate

The AML load allowable to meet water quality criteria [$AML_{TMDL}$] to meet TMDL criteria was calculated using the estimated AML % ranges and the assumption that AMLs and revoked mines would be remediated to meet in-stream water quality criteria.

For Snyder Run, this calculation was as follows:

$$AML_{TMDL} = \left( \frac{AREA_{NPS} \times AML\%}{AREA_{TOTAL}} \right) \times FLOW_{TS} \times WQ_{CRITERIA} \times CF \quad (5)$$

$$\frac{(3086(ac) - 64(ac)) \times 0.001818}{3086(ac)} \times 0.235(m^3/s) \times 0.75(mg/l) \times 1000(l/m^3)$$
$$\times 60 \times 60 \times 24 \times 365 \times 2.2046E-6 \ (lbs/mg) = \underline{21.8(lbs/yr)}$$

$FLOW_{TS}$ represents the average flow for all of subcatchment #682. The $AML_{TMDL}$ for Snyder Run was determined to be 21.8 lbs/year (9.9 kg/year). This represents the average annual load over the modeling period.

### Allowable Other Nonpoint Source Load Estimate

The allowable other nonpoint source load, $OTHER_{TMDL}$, to meet TMDL criteria was calculated based on the assumption that the other nonpoint sources would remain at existing levels (which are below in-stream criteria, as shown by WARMF results). Assuming that the concentration for Horsecamp Run was representative of reference nonpoint source concentrations, $OTHER_{TMDL}$ for Snyder Run was calculated as follows:

$$OTHER_{TMDL} = \left( \frac{\left(AREA_{TOTAL} - AREA_{PS}\right) \times (1 - AML\%)}{AREA_{TOTAL}} \right) \times FLOW_{TS} \times CONC_{HORSECAMP} \times CF \quad (6)$$

$$\frac{(3086(ac) - 64(ac))(1 - 0.001818)}{3086(ac)} \times 0.235(m^3/s) \times 0.00657(mg/l) \times$$
$$1000(l/m^3) \times 60 \times 60 \times 24 \times 365 \times 2.2046E-6 = \underline{104.9(lbs/yr)}$$

The $OTHER_{TMDL}$ for Snyder Run was determined to be 104.9 lbs/year (47.6 kg/year). This represents the average annual load over the modeling period.

### Allowable Point Source Load

After allocating first to AMLs (and assuming that they must meet water quality criteria) and then to “other” nonpoint sources, the allowable loads from point sources were determined. The total allowable load from all permitted sources was estimated by subtracting the allowable AML load and the allowable “other” nonpoint source load from the TMDL calculated by the WARMF:

$$TOTALPS_{TMDL} = TOTAL_{TMDL} - AML_{TMDL} - OTHER_{TMDL} \quad (7)$$

$$658.23(lbs/yr) - 21.82(lbs/yr) - 104.96(lbs/yr) = \underline{531.5(lbs/yr)}$$

For Snyder Run, the $TOTALPS_{TMDL}$ was 531.5 lbs/year (241.1 kg/year).

**Allowable Permitted Concentrations**

After establishing the total allowable load from permitted and other sources for each impaired waterbody for each drainage area, the average allowable point source concentration for all permitted sources was estimated, $PSCONC_{TMDL}$. This concentration was estimated by dividing the $TOTALPS_{TMDL}$ by the total combined flow for permitted facilities in the drainage area, $PSFLOW_{TOTAL}$.

$$PSCONC_{TMDL} = \left( \frac{TOTALPS_{TMDL}}{PSFLOW_{TOTAL}} \right) \times CF \qquad (8)$$

$$\frac{531.45(lbs/yr)}{0.00487(m^3/s)} \times \frac{1}{2.2046E-6}(mg/lbs) \times \frac{1}{1000}(m^3/l) \times \frac{1}{60 \times 60 \times 24 \times 365} = \underline{1.57(mg/l)}$$

For Snyder Run, the $PSCONC_{TMDL}$ was equivalent to 1.57 mg/L. This calculation methodology assumed that all permits within a given drainage area were given the same allowable concentration.

All permitted facilities within a given drainage area were assigned the same allowable concentration level, $PSCONC_{TMDL}$ for each metal. The assigned metal concentration ranges are Fe: 0.5 or 1.5 - 3.2(mg/l), Al: 0.75 - 4.3 (mg/L), Mn: 1.0 - 2.0 (mg/L). The highest average allowable discharge concentration was calculated using the methods described in EPA's Technical Support Document for Water Quality based Toxics Control. The lowest average allowable discharge concentration for each metal was based on in-stream water quality criteria. $PSCONC_{TMDL}$ values used for calculating WLAs were always set within the range of average allowable discharge concentrations. For Snyder Run, the concentration level for permitted facilities was assigned as 1.57 mg/L, because this concentration is within the allowable level at which permitted facilities can discharge while maintaining compliance with water quality criteria. If the calculated average concentration level resulted in lower than the allowable ranges, the most stringent value (in-stream water quality criteria based) in the range was used to calculate WLAs. If the calculated average concentration level resulted in higher than the allowable ranges, the least stringent value (current technology based) in the range was used to calculate WLAs.

*TMDL Components*

Based on the preceding discussion, the individual components of the TMDL were assigned as follows .

**WLAs**

The ∑WLAs for each impaired waterbody's drainage area was equal to the assigned average concentration level multiplied by the total permitted facility flow rates ($m^3/s$):

$$\sum WLAs = PSCONC_{TMDL} \times FLOW_{PS} \times CF \qquad (9)$$

$$1.5696(mg/l) \times 0.00487(m^3/s) \times 60 \times 60 \times 24 \times 365 \times 1000(l/m^3) \times 2.2046E-6(lbs/mg) = \underline{531.4(lbs/yr)}$$

For Snyder Run, ∑WLAs was 531.4 lbs/year (241.0 kg/year). The individual WLA for permit # s200595 was also 531.4 lbs/year (241.0 kg/year), because it is the only permitted facility in the watershed (not falling into the Phase 2 or Completely Released categories).

In situations where there were more than one permitted facility, individual WLAs were assigned using an area-weighted approach. This approach was based on the area designated in OMR's mining coverage for each permitted facility. For example, if the ∑WLAs was 100 lbs/year, and there were two permits in the drainage area (#1 representing 75 acres and #2 representing 25 acres), the WLA for #1 would have been assigned 75 lbs/year and the WLA for #2 would have been assigned 25 lbs/year.

**LAs**

The ∑LAs for each impaired waterbody's drainage area was equal to the sum of the allowable AML load (including revoked mines) and the allowable "other" nonpoint source load. In some situations, the ∑LAs also included a future growth ( described as *FUTURE* in the equation ). This occurred where permitted facilities were assigned the maximum average allowable concentration level in the range (Fe: 3.2(mg/l), Al: 4.3 (mg/L), Mn: 2.0 (mg/L)) and an additional load was still available while meeting the water quality criteria.

$$\sum LAs = AML_{TMDL} + OTHER_{TMDL} + FUTURE \qquad (10)$$

*21.815(lbs/yr) + 104.962 (lbs/yr) =* <u>*126.8 (lbs/yr)*</u>

For Snyder Run, $\sum$LAs was 126.8 lbs/year (57.5 kg/year).

*TMDLs and Allocations for Downstream Waterbodies*

A top-down methodology was followed to develop the TMDLs for each impaired waterbody in the Cheat River Watershed and to assign allocations to individual sources. Impaired headwaters were first analyzed, followed by downstream waterbodies. After assigning WLAs and LAs for headwaters, the values were carried over and used as inputs into calculations for downstream waterbodies. For example, WLAs were assigned for upstream impaired waterbodies first and were not re-assigned during downstream calculations.

# Appendix E-I.

## TMDL Concepts

### *1. Annual Aluminum Load (Total Existing Load)*

| Annual Aluminum Load ($TOTAL_{EXIST}$) | |
|---|---|
| Annual Permitted Load( $PSLOAD_{PERMIT}$) | Total Existing Nonpoint Source Load($TOTALNPS_{EXIST}$) |

- An Average Annual Aluminum Load ($TOTAL_{EXIST}$)
  $TOTAL_{EXIST} = PSLOAD_{PERMIT} + TOTALNPS_{EXIST}$
- Annual Permitted Load ($PSLOAD_{PERMIT}$)
  Area-weighted flow and maximum permit limits were used to estimate $PSLOAD_{PERMIT}$.
- Total Existing Nonpoint Source Load ($TOTALNPS_{EXIST}$)
  $TOTALNPS_{EXIST} = TOTAL_{EXIST} - PSLOAD_{PERMIT}$
  The total existing nonpoint source load was used to estimate the total nonpoint source aluminum unit area load (OUAL), in order to estimate AML%.

### *2. Total TMDL*

| TOTAL TMDL ($TOTAL_{TMDL}$) | | |
|---|---|---|
| AML including revoked mines TMDL ($AML_{TMDL}$) | Other TMDL ($OTHER_{TMDL}$) | Allowable Point Source TMDL ($TOTALPS_{TMDL}$) |

- Total TMDL ($TOTAL_{TMDL}$)
  $TOTAL_{TMDL} = AML_{TMDL} + OTHER_{TMDL} + TOTALPS_{TMDL}$ (+ FUTURE)
- AML including revoked mines TMDL ( $AML_{TMDL}$ )
  This value was estimated using water qulaity criteria (0.75mg/l), area-weighted flow, and the AML %.
- Other TMDL ($OTHER_{TMDL}$)
  This value was estimated using a reference concentration from the Horsecamp subcatchment and area weighted flow.
- Allowable Point Source TMDL ($TOTALPS_{TMDL}$)
  $TOTALPS_{TMDL} = TOTAL_{TMDL} - AML_{TMDL} - OTHER_{TMDL}$

# Appendix E-II.

## Summary of Snyder Run TMDL Calculation Steps

**Step 1.**
Use the WARMF to estimate an existing load and a TMDL load for Aluminum.

⇓

**Step 2.**
Estimate the annual permitted load for #s200595 using:
Concentration = maximum permit concentration, 6mg/L
Flow = area-weighted flow calculated using the areas of the permited mine and subcatchment #682
See equations (1) and (2)

⇓

**Step 3.**
Estimate the total existing nonpoint source load for Subcatchment of the #682 based on the total existing load from the WARMF and the annual permitted load derived in step 2.
See equation (3)

⇓

**Step 4.**
Distinguish between the AML and other nonpoint source loads.
Estimate the percentage of AML area using known AML areas for other watersheds.

⇓

**Step 5.**
Estimate the portion of the TMDL attributed to the AML load using area-weighted flow and the water quality criteria.
See equation (5)

⇓

**Step7.**
Estimate the portion of the TMDL attributed to the other nonpoint source load based on area-weighted flow and a concentration representing pristine conditions.
See equation (6)

⇓

**Step8.**
Estimate the allowable point source load by subtracting the AML portion of the TMDL( from step 6) and the other nonpoint source portion of the TMDL (from step 7) from the TMDL load calculated by the WARMF.
See equation (7)

⇓

**Step 9.**
Estimate an allowable point source concentration based on the allowable point source load derived in step 8 and the point source flow in step 2.
See equation (8)

⇓

**Step10.**
Calculate the WLA based on the allowable point source concentration and point source flow.
Calculate the LA based on the AML and other nonpoint source TMDL components.
See equations (9) and (10).

# Appendix E-III.

## Definition of Parameters

| | |
|---|---|
| ***AML %*** | Percentage of each impaired waterbodies drainage area assumed to be AML |
| $AML_{TMDL}$ | The AML allowable load to meet water quality criteria |
| $AREA_{PS}$ | The area of Permit #s200595 |
| $AREA_{TOTAL}$ | The drainage area of Synder Run |
| ***CF*** | Conversion Factor |
| $CONC_{HORSECAMP}$ | The concentration of reference nonpoint source (Horsecamp subcatchment) |
| $OTHER_{TMDL}$ | The allowable other nonpoint source load to meet TMDL criteria |
| ***OUAL*** | The total nonpoint source aluminum unit area load |
| $FLOW_{PS}$ | The average flow for permit #200595 |
| $FLOW_{TS}$ | The average flow for subcatchment #682, Snyder Run |
| $PSCONC_{PERMIT}$ | 6.0mg/l, the concentration of permit limit |
| $PSCONC_{TMDL}$ | The average allowable point source concentration |
| $PSFLOW_{TOTAL}$ | The total combined flow of permitted facilities in the drainage area |
| $PSLOAD_{PERMIT}$ | The average annual permitted load |
| $TOTAL_{EXIST}$ | The WARMF estimated an average annual aluminum load |
| $TOTAL_{TMDL}$ | The WARMF estimated TMDL |
| $TOTALNPS_{EXIST}$ | The total existing nonpoint source load |
| $TOTALPS_{TMDL}$ | The total allowable point source to meet TMDL criteria |
| $WQ_{CRITERIA}$ | 0.75 mg/l for aluminum |

# Appendix F

## Holistic Watershed Approach
## Protocol for Integrated Watershed Characterization

## Background

Integrated watershed characterizations produce better environmental data and information to make more informed decisions about where and how we invest our resources toward watershed management of mine drainage pollution and associated Total Maximum Daily Load (TMDL) implementation. Involving local, state, and federal agencies; industry; academia; and the public in planning and sampling for watershed characterizations, has led to effective protection, restoration, and enhancement of the ecological integrity of water quality and quantity. Time, costs, knowledge, skills, and abilities are some of the limiting factors when attempting to perform these tasks separately for the desired ecological integrity. Inconsistencies in planning, sampling, and data collection methodologies create quality assurance and quality control concerns. A standard operating procedure, or protocol, eliminates these inconsistencies. Implementation of a protocol, in an integrated fashion, reduces limitations and promotes outreach, education, and training, as well as improves knowledge, skills, and abilities. The West Virginia Division of Environmental Protection's Stream Restoration Group currently implements a Holistic Watershed Approach Protocol involving diverse stakeholders in planning and sampling for integrated watershed characterizations in six of West Virginia's thirty-two hydrologic regions. The Protocol is a dynamic document continually evolving to accommodate multiple applications and satisfy specific needs of diverse stakeholders.

## Methodology

When a watershed is designated for watershed characterization to determine impairment from mine drainage pollution discharges, the *study area* watershed boundaries are determined and stakeholders are notified. Watersheds are defined based on the USGS-developed hydrologic unit cataloging (HUC) system. Stakeholder involvement, spearheaded by watershed organizations, is incorporated into all aspects of watershed characterizations, including: restoration, protection, and enhancement.

With the assistance of the stakeholders, a *comprehensive sampling network* is established, mapped, and staked. This *network* includes sampling locations that divide the mainstem into segments representing changes in water quality from upstream to downstream. Sampling locations at the mouth of all mainstem tributaries along with extensive sampling locations throughout the tributary stream reach are also included. Water quality and quantity measurements are obtained three to six times, spanning a range of hydrologic and climatologic conditions. Benthic macroinvertebrate surveys and fish surveys at selected locations are also collected during this time period.

If the watershed is large and dendritic, additional sampling of a *streamlined sampling network* is conducted. This consists of sampling locations of the mainstem and all the mainstem tributaries at the mouth locations only.

The environmental data and information is reviewed and mainstem tributaries are prioritized according to degree of impairment. A *focus area sampling network* of a selected mainstem tributary is then established and mapped. The *network* consists of sampling locations at the pollution sources as well as at various locations throughout the mainstem tributary reach. Sampling locations are determined by researching existing data and field reviewing the area for all sources of mine drainage pollution discharges. As with the *comprehensive sampling network*, water quality and quantity measurements are obtained three to six times, spanning a range of hydrologic and climatologic conditions. Benthic macroinvertebrate surveys are also collected during this time period.

The data is reviewed and utilized for: establishing the impact of the mine drainage pollution sources to the *focus area* tributaries, selecting the most feasible pollution sources within the *focus area* to address, and identifying the best available technology for the abatement or treatment of the pollution sources.

Following mine drainage pollution remediation of selected project sites within the *focus area*, a *post construction sampling network* is established. It consists of the same *focus area* locations sampled prior to construction, in addition to the treated discharges resulting from the installation of any mine drainage pollution abatement technologies. All new sampling site coordinates are obtained and mapped. Three to six water quality and quantity sampling sweeps are conducted spanning a range of hydrologic and climatologic conditions. Benthic macroinvertebrate surveys are also collected during this time period.

This process continues until all *focus areas* in the initial *study area* have been addressed, and all feasible treatment or abatement technologies applied. At that time, three to six water quality and quantity sampling sweeps of the initial *comprehensive sampling network* are conducted spanning a range of hydrologic and climatologic conditions. Benthic macroinvertebrate surveys and fish surveys are also collected during this time period.

Results are analyzed and a report prepared evaluating the effect of the abatement or treatment technologies on the mine drainage pollution sources and their receiving streams.

Once implemented, the Protocol is a perpetual cycle with many overlapping process steps. The Protocol outline and a process flowchart is presented below:

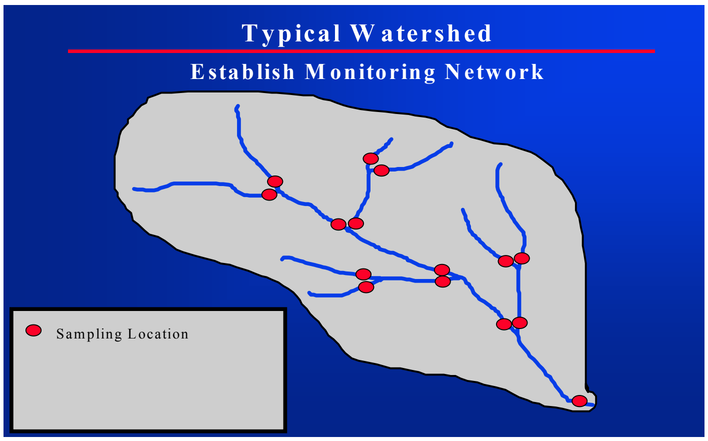
## Holistic Watershed Approach Protocol

### I. Define the *study area* and stakeholders.

- Select mainstem stream.
- Delineate watershed boundary.
- Foster Stakeholders.

**II.** **Establish *comprehensive sampling network* within the *study area*.**

- Select and number stream sampling stations utilizing USGS 7.5 Minute Topographic Quadrangle Maps and field reconnaissance.
  - Select mainstem stream sampling stations representing mainstem stream segments.
  - Select all mainstem tributary sampling stations at the mouth locations and at extensive locations throughout the mainstem tributary stream reach.




**III.** **Geo-reference *comprehensive sampling network* for input into Geographical Information Systems (GIS).**

**IV.** **Implement sampling sweeps of the *comprehensive sampling network*.**

- Conduct *Water Quality Study* sweeps three to six times spanning a range of hydrologic and climatologic conditions.
  - Perform water sample collection.
    - Collect stream water sample for laboratory analysis employing "grab" sample method.
  - Perform field measurements.
    - Obtain insitu water quality measurements at all sampling stations.
    - Obtain stream flow.
- Conduct *Biological and Physical Study* one time between April and November.
  - Perform stream habitat assessments and qualitative benthic macroinvertebrate surveys at all stream sampling stations.
  - Perform fish survey at selective stream sampling stations only.

**V.** **Review all data collected. (If watershed is large and dendritic, continue or otherwise skip to IX.)**

- Analyze changes in tributary and mainstem stream segments and compare tributaries.

- Represent *Water Quality Study* data graphically.
- Compare *Biological and Physical Study* data.

**VI. Establish *streamlined sampling network* within the *comprehensive sampling network*.**

- Select and number stream sampling stations.
  - Select mainstem stream sampling stations representing mainstem stream segments.
  - Select all mainstem tributary sampling stations at the mouth locations only.

**VII. Implement sampling sweeps of *streamlined sampling network*.**

- Conduct *Water Quality Study* sweeps three to six times spanning a range of hydrologic and climatologic conditions.
  - Perform water sample collection.
    - Collect stream water sample for laboratory analysis employing "grab" sample method.
  - Perform field measurements.
    - Obtain insitu water quality measurements at all sampling stations.
    - Obtain stream flow.

**VIII. Review all data collected.**

- Analyze changes in tributary and mainstem stream segments and compare tributaries.
  - Represent *Water Quality Study* data graphically.
  - Compare *Biological and Physical Study* data.
  - Compare mainstem tributaries with respect to degree of impairment.

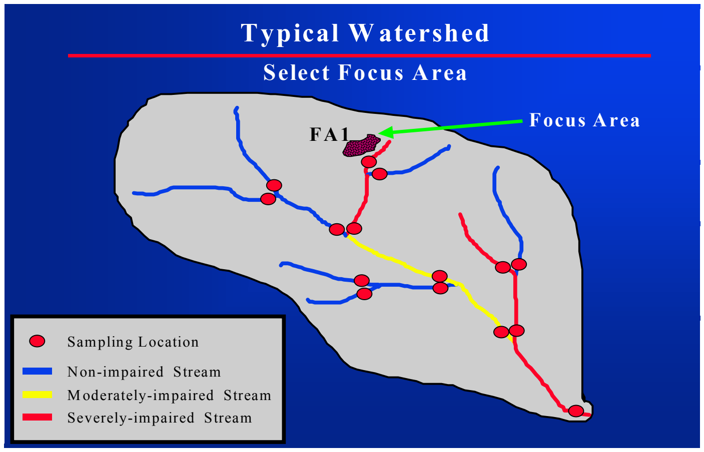
**IX. Define *focus study area*.**

- Select impaired tributary within *comprehensive sampling network* and determine watershed boundary.

**X. Establish *focus area sampling network* within the *focus study area*.**

- Locate mine drainage pollution discharge sampling stations within impaired tributary watershed.
  - Research existing data.
  - Field review entire impaired tributary watershed.
- Select impaired tributary sampling stations at mouth location and at extensive locations throughout the tributary stream reach, including stations upstream and downstream of mine drainage pollution discharge influx.

- Select receiving stream sampling stations upstream and downstream of the confluence with the impaired tributary.




**XI. Geo-reference *focus area sampling network* for input into Geographical Information Systems (GIS).**

**XII. Implement sampling sweeps of *focus area sampling network*.**

- Conduct *Water Quality Study* sweeps two to three times spanning a range of hydrologic and climatologic conditions.
  - Perform water sample collection.
    - Collect stream water sample for laboratory analysis employing "grab" sample method.
    - Collect pollution source water sample at origin. (When several sources co-mingle, it is necessary to collect a sample of the combined discharge.)
  - Perform field measurements.
    - Obtain insitu water quality measurements at all sampling stations.
    - Obtain stream flow.
- Conduct *Biological and Physical Study* one time between April and November.
  - Perform stream habitat assessments and qualitative benthic macroinvertebrate surveys upstream and downstream of mine drainage pollution discharge project areas.

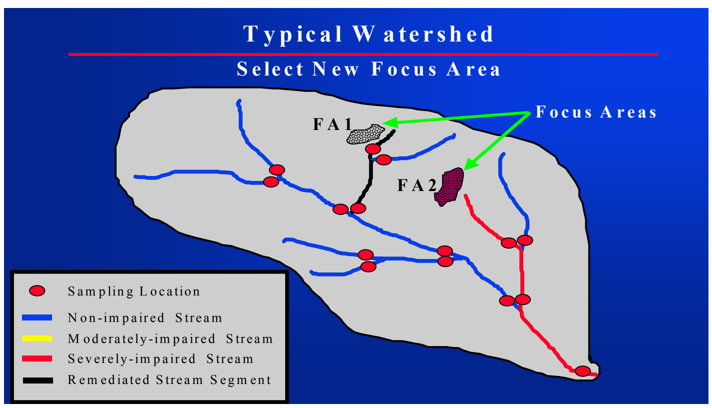
**XIII. Review all data collected.**

- Analyze *focus area sampling* network data.
  - Determine extent of impairment mine drainage pollution discharge contributes to the *focus area* impaired tributaries.
  - Determine site-specific mine drainage pollution discharge treatment technology for the sources at each project area.

    - Evaluate chemical suitability of selected mine drainage pollution discharge treatment technology.
    - Evaluate physical suitability of selected mine drainage pollution discharge treatment technology.
- Determine in-stream mine drainage pollution discharge treatment technology for stream benefits in addition to, or in lieu of site-specific pollution discharge treatment.

**XIV. Modify *focus area sampling network*. [If additional data is or may be required to support pre construction design(s), repeat XII through XIII.]**

- Cease sampling of any portion of project for which polluted water abatement appears infeasible.
- Incorporate sampling of any additional *focus area(s)* mine drainage pollution discharges found following completion of **XII**.




**XV. Report findings.**

- Prepare preliminary pre-design *Water Quality Study* report.

**Implementation**

**XVI. Establish *post construction focus area sampling network* when mine drainage pollution discharge treatment is complete in the *focus study area*. (If initial *study area* contains other *focus study area(s)* that have not been addressed, repeat IX through XV, otherwise continue.)**

- Locate constructed mine drainage pollution discharge treatment systems within treatment project boundaries.
    - Field review mine drainage pollution discharge treatment project site.
- Select and number stream sampling stations throughout *focus study area*.
    - Select the previously impaired tributary sampling stations at mouth location and at extensive locations throughout the tributary stream reach,

including stations upstream and downstream of mine drainage pollution discharge treatment project influx.
- Select receiving stream sampling stations upstream and downstream of the confluence with the previously impaired tributary.

**XVII. Geo-reference *post construction focus area sampling network* for input into Geographical Information Systems (GIS).**

**XVIII. Implement sampling sweeps of *post construction focus area sampling network*.**

- Conduct *Water Quality Study* sweeps monthly during the first year period; quarterly during the second year period; and semiannually during the third and every subsequent year period spanning a range of hydrologic and climatologic conditions.
  - Perform water sample collection.
    - Collect stream water sample for laboratory analysis employing "grab" sample method.
    - Collect untreated source water sample at origin if possible.
    - Collect treated source water sample at mine drainage pollution discharge treatment system outflow.
  - Perform field measurements.
    - Obtain insitu water quality measurements at all sampling stations.
    - Obtain stream flow.
- Conduct *Biological and Physical Study* one time between April and November, at least one year after completion of project construction.
  - Perform stream habitat assessments and qualitative benthic macroinvertebrate surveys upstream and downstream of mine drainage pollution discharge treatment project influx.

**XIX. Implement sampling sweeps of the *comprehensive sampling network*. (If mine drainage pollution discharge treatment is complete throughout initial *study area* continue.)**

- Conduct *Water Quality Study* sweeps three to six times spanning a range of hydrologic and climatologic conditions.
  - Perform water sample collection.
    - Collect stream water sample for laboratory analysis employing "grab" sample method.
  - Perform field measurements.
    - Obtain insitu water quality measurements at all sampling stations.
    - Obtain stream flow.
- Conduct *Biological and Physical Study* one time between April and November.
  - Perform stream habitat assessments and qualitative benthic macroinvertebrate surveys at all stream sampling stations.

- Perform fish survey at selective stream sampling stations only.

**XX. Review all data collected.**

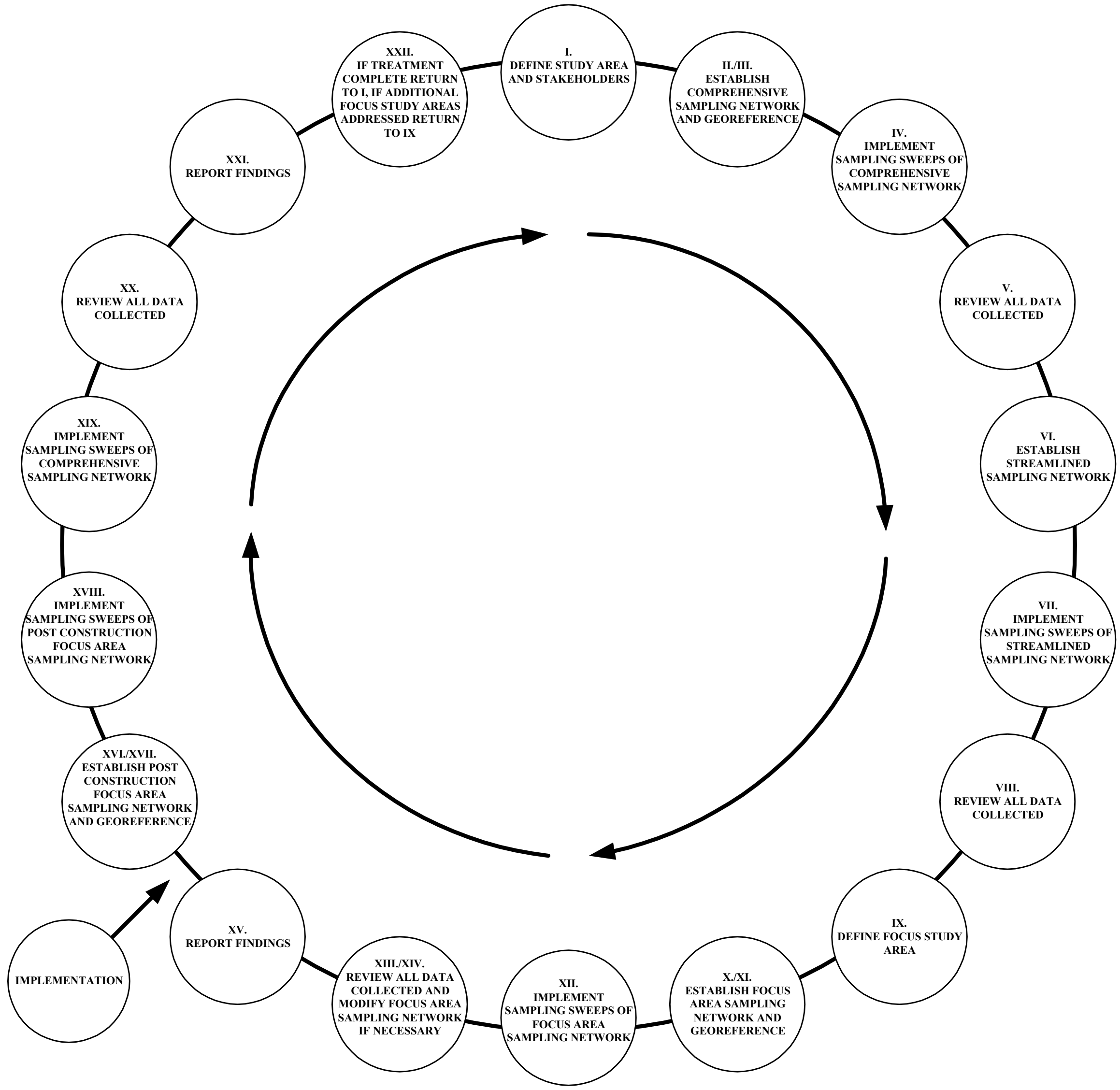
- Analyze changes in stream water quality.
- Analyze effectiveness and efficiency of constructed mine drainage pollution discharge treatment systems.
- Determine the effect of constructed mine drainage pollution discharge treatment systems on the mine drainage pollution discharges, *focus area sampling networks*, and *comprehensive sampling network*.

**XXI. Report findings**

- Prepare final post construction *Water Quality Study* report.

**XXII. If mine drainage pollution discharge treatment is complete throughout the *study area*, return to I. If additional *focus study areas* will be addressed within the *study area*, return to IX.**

# Holistic Watershed Approach Protocol




Holistic Watershed Approach Protocol

# Appendix G

Remedial Projects in Cheat Watershed

**Cheat River Watershed Abandoned Mine Land and Mine Drainage Pollution Treatment and Abatement Projects in Planning, Mapping, Design, Completed and/or Ongoing Phase**

| Project | County | Status | Costs/Estimated Costs |
|---|---|---|---|
| Albert Highwall | Tucker | Completed | $3,650,808.00 |
| Albright Reclamation Project (Anker) | Preston | Planning | $? |
| Beatty Church/Wetzel Rd Hw/Portal | Preston | Completed | $ 190,960.00 |
| Beaver Creek Refuse | Tucker | Completed | $ 86,817.00 |
| Benbush Refuse | Tucker | Completed | $ 214,451.00 |
| Benson Highwall | Tucker | Completed | $3,650,808.00 |
| Blackwater Manor | Tucker | Completed | $ 283,929.00 |
| Blackwater River Drum & Doser | Tucker | Completed/Ongoing | $1,200,000.00 |
| Blaser Refuse & Portals (Pringle Creek) | Preston | Mapping | $ 681,925.00 |
| Bull Run #27 | Preston | Design | $ 909,260.00 |
| Bull Run #35 | Preston | Completed | $ 543,472.00 |
| Burke/Rand Refuse | Preston | Completed | $ 278,760.00 |
| Burnwell Tipples | Preston | Completed | $ 423,625.00 |
| Cherry Run #3 | Preston | Mapping | $ 271,464.00 |
| Conner Highwall | Preston | Completed | $ 336,683.00 |
| Davis Highwall | Tucker | Completed | $ 53,415.00 |
| DeMoss/Goines Project | Preston | Completed | $ 20,588.00 |
| Douglas Highwall | Tucker | Completed | $1,653,718.00 |
| Fickey Run Portal & Refuse (Muddy Creek) | Preston | Completed | $ 246,840.00 |
| Glade Run I & II | Preston | Completed | $ 59,666.00 |
| Greens Run (Middle Fork) (Anker) | Preston | Planning | $ 200,000.00 |
| Greens Run AMD & Refuse Limestone Sand Application | Preston | Completed/Ongoing | $ 216,000.00 |
| Greens Run Highwall | Preston | Completed | $ 330,887.00 |
| Irona Refuse Area | Preston | Completed | $1,244,681.00 |
| Kyle Highwall | Preston | Completed | $ 23,000.00 |
| Laurel Point Portals | Preston | Completed | $ 55,857.00 |
| Lick Run #2 | Preston | Completed | $ 481,600.00 |
| Limestone Sand Application (Big Sandy Creek, Greens Run, Heather Run, N Fork Blackwater River and Laurel Run, Pringle Run) | Preston/Tucker | Completed/Ongoing | $ 250,000.00 |
| Livengood HW and AMD (Beaver Creek) | Preston | Design | $ 318,670.00 |
| Marrara Spoil Area | Preston | Completed | $ 182,707.00 |
| Martin Creek Refuse | Preston | Mapping | $ 459,874.00 |
| Masontown #4 (Bull Run) | Preston | Completed | $1,044,000.00 |
| Masontown #4 | Preston | Mapping | $1,044,000.00 |
| Muddy Creek Tipple | Preston | Completed | $ 743,158.00 |
| Philip Thorn Highwall & Portals (Lick Run) | Preston | Mapping | $ 197,780.00 |
| Pierce Refuse Pile | Tucker | Completed | $ 198,596.00 |
| Pisgah Highwall | Preston | Completed | $ 180,600.00 |
| Preston Refuse | Preston | Completed | $ 112,000.00 |
| Rosati Mine Drainage | Preston | Completed | $ 147,944.00 |
| Ruthbell Refuse Area | Preston | Completed | $ 737,796.00 |
| Snider Highwall | Preston | Completed | $ 364,679.00 |
| Snider Portal | Preston | Completed | $ 11,700.00 |
| Sovern Run Mine Drainage | Preston | Design | $ 221,068.00 |
| Sovern Run Mine Drainage | Preston | Design | $ 762,750.00 |
| Sugar Valley Portals | Preston | Planning | $ 96,323.00 |
| Tunnelton Refuse Area | Preston | Completed | $ 271,943.00 |
| Webster Refuse & AMD | Preston | Completed | $ 519,333.00 |

Completed $1,174,839.00

The Special Reclamation Group has completed reclamation of the following bond forfeiture sites in the Cheat River watershed:

| Permit No. | Permit Name | Forfieture Date | County | Receiving Stream |
|---|---|---|---|---|
| U032100 | AMANDA MINING, INC. | 06/01/88 | PRESTON | UTof Gum Run |
| U015482 | ANGELA MINING CO. | 09/24/92 | PRESTON | Lick Run |
| S013180 | BJORKMAN MINING CO. | 09/23/92 | PRESTON | Morgan Run |
| S003781 | BJORKMAN MINING CO. | 09/23/92 | PRESTON | Morgan Run |
| E032000 | BORGMAN COAL CO. | 10/01/91 | PRESTON | Heather Run |
| U102089 | BULL RUN MINING CO. | 01/12/93 | PRESTON | Sovern Run |
| S012479 | DAUGHERTY COAL CO. | 08/18/89 | PRESTON | UT of Cheat River |
| Z001781 | DAUGHERTY COAL CO. | 04/01/89 | PRESTON | Bull Run &Gum Run |
| S019277 | DAUGHERTY COAL CO. | 07/01/89 | PRESTON | Gum Run |
| S024674 | DAUGHERTY COAL CO. | 08/01/89 | PRESTON | UT of Cheat River |
| S006577 | DAUGHERTY COAL CO. | 07/12/89 | PRESTON | UT of Cheat River |
| S100986 | DAUGHERTY COAL CO. | 07/17/89 | PRESTON | Bull Run &Gum Run |
| S007383 | DAUGHERTY COAL CO. | 07/17/89 | PRESTON | UT Cheat River |
| S107386 | F & M COAL CO. | 03/13/92 | PRESTON | |
| S004478 | F & M COAL CO. | 09/02/93 | PRESTON | UT of Crab Orchard Run |
| S101887 | G & B COAL CO. | 06/29/95 | PRESTON | Middle & North Fk. of Greens Run |
| S004081 | HALLELUJAH MINING | 09/24/92 | PRESTON | Greens Run |
| S006084 | HIDDEN VALLEY COAL CO. | 08/29/89 | PRESTON | UT of Mill Run |
| S100888 | HORIZON FUELS, INC. | 01/09/90 | PRESTON | Muddy Creek |
| S106386 | J. E. B., INC. | 11/01/91 | PRESTON | UT of Morgan Run |
| S006182 | J. E. B., INC. | 11/01/91 | PRESTON | Church Ck |
| S006284 | J. E. B., INC. | 07/17/91 | PRESTON | Church Ck. |
| S103086 | JONES COAL CO. | 07/24/92 | PRESTON | Glade Run of Big Sandy |
| S00983 | JONES COAL CO. | 11/17/92 | PRESTON | |
| U020400 | LOBO CAPITOL, INC. | 08/07/85 | PRESTON | Glade Run |
| U044900 | NEW COALS, INC. | 04/03/87 | PRESTON | UT of Muddy Creek |
| S015776 | NORTHWEST COAL CO. | 07/28/77 | PRESTON | UT Fikes Run |

| | | | | |
|---|---|---|---|---|
| O002082 | PIONEER COAL SALES INC. | 09/22/92 | PRESTON | UT of Heather Run |
| U023500 | PRESTON ENERGY, INC. | 03/18/94 | PRESTON | UT Roaring Ck. |
| U042900 | PRESTON ENERGY, INC. | 05/05/94 | PRESTON | Glade Run |
| U040800 | ROCK BULL MINING | 01/28/93 | PRESTON | Conner Run |
| S023776 | ROCKVILLE MINING CO. | 01/12/94 | PRESTON | Conner Run |
| S006578 | ROCKVILLE MINING CO. | 01/12/94 | PRESTON | UT of Glade Run |
| S103586 | ROCKVILLE MINING CO. | 01/12/94 | PRESTON | Sovern Run |
| S105386 | ROCKVILLE MINING CO. | 05/24/94 | PRESTON | Glade Run |
| S009185 | ROCKVILLE MINING CO. | 01/12/94 | PRESTON | Fickey Run |
| P013185 | T & J COAL CO. | 05/29/87 | PRESTON | UT of Pringle Run |
| P117785 | T & J COAL CO. | 05/29/87 | PRESTON | UT of Pringle Run |
| S011077 | WILLIFORD EXCAVATING | 02/08/85 | PRESTON | UT of Muddy Creek & Muddy Creek |
| S000476 | WILLIFORD EXCAVATING | 02/01/85 | PRESTON | UT. Muddy Creek |
| S010375 | WILLIFORD EXCAVATING CO., INC. | 07/12/83 | PRESTON | |
| S002685 | WOCAP ENERGY RESOURCES | 12/14/93 | PRESTON | UT of Church Ck. |
| S006079 | ZINN COAL CO. | 04/16/91 | PRESTON | Fike and Cherry Run . |

## Reclamation activities are initiated, but not yet completed at the following sites:

| Permit No. | Permit Name | Forfieture Date | County | Receiving Stream |
|---|---|---|---|---|
| S100688 | F & M COAL CO. | 09/24/92 | PRESTON | Hacklebarney Run |
| S102687 | F & M COAL CO. | 04/30/92 | PRESTON | Hogback & UT of Cheat River |
| S004679 | F & M COAL CO. | 09/24/92 | PRESTON | Ashpole Run |
| U012583 | T & T FUELS, INC. | 12/04/95 | PRESTON | Muddy Creek |
| S011280 | INTER-STATE LUMBER CO. | 07/31/95 | PRESTON | Cheat River |
| E011300 | T & T FUELS, INC. | 10/31/95 | PRESTON | Muddy Creek |
| S007179 | WETER CO. | 07/10/95 | PRESTON | UT of Cheat River |
| S017677 | INTER-STATE LUMBER CO. | 07/31/95 | PRESTON | Roaring Ck |

Reclamation has yet to be initiated at the following sites:

| Permit No. | Permit Name | Forfieture Date | County | Receiving Stream |
|---|---|---|---|---|
| S102488 | BOLINGREEN MINING COMPANY | 02/10/00 | PRESTON | Beech Run |
| E066000 | BULL RUN MINING CO. | 06/09/92 | PRESTON | Webster Run |
| S005882 | CENTURY ENTERPRISES | 01/06/94 | PRESTON | Barnes Run |
| S002783 | CRANE COAL CO., INC. | 01/03/92 | PRESTON | Glade Run |
| S018875 | DAUGHERTY COAL CO. | 05/19/92 | PRESTON | UT Bull Run |
| S004073 | DAUGHERTY COAL CO. | 03/09/90 | PRESTON | Bull Run |
| S100688 | F & M COAL CO. | 09/24/92 | PRESTON | Hacklebarney Run |
| S102687 | F & M COAL CO. | 04/30/92 | PRESTON | Hogback & UT of Cheat River |
| S004679 | F & M COAL CO. | 09/24/92 | PRESTON | Ashpole Run |
| s010582 | ROCKVILLE MINING CO. | 05/24/94 | PRESTON | Conner Run |
| S006582 | ROCKVILLE MINING CO. | 01/12/94 | PRESTON | Glade Run |

The Special Reclamation Group is currently applying active chemical treatment at the T&T Mine Complex in Preston County. Treatment began in 1995 with a goal to neutralize all acidity and remove as much metal loading as the treatment facilities allow. A consent decree between the USEPA, Coastal Coal Company, and the West Virginia DEP resulted in an agreement for an abatement plan to be jointly funded by Coastal Coal and the WVDEP. The alkaline injection project is currently in progress. Drainage from the site flows into Muddy Creek of the Cheat River.