


MUDDY CREEK WATERSHED BASED PLAN

May 2020

FRIENDS OF THE CHEAT – 1343 N PRESTON HIGHWAY, KINGWOOD, WV 304-329-3621


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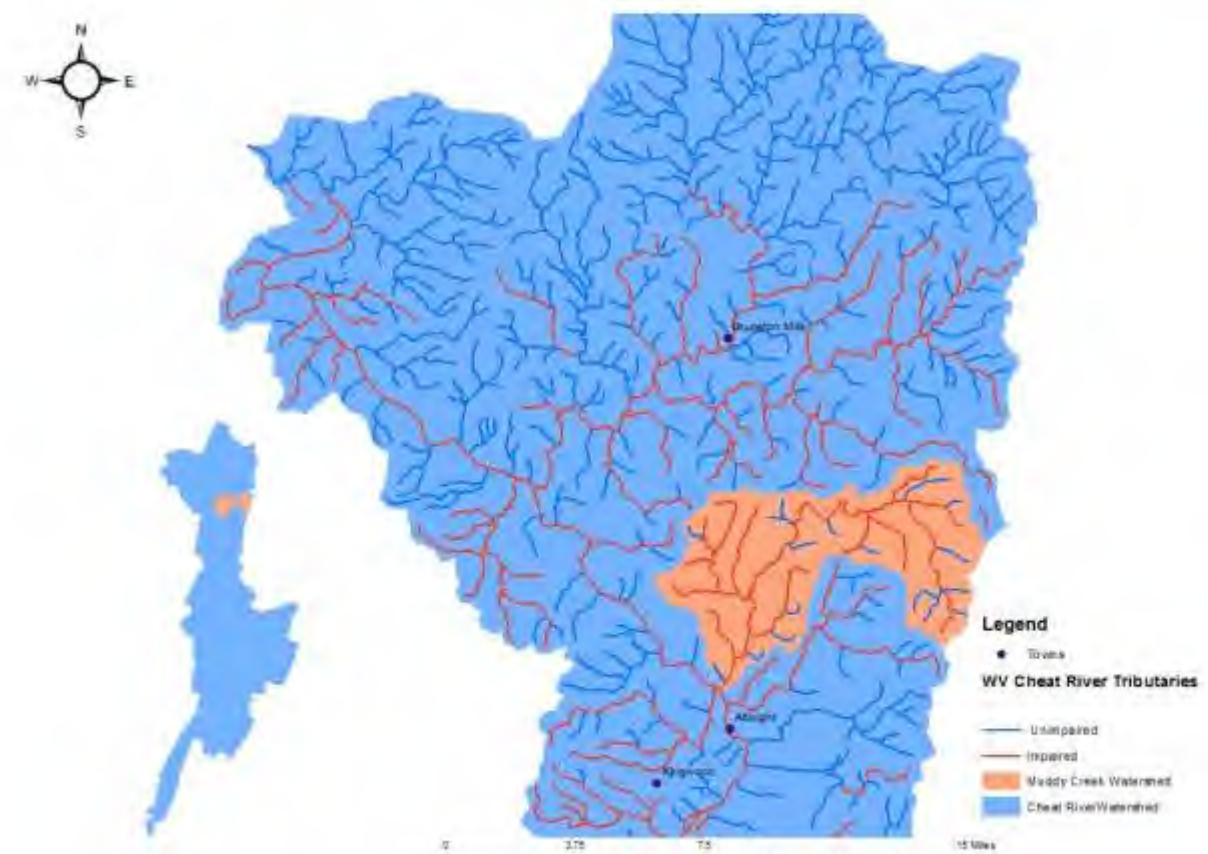
1. Introduction

1.1 Purpose

This Watershed Based Plan (WBP) covers the Muddy Creek watershed (HUC12 050200040703) in West Virginia, including all tributaries (Figure 1). Muddy Creek and its tributaries are impaired by Fe, Al, pH, CNA-biological, and Fecal Coliform impairments, depending on the specific tributary or reach. This document serves as a plan for Friends of the Cheat (FOC) and partnering agencies to implement projects that improve the water quality in the Muddy Creek and its tributaries. Funding for these projects will come from the Environmental Protection Agency (USEPA) under the Clean Water Act (CWA) Section 319, Office of Surface Mining and Reclamation (OSMRE), West Virginia Department of Environmental Protection (WVDEP), non-government organizations, in-kind donations from interested persons, and volunteers.

This document outlines a restoration plan for the Muddy Creek Watershed based on USEPA's Nine Elements of a WBP (1), focusing on the most significant water quality problem, acid mine drainage (AMD).

***Figure 1:* Muddy Creek Watershed Map**



1.2 Background

From its headwaters in Randolph and Pocahontas Counties, West Virginia, the Cheat River flows 157 miles north to the Pennsylvania state line through Tucker and Preston counties. In its lower 20 miles, the river has been severely polluted by acid mine drainage. Much of this damage has been caused by coal mines that were abandoned before the passage of the Surface Mining Control and Reclamation Act (SMCRA) in 1977, with Muddy Creek being one of the largest contributors to acidity to the Cheat River. The damage from acid mine drainage to both Muddy Creek and the Cheat River was exacerbated in 1994 and 1995 when an illegally-sealed mine (known as the T&T No. 2 Mine) blew out of the hillside two separate occasions delivering catastrophic levels of acidity to Muddy Creek and the Cheat River mainstem. These events exacerbated inhospitable conditions for aquatic life in Muddy Creek downstream of the blowout as well as the Cheat River downstream of its confluence with Muddy Creek.

After this event, the Cheat River was named one of the most endangered rivers in America by *American Rivers* (2), and Friends of the Cheat formed to address these impacts. Over the last 25 years Friends of the Cheat (FOC) has installed 18 AMD Restoration Sites in the Cheat River watershed, including four within the Muddy Creek Watershed. Today the Cheat River has rebounded because of the work of many state, federal, and non-governmental organizations and the Cheat River mainstem no longer fails to meet the pH criterion according to the 2011 TMDL (3). Also, walleye and other acid-sensitive fish have been recorded using the Cheat Lake and Cheat River main-stem as seasonal habitat (4).

Despite these efforts by FOC and its partners with support from USEPA, WVDEP, and US OSMRE, the legacy of AMD persists in Muddy Creek through the loss of habitat and wildlife, deteriorated aesthetic value of polluted waterways, degraded drinking water, and economic losses from diminished opportunities for recreation such as boating and fishing in Muddy Creek. However, due to new technology in place and ongoing partnerships, FOC is moving forward in its goal to restore Muddy Creek and is confident this plan will help FOC reach its restoration goal.

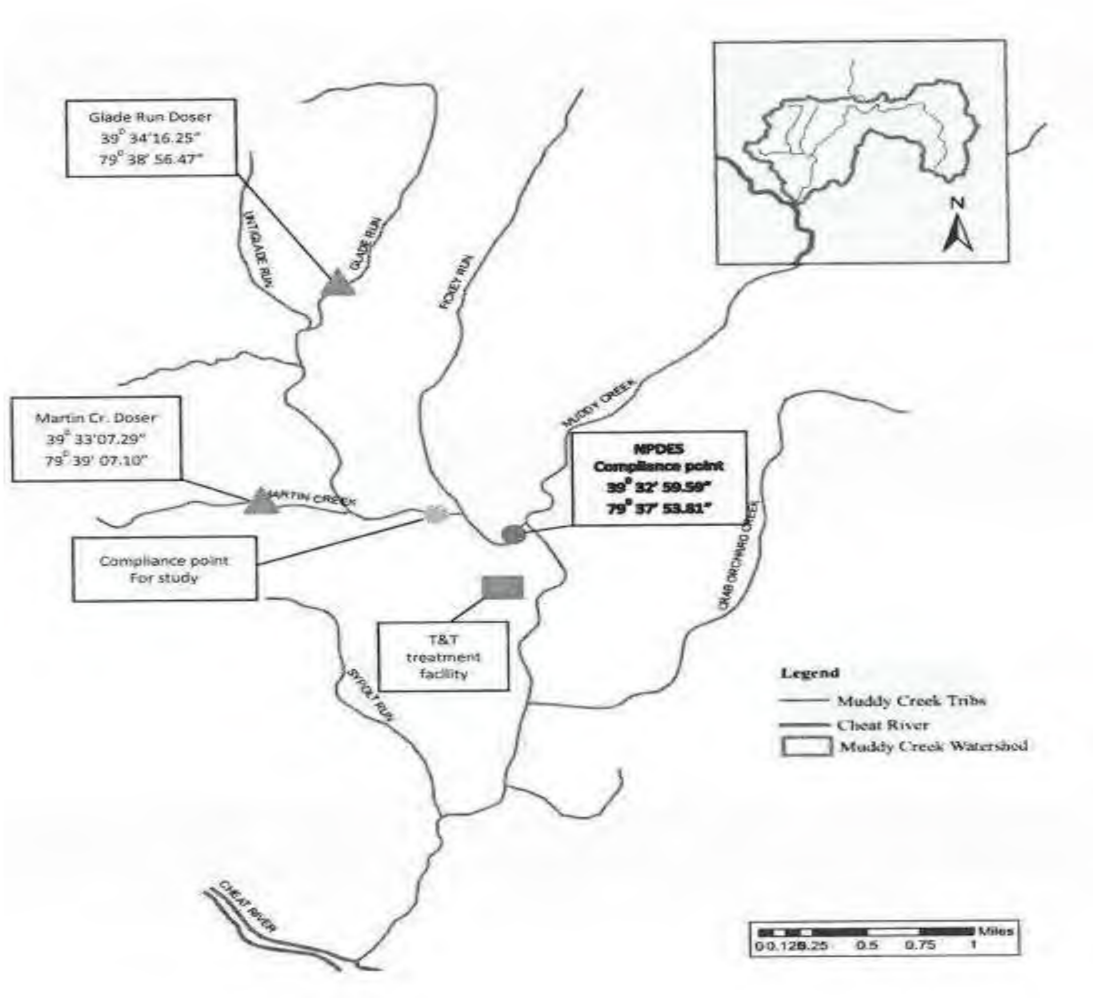
Most recently, the WVDEP Office of Special Reclamation (OSR) has adopted a new approach to the AMD pollution caused by pre and post law acid mine drainage in Muddy Creek—watershed scale treatment in the form of the T&T water treatment facility, headwater in-stream dosers, and a pipeline and lift station to collect and transport water from Fickey Run to the T&T treatment facility (Figure 2) (5) (6). Because of this strategy, streams such as Glade Run are acting as a treatment mechanism, at times treating as high as 10.0 pH directly into the stream, and the current NPDES variance permit (the compliance point of which is located at the mouth of Martin Creek) allows pH to range from 3.2 – 9.0, total Iron to be as high as 10 mg/L, and dissolved Aluminum as high as 15 mg/L-- although it should be noted that these limits represent "worst-case scenario", and the long term strategy from OSR is to adjust these parameters to reflect WV Water Quality Standards as stream conditions improve.

Martin Creek, Fickey Run, Glade Run, and each's subsequent tributaries are severely impacted and are considered a "zone of no recovery". However, FOC would like to continue to restore Muddy Creek by selecting appropriate sites and treatment methods to address the multitude of pre-law AMD sources through the Martin Creek, Fickey Run, and Glade Run watersheds. WVDEP OSR's Muddy Creek watershed restoration approach is substantially decreasing both point-source and nonpoint-source pollutant loads in Muddy Creek. However, because the current effluent limitations at the variance compliance point vary greatly (as described above), Muddy Creek may not meet water quality standards downstream of Martin Creek without tackling additional sources of pre-law AMD in Martin, Glade and Fickey Run. The water quality at the compliance point at the mouth of Martin Creek will not only be bound by the limitations set forth in the variance but will also become more reflective of WV Water Quality Standards because of reductions of non-point source loads upstream.

There are 49 AMD seeps in the Martin, Fickey, and Glade Run watersheds. It is not feasible to treat each one of these seeps with the current funding opportunities and technologies available to groups who tackle pre-law AMD restoration. FOC is noticing a trend that AMD restoration projects are more expensive than in former years, and often require a 'phased' approach, requiring 2-3 secured 319 grants and two sources of match, rather than one secured 319 grant and 1 40% match grant. The average life span for passive AMD Treatment sites with current technologies is 10-15 years before large scale maintenance or a site improvements project occurs to assure water quality goals are being maintained, usually requiring an additional 319 grant or other large funding source. At this rate, without additional funding avenues or new technologies, it would be impossible to treat each seep in Martin, Fickey, and Glade Run by any non-profit group.

This plan is based on logical, feasible pathways for the restoration of Muddy Creek. FOC believes the techniques addressed in this plan will result in the restoration of Muddy Creek from AMD impairment. FOC proposes writing a separate watershed based plan for the full recovery of Martin Creek (which includes Fickey Run and Glade Run) when funding mechanisms and technologies advance and restoration becomes feasible.

Figure 2: ***WVDEP-OSR Muddy Creek Watershed Scale Treatment Approach***



Muddy Creek is a healthy trout fishery upstream of its confluence with Martin Creek, making restoration of the remaining 3.4 impaired miles in order to ecologically connect Muddy Creek with the confluence with the Cheat River of utmost importance. FOC and its partners have targeted Muddy Creek to create a WBP to assess and address sources of point-source and nonpoint-source pollution within the watershed. Previous AMD remediation projects include “Allen Connor Messenger” “Gary Connor” “Dream Mountain”’ and “Upper Muddy Schwab” projects. These projects were implemented with CWA §319 funds and have improved water quality within the watershed.

In the past FOC has chosen project sites based primarily on landowner interest. While still considering landowner interest as one of several facets, this plan favors the feasibility of meeting water quality standards based on the goals set by the 2011 Cheat River Basin TMDL to prioritize restoration efforts. This plan will act as a guide for FOC to prioritize restoration efforts based on feasibility and projected water quality success.

2. Identification of Causes and Sources of Impairments

CWA section 303(d) requires states to identify and list streams that do not meet water quality standards. Water quality standards are based on the designated uses of the stream. The numeric water quality standards are relevant for the pollution problems addressed by this WBP (See Table 1). Although trout are present within Muddy Creek, this plan was based on Aquatic Life/Warmwater fisheries standards as it is a feasible end goal for Muddy Creek considering the immense impact from AMD. Once Aquatic Life/Warmwater fisheries standards are attained, FOC would look to reduce pollutants to Trout Water Standards in future planning efforts. Impairments in the Muddy Creek Watershed include pH, dissolved Al, Fe, Fecal Coliform and CNA biological. Fe, Al, and pH impairments are commonly a result of AMD (acid mine drainage) in this region. This WBP focuses on these AMD - caused impairments, which may be the cause of the conditions not allowable (CAN) biological listing as well. Table 2 lists the streams designated as impaired by pH, dissolved Al, or Fe on the 303(d) list of impaired streams in the Muddy Creek Watershed that also are listed on the TMDL with required reductions of pollutants from AMLs. Figure 3 highlights these streams in red.

Table 1: West Virginia State Water Quality Criteria

Pollutant	Designated Use				
	Aquatic Life				Human Health
	Warmwater Fisheries		Trout Waters		Contact Recreation & Public Water Supply
	Acute[a]	Chronic[b]	Acute[a]	Chronic[b]	
Aluminum, dissolved **(µg/L)**	750	750	750	87	--
Iron, total **(mg/L)**	--	1.5	--	0.5	1.5
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

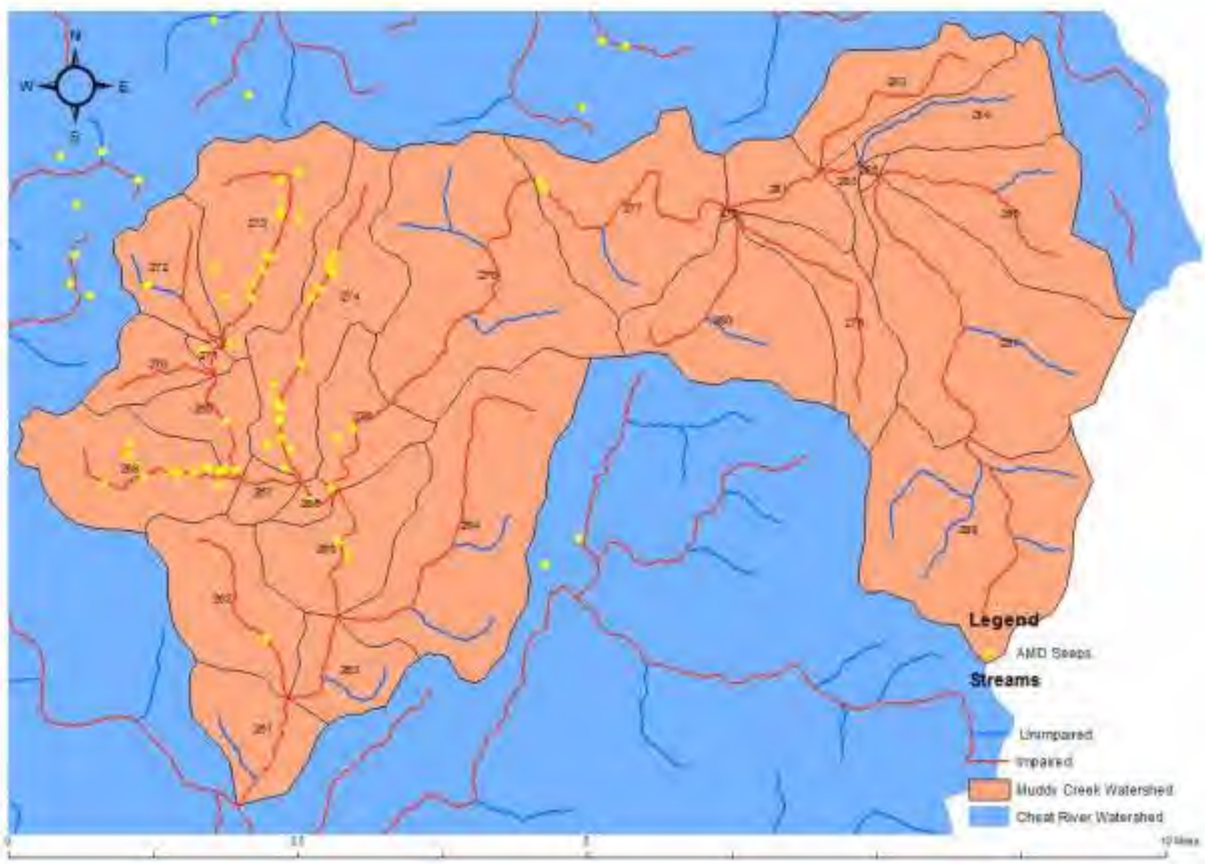
[a] One-hour average concentration not to be exceeded more than once every 3 years on the average.
[b] Four-day average concentration not to be exceeded more than once every 3 years on the average.
Source: 47 CSR, Series 2, *Legislative Rules, Department of Environmental Protection: Requirements Governing Water Quality Standards (7)*.

*Table 2: **Impaired Streams in Muddy Creek Watershed***

Stream Name	NHD Code	Stream Code	SWS Code	HUC 12 Code	Trout?	pH	Fe	Al	Bio	FC
Muddy Creek	WV-MC-39	WVMC-17	261, 263, 265, 275, 276, 277, 281, 283, 285, 287, 288	050200040703	Yes	X	X	X	X	X
Sypolt Run	WV-MC-39-B	WVMC-17-0.5A	262	050200040703		X	X			
Crab Orchard Run	WV-MC-39-D	WVMC-17-0.7A	SWS 264	050200040703		X	X	X	X	
Martin Creek	WV-MC-39-E	WVMC-17-A	266, 267, 268	050200040703		X	X	X		X
Fickey Run	WV-MC-39-E-1	WVMC-17-A-0.5	274	050200040703		X	X	X	X	X
Glade Run	WV-MC-E-2	WVMC-17-A-1	269, 271, 273	050200040703		X	X	X	X	
UNT/Glade Run RM 1.06	WV-MC-39-E-2-A	WVMC-17-A-1-A	270	050200040703		X	X	X		
UNT/Glade Run RM 1.36	WV-MC-39-E-2-B	WVMC-17-A-1-B	272	050200040703		X	X	X		
UNT/Muddy Creek RM 9.80	WV-MC-39-I	WVMC-17-A.8	278, 280	050200040703			X			X
UNT/UNT RM 0.12/Muddy Creek RM 9.80	WV-MC-39-I-1	WVMC-17-A.8-1	279	050200040703		X		X		
Jump Rock Run	WV-MC-39-J	WVMC-17-B	282	050200040703	Yes	X	X	X		
Sugarcamp Run	WV-MC-39-L	WVMC-17-C	286	050200040703	Yes	X		X		

An "X" identifies parameters that impair the stream. An "*" indicates impairment was modeled. Source: All are from the 2014 303(d) list Supplemental Tables B and E (WVDEP, 2014a). This table also includes the WV NHD Stream Code used in the 2011 Cheat TMDL and WV Stream codes in the 2014 303(d) list (8).

Figure 3: ***pH, Fe, and/or Al Impaired Streams in the Muddy Creek Watershed***



A total maximum daily load (TMDL) is the maximum amount of pollution a stream can receive and meet water quality standards. The goal of this watershed based plan is to meet required reductions of Fe, Al, and acidity loads from AML seeps set by the 2011 Cheat River Basin TMDL, developed by WVDEP. The endpoint goals of the TMDL are shown in Table 3. The TMDL accounts for waste load allocations (WLA) from permitted point sources and load allocations (LA) from nonpoint sources. The TMDL includes a margin of safety (MOS) to account for uncertainty in the TMDL process. The TMDL is expressed as, TMDL = ΣWLA + ΣLA + MOS (9).

Table 3: ***TMDL Endpoints for Applicable Water Quality Criteria***

Water Quality Criterion	Designated Use	Criterion Value	TMDL Endpoint
Total Iron	Aquatic life, warm water fisheries	1.5 mg/L (4-day average)	1.425 mg/L (4-day average)
Dissolved Aluminum	Aquatic life, trout waters	0.087 mg/L (4-day average)	0.0827 mg/L (4-day average)

TMDL Endpoints are used to establish the TMDL and are based on water quality standard 47 CSR, Series 2, Legislative Rules, Department of Environmental Protection: Requirements Governing Water Quality Standards (7).

2.1 WLAs – permitted sources of pollution

Wasteload allocations are for specific point sources, which require National Pollutant Discharge Elimination System (NPDES) permits. While many of these sites contribute significant amounts of AMD, they are not discussed in detail in this watershed-based plan as the focus is on nonpoint sources, which do not have a responsible party for treatment. FOC expects that WVDEP, through its enforcement branches, will work with permittees to prevent permitted discharges from exceeding wasteload allocations or will address treatment.

Bond Forfeiture Sites

Bond Forfeiture (BF) sites are sites on which the operator did not sufficiently reclaim the land or water after mining. These occur when the operator abandons the property prior to reclamation, or when, due to violations, WVDEP forces operations to cease prior to reclamation. BF sites are considered to be point sources and are assigned wasteload allocations.

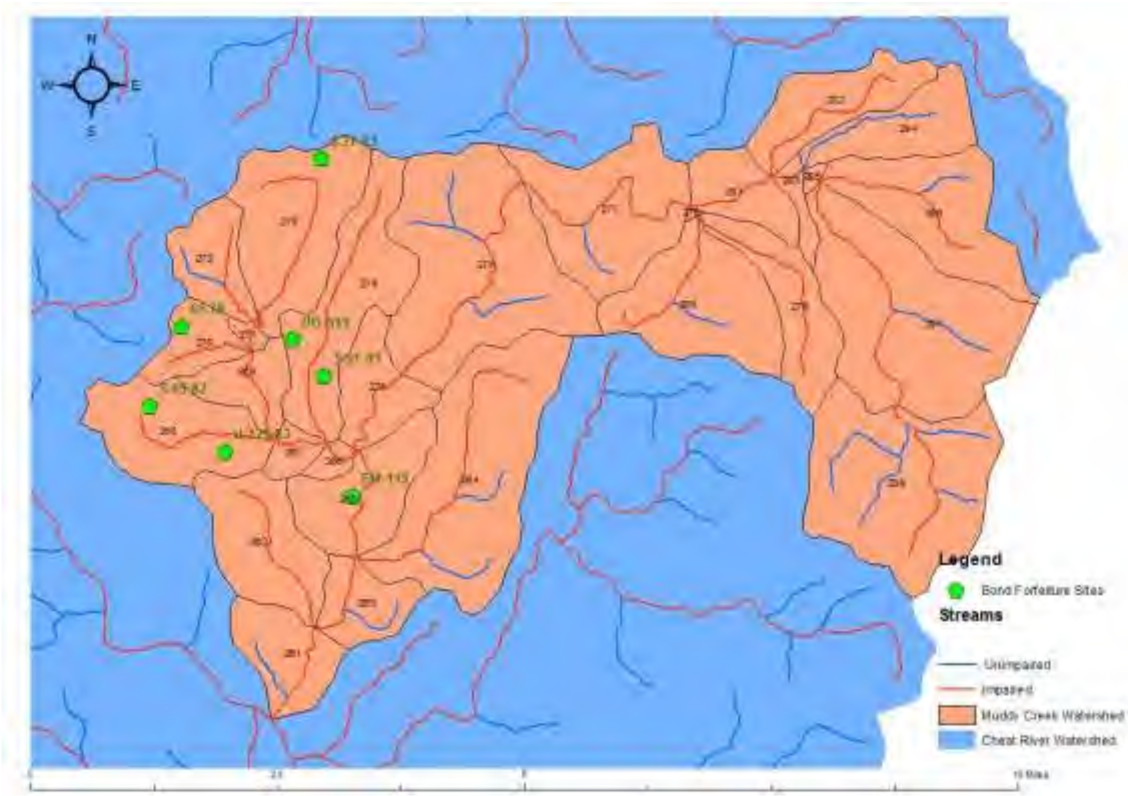
Table 4 lists bond forfeiture sites in the Muddy Creek watershed that have load reduction goals in the TMDL. A GIS database from WVDEP OSR was used to check whether BF sites are meeting the TMDL reduced load goal according to the latest data from 2019, up until the sites were 'turned off' in order to adopt a watershed-scale treatment approach. Most sites complied up until the management strategy change.

Figure 4 shows the bond forfeiture sites in the watershed as of 2019. The results of court decision West Virginia Highlands Conservancy and West Virginia Rivers Coalition vs. Randy Huffman, known as the "The Keeley Decision", requires these bond forfeiture sites to meet effluent limitations set forth in the permitting process. OSR has recently adopted a new treatment approach under their EPA Variance Permit, in which Bond Forfeiture sites have been "turned off" in order to treat pre and post-law mine water on a watershed scale at strategically placed in-stream dosers and the T&T water treatment facility (5) (6). Therefore, this WBP will not provide pricing or restoration plans for these BF sites and will assume that these will meet required reduction or water quality parameters are within the standards set forth by the variance permit issued by the EPA (5) (6).

***Table 4:* Bond Forfeiture Site from 2011 Cheat River TMDL and OSR Database in the Muddy Creek Watershed**

Stream Code	Stream Name	SWS	NPDES Permit	Permit ID	Metal	Baseline Load (lbs/yr)	Reduced Load (lbs/yr)	Data Source	Status
WV-MC-39	Muddy Creek	265	Un-operational	EM-113	Aluminum	45	45.07	TMDL	Inactive
					Iron	111	51.96		
WV-MC-39-E	Martin Creek	268	WV0099139	S-65-82	Aluminum	2,796	1,426.48	TMDL	Inactive
					Iron	6,879	3,224.57		
WV-MC-39-E	Martin Creek	268	WV0099163	U-125-83	Aluminum	126	64.42	TMDL	Inactive
					Iron	311	145.63		
WV-MC-39-E-2-A	UNT/Glade Run RM 1.06	270	Un-operational	65-78	Aluminum	1,308	667.20	TMDL	Inactive
					Iron	3,218	1,508.23		
WV-MC-39-E-2	Glade Run	273	Un-operational	S-27-83	Aluminum	72	72.14	TMDL	Inactive
					Iron	177	83.20		
WV-MC-39-E-1	Fickey Run	274	WV0098442	S-91-85	Aluminum	451	450.82	TMDL	Inactive
						1,109	519.93		
WV-MC-39-E-1	Fickey Run	274	WV0091766	UO-519	Aluminum	99	99.18	TMDL	Inactive
					Iron	244	114.38		

***Figure 4:* Bond Forfeiture Site within the Muddy Creek Watershed**



Active mining permits

Other point sources include active mining permits with NPDES permits (Table 5). There are no non-mining NPDES permits present in Muddy Creek.

***Table 5:* Active Mining Permits from 2011 Cheat River Basin TMDL**

Stream Code	Stream Name	Metal	SWS	PERMIT	Baseline Load (lbs/yr)	Allocated Load (lbs/yr)
WV-MC-39-E-1	Fickey Run	Aluminum	274	WV0063576	1337	682
		Iron	274	WV0063576	3292	1543
WV-MC-39	Muddy Creek	Aluminum	288	WV0119113	342	342
		Iron	288	WV0119113	841	841

T&T Muddy Creek in-stream dosing

WVDEP's OSR has adopted a new approach to treatment in the Muddy Creek Watershed, collecting and treating pre and post-law mine water and treating in-stream at a strategically placed hydrated lime-slurry doser in the Glade Run watershed, with the expectation that water quality at the Mouth of Martin Creek will meet relaxed water quality criteria for pH, Fe, and Al due to the in-stream treatment in the headwaters (5) (6), and that even though these criteria will be relaxed, they will still be stringent enough to prevent the remaining length of Muddy Creek from violating standards. In addition to the Glade Run doser, OSR has constructed an extensive facility (T&T Water Treatment Plant) along Route 26 to collect and treat pre and post-law water from BF Site EM-113 and AML Discharges MC39-100-1 and MC39-350-1. The T&T Water Treatment Plant also collects and treats pre and post law mine water from Fickey Run via an underground pipeline and lift station, deemed one of the worst AMD impaired tributaries in the state of West Virginia. In order to treat on a watershed scale, OSR proposed a USEPA NPDES Variance Permit (5) (6). The compliance point is at the mouth of Martin Creek, where it discharges into Muddy Creek. In order to be in compliance with the variance permit water quality standards must be as follows (5) (6):

***Table 6:* Water Quality Parameters for Compliance with USEPA Variance Permit at Martin Mouth**

Impairment	Water Quality Parameters for Variance Permit Compliance	Water Quality Standards for warm water fisheries and aquatic life
pH	3.2 – 9.0	6.0 – 9.0
Total Iron	10 mg/L	1.5 mg/L
Dissolved Aluminum	15 mg/L	0.75 mg/L

FOC has deemed most AML discharges that fall within the Glade, Martin, and Fickey watershed to be of low priority, as they are being captured and treated by the in-stream doser in Glade Run or by the Fickey Pipeline. In turn, FOC has chosen to treat select sources within the Martin Creek, Glade Run, and Fickey Run watersheds that are economically feasible, have site conditions amenable to constructing a passive treatment system, are not currently being treated to water quality standards, and would significantly improve water quality received into Muddy Creek.

FOC has been collecting water quality at the mouth of Martin Creek, in conjunction with WVDEP OSR. The results of water quality sampling from 2019 are as follows:

***Table 7:* Water Quality Sampling Results for the mouth of Martin Creek, 2019**

Site Name	Sample Date	GPM	Field pH	Acidity (mg/L)	T-Fe (mg/L)	T-Al (mg/L)	Sampled By:	conv	d (cfs)	f	T-Al Load (lbs/yr)	T-Fe Load (lbs/yr)
Martin Mouth	4/26/2019	6,373.18	6.11	9.76	1.92	5.56	FOC	0.002228	14.199445	5.39	15,5320.15	53,635.73
Martin Mouth	5/16/2019	11,248.72	5.46	8.42	0.213	0.174	FOC	0.002228	25.062148	5.39	8,579.25	10,502.18
Martin Mouth	7/10/2019	13,499.45	6.04	5.13	1.51	3.49	FOC	0.002228	30.076786	5.39	206,508.76	89,349.06
Martin Mouth	8/21/2019	3,279.36	5.27	8	0.91	3.53	OSR	0.002228	7.3064141	5.39	50,741.19	13,080.59
Martin Mouth	9/17/2019	986.048	6.07	27	0.92	4.11	OSR	0.002228	2.1969149	5.39	17,763.83	3,976.33
Martin Mouth	10/21/2019	818.94	5.33	47	1.36	5.63	OSR	0.002228	1.8246072	5.39	20,209.68	4,881.91
Martin Mouth	11/18/2019	1,745.40	5.18	30	3.39	9.89	OSR	0.002228	3.888769	5.39	75,664.13	25,935.43
T: total												
Average											**76,398.14**	**28,765.89**

Based on the data above, the new approach to treatment is meeting the variance permit water quality parameters for compliance and is often close to established West Virginia Water Quality Criterion. However, the above sampling shows that even with these treatments in place, Martin Creek (the current largest contributor to acidity, Aluminum, and Iron to Muddy Creek) still does not meet water quality standards and contributes to the impairment of Muddy Creek mainstem downstream of the confluence with Martin Creek.

FOC averaged the above data to create a 2019 load for Total Aluminum and Total Iron and compared it to the 2010 Baseline Load Allocation and the TMDL for Martin Creek. Even with the reduction from 2019 OSR treatment, there are still 65,156 lbs/yr Aluminum and 30,140 lbs/yr Iron that would need to be reduced before Martin Creek met its Baseline Load Allocation. Thus, FOC has targeted to seeps identified below and in this WBP in order to reduce loads in Martin Creek and ultimately improve water quality in Muddy Creek mainstem downstream of the confluence with Martin

Creek. The below table illustrates the need for additional AMD restoration work in the Martin Creek watershed in order to meet TMDLs and reduce impairment to Muddy Creek mainstem:

Table 8: ***Comparative Aluminum and Iron Loads (lbs/yr) for Martin Creek and current and prospective treatment load reductions***

TMDL Watershed	Stream Name	Metal	SWS	Discharge Number	Baseline Load (lbs/yr)	Reduced Load (lbs/yr)	% Reduction	Martin Ck 2010 Baseline LA (lbs/yr)	Martin Ck 2010 TMDL (lbs/yr)	Martin Ck 2019 Load Average (lbs/yr)	Reduction from OSR Treatment	Remaining treatment needed to meet TMDL	Loads Proposed Removed from tmt of WBP seeps (lbs/yr)
Muddy Creek	**Martin Creek**	**Al**						190,697	11,242	76,398	114,299	65,156	92,299
Muddy Creek	UNT/Glade Run RM 1.36	Al	272	MC39E2-200-1	821	16	98						
Muddy Creek	UNT/Glade Run RM 1.36	Al	272	MC39E2-200-2	22,005	521	98						
Muddy Creek	Glade Run	Al	273	MC39E2-350-10	4,946	133	97						
Muddy Creek	Glade Run	Al	273	MC39E2-350-2	9,941	263	97						
Muddy Creek	Glade Run	Al	273	MC39E2-350-9	13,566	204	98						
Muddy Creek	Fickey Run	Al	274	MC39E1-100-2	32,173	654	98						
Muddy Creek	Fickey Run	Al	274	MC39E1-200-1	8,847	766	91						
Muddy Creek	**Martin Creek**	**Fe**						237,939	24,640	28,765	209,174	4,125	30,140
Muddy Creek	UNT/Glade Run RM 1.36	Fe	272	MC39E2-200-1	148	22	85						
Muddy Creek	UNT/Glade Run RM 1.36	Fe	272	MC39E2-200-2	1,538	695	55						
Muddy Creek	Glade Run	Fe	273	MC39E2-350-10	1,679	177	89						
Muddy Creek	Glade Run	Fe	273	MC39E2-350-2	10,359	351	97						
Muddy Creek	Glade Run	Fe	273	MC39E2-350-9	3,029	271	91						
Muddy Creek	Fickey Run	Fe	274	MC39E1-100-2	9,418	872	91						
Muddy Creek	Fickey Run	Fe	274	MC39E1-200-1	3,969	1,021	74						

2.2 Nonpoint source impairments

The model used to develop the 2011 Cheat River Basin TMDL considers land use and known features in order to estimate the pH, Al, and Fe runoff from nonpoint sources like abandoned mines, harvested forest, oil and gas, barren land, urban areas, and roads. "Other nonpoint sources" and stream bank erosion are also considered in the total baseline load but excluded in the TMDL calculations of required load reduction (9).

According to the 2011 Cheat River Basin TMDL load allocations spreadsheet, the acidity, Fe, and Al loads from abandoned mines comprise the highest percentage of the nonpoint source baseline load of Fe and Al (other than the aforementioned "other nonpoint sources" and stream bank erosion) and require the highest reductions. Therefore, this watershed-based plan aims to accomplish the total required reduction from AMLs in the stream as set by the 2011 Cheat Basin TMDL in order to remove the stream from the 303(d) list. This plan will only accomplish the load allocation for abandoned mine lands as set by the TMDL. Any remaining impairment will be addressed by a second phase of restoration to be guided with a new WBP focusing on fecal coliforms, sediment, stream bank protection, and other types of measures.

Abandoned mine lands

FOC assessed the 2011 Cheat River Basin TMDL as well as the FOC database in order to form the following list of all known seeps in the Muddy Creek watershed (Table 9). The baseline load and reduced loads are from the 2011 Cheat River Basin TMDL. The required reduction was calculated using the baseline load and reduced load (9). If the seeps were not listed on the 2011 Cheat River Basin TMDL, the baseline load was calculated from FOC data and the required reduction is listed as 100%. Appendix B displays maps of each SWS watershed and known TMDL AMD sources.

*Table 9: **Causes and Sources of Impairment from Abandoned Mine Lands in Muddy Creek Watershed***

WV NHD Stream Code	Stream Name	SWS	Seep Name	Metal	Baseline Load (lbs/yr)	Reduced Load (lbs/yr)	Required Reduction (lbs/yr)
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-1	Al	4,778	63	4,715
				Fe	5,624	84	5,540
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-2	Al	32,173	654	31,519
				Fe	9,418	872	8,546
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-3	Al	2,621	40	2,581
				Fe	2,443	53	2,390
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-4	Al	3,277	49	3,228
				Fe	3,054	66	2,988
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-5	Al	434	20	414
				Fe	87	27	60
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-6	Al	4	4	0
				Fe	20	9	11
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-7	Al	15	7	8
				Fe	344	9	335
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-8	Al	77	7	70
				Fe	104	9	95
WV-MC-39-E-1	Fickey Run	274	MC39E1-200-1	Al	8,847	766	8,081
				Fe	3,969	1,021	2,948
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-1	Al	1,920	44	1,876
				Fe	13,392	59	13,333
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-2	Al	20,360	110	20,250
				Fe	123,278	147	123,131
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-3	Al	2,237	59	2,178
				Fe	2,331	79	2,252
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-4	Al	2,609	69	2,540
				Fe	2,719	92	2,627
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-5	Al	1,243	33	1,210
				Fe	1,295	44	1,251
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-6	Al	1,864	49	1,815
				Fe	1,942	66	1,876
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-7	Al	2,458	66	2,392
				Fe	7,023	88	6,935
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-8	Al	1,119	99	1,020
				Fe	7,966	132	7,834
WV-MC-39-E-2	Glade Run	269	MC39E2-100-1	Al	6,053	329	5,724
				Fe	944	439	505
WV-MC-39-E-2	Glade Run	269	MC39E2-100-2	Al	1,663	58	1,605
				Fe	81	77	4
WV-MC-27-J-6-D	Glade Run	271	MC39E2-175-1	Al	6,437	130	6,307
				Fe	1,069	174	895
WV-MC-39-E-2	Glade Run	273	MC39E2-300-1	Al	3,927	49	3,878
				Fe	1,832	66	1,766
WV-MC-39-E-2	Glade Run	273	MC39E2-300-2	Al	2,462	99	2,363
				Fe	527	132	395
WV-MC-39-E-2	Glade Run	273	MC39E2-310-1	Al	280	79	201
				Fe	1,348	105	1,243
WV-MC-39-E-2	Glade Run	273	MC39E2-350-1	Al	7,698	60	7,638
				Fe	962	80	882

WV-MC-39-E-2	Glade Run	273	MC39E2-350-10	Al	4,946	133	4,813
				Fe	1,679	177	1,502
WV-MC-39-E-2	Glade Run	273	MC39E2-350-2	Al	9,941	263	9,678
				Fe	10,359	351	10,008
WV-MC-39-E-2	Glade Run	273	MC39E2-350-3	Al	4,506	99	4,407
				Fe	1,297	132	1,165
WV-MC-39-E-2	Glade Run	273	MC39E2-350-4	Al	70	20	50
				Fe	337	26	311
WV-MC-39-E-2	Glade Run	273	MC39E2-350-5	Al	0	0	0
				Fe	2	1	1
WV-MC-39-E-2	Glade Run	273	MC39E2-350-6	Al	40	16	24
				Fe	979	22	957
WV-MC-39-E-2	Glade Run	273	MC39E2-350-7	Al	111	86	25
				Fe	249	114	135
WV-MC-39-E-2	Glade Run	273	MC39E2-350-8	Al	1,412	79	1,333
				Fe	117	105	12
WV-MC-39-E-2	Glade Run	273	MC39E2-350-9	Al	13,566	204	13,362
				Fe	3,029	271	2,758
WV-MC-39-E	Martin Creek	266	MC39E-100-7	Al	163	46	117
				Fe	787	61	726
WV-MC-39-E	Martin Creek	268	MC39E-100-1	Al	441	105	336
				Fe	139	139	0
WV-MC-39-E	Martin Creek	268	MC39E-100-10	Al	294	13	281
				Fe	24	18	6
WV-MC-39-E	Martin Creek	268	MC39E-100-11	Al	241	10	231
				Fe	83	13	70
WV-MC-39-E	Martin Creek	268	MC39E-100-12	Al	1,095	33	1,062
				Fe	469	44	425
WV-MC-39-E	Martin Creek	268	MC39E-100-13	Al	1,184	40	1,144
				Fe	1,337	53	1,284
WV-MC-39-E	Martin Creek	268	MC39E-100-14	Al	803	33	770
				Fe	277	44	233
WV-MC-39-E	Martin Creek	268	MC39E-100-2	Al	674	82	592
				Fe	109	109	0
WV-MC-39-E	Martin Creek	268	MC39E-100-3	Al	579	5	574
				Fe	78	7	71
WV-MC-39-E	Martin Creek	268	MC39E-100-4	Al	217	49	168
				Fe	1,462	66	1,396
WV-MC-39-E	Martin Creek	268	MC39E-100-5	Al	2,534	85	2,449
				Fe	519	114	405
WV-MC-39-E	Martin Creek	268	MC39E-100-6	Al	555	23	532
				Fe	191	30	161
WV-MC-39-E	Martin Creek	268	MC39E-100-7	Al	6,814	444	6,370
				Fe	676	593	83
WV-MC-39-E	Martin Creek	268	MC39E-100-8	Al	117	29	88
				Fe	365	39	326
WV-MC-39-E	Martin Creek	268	MC39E-100-9	Al	441	105	336
				Fe	139	139	0
WV-MC-39	Muddy Creek	265	MC39-100-1	Al	55,178	1,586	53,592
				Fe	164,489	2,115	162,374
WV-MC-39	Muddy Creek	265	MC39-350-1	Al	11,902	2,031	9,871
				Fe	26,513	2,708	23,805
WV-MC-39	Muddy Creek	275	MC39-200-1	Al	16,410	199	16,211

				Fe	16,447	266	16,181
WV-MC-39	Muddy Creek	275	MC39-200-2	Al	14,345	146	14,199
				Fe	20,242	195	20,047
WV-MC-39	Muddy Creek	275	MC39-200-3	Al	3,125	579	2,546
				Fe	394	394	0
WV-MC-39	Muddy Creek	277	MC39-300-1	Al	1	1	0
				Fe	290	26	264
WV-MC-39	Muddy Creek	277	MC39-300-2	Al	3,338	206	3,132
				Fe	233	233	0
WV-MC-39-B	Sypolt Run	262	MC39-050-1	Al	8	8	0
				Fe	3,280	58	3,222
WV-MC-39-E-2-B	UNT/Glade Run RM 1.36	272	MC39E2-200-1	Al	821	16	805
				Fe	148	22	126
WV-MC-39-E-2-B	UNT/Glade Run RM 1.36	272	MC39E2-200-2	Al	22,005	521	21,484
				Fe	1,538	695	843

3. Expected Load Reductions

Load reductions, or "required reductions" are an estimate of how much of the current pollutant load must be removed in order for the pollutant loads to meet the load allocations set by the TMDL for the Cheat River watershed.

The required reductions for the seeps in the impaired SWSs are set by the 2011 Cheat River Basin TMDL to eliminate the excess load in that SWS. Therefore, load reduction goals are set by the load reductions of each seep on the TMDL and expected load reductions are listed for each seep and summed for each SWS in Table 10 and Table 11. Priority Sites are highlighted in yellow.

It is important to note that according to FOC's water quality data several SWSs in the Muddy Creek Watershed met water quality standards despite being classified as 'Impaired' in WVDEP's Integrated Report for pH, Fe, Al. The perceived improvement in water quality may be due to FOC treatment sites in the watershed, or the fact that some of the SWSs were modeled for impairment without physical data, or several years have passed since the most recent state sample event that provided data for the TMDL. Data were collected between 2006 and 2007 for the SWSs of Muddy Creek for the 2011 Cheat River Basin TMDL, allowing the possibility of changes in water quality conditions since 2007. FOC data was collected in key subwatersheds from 2016 – 2019, several of which revealed to be non-impaired based on FOC findings (see Table 12).

No reductions are planned for SWS's where mouth data collected by FOC showed that water quality standards were met specifically for Fe, Al, and pH. However, FOC plans to work with the WVDEP Watershed Improvement Branch (WIB) and WVDEP Watershed Assessment Branch (WAB) to develop a plan in order to continue to assess for future listing decisions for SWSs of Muddy Creek by WVDEP in regard to Fe, Al, and pH.

Treatment at each source is sized to reduce 100% of dissolved Al and total Fe for seeps for which FOC was able to gather water quality data. Proposed treatment measures are sized to remove 100% of total Fe and total Al for seeps for which FOC was not able to gather water data, because the TMDL data that are available for each seep only list total Al. Treatment to remove 100% of total Al will remove 100% of dissolved Al to meet WV's water quality standards.

2011 Cheat River Basin TMDL states, "TMDLs for pH impairments were developed using a surrogate approach where it was assumed that reducing instream metal (iron and aluminum) concentrations allows for attainment of pH water quality criteria" (9). This watershed based plan outlines plans to treat to the required reduction of metals set by 2011 Cheat River Basin TMDL, with the understanding that this will also treat the pH.

*Table 10: **Dissolved Aluminum Allocations, reductions required, and reductions achieved***

WV NHD Stream Code	Stream Name	SWS	Discharge Number	Required Reduction of Seep (lbs/yr) as listed in TMDL	Reduction of Seeps (lbs/yr) from Management Measures	% Reduction	Notes
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-1	4,715	0	No Reduction Planned	Zone of No Recovery
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-2	31,519	31,519	Priority Site, Treated 100%	
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-3	2,581	0	No Reduction Planned	Zone of No Recovery
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-4	3,228	0	No Reduction Planned	Zone of No Recovery
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-5	414	0	No Reduction Planned	Zone of No Recovery
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-6	0	0	Low Priority, No Reduction Planned	
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-7	8	0	Low Priority, No Reduction Planned	
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-8	70	0	No Reduction Planned	Zone of No Recovery
WV-MC-39-E-1	Fickey Run	274	MC39E1-200-1	8,081	8,081	Priority Site, Treated 100%	
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-1	1,876	1,876	Treated 100%	Captured by Fickey Pipeline
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-2	20,250	20,250	Treated 100%	Captured by Fickey Pipeline
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-3	2,178	2,178	Treated 100%	Captured by Fickey Pipeline
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-4	2,540	2,540	Treated 100%	Captured by Fickey Pipeline
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-5	1,210	0	No Reduction Planned	Zone of No Recovery
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-6	1,815	0	No Reduction Planned	Zone of No Recovery
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-7	2,392	2,392	Treated 100%	Captured by Fickey Pipeline
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-8	1,020	1,020	Treated 100%	Captured by Fickey Pipeline
WV-MC-39-E-1	**Fickey Run**	**274**	**TOTAL**	**83,897**	**69,856**	**83.2%**	
			Baseline Load	**86,172**	**69,856**	**81.%**	
WV-MC-39-E-2	Glade Run	269	MC39E2-100-1	5,724	0	No Reduction Planned	Zone of No Recovery
WV-MC-39-E-2	Glade Run	269	MC39E2-100-2	1,605	0	No Reduction Planned	Zone of No Recovery
WV-MC-39-E-2	**Glade Run**	**269**	**TOTAL**	**7,329**	**0**	**0%**	
			Baseline Load	**7,797**	**0**	**0%**	
WV-MC-27-J-6-D	Glade Run	271	MC39E2-175-1	6,307	6,307	Treated 100%	Treated by OSR Glade Run In-stream Doser
WV-MC-27-J-6-D	**Glade Run**	**271**	**Total**	**6,307**	**6,307**	**100%**	
			Baseline Load	**6,462**	**6,307**	**97.6%**	
WV-MC-39-E-2	Glade Run	273	MC39E2-300-1	3,878	3,878	Treated 100%	Treated by OSR Glade Run In-stream Doser

WV-MC-39-E-2	Glade Run	273	MC39E2-300-2	2,363	2,363	Treated 100%	Treated by OSR Glade Run In-stream Doser
WV-MC-39-E-2	Glade Run	273	MC39E2-310-1	201	201	Treated 100%	Treated by OSR Glade Run In-stream Doser
WV-MC-39-E-2	Glade Run	273	MC39E2-350-1	7,638	7,638	Treated 100%	Treated by OSR Glade Run In-stream Doser
WV-MC-39-E-2	Glade Run	273	MC39E2-350-10	4,813	4,813	Priority Site, Treated 100%	FOC 'Allen Connor Messenger' Treatment Site
WV-MC-39-E-2	Glade Run	273	MC39E2-350-2	9,678	9,678	Priority Site, Treated 100%	FOC 'Allen Connor Messenger' Treatment Site
WV-MC-39-E-2	Glade Run	273	MC39E2-350-3	4,407	4,407	Treated 100%	Treated by OSR Glade Run In-stream Doser
WV-MC-39-E-2	Glade Run	273	MC39E2-350-4	50	50	Treated 100%	Treated by OSR Glade Run In-stream Doser
WV-MC-39-E-2	Glade Run	273	MC39E2-350-5	0	0	Treated 100%	Treated by OSR Glade Run In-stream Doser
WV-MC-39-E-2	Glade Run	273	MC39E2-350-6	24	24	Treated 100%	Treated by OSR Glade Run In-stream Doser
WV-MC-39-E-2	Glade Run	273	MC39E2-350-7	25	25	Treated 100%	Treated by OSR Glade Run In-stream Doser
WV-MC-39-E-2	Glade Run	273	MC39E2-350-8	1,333	1,333	Treated 100%	Treated by OSR Glade Run In-stream Doser
WV-MC-39-E-2	Glade Run	273	MC39E2-350-9	13,362	13,362	Priority Site, Treated 100%	FOC 'Allen Connor Messenger' Treatment Site
WV-MC-39-E-2	**Glade Run**	**273**	**TOTAL**	**47,772**	**47,772**	**100%**	
			Baseline Load	**49,059**	**47,772**	**97.3%**	
WV-MC-39-E	Martin Creek	266	MC39E-100-7	117	117	Treated 100%	Addressed by OSR Glade Creek In-stream Doser
WV-MC-39-E	**Martin Creek**	**266**	**TOTAL**	**117**	**117**	**Treated 100%**	
			Baseline Load	**755**	**117**	**15.4%**	
WV-MC-39	Muddy Creek	265	MC39-100-1	53,592	53,592	Treated 100%	Treated by OSR T&T Water Treatment Plant
WV-MC-39	Muddy Creek	265	MC39-350-1	9,871	9,871	Treated 100%	Treated by OSR T&T Water Treatment Plant
WV-MC-39	**Muddy Creek**	**265**	**TOTAL**	**63,463**	**63,463**	**100%**	
			Baseline Load	**68,772**	**68,463**	**92.2%**	
WV-MC-39-E	Martin Creek	268	MC39E-100-1	336	336	Treated 100%	Addressed by OSR Glade Run

							In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-10	281	281	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-11	231	231	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-12	1,062	1,062	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-13	1,144	1,144	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-14	770	770	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-2	592	592	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-3	574	574	Treated 100%	Addressed by OSR Glad Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-4	168	168	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-5	2,449	2,449	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-6	532	532	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-7	6,370	6,370	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-8	88	88	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-9	336	336	Treated 100%	In-stream Doser
WV-MC-39-E	**Martin Creek**	**268**	**TOTAL**	**14,933**	**14,933**	**100%**	
			Baseline Load	**15,644**	**14,933**	**95.4%**	
WV-MC-39	Muddy Creek	275	MC39-200-1	16,211	16,211	Priority Site, Treated 100%	FOC 'Dream Mountain Improvements' Project

WV-MC-39	Muddy Creek	275	MC39-200-2	14,199	14,199	Priority Site, Treated 100%	FOC 'Dream Mountain Improvements' Project
WV-MC-39	Muddy Creek	275	MC39-200-3	2,546	0	No Reduction Planned	Sampled by FOC, within water quality parameters
WV-MC-39	**Muddy Creek**	**275**	**TOTAL**	**32,956**	**30,410**	**92.2%**	
			Baseline Load	**35,500**	**30,410**	**85.6%**	
WV-MC-39	Muddy Creek	277	MC39-300-1	0	0	Treated 100%	FOC 'Upper Muddy Schwab' Project
WV-MC-39	Muddy Creek	277	MC39-300-2	3,132	3,132	Treated 100%	FOC 'Upper Muddy Schwab' Project
WV-MC-39	**Muddy Creek**	**277**	**TOTAL**	**3,132**	**3,132**	**100%**	
			Baseline Load	**3,474**	**3,132**	**90.1%**	
WV-MC-39-B	Sypolt Run	262	MC39-050-1	0	0	No Treatment Planned	Low Priority Site
WV-MC-39-B	**Sypolt Run**	**262**	**TOTAL**	**0**	**0**	**100%**	
			Baseline Load	**174**	**0**	**0%**	
WV-MC-39-E-2-B	UNT/Glade Run RM 1.36	272	MC39E2-200-1	8,05	805	Priority Site, Treated 100%	FOC 'Gary Connor' Treatment Site
WV-MC-39-E-2-B	UNT/Glade Run RM 1.36	272	MC39E2-200-2	21,484	21,482	Priority Site, Treated 100%	FOC 'Gary Connor' Treatment Site
WV-MC-39-E-2-B	**UNT/Glade Run RM 1.36**	**272**	**TOTAL**	**22,289**	**22,287**	**100%**	
			Baseline Load	**22,879**	**22,287**	**97.4%**	
	Muddy Creek Watershed		**TOTAL**	**282,195**	**258,277**	**91.5%**	

*Table 11: **Total Iron Allocations, reductions required, and reductions achieved***

WV NHD Stream Code	Stream Name	SWS	Discharge Number	Required Reduction of Seep (lbs/yr) as listed in TMDL	Reduction of Seeps (lbs/yr) from Management Measures	% Reduction	Notes
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-1	5,540	0	No Reduction Planned	Zone of No Recovery
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-2	8,546	8,546	Priority Site, Treated 100%	
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-3	2,390	0	No Reduction Planned	Zone of No Recovery
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-4	2,988	0	No Reduction Planned	Zone of No Recovery
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-5	60	0	No Reduction Planned	Zone of No Recovery
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-6	11	11	Low Priority, No Reduction Planned	
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-7	335	335	Low Priority, No Reduction Planned	
WV-MC-39-E-1	Fickey Run	274	MC39E1-100-8	95	95	No Reduction Planned	Zone of No Recovery
WV-MC-39-E-1	Fickey Run	274	MC39E1-200-1	2,948	2,948	Priority Site, Treated 100%	
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-1	13,333	13,333	Treated 100%	Captured by Fickey Pipeline
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-2	123,131	123,131	Treated 100%	Captured by Fickey Pipeline
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-3	2,252	2,252	Treated 100%	Captured by Fickey Pipeline
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-4	2,627	2,627	Treated 100%	Captured by Fickey Pipeline
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-5	1,251	0	No Reduction Planned	Zone of No Recovery
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-6	1,815	0	No Reduction Planned	Zone of No Recovery
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-7	6,935	6,935	Treated 100%	Captured by Fickey Pipeline
WV-MC-39-E-1	Fickey Run	274	MC39E1-300-8	7,834	7,834	Treated 100%	Captured by Fickey Pipeline
WV-MC-39-E-1	**Fickey Run**	**274**	**TOTAL**	**182,091**	**168,047**	**92.2%**	
			Baseline Load	**185,741**	**168,047**	**90.4%**	
WV-MC-39-E-2	Glade Run	269	MC39E2-100-1	505	0	No Reduction Planned	Zone of No Recovery
WV-MC-39-E-2	Glade Run	269	MC39E2-100-2	4	0	No Reduction Planned	Zone of No Recovery
WV-MC-39-E-2	**Glade Run**	**269**	**TOTAL**	**509**	**0**	**0%**	
			Baseline Load	**1,462**	**0**	**0%**	
WV-MC-27-J-6-D	Glade Run	271	MC39E2-175-1	895	895	Treated 100%	Treated by OSR Glade Run In-stream Doser
WV-MC-27-J-6-D	**Glade Run**	**271**	**TOTAL**	**895**	**895**	**100%**	
			Baseline Load	**1,203**	**895**	**74.3%**	
WV-MC-39-E-2	Glade Run	273	MC39E2-300-1	1,766	1,766	Treated 100%	Treated by OSR Glade Run In-stream Doser

WV-MC-39-E-2	Glade Run	273	MC39E2-300-2	395	395	Treated 100%	Treated by OSR Glade Run In-stream Doser
WV-MC-39-E-2	Glade Run	273	MC39E2-310-1	1,243	1,243	Treated 100%	Treated by OSR Glade Run In-stream Doser
WV-MC-39-E-2	Glade Run	273	MC39E2-350-1	882	882	Treated 100%	Treated by OSR Glade Run In-stream Doser
WV-MC-39-E-2	Glade Run	273	MC39E2-350-10	1,502	1,502	Priority Site, Treated 100%	FOC 'Allen Connor Messenger' Treatment Site
WV-MC-39-E-2	Glade Run	273	MC39E2-350-2	10,008	10,008	Priority Site, Treated 100%	FOC 'Allen Connor Messenger' Treatment Site
WV-MC-39-E-2	Glade Run	273	MC39E2-350-3	4,407	4,407	Treated 100%	Treated by OSR Glade Run In-stream Doser
WV-MC-39-E-2	Glade Run	273	MC39E2-350-4	311	311	Treated 100%	Treated by OSR Glade Run In-stream Doser
WV-MC-39-E-2	Glade Run	273	MC39E2-350-5	1	1	Treated 100%	Treated by OSR Glade Run In-stream Doser
WV-MC-39-E-2	Glade Run	273	MC39E2-350-6	957	957	Treated 100%	Treated by OSR Glade Run In-stream Doser
WV-MC-39-E-2	Glade Run	273	MC39E2-350-7	135	135	Treated 100%	Treated by OSR Glade Run In-stream Doser
WV-MC-39-E-2	Glade Run	273	MC39E2-350-8	12	12	Treated 100%	Treated by OSR Glade Run In-stream Doser
WV-MC-39-E-2	Glade Run	273	MC39E2-350-9	2,758	2,758	Priority Site, Treated 100%	FOC 'Allen Connor Messenger' Treatment Site
WV-MC-39-E-2	**Glade Run**	**273**	**TOTAL**	**24,377**	**24,377**	**100%**	
			Baseline Load	**23,249**	**24,377**	**100.4%**	
WV-MC-39-E	Martin Creek	266	MC39E-100-7	726	726	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	**Martin Creek**	**266**	**TOTAL**	**726**	**726**	**100%**	
			Baseline Load	**3,953**	**726**	**19.8%**	
WV-MC-39	Muddy Creek	265	MC39-100-1	162,374	162,374	Treated 100%	Treated by OSR T&T Water Treatment Plant
WV-MC-39	Muddy Creek	265	MC39-350-1	23,805	23,805	Treated 100%	Treated by OSR T&T Water Treatment Plant
WV-MC-39	**Muddy Creek**	**265**	**TOTAL**	**186,179**	**186,179**	**100%**	
			Baseline Load	**200,057**	**186,179**	**93%**	
WV-MC-39-E	Martin Creek	268	MC39E-100-1	0	0	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-10	6	6	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-11	70	70	Treated 100%	Addressed by OSR Glade Run In-stream Doser

WV-MC-39-E	Martin Creek	268	MC39E-100-12	425	425	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-13	1,284	1,284	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-14	233	233	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-2	0	0	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-3	71	71	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-4	1,396	1,396	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-5	405	405	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-6	161	161	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-7	83	83	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-8	326	326	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	Martin Creek	268	MC39E-100-9	0	0	Treated 100%	Addressed by OSR Glade Run In-stream Doser
WV-MC-39-E	**Martin Creek**	**268**	**TOTAL**	**4,460**	**4,460**	**100%**	
			Baseline Load	**6,248**	**4,460**	**71.3%**	
WV-MC-39	Muddy Creek	275	MC39-200-1	16,181	16,181	Priority Site, Treated 100%	FOC 'Dream Mountain Improvements' Project
WV-MC-39	Muddy Creek	275	MC39-200-2	20,047	20,047	Priority Site, Treated 100%	FOC 'Dream Mountain Improvements' Project
WV-MC-39	Muddy Creek	275	MC39-200-3	0	0	No Reduction Planned	Sampled by FOC, within water quality parameters
WV-MC-39	**Muddy Creek**	**275**	**TOTAL**	**36,228**	**36,228**	**100%**	
			Baseline Load	**45,763**	**36,228**	**79.1%**	
WV-MC-39	Muddy Creek	277	MC39-300-1	264	264	Treated 100%	FOC 'Upper Muddy Schwab' Project
WV-MC-39	Muddy Creek	277	MC39-300-2	0	0	Treated 100%	FOC 'Upper Muddy Schwab' Project
WV-MC-39	**Muddy Creek**	**277**	**TOTAL**	**264**	**264**	**100%**	
			Baseline Load	**1,537**	**264**	**17.1%**	
WV-MC-39-B	Sypolt Run	262	MC39-050-1	3,222	0	No Treatment Planned	Low Priority Site
WV-MC-39-B	**Sypolt Run**	**262**	**TOTAL**	**3,222**	**0**	**0%**	
			Baseline Load	**5,036**	**0**	**0%**	
WV-MC-39-E-2-B	UNT/Glade Run RM 1.36	272	MC39E2-200-1	126	126	Priority Site, Treated 100%	FOC 'Gary Connor' Treatment Site

WV-MC-39-E-2-B	UNT/Glade Run RM 1.36	272	MC39E2-200-2	843	843	Priority Site, Treated 100%	FOC 'Gary Connor' Treatment Site
WV-MC-39-E-2-B	**UNT/Glade Run RM 1.36**	**272**	**TOTAL**	**969**	**969**	**100%**	
			Baseline Load	**1,970**	**969**	**49.1%**	
	Muddy Creek Watershed		**TOTAL**	**439,920**	**422,145**	**95.9%**	

4. Proposed Management Measures

4.1 AMDTreat calculations

AMDTreat (5.0.2 + PHREEQ) was used to estimate cost for each of the AML discharges in the Muddy Creek watershed identified in the 2011 Cheat River Basin TMDL and for which FOC determined reductions were necessary (10). Although the program is capable of designing both active and passive treatment systems, only passive treatment was considered in this plan (Table 12). A more in-depth cost and treatment analysis of each site will occur prior to requesting funds. The purpose of this exercise is to have a general idea of costs associated with treating each seep.

AMDTreat contains default values for various components used in the cost estimations and these default values were used for the purpose of this plan.

Water quality data for each high priority site were obtained from the 2011 Cheat River Basin TMDL report as well as from the FOC Water Quality Database when possible (Appendix A). The flow (discharge) was converted to gallons per minute (GPM) and was input as the *Typical Flow*. The *Typical Flow* was multiplied by a 3x safety factor to estimate the *Design Flow. Total Iron, Total Aluminum, Manganese, pH,* and *Sulfate* were entered into the program. FOC used a weighted averaging spreadsheet tool to create inputs for *Typical Flow, Total Iron, Total Aluminum, Manganese, pH, Alkalinity and Sulfate* in AMDTreat per site. Lab results without corresponding flow data were not included in the average. Data used for input into AMDTreat can be found in the 'AMDTreat Data' tab in the 'Muddy Creek WBP Master Data 9.30.2019 Spreadsheet' Excel File. Seeps MC39-200-1 and MC39-200-2 were not included in this AMDTreat exercise, as FOC has already secured funding for the project. Instead, the actual cost has been entered into Table 13.

4.2 Capital cost estimations

For each AML discharge, a theoretical passive treatment was designed to contain a 100-ft oxic limestone channel, a limestone bed, and a settling pond, with the exception of treatment for SWS 279. FOC believes a Limestone Fines project would be suitable for this site, so FOC only considered cost of limestone needed for acidity neutralization for Capital Cost, which would be 660 tons of limestone for 10 years, equaling $23,114. FOC anticipates partnership with WV DNR for this specific project, as WV Division of Natural Resources (WVDNR) already has an active stream liming program, which is why there is an N/A in place for engineer costs. For all other priority sites, the limestone bed was sized based on the estimated tons of limestone required *based on acidity neutralization*, entered as the estimated tons of limestone *based on tons of limestone entered*. This sizing method ensures the limestone bed maintains a retention time of 16 hours and adequate acidity neutralization capabilities for a 10-year system life. Additionally, a synthetic liner and AMDTreat Piping Costs were included to the capital cost for each limestone bed. Future site assessment may deem a liner unnecessary for individual systems. A settling pond was sized for a 48 hour retention time. A synthetic liner for the settling pond was also included in the cost estimation.

4.3 Other cost estimations

In addition to the oxic limestone channel, limestone bed, and settling pond included in the capital cost estimate, a contingency cost of 10% of the capital cost was added to allow for variable economic fluctuations. Additionally, engineering cost was estimated as 10% of the capital cost for projects between $100,001 - $500,000, and 6% of the capital cost for projects over $500,000.

Ancillary costs are included as a percentage of the estimated capital costs, based on site characterization (Table 12). Sites that are more remote and undeveloped require more ancillary cost than previously established sites. These costs include construction costs such as access road construction, clearing and grubbing, culverts and ditching, fencing and gates, incidental stone, mobilization, piping, regrading and revegetation, sediment control, etc.

***Table 12:* Scheme for calculating ancillary costs, as a percentage of the capital cost of the passive treatment system.**

% of estimated capital	Description
60%	New site; poor access; no AML activity anticipated
50%	Established access; no AML activity anticipated
40%	AML reclamation anticipated or completed
30%	Retrofit/improvements required to an existing treatment system

***Table 13:* Proposed Treatment Costs of High Priority Sites**

Stream	SWS	Discharge	Capital Cost	Ancillary Cost	Contingency Cost	Engineering Cost	Total Cost
Fickey Run	274	MC39E1-100-2	$591,934.00	$236,773.60	$59,193.40	$35,516.04	$923,417.04
Fickey Run	274	MC39E1-200-1	$195,658.00	$78,263.20	$19,565.80	$19,565.80	$313,052.80
Glade Run	273	MC39E2-350-10, MC39E2-350-2, MC39E2-350-9	$462,319.00	$138,695.70	$46,231.90	$46,231.90	$693,478.50
Muddy Creek	275	MC39-200-1, MC39-200-2	$245,600.00	N/A	N/A	$26,000.00	$271,600.00
UNT/Glade Run RM 1.36	272	MC39E2-200-1, MC39E2-200-2	$340,026.00	$102,007.80	$34,002.60	$34,002.60	$510,039.00
SWS 279 – UNT/UNT RM 0.12 MUDDY CREEK RM 9.80	279	No associated discharge	$23,114.00	$11,557.00	$2,311.40	N/A	$36,982.40
Total Treatment Cost for High Priority Sites							**$2,748,569.74**

4.4 Existing treatment sites

Existing FOC treatment sites in the Muddy Creek Watershed include “Gary Connor”, “Allen Connor Messenger”, “Dream Mountain”, and “Upper Muddy Schwab”. While the “Upper Muddy Schwab” site is still functioning to improve water quality, all other sites need site improvements to meet water quality standards at system out. FOC has already secured funding for to treat seeps MC39-200-1 and MC39-200-2, associated with the “Dream Mountain” Passive Treatment site. Seeps MC39E2-350-10, MC39E2-350-2, and MC39E2-350-9, associated with the “Allen Connor Messenger” are not meeting water quality standards and a site improvements project is needed. Site Improvements are also needed for the "Gary Connor" site, which treats seeps MC39E2-200-1 and MC39E2-200-2.

4.5 High Priority treatment implementation areas

Treatment of seeps in the following subwatersheds is planned and prioritized because:

A. The 303(d) list lists these streams as impaired by Fe, dissolved Al, or pH.
B. The TMDL lists required reductions of Fe or dissolved Al from AMLs in these subwatersheds.
C. FOC data supports the stream impairments stated in the 303(d) list.

High Priority seeps selected for treatment have the following characteristics:

A. The landowner is interested in partnership.*
B. The seep is accessible for construction.
C. There is space and topsoil available for construction.
D. The seep flow is significant.
E. The pollutant load from the seep is significant.

*Landowners designated as "interested in partnership" are designated as such because they were open to the discussion of treatment. We did not go any further with developing partnership, because often the landowners expect a big project to be completed quickly and it can take much longer than they anticipate. Also communications about projects is difficult when there is Monitoring Coordinator/Project Manager turnover at FOC. It has been most successful to maintain communication, but to develop the partnership relationship closer to the start of the project.

Fickey Run – SWS 274

Fickey Run is considered one of, if not the most impaired stream in West Virginia for acid mine drainage impairments. While treating every source of AMD in the Fickey Run watershed due to ownership, loads, and complexity of the sites is not currently feasible, FOC has targeted specific sources in this plan to treat in order to reduce the loads, and improve water quality to receiving streams, Martin Creek and Muddy Creek. In Tables 10 and 11 many seeps are listed with 0% treatment, with the explanation that they are in the 'Sacrificial Zone.' Because of complexity and sheer concentrations of pollutant loads in Fickey Run, Martin Creek, and Glade Run, full restoration is not currently feasible based on monetary and technological constraints. Instead, a new approach focuses on targeting specific sources of AMD that can have positive impacts on water quality to the receiving Muddy Creek main stem. When funding mechanisms improve and technologies advance for AMD treatment, FOC will propose to complete a Martin Creek WBP (including Martin Creek, Fickey Run, and Glade Run) to fully restore these heavily impacted tributaries. At this time, partial treatment of these tributaries can still result in Muddy Creek meeting water quality standards for AMD-related pollutants, and FOC's current goal is the restoration of Muddy Creek.

MC39E1-100-2

MC39E1-100-2 is a seep located in Fickey Run, but at this time is not collected in the Fickey Run Pipeline. The water from this seep drains into Fickey Run, and eventually Martin Creek. At this time the OSR Glade Run Doser is treating at high alkalinity in order to neutralize the acidity Martin Creek still receives from its own headwaters and Fickey Run, with pH at times as high as 10.00 to assure the pH is between 6.0 and 9.0 at the mouth of Martin Creek. If FOC develops treatment sites at key upstream locations, improved water quality will result in less drastic changes in pH as the water from the site reaches impacted stream reaches and therefore improve water quality in-stream and downstream. MC39E1-100-2 has the highest aluminum and iron loads in the Fickey Run watershed that is not currently being captured by the Fickey Run Pipeline, is accessible and is on non-residential property. Thus, MC39E1-100-2 is a high priority site for FOC.

MC39E1-200-1

MC39E1 is a seep located in Fickey Run, but at this time is not collected in the Fickey Run Pipeline. The water from this seep drains into Fickey Run, and eventually Martin Creek. At this time the OSR Glade Run Doser is treating at high alkalinity in order to neutralize the acidity Martin Creek still receives from its own headwaters and Fickey Run, with the in-stream pH at times as high as 10.00 to assure the pH is between 6.0 and 9.0 at the mouth of Martin Creek. . If FOC develops treatment sites at key upstream locations, improved water quality will result in less drastic changes in pH as the water from the site reaches impacted stream reaches and therefore improve water quality in-stream and downstream. MC39E1-200-1 has the second highest aluminum loads and fourth highest iron loads in the Fickey Run watershed that is not currently being captured by the Fickey Run Pipeline, is accessible and is on non-residential property. Thus, MC39E1-200-1 is a high priority site for FOC.

Glade Run – SWS 273

Glade Run is heavily impaired by acid mine drainage. While treating every source of AMD in the Glade Run watershed due to ownership, loads, and complexity of the sites is not currently feasible, FOC has targeted specific sources in this plan to treat in order to reduce the loads, and improve water quality to receiving streams, Martin Creek and Muddy Creek. In Tables 10 and 11 many seeps are listed with 0% treatment, with the explanation that they are in the 'Sacrificial Zone.' Because of complexity and sheer concentrations of pollutant loads in Fickey Run, Martin Creek, and Glade Run, full restoration is not currently feasible based on monetary and technological constraints. Instead, a new approach focuses on targeting specific sources of AMD that can have positive impacts on water quality to the receiving Muddy Creek main stem. When funding mechanisms improve and technologies advance for AMD treatment, FOC will propose to complete a Martin Creek Watershed Based Plan (including Martin Creek, Fickey Run, and Glade Run) to fully restore these heavily impacted tributaries. At this time, partial treatment of these tributaries can still result in Muddy Creek meeting water quality standards for AMD-related pollutants, and FOC's current goal is the restoration of Muddy Creek.

MC39E2-350-10, MC39E2-350-2, MC39E2-350-9

Seeps MC39E2-350-10, MC39E2-350-2, and MC39E2-350-9 are currently collected and treated by FOC's passive AMD treatment site "Allen Connor Messenger." "Allen Connor Messenger" was constructed in 2012 and in need of site improvements in order to fully treat the Aluminum and Iron loads coming from MC39E2-350-10, MC39E2-350-2, and MC39E2-350-9. These seeps also possess some of the highest Al and Fe loads in SWS 273. Because of the high loads, pre-existing site, and amicable landowner relationship FOC considers the rehabilitation of the "Allen Connor Messenger" site and treatment of seeps MC39E2-350-10, MC39E2-350-2 and MC39E2-350-9 a high priority that will result in improved water quality to Glade Run, Martin Creek, and Muddy Creek.

UNT/Glade Run RM 1.36 – SWS 272

UNT/Glade Run RM 1.36 is impaired by two AMD seeps. FOC installed a Passive AMD Treatment Site in 2012 named "Gary Connor", however due to landowner disputes FOC is no longer welcome on the property and is unsure of the status of the treatment site. If the landowner were ever to reconsider or if the property were to ever change hands, FOC considers this to be a priority area in order to improve water quality to Glade Run, Martin Creek, and Muddy Creek.

MC39E2-200-1, MC39E2-200-2

Seeps MC39E2-200-1 and MC39E2-200-2 were treated by the FOC "Gary Connor" Passive AMD Treatment Site. However, due to landowner disputes, FOC is no longer able to access and assess to efficacy of the site. FOC considers the "Gary Connor" site to be a high priority, as treating MC39E2-200-1 and MC39E2-200-2 will result in improved water quality to Glade Run, Martin Creek, and Muddy Creek and because of the existing infrastructure. Because of the extended schedule for the execution of the Muddy Creek WBP, FOC is hopeful landowner relations will change in FOC's favor or the property will change ownership by the time funding is available to rehabilitate the "Gary Connor" site.

Muddy Creek – SWS 275

Muddy Creek upstream of its confluence with Martin Creek has few impairments and holds various species of trout, however seeps MC39-200-1 and MC39-200-2 are significant and must be treated in order to achieve full restoration of Muddy Creek. One lesser seep, MC39-200-3 has been found through FOC sampling to not be a significant source of AMD impairments and thus is not a priority for FOC at this time.

MC39-200-1, MC39-200-2

Seeps MC39-200-1 and MC39-200-2 are currently captured by FOC's Passive AMD Treatment Site "Dream Mountain", however the system is not functioning. A steel slag treatment system was installed in 2010, and the site has proved challenging for steel-slag treatment. FOC secured funding in 2017 to improve the site by removing the steel slag beds and replacing them with a large limestone leach bed and settling pond. FOC recently procured an engineer and is making significant headway to treat seeps MC39-200-1 and MC39-200-2.

SWS 279 - UNT/UNT RM 0.12/MUDDY CREEK RM 9.80

SWS 279 is listed as impaired for pH and Al, although possesses no BF Sites or known seeps. However, FOC has found through sampling that the only impairment present is pH. SWS 279 has been consistently within water quality standards for dissolved aluminum and total iron. pH varies from 4.54 – 4.73. Because of the extensive work from multiple partners to restore Muddy Creek and the fact that the landowner, the Muddy Creek Recreation Club, has invested in improving water quality and fish habitat on the property, FOC believes SWS 279 would benefit from a strategically placed 'Limestone Fines' project to boost the low pH. FOC would partner with WVDNR to secure funding and establish a limestone fines project in SWS 279 in order to address this issue.

Low priority subwatersheds

The TMDL is produced using a model and limited samples, monitoring of which primarily occurred between June 2006 and June 2007. The following streams have measured impairments and/or modeled impairments in the 2014 303(d) list, but FOC analysis at the SWS mouths indicate that the streams actually meet water quality standards for some or all of the listed impairments, or are just above the criteria threshold, and/or have relatively low flows (Table 14). FOC also considers some of the following subwatersheds as 'Low Priority' because they are already being treated by OSR via in-stream dosing or AMD sources in the SWS are being collected and treated at the T&T water treatment facility. Another point to consider is that in-stream loads were considerably higher during TMDL development (2006 – 2007), making it nearly impossible to determine quantitative effects on loads in downstream subwatersheds, such as SWS 261, SWS 263, and SWS 265. Because of the recent restoration efforts, FOC is only considering water quality data from 9/30/2018 to present for particular stretches where extensive sampling has occurred over two decades (see those with an asterisk*). All other data considered were collected from 2010 – 2019. Only SWS 262 and SWS 277 in the below table possess AMD seeps, all other SWSs have required reductions for AMLs but possess no known AMD seeps. Seeps in SWS 277 are treated effectively by FOC's "Upper Muddy Schwab" Passive Treatment site. Table 15 features SWSs in which OSR watershed scale treatment is being adopted for AMD seeps. Table 16 possesses unimpaired and impaired SWSs that were not considered for the purpose of this plan, either due to their lack of impairment, or their relatively small size with no AMD seeps present in the watershed.

*Table 14: **Low Priority Subwatersheds***

WV NHD Stream Code	**Stream Name**	**Impairment**	**SWS**	**Lowest FOC lab pH**	**Highest FOC total Fe (mg/L)**	**Highest FOC dissolved Al (mg/L)**	**Reasoning**
WV-MC-39	Muddy Creek	pH, Fe, Al	261	6.88*	**3.82***	**1.11***	No untreated AMD seeps in this SWS
WV-MC-39-B	Sypolt Run	pH, Fe	262	7.36	**1.84**	**0.821**	pH consistently above 6, Very minimally above WQ standards and considerably low flow
WV-MC-39-D	Crab Orchard Run	Fe	264	7.89*	0.906*	0.352*	Within WQ standards
WV-MC-39	Muddy Creek	pH, Fe, Al	265	7.12	1.47	0.00	Within WQ Standards
WV-MC-39	Muddy Creek	pH, Fe, Al	275	6.77*	1.3*	0.155*	Within WQ standards
WV-MC-39	Muddy Creek	pH, Fe, Al	276	**5.86**	0.13	0.273	One instance of pH below 6, all other instances (9 other sampling efforts) pH above 6
WV-MC-39	Muddy Creek	pH, Fe, Al	277	7.38*	0.286*	0.119*	Within WQ standards
WV-MC-39-I	UNT/Muddy Creek RM 9.80	Fe	280	6.73	0.99	0.157	Within WQ standards
MC-MC-39	Muddy Creek	pH, Al, Fe	281	6.98	0.398	0.0395	Within WQ standards
WV-MC-39-J	Jump Rock Run	pH, Fe, Al	282	7.02*	0.445*	0.0799*	Within WQ standards
WV-MC-39-L	Sugarcamp Run	pH, Al	286	6.98	ND	0.126	Within WQ standards
WV-MC-38	Muddy Creek	pH, Fe, Al	287	7.69	0.227	ND	Within WQ standards
WV-MC-38	Muddy Creek	pH, Fe, Al	288	7.45	0.196	ND	Within WQ standards

ND =Non-detect

*Table 15: **Subwatersheds of Muddy Creek with AMD seeps and OSR Watershed Scale Treatment***

WV NHD Stream Code	Stream Name	Impairment	SWS
WV-MC-39	Muddy Creek	pH, Fe, Al	261
WV-MC-39	Muddy Creek	pH, Fe, Al	263
WV-MC-39	Muddy Creek	pH, Fe, Al	265
WV-MC-39-E	Martin Creek	pH, Fe, Al	266
WV-MC-39-E	Martin Creek	pH, Fe, Al	268
WV-MC-E-2	Glade Run	pH, Fe, Al	269
WV-MC-E-2-A	UNT/Glade Run RM 1.06	pH, Fe, Al	270
WV-MC-E-2	Glade Run	pH, Fe, Al	271
WV-MC-39-E-2-B	UNT/Glade Run RM 1.36	pH, Fe, Al	272
WV-MC-39-E-2	Glade Run	pH, Fe, Al	273
WV-MC-39-E-1	Fickey Run	pH, Fe, Al	274

*Table 16: **Other Subwatersheds of Muddy Creek with no AMD seep source***

WV NHD Stream Code	Stream Name	Impairment	SWS
WV-MC-39	Muddy Creek	pH, Fe, Al	263
WV-MC-39-E	Martin Creek	pH, Fe, Al	267
WV-MC-39-E-2-A	UNT/Glade Run RM 1.06	pH, Fe, Al	270
WV-MC-39-I	UNT/Muddy Creek RM 9.80	Fe	278
WV-MC-39	Muddy Creek	pH, Fe, Al	283
WV-MC-39-K	UNT/ Muddy Creek RM 11.11	None	284
WV-MC-39	Muddy Creek	pH, Fe, Al	285

5. Technical and Financial Assistance

Technical and financial assistance is needed for water sample analysis, creating conceptual designs and detailed engineering designs, and funding and managing the projects through bidding, construction, operation, and maintenance.

Financial assistance is needed to design and build the selected remediation projects. Many funding sources are available for nonpoint source AMD remediation on AMLs and for water quality monitoring, including:

- Section 319 funds
- Abandoned Mine Reclamation (AMR) Fund, including money in the AMD Set-Aside Fund
- Watershed Cooperative Agreement Program grants
- Stream Partners Program grants
- Private Foundation grant opportunities
- local government contributions

- business contributions
- service donations from businesses
- private donations

OSM grants specifically for AMD remediation projects on AMLs are available through the WCAP, part of the Appalachian Clean Streams Initiative. Grants of up to $100,000 are awarded to not-for-profit organizations that have developed cooperative agreements with other entities to reclaim AML sites (11). A match from 319 funds is required to receive these grants and is sometimes met with money from the AMR Fund or WVDEP's Stream Restoration Fund.

Two WVDEP divisions will provide technical assistance. The Division of Water and Waste Management (DWWM) provides technical assistance for the use of BMPs, educates the public and land users on nonpoint source issues, enforces water quality laws that affect nonpoint sources, and restores impaired watersheds through WIB (12).

CWA §319 funds are provided by USEPA to WVDEP and can be used for reclamation of nonpoint source AMD sources. This watershed-based plan is being developed so that these funds can be allocated to the Muddy Creek Watershed. WVDEP's WIB sets priorities and administers the state Section 319 program (11).

A second division within WVDEP, the Office of Abandoned Mine Lands and Reclamation (OAMLR), directs technical resources to watersheds to address AMLs.

OAMLR also funds AML remediation projects via the AMR Fund. Before 1977 when the SMRCA was enacted, coal mines generally did not manage acid-producing material to prevent AMD or treat the AMD that was produced. These "pre-law" mines continue to be significant AMD sources and are treated as nonpoint sources under the Clean Water Act.

To reclaim these AMLs, the Act established the AMR Fund. This fund, supported by a per-ton tax on mined coal, is allocated to coal mining states for remediation projects. WVDEP has funded many AMD remediation projects on AMLs, but these projects are typically not designed to meet stringent water quality goals. The agency typically uses a small number of cost-effective techniques, such as OLCs, and chooses the layout for these measures based on how much land is available (for example, the distance between a mine portal and the boundary of properties for which the agency has right-of-entry agreements). The AMR Fund is slated to sunset in 2022, meaning that Fund allocations may not be sufficient to reclaim many AML sites—even for safety issues.

OAMLR also administers a closely linked source of funding: the AMD Set-Aside Fund. In the past, up to 10% of states' annual AMR Fund allocations could be reserved as an endowment for use on water quality projects. States can now reserve up to 30%. These funds are critically important, because while regular AMR Fund allocations can only be spent on capital costs, AMD Set-Aside Fund allocations can be spent on O&M.

Office of Surface Mining, Reclamation, and Enforcement

OSM grants specifically for AMD remediation projects on AMLs are available through the WCAP, part of the Appalachian Clean Streams Initiative. Grants of up to $100,000 are awarded to not-for-profit organizations that have developed cooperative agreements with other entities to reclaim AML sites (11). A match from additional funds is required to receive these grants and is sometimes met with money from the AMR Fund or WVDEP's Stream Restoration Fund.

Stream Partners Program

The Stream Partners Program offers grants of up to $5,000 to watershed organizations in West Virginia (13). Grants can be used for range of projects including small watershed assessments and water quality monitoring, public education, stream restoration, and organizational development. Stream Partners grants will be pursued in the future to compliment nonpoint source research, education, and reclamation projects in the watershed as well as possibly fund research to support new listing status for SWSs FOC believes should no longer be listed as 'Impaired' for pH, Al, or Fe.

6. Information, Education and Public Participation

State of the Cheat River Watershed outreach events

FOC completed a three part series of outreach events for the public called the State of the Cheat River Watershed (14). This outreach initiative aimed to educate the public about past challenges, current successes, and future goals to restore, preserve, and promote the watershed. The series highlighted remediation efforts including treatment projects and watershed based plans and asked landowners to report known AMD on their property. Friends of the Cheat plans to continue this series annually.

Cheat River Festival

Every spring, for 25 years, FOC has been hosting the Cheat River Festival. This is FOC's largest outreach and fundraising event. Thousands of patrons come to learn about all aspects of FOC's mission, including restoration initiatives. FOC will have information regarding restoration successes and plans at the informational area in the festival. FOC also invited landowners and other restoration stake holders to learn more about how they can be involved and to teach the public about their current involvement in restoration.

Newsletters

FOC newsletters are distributed in print every quarter. They are also available online. Newsletters will continue to update readers about planned nonpoint source remediation projects and about remediation priorities.

Youth education

FOC has developed curriculum to teach youth about the Cheat River Watershed, its tributaries, and the importance of stream health. In summer of 2018 FOC partnered with the U.S. Forest Service to host three snorkel outreach events among the local community to foster stewardship and appreciation of the Cheat's unique freshwater ecological resources The Cheat River Snorkel Program continued into 2019 to host 3 events. FOC visits a local 4-H camp each year and attends many music festivals to teach participants about ecology and pollution in streams. Hosting outreach and education events to youth and the general public is one effective strategy FOC utilizes for building long-term support for the watershed's remediation priorities.

Website - https://www.cheat.org/

FOC also maintains a website, www.cheat.org, with information about remediation projects and priorities (15).

Landowner handbook

FOC created a handbook for landowners to describe the reclamation process and updated this book in 2017. The booklet describes monitoring, implementation, funding, and regulation to landowners and potential landowner partners.

River of Promise

River of Promise began in 1995. The premise was to bring together stakeholders including industry, state and federal agencies, watershed groups, and the public to share information and work on solving AMD issues. Quarterly River of Promise meetings are open to the public. Information on nonpoint source remediation projects and priorities will be freely available to all who attend these meetings.

7. Schedule and Milestones

FOC hopes to secure funds to address and treat all priority sites between the years 2025 – 2033 in the Muddy Creek WBP. After each priority site is developed, the site and the corresponding SWS will be monitored through the course of one year to ensure the pollutant loads are appropriately reduced. If loads are not appropriately reduced, low priority seeps will be revisited for possible projects until the proper load reduction for specific SWS is met. Sites in which landowner cooperation is not currently viable will be revisited if/when property changes ownership.

Milestones for each project in the Muddy Creek WBP are as follows:

- Secure Funding For Priority Sites
- Implement Site Design and Construction of Priority Sites
- Conduct Post Monitoring of Priority Sites
- Evaluate Success of Priority Sites
- Reassess Low Priority Sites and Site Ownership
- Secure Funding for Low Priority Sites as needed for Load Reduction
- Implement Site Design and Construction for Low Priority Sites as needed
- Conduct Post Monitoring of Low Priority Sites
- Routine Sampling of Sites to Ensure System Outs are Meeting Water Quality Standards

A general example of the timeline for a watershed project is provided in Table 17. Tables 18a – 18f provide anticipated schedule for the implementation of the high priority sites. Because of FOC's other WBP Implementation schedules for North Fork Greens Run and Big Sandy Creek, FOC has moved out the milestone schedule for Muddy Creek Priority Sites to fall after Priority Sites have been implemented in these two watersheds. If a new funding source or additional §319 funding can be provided to complete two projects at a time, FOC will move up the implementation schedule as needed.

***Table 17:* General example of a watershed project timeline**

	Pre	Year 1	Year2	Year3	Year 4	Year 5	Post
Planning							
Develop WBP	<--						
Collect Monitoring Data							
Assess Project Sites							
Feasibility Study							
Landowner Contact							
Apply for Funding							
Receive Funding							
Implementation							
Engineering Services							
Environmental Permitting							
Construction							
Operation and Maintenance							
Operation and Maintenance							

***Table 18a:* Implementation Schedule for MC39E1-100-2**

AMD Source: MC39E1-100-2																	
Stream: Fickey Run, SWS 274																	
Project: MC39E1-100-2 PASSIVE TREATMENT																	
	2025	2026				2027				2028				2029			
Milestones	Q2	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Submit §319 proposal	X																
Receive §319 Funding				X													
Procure engineer								X	X	X	X	X	X				
Apply for match funding								X									
Obtain necessary landowner agreements							X										
Water Quality Monitoring				X	X	X	X	X	X	X	X	X	X	X	X	X	X
Obtain necessary construction permits									X	X	X	X					
Procure construction contractor											X						
Construct Treatment system												X	X	X			
Post Construction Quarterly Monitoring														X	X	X	X

Table 18b: ***Implementation Schedule for MC39E1-200-1***

AMD Source: MC39E1-200-1																	
Stream: Fickey Run, SWS 274																	
Project: MC39E1-200-1 PASSIVE TREATMENT																	
	2026	2027				2028				2029				2030			
Milestones	Q2	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Submit §319 proposal	X																
Receive §319 Funding				X													
Procure engineer								X	X	X	X	X	X				
Apply for match funding								X									
Obtain necessary landowner agreements							X										
Water Quality Monitoring				X	X	X	X	X	X	X	X	X	X	X	X	X	X
Obtain necessary construction permits									X	X	X	X					
Procure construction contractor												X					
Construct Treatment system												X	X	X			
Post Construction Quarterly Monitoring														X	X	X	X

Table 18c: ***Implementation Schedule for MC39E2-350-10, MC39E2-350-2, MC39E2-350-9***

AMD Source: MC39E2-350-10, MC39E2-350-2, MC39E2-350-9																	
Stream: Glade Run, SWS 273																	
Project: Allen Connor Messenger Site Improvements																	
	2027	2028				2029				2030				2031			
Milestones	Q2	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Submit §319 proposal	X																
Receive §319 Funding				X													
Procure engineer								X	X	X	X	X	X				
Apply for match funding								X									
Obtain necessary landowner agreements							X										
Water Quality Monitoring				X	X	X	X	X	X	X	X	X	X	X	X	X	X
Obtain necessary construction permits									X	X	X	X					
Procure construction contractor												X					
Construct Treatment system												X	X	X			
Post Construction Quarterly Monitoring														X	X	X	X

Table 18d: ***Implementation Schedule for MC39-200-1, MC39-200-2***

AMD Source: MC39-200-1, MC39-200-2																	
Stream: Muddy Creek, SWS 275																	
Project: Dream Mountain Site Improvements																	
	2017	2018				2019				2020				2021			
Milestones	Q2	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Submit §319 proposal	X																
Receive §319 Funding				X													
Procure engineer								X	X	X	X	X	X				
Apply for match funding								X									
Obtain necessary landowner agreements							X										
Water Quality Monitoring				X	X	X	X	X	X	X	X	X	X	X	X	X	X
Obtain necessary construction permits									X	X	X	X					
Procure construction contractor											X						
Construct Treatment system												X	X	X			
Post Construction Quarterly Monitoring														X	X	X	X

Table 18e: ***Implementation Schedule for MC39E2-200-1 and MC39E2-200-2***

AMD Source: MC39E2-200-1, MC39E2-200-2																	
Stream: UNT/Glade Run RM 1.36, SWS 272																	
Project: Gary Connor Site Improvements																	
	2028	2029				2030				2031				2032			
Milestones	Q2	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Submit §319 proposal	X																
Receive §319 Funding				X													
Procure engineer								X	X	X	X	X	X				
Apply for match funding								X									
Obtain necessary landowner agreements							X										
Water Quality Monitoring				X	X	X	X	X	X	X	X	X	X	X	X	X	X
Obtain necessary construction permits									X	X	X	X					
Procure construction contractor											X						
Construct Treatment system												X	X	X			
Post Construction Quarterly Monitoring														X	X	X	X

Table 18f: ***Implementation Schedule for UNT/UNT RM 0.12/MUDDY CREEK RM 9.80***

AMD Source: Unknown																	
Stream: UNT/UNT RM 0.12/MUDDY CREEK RM 9.80, SWS 279																	
Project: SWS 279 - Limestone Fines																	
	2029	2030				2031				2032				2033			
Milestones	Q2	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Submit §319 proposal	X																
Receive §319 Funding				X													
Procure engineer								X	X	X	X	X	X				
Apply for match funding								X									
Obtain necessary landowner agreements							X										
Water Quality Monitoring				X	X	X	X	X	X	X	X	X	X	X	X	X	X
Obtain necessary construction permits									X	X	X	X					
Procure construction contractor											X						
Construct Treatment system												X	X	X			
Post Construction Quarterly Monitoring														X	X	X	X

8. Load Reduction Evaluation Criteria

The long-term measurable goals are to achieve required reduction for each seep set by the TMDL and verified by FOC for iron, aluminum, and pH. Achieving these goals should lend to the resolution of in-stream pH, Al, Fe, biological, and sedimentation impairments, however it might not accomplish all West Virginia water quality standards in-stream since AMD is not the only source of these impairments. In addition, streams “inside” the Martin Creek variance area are not expected to make a full recovery. The purpose of projects in that area will be to increase OSR’s ability to keep water quality in Martins Creek close to water quality standards.

Samples will be collected and analyzed quarterly for one year after construction to assess treatment effectiveness. FOC will collect a general grab sample to determine pH, Alkalinity, Acidity, SO4, and Electrical Conductivity, as well as samples preserved in nitric acid (one filtered) to determine Total and Dissolved Aluminum, Calcium, Iron, Magnesium, and Manganese. Samples will be stored and sent off for analysis in accordance with Fairway Laboratories, Inc. protocol. FOC will also collect field data such as pH, water temperature, Electrical Conductivity, and stream flow. Results will be compared to West Virginia water quality standards. FOC will assess to see if required load reductions are being met at the treatment ‘System Out.’ SWS mouth will also be sampled quarterly to evaluate impairment—although taking into consideration some SWS will have inherent impairment due to the watershed-scale treatment approach implemented by OSR. Evaluation of load reduction will be accomplished by:

1. Comparing the instream water quality upstream of the seep and downstream of the seep
2. Comparing the pollutant loads in the water entering the system to the pollutant loads in the water exiting the system
3. Comparing the water quality at the SWS mouth before and after the treatment system is implemented.

9. Monitoring Component

Monitoring parameters include temperature, flow, pH, conductivity, acidity, alkalinity, sulfate, total aluminum, dissolved aluminum, total iron, dissolved iron, total manganese, and dissolved manganese. FOC will monitor water quality pre-construction, during construction, and post-construction. FOC will monitor annually until §319 or alternative funds are secured. After securing funds, during the pre-construction period FOC will collect and analyze upstream, downstream and seep samples monthly, likely straddling two fiscal years. During the construction period upstream, downstream, and seep samples will be collected and analyzed quarterly. Quarterly post construction samples will be collected and analyzed upstream of treatment, downstream of treatment and after each treatment component for one year, and then biannually after.

FOC uses a monitoring cost calculation spreadsheet that factors in lab fees, mileage, and staff time cost using eight hours per sampling visit per site, which includes, preparing, driving, sampling, returning the samples to the lab, cleaning up the equipment, entering the data, and initially analyzing the data.

Table 19 outlines the monitoring plan and Table 20 outlines the monitoring budget including staff time and lab fees in order to carry out the restoration efforts, with Table 21 as reference to the constants used to calculate the monitoring budget. Each of the sites that are selected for treatment in the Priority Implementation Section are listed in Tables 18a-f and Table 19.

The order of the project implementation for those listed in Tables 18a-f and Table 19 may be subject to change, based on landowner partnerships.

***Table 19:* Monitoring efforts per Priority site per year**

Site	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
MC39E1-100-2 Passive Treatment	1	1	1	1	1	1	8	8	6	4	2	2	2	2	2
MC39E1-200-1 Passive Treatment	0	1	1	1	1	1	1	8	6	4	2	2	2	2	2
Allen Connor Messenger Site Improvements	1	1	1	1	1	1	1	1	8	6	4	2	2	2	2
Dream Mountain Site Improvements	6	4	2	2	2	2	2	2	2	2	2	2	2	2	2
Gary Connor Site Improvements	0	0	0	0	0	0	0	0	0	8	6	4	2	2	2
SWS 279 – Limestone Fines	3	1	1	1	1	1	1	1	1	1	8	6	4	2	2

*Table 20: **Monitoring Budget***

Projections					Sampling Cost			
Project Name	Mileage (Site-Office)	# Sample Sites	Sample Period (Yrs)	Average Sample Efforts per year	Travel	Lab	Personnel	Total
MC39E1-100-2 Passive Treatment	7	4	4	5.5	$ 178.64	$ 6,600.00	$ 1,522.91	$ 8,301.55
MC39E1-200-1 Passive Treatment	7	4	4	5.5	$ 178.64	$ 6,600.00	$ 1,522.91	$ 8,301.55
Allen Connor Messenger Site Improvements	8	6	4	5.5	$ 204.16	$ 9,900.00	$ 1,938.24	$ 12,042.40
Dream Mountain Site Improvements	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gary Connor Site Improvements	10	6	4	5.5	$ 255.20	$ 9,900.00	$ 1,977.80	$ 12,133.00
SWS 279 - Limestone Fines	10	4	4	5.5	$ 255.20	$ 6,600.00	$ 1,582.24	$ 8,437.44
Total								**$ 49,215.94**

*Table 21: **Monitoring Budget Table of Constants***

Table of Constants					
Cost/Sample ($)	Cost/Mile ($)	Personnel Pay ($/hr)	Personnel Time/Mile (min)	Personnel Prep Time (min)	Personnel Time/Sample (min)
$ 75.00	$ 0.58	$ 17.98	1.5	90	30

10. References

1. **United States Environmental Protection Agency.** *Handbook for Developing Watershed Plans to Restore and Protect Our Waters, Chapter 2.* 2008

2. **Ted O'Callahan**. *The Cheat River Takes a Turn. T*he Nature Conservancy, 2016.

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4. **Dustin M. Smith.** *Evaluation of a re-established Walleye Population within a Hydropower Reservoir Recovering from Acidification*. Davis College of Agriculture, Natural Resource and Design. West Virginia University, 2018.

5. **West Virginia Department of Environmental Protection: Office of Special Reclamation.** *U.S. EPA Approval of WV 2016 WQS Variance for Muddy Creek,* 2016.

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7. **Department of Environmental Protection Water Resources.** *47 CSR, Series 2, Legislative Rules, Department of Environmental Protection: Requirements Governing Water Quality Standards.* 2011.

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11. **Office of Surface Mining Reclamation and Enforcement (OSMRE).** *Watershed Cooperative Agreement Program-Federal Assistance Manual, Chapter 6-100.* 2010.

12. **West Virginia Department of Environmental Protection.** Nonpoint Source Web page. [Online] Division of Water and Waste Management, 2014. http://www.dep.wv.gov/WWE/Programs/nonptsource/Pages/home.aspx.

13. **West Virginia Department of Environmental Protection.** Stream Partners Web page. [Online] Division of Water and Waste Management, 2014. https://dep.wv.gov/WWE/getinvolved/WSA_Support/Pages/StreamPartners.aspx.

14. **Friends of the Cheat.** *State of the Cheat River Watershed.* 2017. https://www.cheat.org/archive/publications/.

15. **Friends of the Cheat.** www.cheat.org.

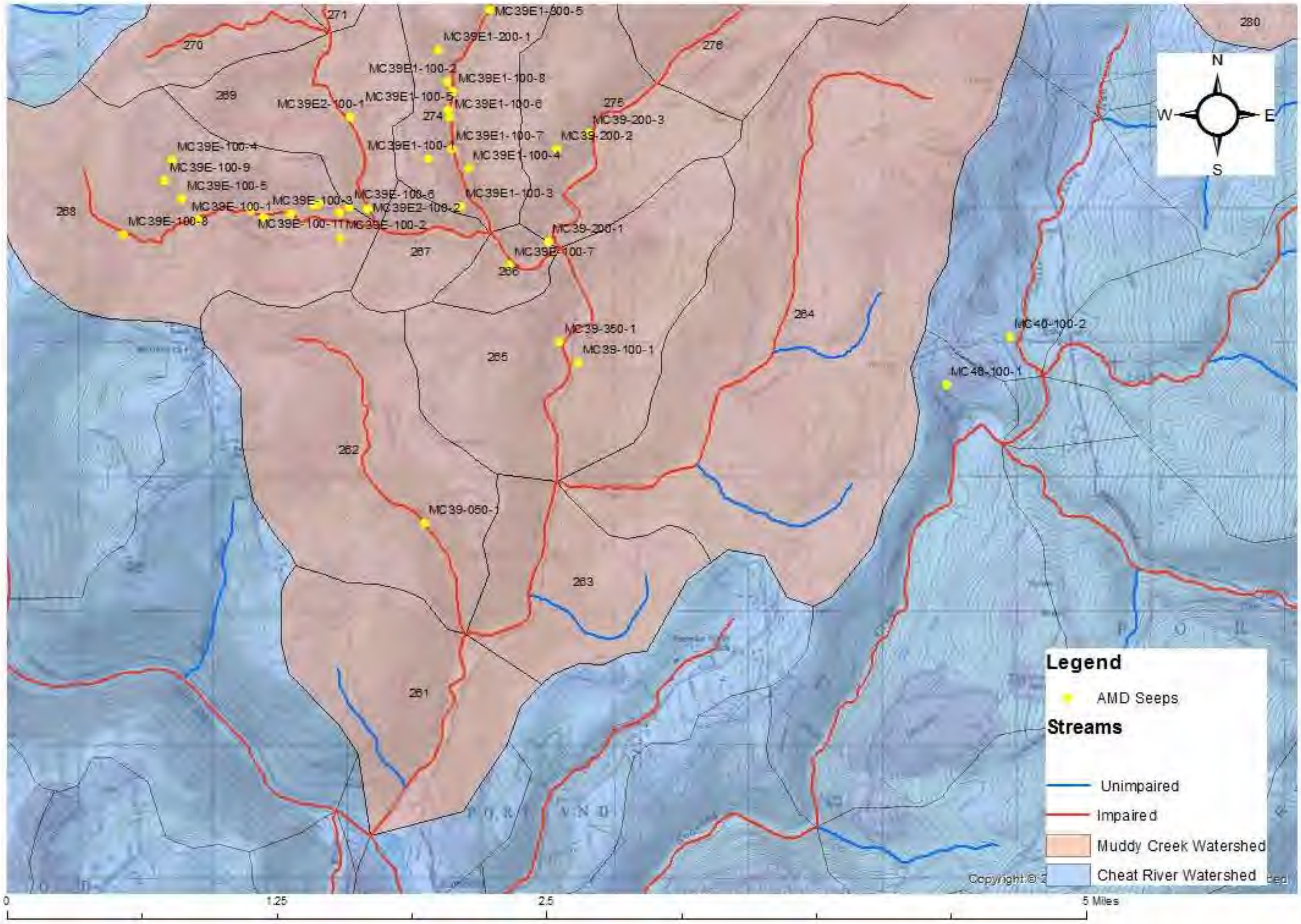
Appendix

Appendix A: TMDL Seep Data

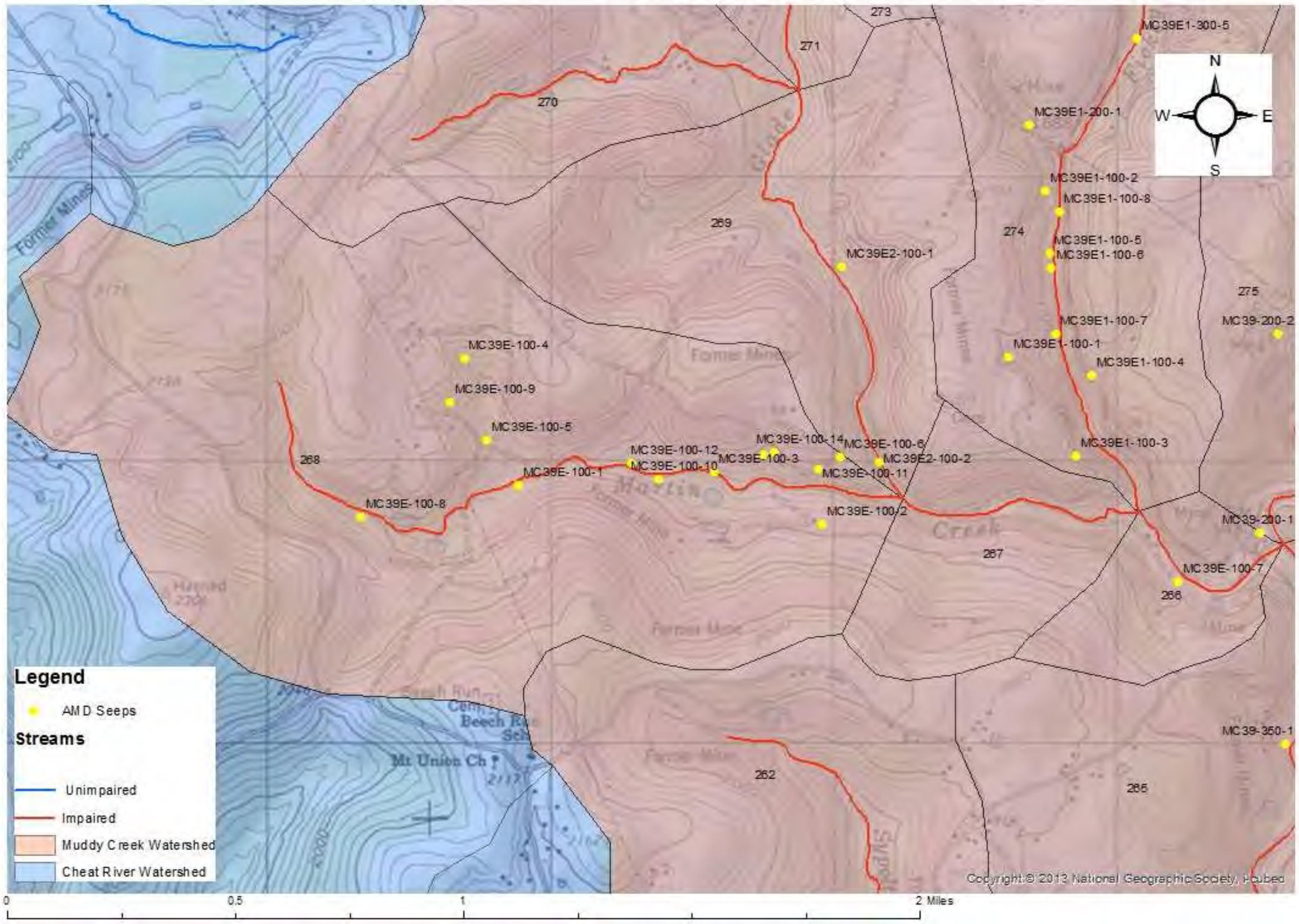
OID	Discharge	Stream_Nam	NHD_Code	Flow_CFS_	pH	Total_Al	Total_Fe	Total_Mn	ALKALINITY	SULFATE	LAT	Long	SUBID
0	MC39-050-1	Sypolt Run	WV-MC-39-B	0.02941	5.9	0.13	56.62	0.28	0	379	39.531639	-79.643444	262
1	MC39-100-1	Muddy Creek	WV-MC-39	1.073343	2.93	26.095	77.79	1.525	0.165	845.25	39.542203	-79.629944	265
2	MC39-350-1	Muddy Creek	WV-MC-39	1.374681	8.875	4.395	9.79	0.68	79.16	980	39.543614	-79.6315	265
3	MC39E-100-7	Martin Creek	WV-MC-39-E	0.031192	3.48	2.66	12.8	0.89	0	379	39.548831	-79.635781	266
4	MC39E-100-1	Martin Creek	WV-MC-39-E	0.071296	4.3	3.14	0.99	0.66	0	318	39.552222	-79.662833	268
5	MC39E-100-10	Martin Creek	WV-MC-39-E	0.008912	3.3	16.72	1.37	2.98	0	1020	39.552333	-79.657083	268
6	MC39E-100-11	Martin Creek	WV-MC-39-E	0.006684	3.3	18.305	6.3075	5.54	0	1655.75	39.552567	-79.650514	268
7	MC39E-100-12	Martin Creek	WV-MC-39-E	0.02228	3.3	24.94	10.69	1.73	0	498	39.552833	-79.658139	268
8	MC39E-100-13	Martin Creek	WV-MC-39-E	0.026736	2.78	22.47	25.39	3.16	0	433	39.553056	-79.652722	268
9	MC39E-100-14	Martin Creek	WV-MC-39-E	0.02228	3.22	18.305	6.3075	5.54	0	1655.75	39.553139	-79.652306	268
10	MC39E-100-2	Martin Creek	WV-MC-39-E	0.0557	3.95	6.14	0.99	0.66	0	318	39.550833	-79.650361	268
11	MC39E-100-3	Martin Creek	WV-MC-39-E	0.003509	2.7	83.815	11.225	17.405	0	2360	39.552556	-79.654778	268
12	MC39E-100-4	Martin Creek	WV-MC-39-E	0.03342	3.2	3.29	22.21	1.33	0	670	39.556258	-79.664964	268
13	MC39E-100-5	Martin Creek	WV-MC-39-E	0.05772	3.816667	22.286667	4.56	7.266667	0	807	39.553644	-79.6641	268
14	MC39E-100-6	Martin Creek	WV-MC-39-E	0.015384	3.1825	18.305	6.3075	5.54	0	1655.75	39.552936	-79.649611	268
15	MC39E-100-8	Martin Creek	WV-MC-39-E	0.300781	3.39	11.5	1.14	16.3	0.1	1870	39.551275	-79.669306	268
16	MC39E-100-9	Martin Creek	WV-MC-39-E	0.019606	3.5	3.03	9.45	1.33	0	810	39.554889	-79.665583	268
17	MC39E2-100-1	Glade Run	WV-MC-39-E-2	0.222801	3.5	13.79	2.15	0.94	0	869	39.558972	-79.649417	269
18	MC39E2-100-2	Glade Run	WV-MC-39-E-2	0.03899	3.07	21.65	1.05	5.59	0.1	1634.5	39.552781	-79.648	269
19	MC39E2-175-1	Glade Run	WV-MC-39-E-2	0.088318	2.961667	36.998333	6.145	5.908333	0	692.333333	39.567944	-79.653056	271
20	MC39E2-200-1	UNT/Glade Run RM 1.36	WV-MC-39-E-2-B	0.01114	3.1	37.4	6.73	6.24	0	792	39.576175	-79.661747	272
21	MC39E2-200-2	UNT/Glade Run RM 1.36	WV-MC-39-E-2-B	0.352662	3.291429	31.672857	2.214286	20.101429	0	1287.285714	39.576222	-79.661917	272
22	MC39E2-300-1	Glade Run	WV-MC-39-E-2	0.03342	2.91	59.65	27.83	19.18	0	1060	39.578361	-79.650722	273
23	MC39E2-300-2	Glade Run	WV-MC-39-E-2	0.06684	3.8	18.7	4	0.33	0.1	29	39.574667	-79.649389	273
24	MC39E2-310-1	Glade Run	WV-MC-39-E-2	0.053472	3.3	2.66	12.8	0.89	0	379	39.568611	-79.648694	273
25	MC39E2-350-1	Glade Run	WV-MC-39-E-2	0.040409	3.136667	96.703333	12.08	17.926667	0	1543.333333	39.579317	-79.641733	273
26	MC39E2-350-10	Glade Run	WV-MC-39-E-2	0.089989	3	27.9	9.47	2.36	0	794	39.577811	-79.643097	273
27	MC39E2-350-2	Glade Run	WV-MC-39-E-2	0.178241	3	28.31	29.5	4.82	0.1	656	39.574417	-79.645	273
28	MC39E2-350-3	Glade Run	WV-MC-39-E-2	0.066751	2.853333	34.263333	9.863333	2.186667	0	695.333333	39.579817	-79.642392	273
29	MC39E2-350-4	Glade Run	WV-MC-39-E-2	0.013368	4.4	2.66	12.8	0.89	0	379	39.584558	-79.640294	273
30	MC39E2-350-5	Glade Run	WV-MC-39-E-2	0.000499	3.5	0.43	2.28	2.67	0	262	39.585553	-79.639772	273
31	MC39E2-350-6	Glade Run	WV-MC-39-E-2	0.010917	3.266667	1.853333	45.53	2.573333	0	569.333333	39.58925	-79.639944	273
32	MC39E2-350-7	Glade Run	WV-MC-39-E-2	0.057928	6.58	0.97	2.18	2.24	17.8	363	39.590139	-79.637	273
33	MC39E2-350-8	Glade Run	WV-MC-39-E-2	0.053472	4.49	13.4	1.11	0.485	0.1	288	39.584333	-79.637111	273
34	MC39E2-350-9	Glade Run	WV-MC-39-E-2	0.13778	3.1	49.98	11.16	6.45	0	1595	39.578119	-79.644564	273
35	MC39E1-100-1	Fickey Run	WV-MC-39-E-1	0.042711	2.77	56.783333	66.843333	1.736667	0	878.666667	39.556061	-79.642614	274
36	MC39E1-100-2	Fickey Run	WV-MC-39-E-1	0.442534	2.933333	36.903333	10.803333	7.473333	0	1185	39.561289	-79.641003	274
37	MC39E1-100-3	Fickey Run	WV-MC-39-E-1	0.026736	2.83	49.77	46.39	1.85	0	704	39.552889	-79.639917	274
38	MC39E1-100-4	Fickey Run	WV-MC-39-E-1	0.03342	3.06	49.77	46.39	1.85	0	704	39.555411	-79.639217	274
39	MC39E1-100-5	Fickey Run	WV-MC-39-E-1	0.013502	3.1	16.32	3.27	1.9	0	326	39.559333	-79.64087	274
40	MC39E1-100-6	Fickey Run	WV-MC-39-E-1	0.004456	3.64	0.43	2.28	2.67	0	262	39.558839	-79.640795	274
41	MC39E1-100-7	Fickey Run	WV-MC-39-E-1	0.004456	3.71	1.75	39.13	2.16	0	468	39.556744	-79.640661	274
42	MC39E1-100-8	Fickey Run	WV-MC-39-E-1	0.004456	2.8	8.75	11.83	7.67	0	1505	39.560613	-79.640446	274
43	MC39E1-200-1	Fickey Run	WV-MC-39-E-1	0.518383	7.196667	8.663333	3.886667	1.98	19.17	988	39.563386	-79.641625	274
44	MC39E1-300-1	Fickey Run	WV-MC-39-E-1	0.030078	3.25	32.4	226.01	6.68	0	910	39.575453	-79.633933	274
45	MC39E1-300-2	Fickey Run	WV-MC-39-E-1	0.074638	2.795	138.465	838.395	22.27	0	3945	39.577356	-79.631347	274
46	MC39E1-300-3	Fickey Run	WV-MC-39-E-1	0.040104	3.12	28.31	29.5	4.82	0	656	39.578481	-79.632103	274
47	MC39E1-300-4	Fickey Run	WV-MC-39-E-1	0.046788	3.02	28.31	29.5	4.82	0	656	39.578692	-79.632156	274
48	MC39E1-300-5	Fickey Run	WV-MC-39-E-1	0.02228	3.36	28.31	29.5	4.82	0	656	39.566083	-79.637153	274
49	MC39E1-300-6	Fickey Run	WV-MC-39-E-1	0.03342	3.08	28.31	29.5	4.82	0	656	39.574275	-79.635369	274
50	MC39E1-300-7	Fickey Run	WV-MC-39-E-1	0.04456	2.7	28	80	3.2	0.1	2320	39.5775	-79.631944	274
51	MC39E1-300-8	Fickey Run	WV-MC-39-E-1	0.06684	3.1	8.5	60.5	0.8	0.1	540	39.57975	-79.631389	274
52	MC39-200-1	Muddy Creek	WV-MC-39	0.134964	2.637778	61.718889	61.857778	3.184444	0.011111	901.111111	39.550353	-79.632394	275
53	MC39-200-2	Muddy Creek	WV-MC-39	0.099146	2.8	73.4425	103.6325	3.875	0	1542	39.556631	-79.631544	275
54	MC39-200-3	Muddy Creek	WV-MC-39	0.392129	5.17	4.045	0.51	0.955	0	248	39.557692	-79.628731	275
55	MC39-300-1	Muddy Creek	WV-MC-39	0.013368	6.34	0.02	11	0.633	0.1	16	39.588361	-79.597861	277
56	MC39-300-2	Muddy Creek	WV-MC-39	0.139629	3.9	12.135	0.8475	5.0525	0	801.25	39.587444	-79.597	277

Appendix B: Maps of Subwatersheds

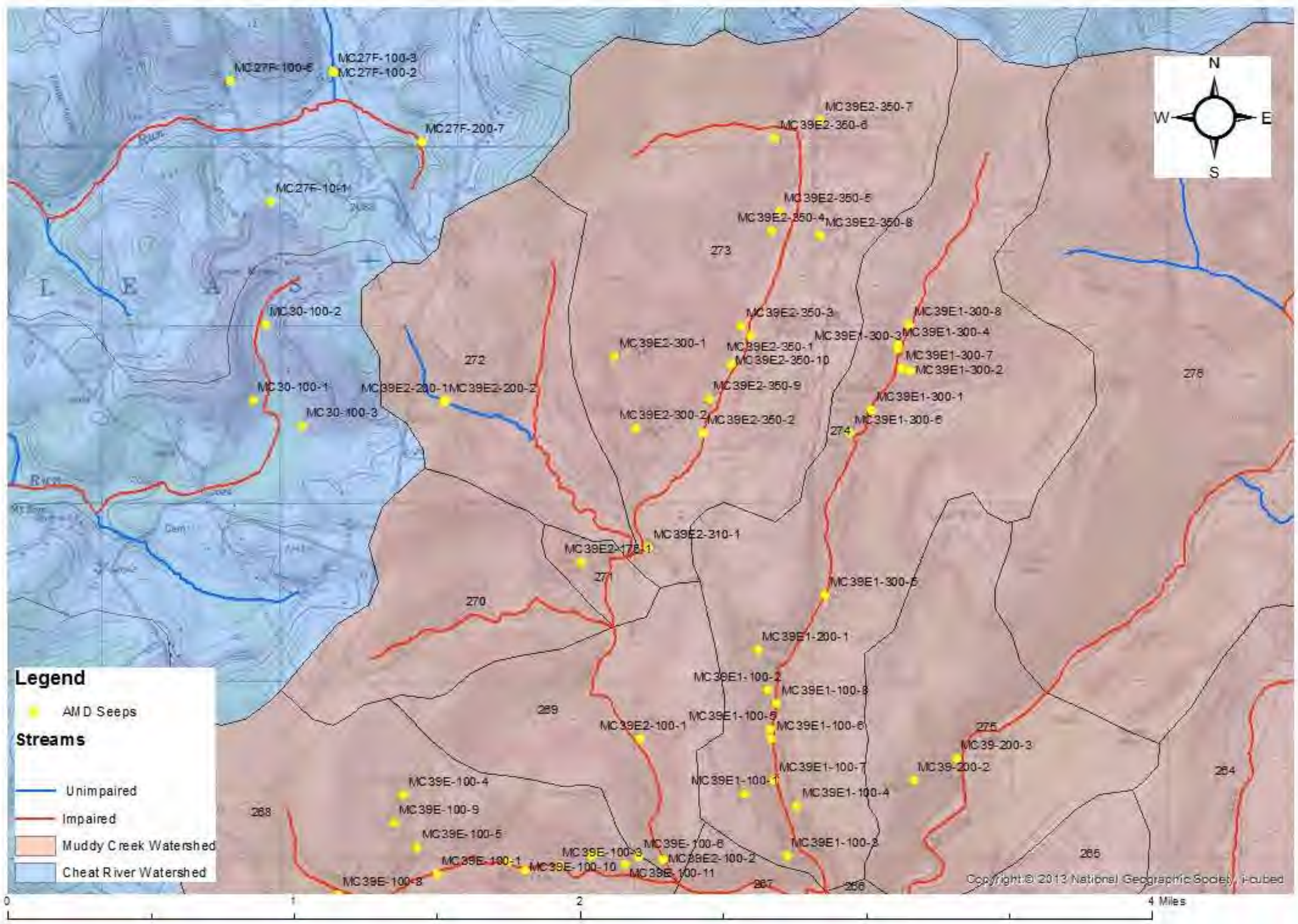
Lower Muddy Creek, Sypolt Run, and Crab Orchard Run – SWS 261–265



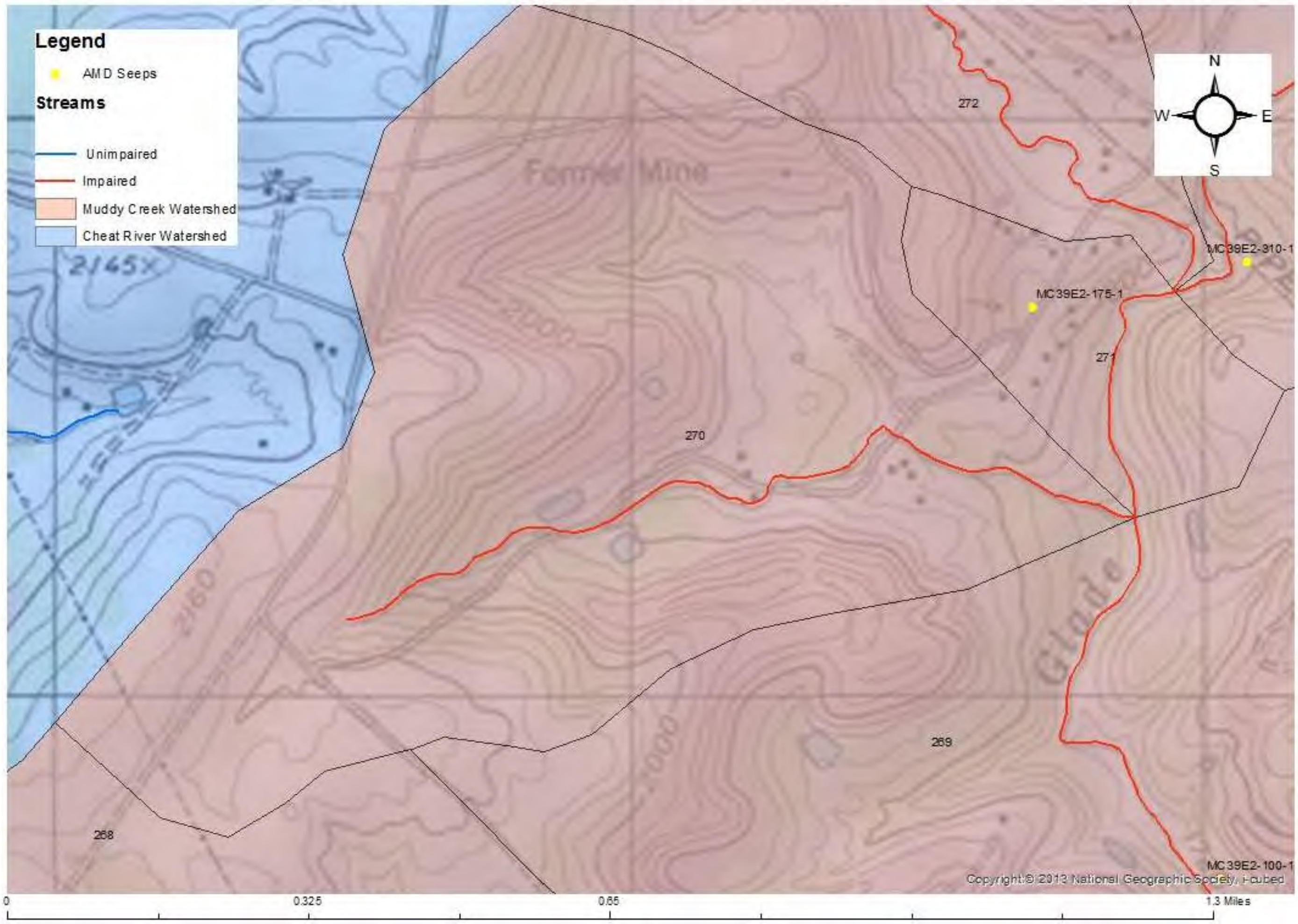
Martin Creek, SWS 266–268



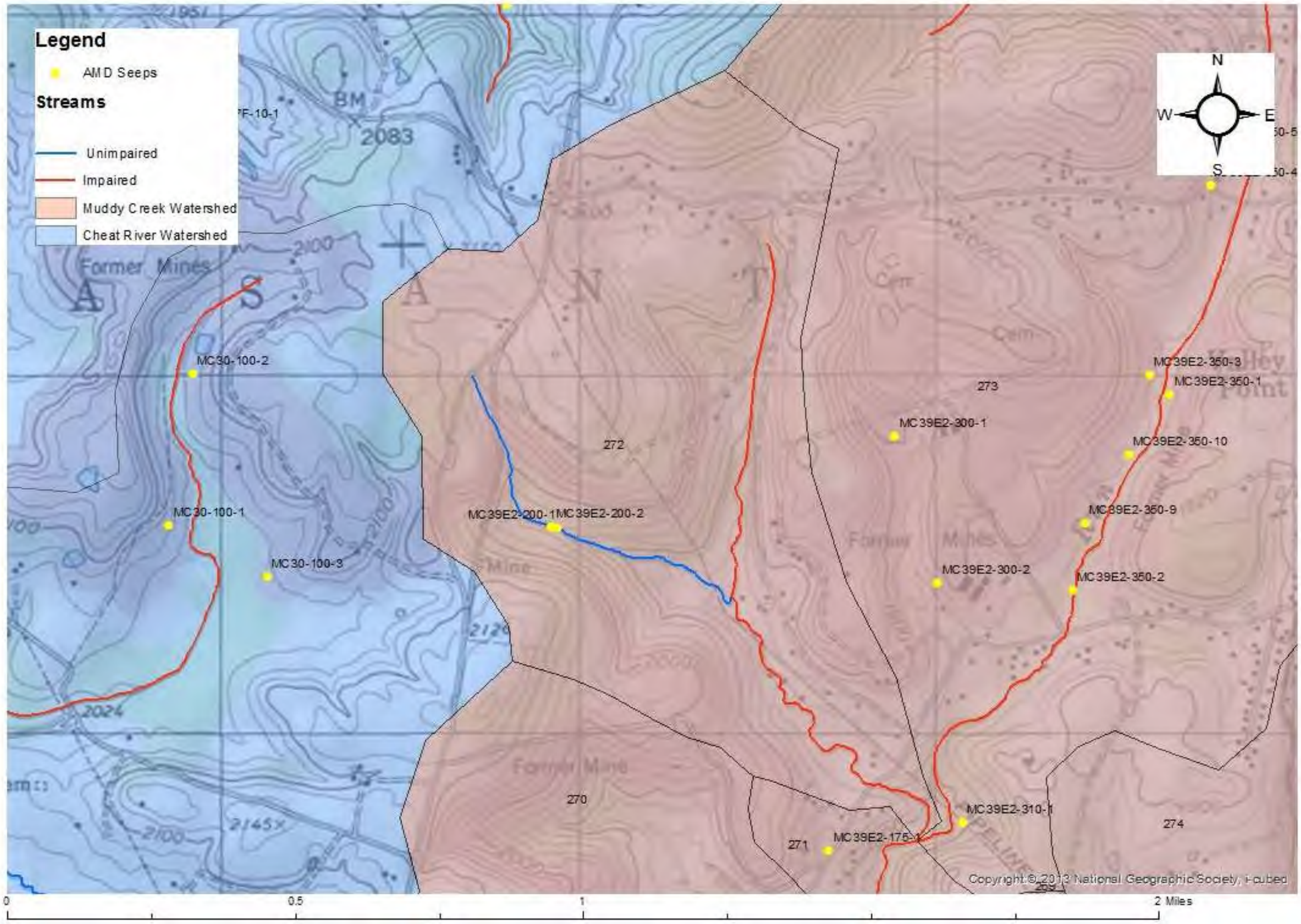
Glade Run, SWS 269, 271 and 273



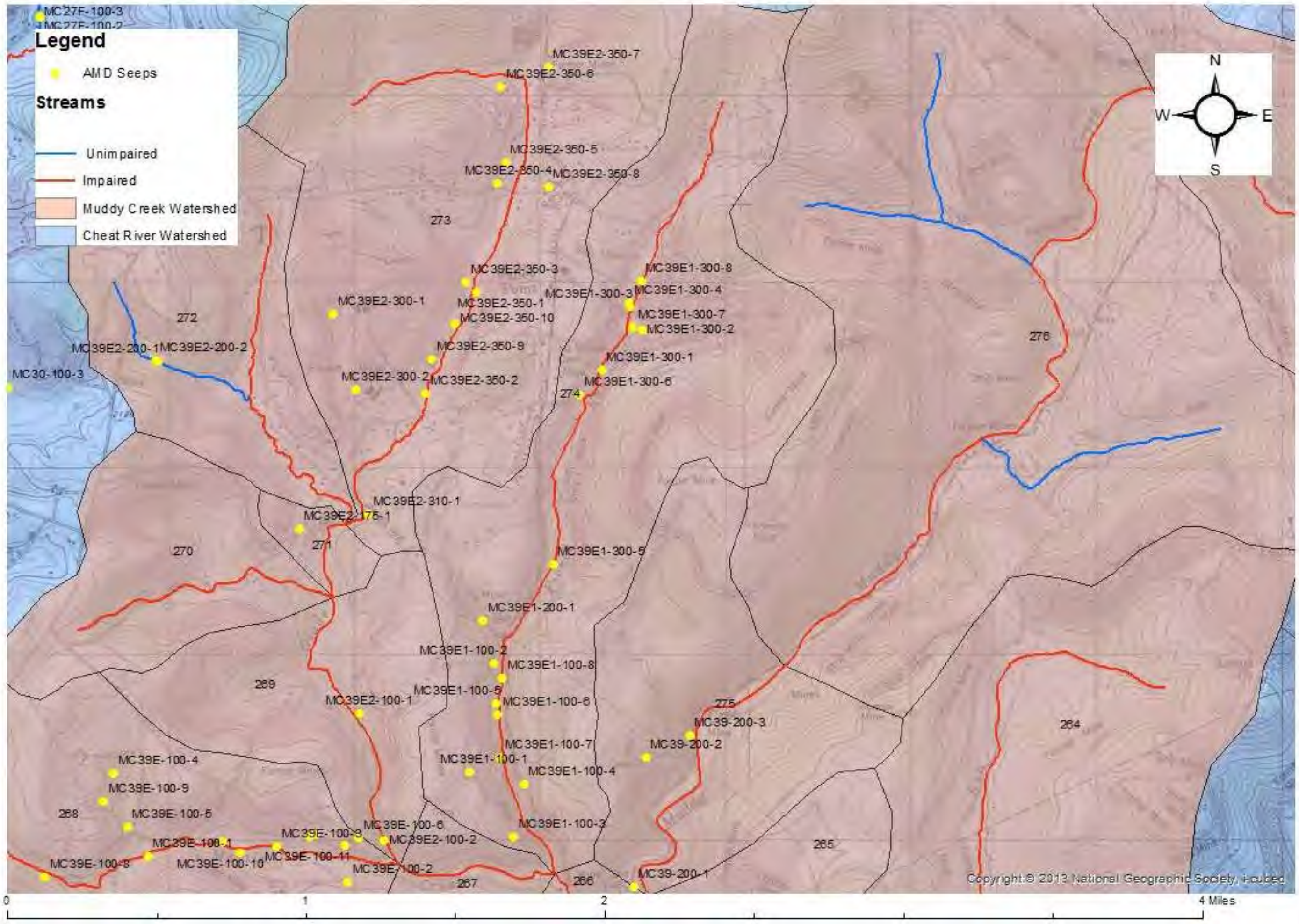
UNT/Glade Run RM 1.06 – SWS 270



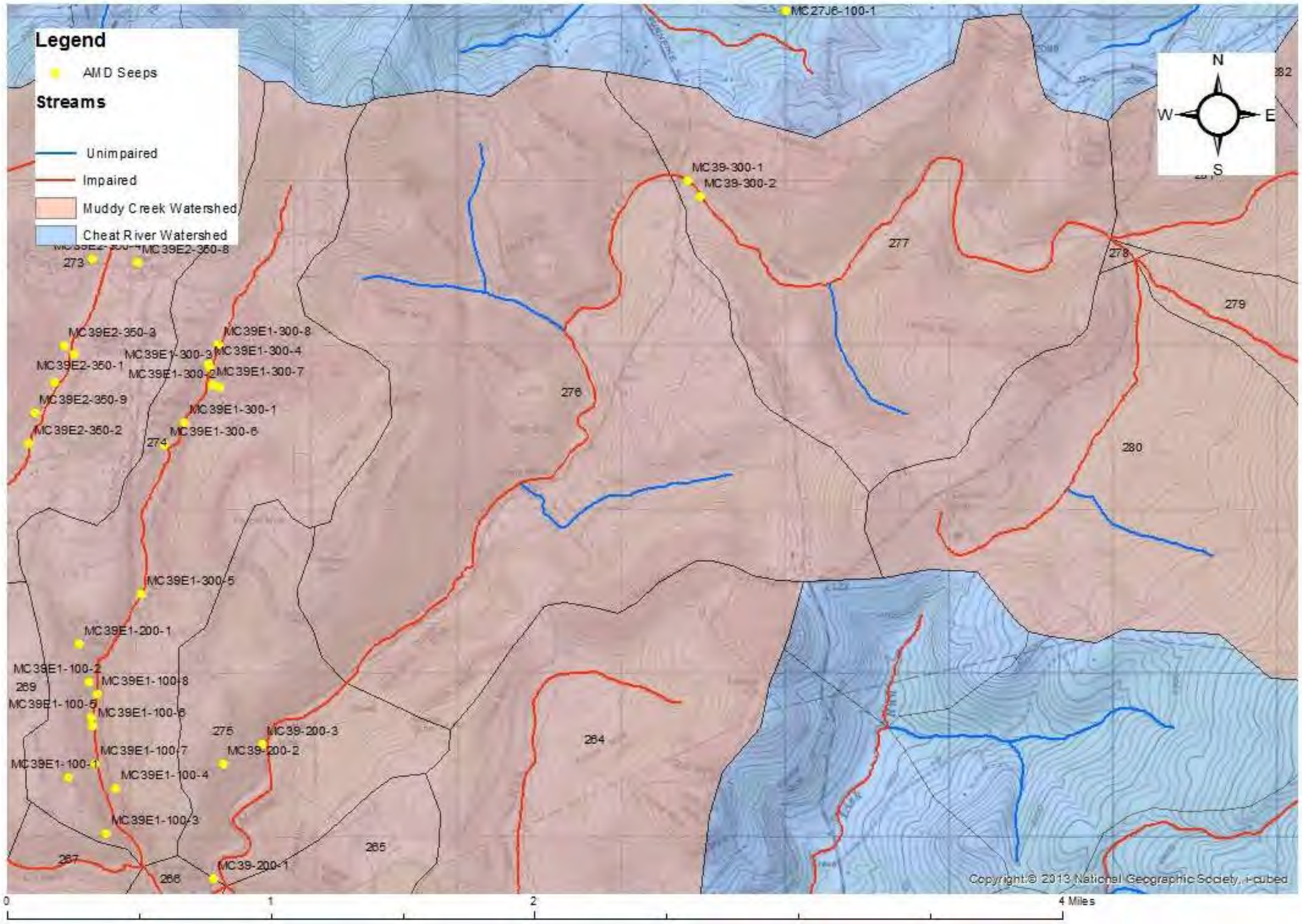
UNT/Glade Run RM 1.36 – SWS 272



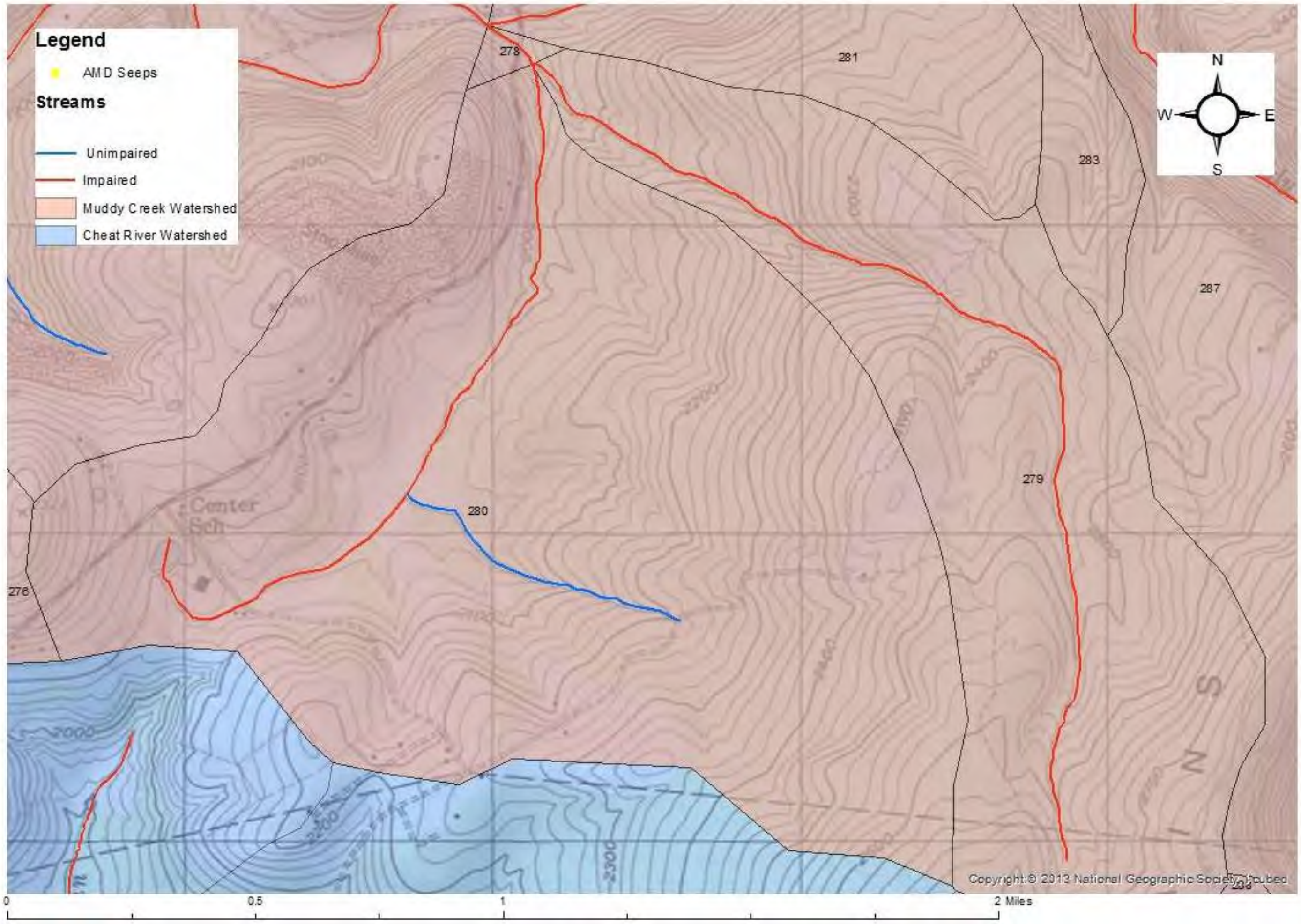
Fickey Run – SWS 274



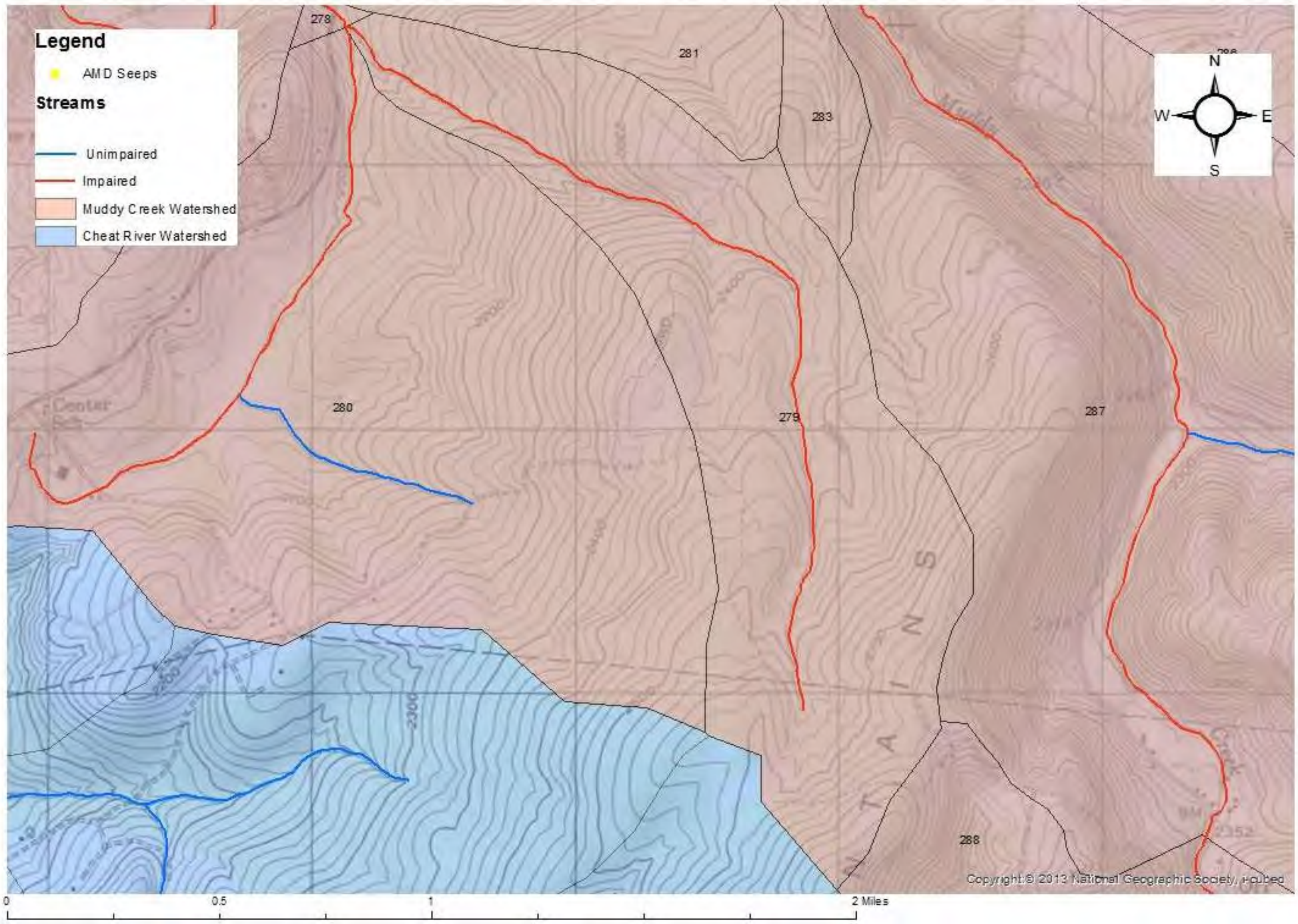
Muddy Creek – SWS 275–277



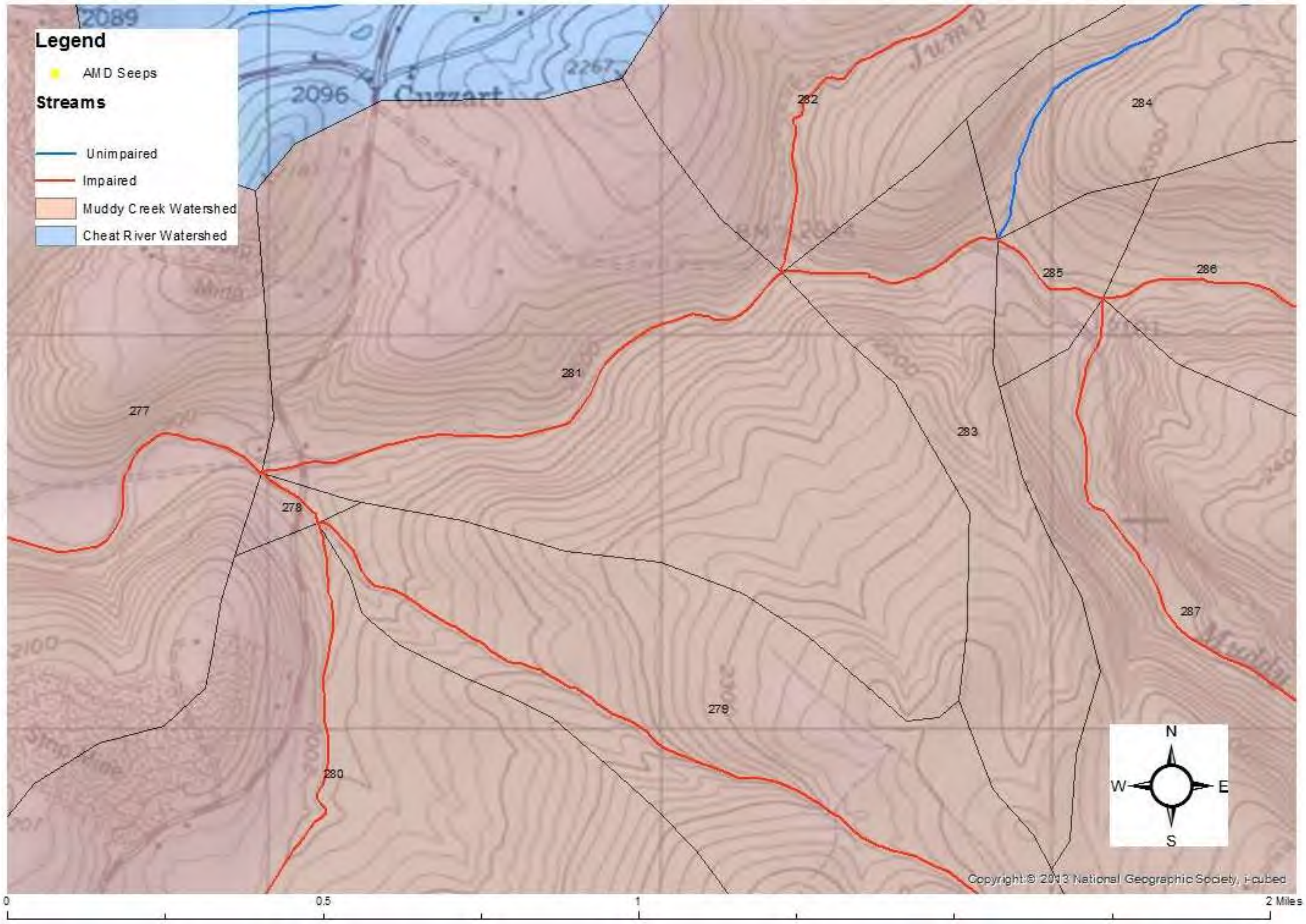
UNT/Muddy Creek RM 9.80 – SWS 278, SWS 280



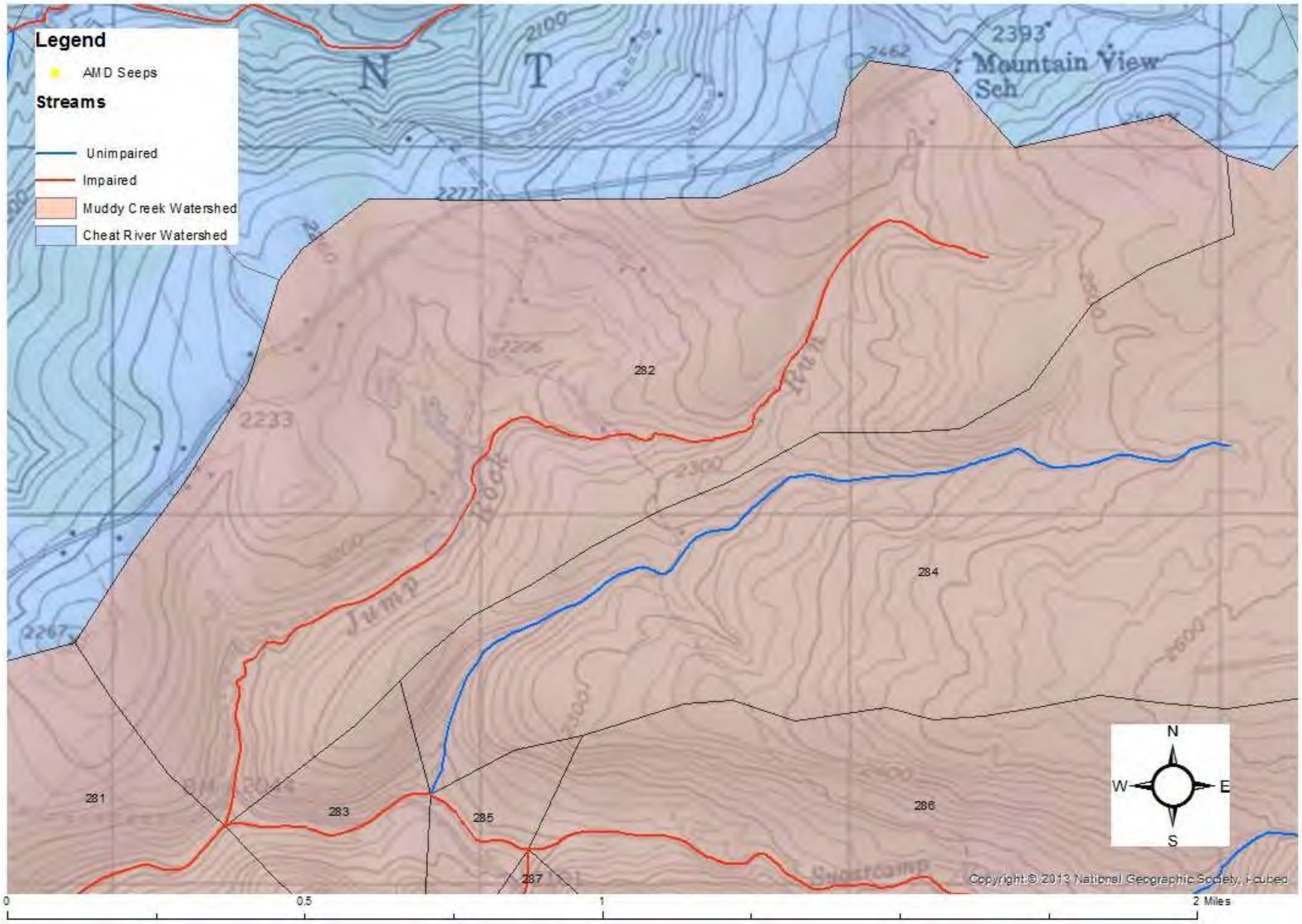
UNT/UNT RM 0.12/Muddy Creek RM 9.80 – SWS 279



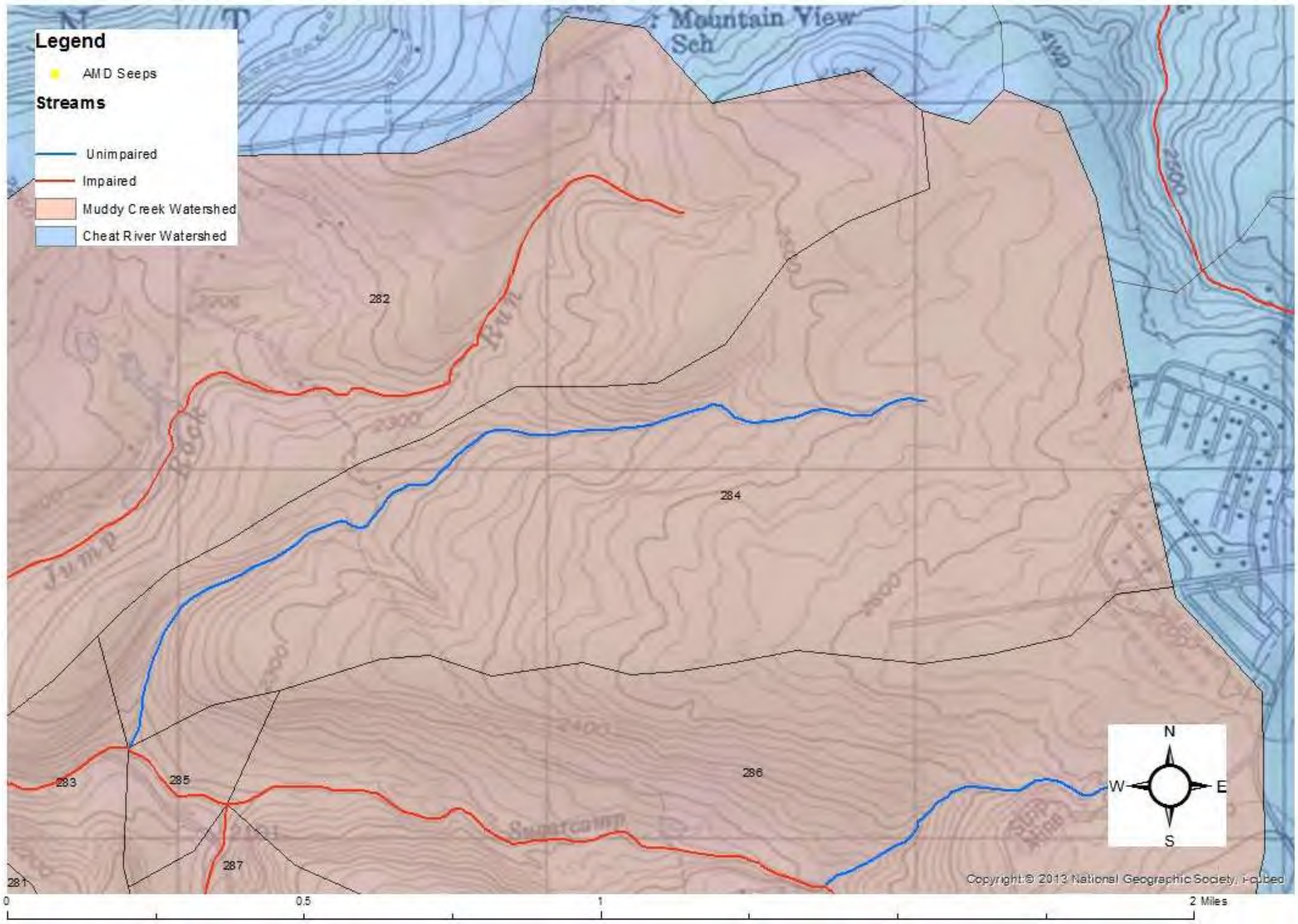
Muddy Creek – SWS 281, 283, 285



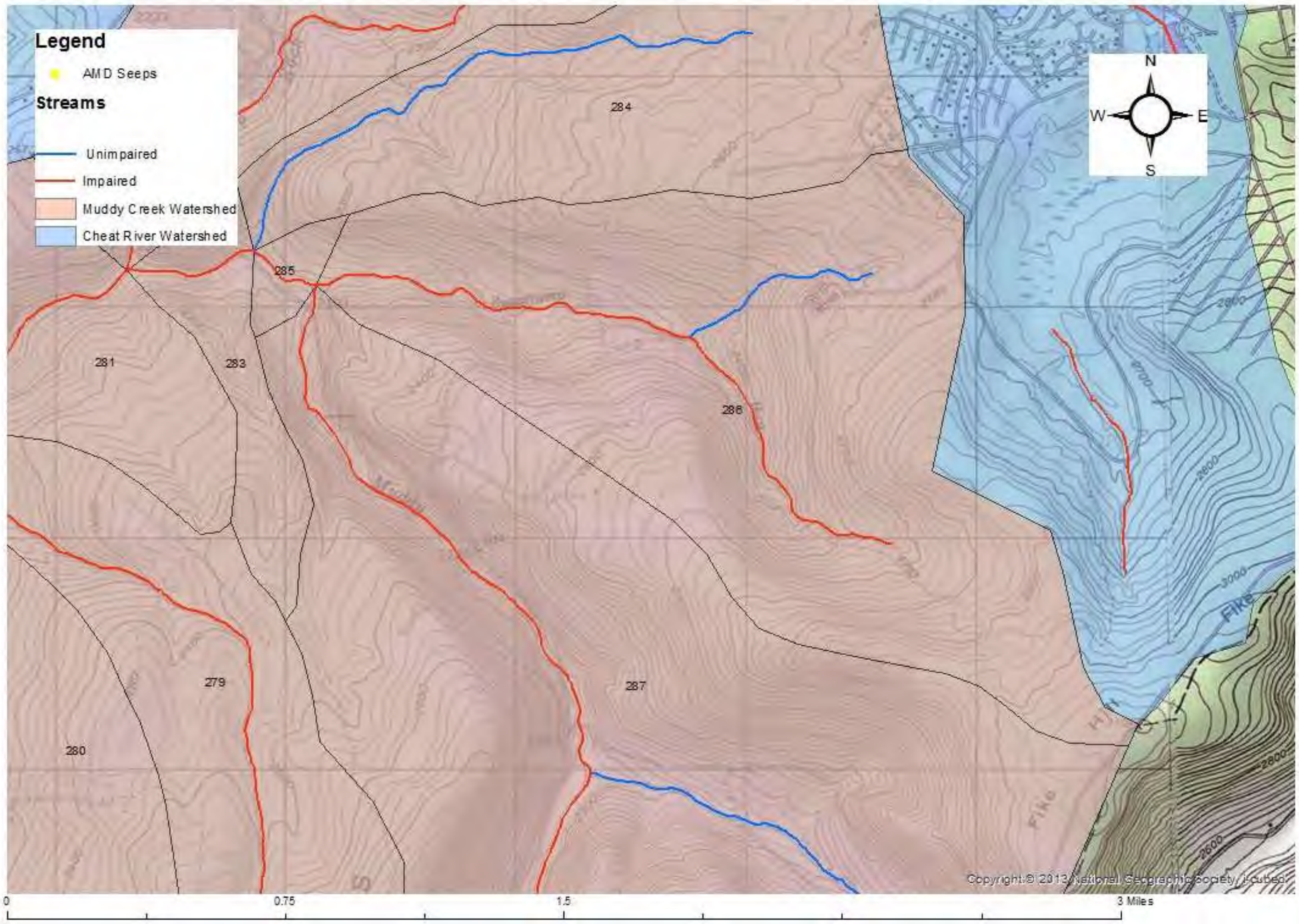
Jump Rock Run – SWS 282



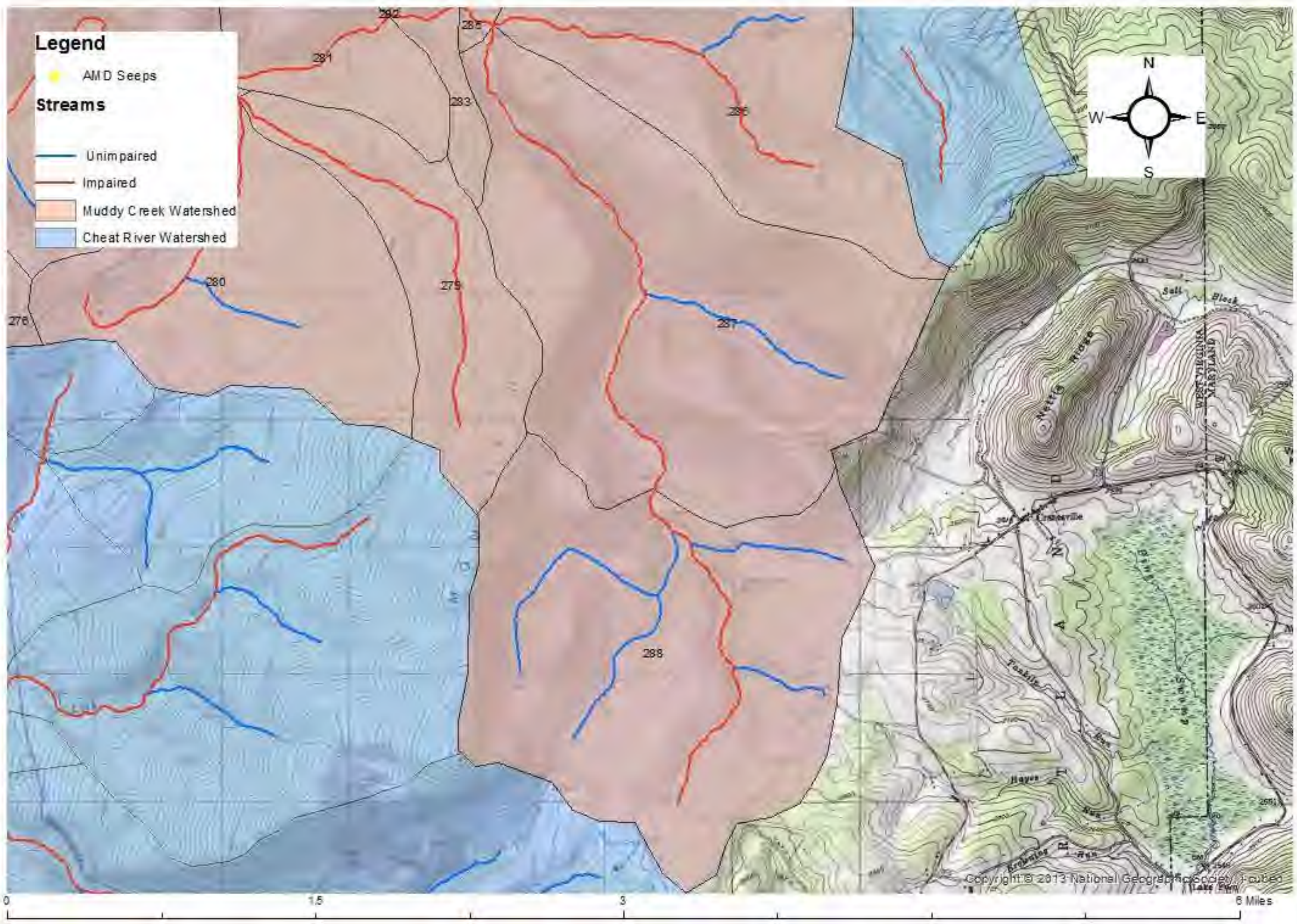
UNT/Muddy Creek RM 11.11 – SWS 284



Sugarcamp Run – SWS 286



Muddy Creek – SWS 287–288



Appendix C: WVDEP OSR support

west virginia department of environmental protection

Division of Land Restoration, Office of Special Reclamation
601 57th St SE
Charleston, WV 25304
Phone: (304) 926-0499

Jim Justice, Governor
Austin Caperton, Cabinet Secretary
dep.wv.gov

Friends of the Cheat
1343 North Preston Highway
Kingwood, WV 26537

The West Virginia Department of Environmental Protection's Office of Special Reclamation (OSR) is in full support of the Friends of the Cheat's (FOC) Watershed Based Plan (WBP) for Muddy Creek in Preston County, West Virginia. For decades, lower Muddy Creek has been polluted with acid mine drainage (AMD) from mostly pre-law, abandoned coal mines, which are ubiquitous throughout the sub-watersheds (Glade, Martin, and Fickey) in Muddy Creek. Bond forfeitures exist as well, to a lesser extent throughout the sub watersheds. Since the mid 90's both OSR and FOC have been treating pre and post law mine sites in the Muddy Creek watershed with no success in aquatic restoration in lower Muddy Creek.

To improve water quality and restore the Lower Muddy Creek watershed, OSR has concentrated on the major sources of AMD throughout the watershed by constructing industrial water treatment facilities, to include the T&T Treatment facility, and the Glade and Martin Creek Instream dosing facilities. FOC is adopting a complementary approach to further enhance the restoration of the lower Muddy Creek watershed by installing and operating water treatment sites on smaller, yet high priority AMD sources throughout the sub watersheds. This strategic approach by FOC will extend water quality improvements of the Muddy Creek watershed upstream of the Martin Creek confluence (by decreasing loads) and ultimately restoring lower Muddy Creek. Treating the high priority secondary and tertiary AMD sources upstream of the Martin Creek Confluence will have a significant effect on the sub watershed/reaches, ultimately improving and restoring the lower Muddy Creek watershed.

The pre-law AMD sources included in FOC's Muddy Creek WBP are sites that have high metal loadings, with flows in excess of 100 gallons per minute (gpm). Developing quality passive or active treatment systems at these sites will decrease loadings and enhance restoration in lower Muddy Creek. It's fiscally unrealistic to treat (passive or active) all the pre-law AMD sources in the sub-watersheds of Glade, Martin and Fickey. All the tributaries in these sub-watersheds are so heinously polluted with AMD that, efforts to treat them, in the foreseeable future, would be moot.

In Summary, FOC's Muddy Creek WBP treatment approach in the upper reaches of the Martin, Glade and Fickey watersheds will decrease loads so that lower Muddy Creek will meet water quality standards and aquatic restoration. The result will be a holistic win-win situation for the lower Muddy Creek watershed.

Mike Sheehan, Deputy Director
WVDEP, Division of Land Restoration