

# Watershed Scale Approach to AMD Remediation

A dosing trial study was conducted by the National Mine Land Reclamation Center (NMLRC) for the West Virginia Department of Environmental Protection (WVDEP) Office of Special Reclamation (OSR) to determine the effectiveness of in-stream dosing in the Martin Creek sub watershed.



Figure 1. Martin Doser (M1).

## Background

Approximately 3.4 stream miles in the Muddy Creek drainage are impaired by AMD. The majority of the acid load comes from the Martin Creek subwatershed, including Fickey Run and Glade Run. According to the Lower Cheat River Watershed Based Plan (WBP), Fickey Run is impaired by two abandoned mine land (AML) and two bond forfeiture sites, while Glade Run is impaired by five AML and five bond forfeiture sites. Both Fickey Run and Glade Run flow into Martin Creek, which receives AMD from two AML sites before it joins Muddy Creek 3.2 miles above its confluence with the Cheat River. Approximately 0.7 miles above Martin Creek, Muddy Creek receives AMD from several AML sources originating from the Dream Mountain Ranch. Muddy Creek supports a quality cold water fishery upstream of Dream Mountain.

## Site Locations

The Fickey (F1) doser was taken off line at the end of January and was moved to the Left Fork Little Sandy site on 12 Feb 16 for project WV 347. However, water quality monitoring on Fickey Run has been continued. The compliance point was moved to the Martin upstream Fickey (MUF) site, rather than at the mouth of Martin. Doser and sampling locations are shown in Figure 2.

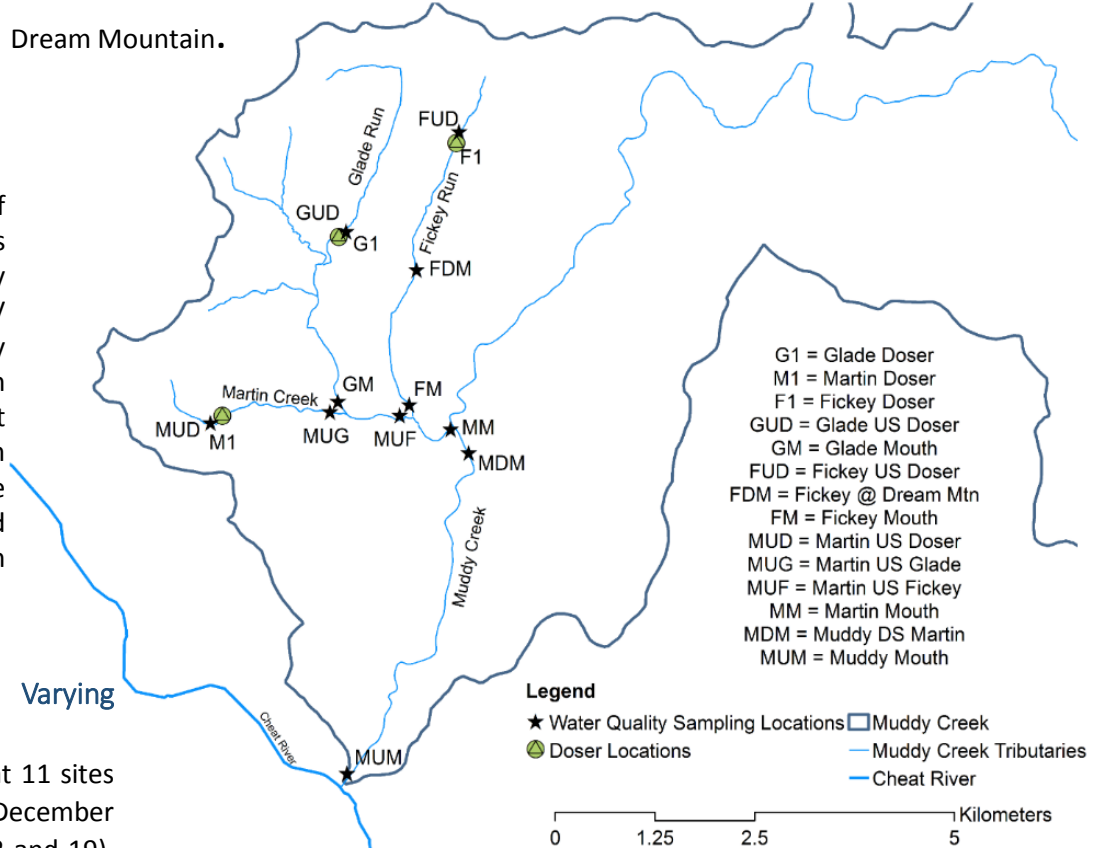


Figure 2. Martin Creek doser and water quality sampling stations.

## Acid and Metal Loading under Varying Conditions

Martin Creek was sampled weekly at 11 sites between 27 October 2015 and 20 December 2016 (with the exception of April 12 and 19). Hydraulic conditions varied widely in these headwater streams both seasonally and in response to storms. At various times both, one or no dosers were engaged as part of the test and in response to power and feed interruptions.

## Sludge Monitoring

Field measured turbidity (via a transparency tube) and laboratory measured TSS provided a measurement of “sludge” at sampling stations. Photos were taken at sites to show aesthetic changes to the Martin Creek watershed in

## Restoration Target Performance

The goal of this project was to determine whether in stream dosing could achieve water quality levels consistent with the three restoration targets: pH (3.2 to 9.0), dissolved aluminum (15 mg/L) and total iron (10 mg/L) as determined at the compliance point: Martin Creek Upstream of Fickey Run (MUF). Despite periodic inconsistencies in doser operations, the pH, dissolved aluminum and total iron targets have been met at MUF since initiation of dosing in early November 2015 (Figure 3).

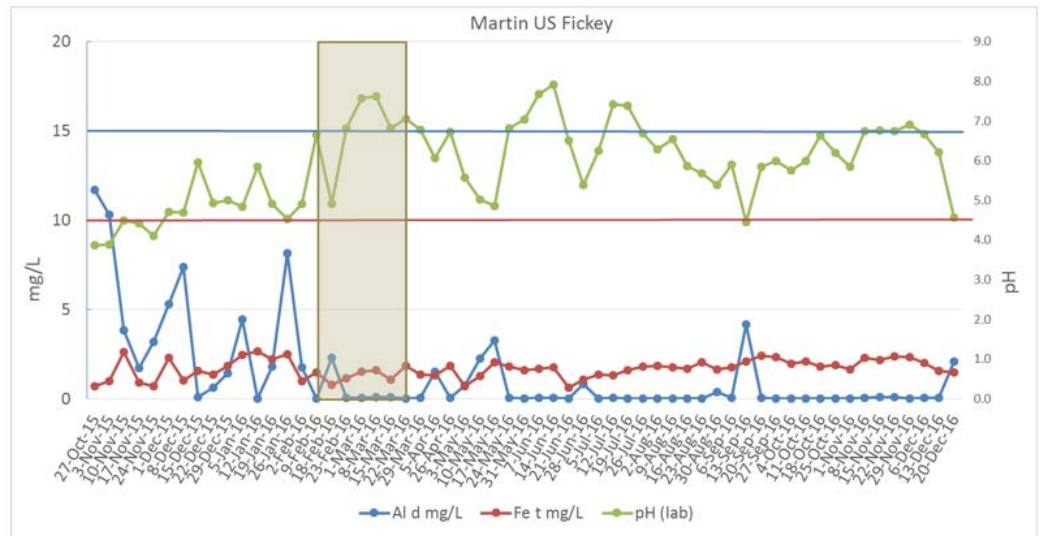


Figure 3. Restoration target performance measured at the compliance point (MUF). The blue horizontal line represents the dissolved aluminum (Al d) restoration target and the red horizontal line represents the total iron (Fe t) restoration target. The shaded area indicates the dates when the Martin Creek at-source dosers were turned off.

## Results

AML discharges in the upstream end of Fickey Run are responsible for the majority of iron loading to Martin Creek. Dosing trials in November 2015 through January 2016 caused dissolved iron to precipitate resulting in significant iron hydroxide moving through Martin Creek and into Muddy Creek, particularly during high flow conditions. As a result it was decided to terminate dosing at the upper Fickey Run location and move the compliance point to Martin Creek immediately upstream of its junction with Fickey Run.

Figure 4 depicts stream conditions when F1 was operational. Total suspended solids (TSS) were measured weekly and showed no correlation with flow (Q) as shown in Figure 5. The tables and below figures show loadings in tons per year (tpy) which are calculated by a formula using concentration (mg/L) and flow (gpm).



Figure 4. Fickey Run at Dream Mountain (left); Martin Creek entering Muddy Creek (right) on 17 November 2015.

Table 1. Average contaminant loads during low flow at Martin US Fickey with doser operating status, t=total, d=dissolved.

LOW FLOW < 1000 gpm						
		tpy	tpy	tpy	tpy	tpy
AVERAGE	pH	Acid Load	Al t Load	Fe t Load	Al d Load	Fe d Load
Both OFF	4.1	78	13	1.7	11	1
Both ON	7.4	6	6	1.5	0	0
One ON	4.3	38	17	1.0	4	0

Table 2. Average contaminant loads during low flow at Martin US Fickey with doser operating status, t=total, d=dissolved.

NORMAL FLOW 1000-4000gpm						
		tpy	tpy	tpy	tpy	tpy
AVERAGE	pH	Acid Load	Al t Load	Fe t Load	Al d Load	Fe d Load
Both OFF	3.9	347	51	4	-	3
Both on	6.5	30	39	10	1	0
One on	6.1	36	30	8	3	1

Table 3. Average contaminant loads during low flow at Martin US Fickey with doser operating status, t=total, d=dissolved.

HIGH FLOW >4000 gpm						
		tpy	tpy	tpy	tpy	tpy
AVERAGE	pH	Acid Load	Al t Load	Fe t Load	Al d Load	Fe d Load
Both OFF	4.4	429	89	20	59	9
Both on	6.4	149	113	25	15	2
One on	5.5	193	92	26	23	2

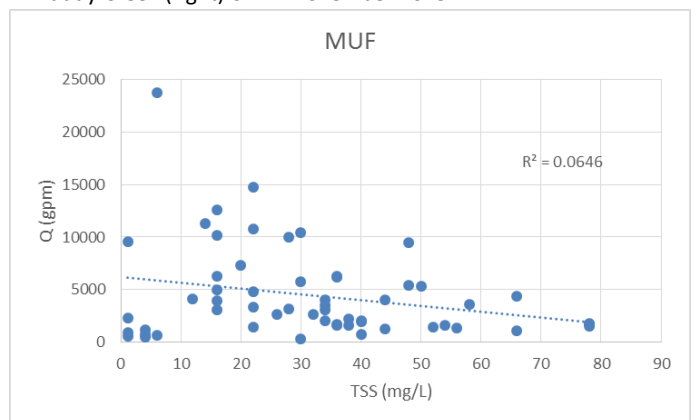


Figure 5. Total Suspended Solids (TSS) and Flow (Q) at Martin Upstream Fickey (MUF) site.