west virginia department of environmental protection

Office of Special Reclamation
47 School Street, Suite 301
Philippi, WV 26416
Phone: 304-457-3219
Fax: 304-457-5613

Austin Caperton, Cabinet Secretary
dep.wv.gov

Squires Creek, Bird's Creek, and Raccoon Creek Watershed Variance

I. Variance Language from WV Rule, Requirements Governing Water Quality Standards, §47 CSR 2 7.2.d.8.2.

The West Virginia Department of Environmental Protection's (WVDEP) Office of Abandoned Mine Lands (AML) has been treating Squires Creek, both forks of Birds Creek, and Raccoon Creek, with lime dosers since April 2011 with the goal of restoring the Three Fork Creek Mainstem. All three streams are heavily impaired with Acid Mine Drainage (AMD) from pre-law mining. And, prior to 2011, the Three Fork mainstem was impaired with AMD as well. In support of the continuation of this ongoing restoration project, the WVDEP's Division of Land Restoration's (DLR) Office of Special Reclamation (OSR) is applying to request three (3) variances pursuant to 46 CSR 6, Section 5.1. The variances shall apply to OSR's Bond Forfeiture (BF) discharges into Squires Creek, Bird's Creek, and Raccoon Creek and their unnamed tributaries with the goal of continued Three Fork Creek Restoration. Again, these creeks are major AMD impaired tributaries of Three Fork Creek, a tributary of the Tygart River. The circumstance being used to request these variances is that continuing to treat post-law AMD at the BF mine sites in these watersheds simply has no measurable effects on downstream water quality, when compliant water is discharged into AMD impaired streams from historic pre-law mining. Additionally, the circumstance being used to request these variances is that human-caused conditions or sources of pollution, in this case pre-law AMD, prevents the full attainment of any designated use and cannot be immediately remedied. Combining resources between the pre-law and post-law reclamation programs will ensure healthy aquatic resources for future generations in West Virginia.

To further clarify, the bond forfeited mine sites with existing National Pollutant Discharge Elimination System (NPDES) permits in the three variance watersheds will be relinquished and turned off. AMD emanating from the BF site will discharge directly into Squires, Birds, and Raccoon Creeks, or tributaries thereof. New NPDES points will be established ***In-Stream*** at the mouths of Squires, Birds, and Raccoon Creeks, instead of the BF point source discharge.

It is important to note that these creeks have never been able to meet their designated uses as a result of human-caused conditions (pre-law mining) that were in existence before the stream designations were assigned. Existing pollutant concentrations prevent attainment of the following designated uses: pH for any designated use; iron for aquatic life use and human health use; and dissolved aluminum for aquatic life use. Pre-law mining is ubiquitous in the Three Fork watershed and to correct or remediate the pre-law mining impacts would be fiscally and environmentally impractical. Land disturbance from developing all the pre-law mining treatment sites would have a much greater environmental impact due to forest fragmentation and habitat loss in the watershed.

Alternative restoration measures, as described in this variance application submitted by WVDEP-OSR, shall be used to achieve significant improvements to existing conditions in these waters during the variance period. Conditions will be evaluated and reported upon during each triennial review throughout the variance period. This variance shall remain in effect until action by the Secretary to revise the variance or until July 1, 2031, whichever comes first.

II. Watershed Information

Three Fork Creek is situated in West Virginia's Preston and Taylor counties, with a drainage area of 103 square miles (Map 1). The headwaters are predominantly located in Preston County, with minor contributing tributaries originating in Monongalia and Taylor counties at elevations exceeding 2,200 feet. The mainstem, located in Preston (7.5 miles) and Taylor (11 miles) counties, is formed by the confluence of Birds Creek, Squires Creek, and Fields Creek in western Preston County. Three Fork Creek then flows southwest before emptying into the Tygart Valley River (in the Monongahela River basin) in the city of Grafton, Taylor County, at an elevation of 1,000 feet. The chief tributaries of Three Fork Creek are Birds Creek (consisting of the North and South Fork), Fields Creek, Raccoon Creek, Squires Creek, and Laurel Run.

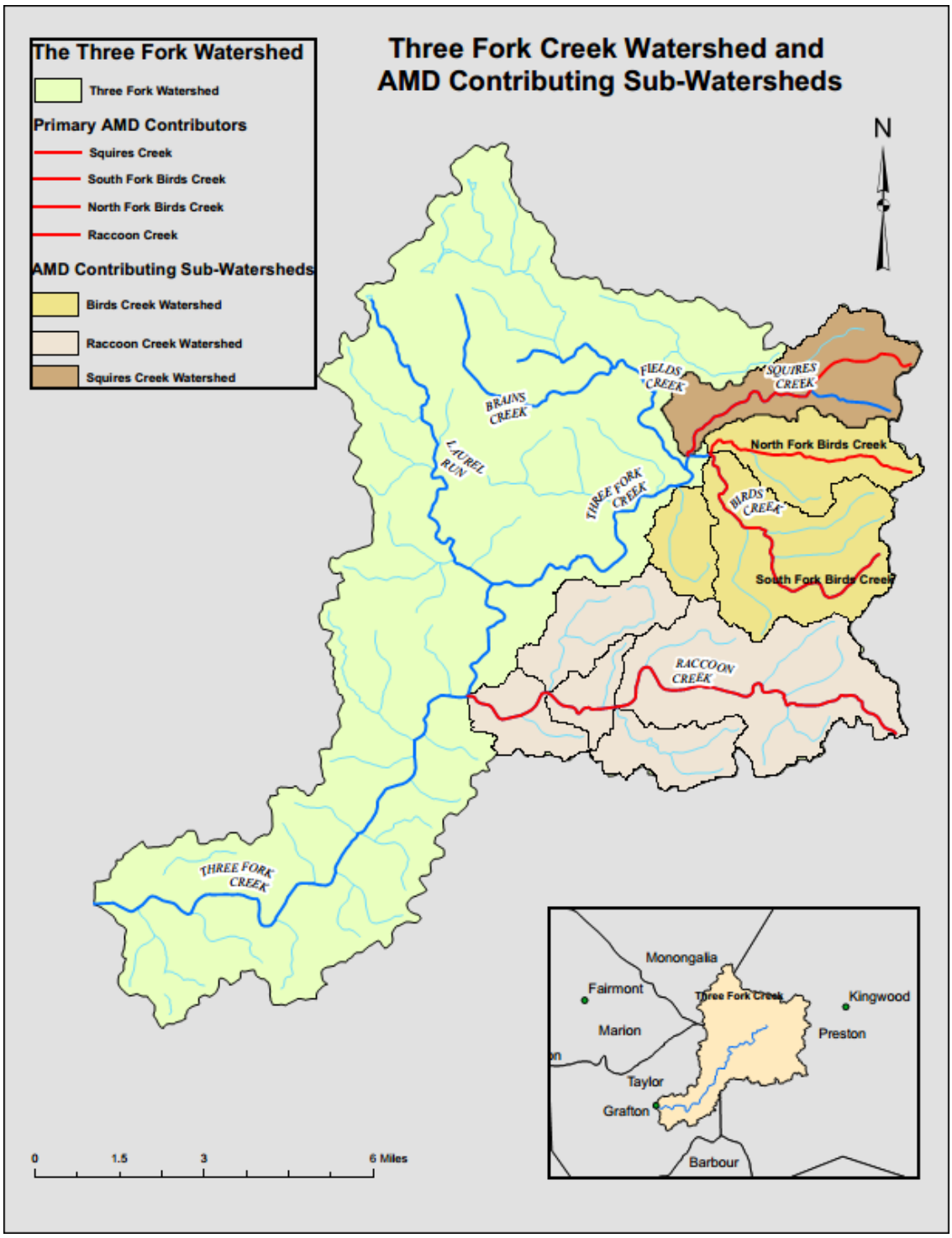
Except for Laurel Run and Fields Creek, acid mine drainage (AMD) generated from extensive pre-SMCRA underground mining had degraded the chief tributaries of Three Fork Creek. As a result, the entire length of the Three Fork Creek mainstem was mostly devoid of aquatic life. The effects of AMD impairment extended from Three Fork Creek downstream into the Tygart Valley River (Figure 1). In 2004 the West Virginia Division of Natural Resources (WVDNR) determined that Three Fork Creek was the second highest contributor of AMD in the Monongahela River basin. When localized rainstorms occurred in the Three Fork Creek watershed during low flow conditions, acid slugs were pushed downstream, sometimes causing fish kills in the Tygart Valley River. High concentrations of acid and iron carried by Three Fork Creek from abandoned coal mines created a plume (Figure 1) in the river through the town of Grafton.

Land use within Three Fork Creek's watershed is primarily farming and mining. Several small communities exist along the stream and its main tributaries; these include Gladesville, Independence, Newburg, Denver, and Thornton. Grafton and Blueville are

located at the mouth of Three Fork Creek. There are no drinking water intakes on Three Fork Creek or any of the tributaries for which variances are being sought.

In the upstream reaches of the Three Fork Creek watershed much of the stream is bordered with woody riparian vegetation. The riparian areas contain species such as sugar maple, red maple, river birch, oak, and rhododendron. From the community of Three Fork Bridge (two miles downstream of the beginning of Three Fork Creek) to one mile downstream, the creek is bordered by residential areas on one side and by forested hillside on the other. Downstream, the creek is inaccessible by road (for about three miles) until Martin Run near Victoria. This is the only section of the creek that is not bordered by a road. There are three islands in the creek downstream of Victoria. Hemlock, sycamore, and white pine vegetate these islands. Downstream to the mouth of Raccoon Creek, the riparian area includes trees such as elm, hemlock, sycamore, sugar maple, redbud, and willow.

Figure 1. Plume from Three Fork Creek in Tygart Valley River at Grafton.



Map 1. Three Fork Creek watershed and AMD contributing sub-watersheds.

Streams

Bird's Creek, a perennial stream, is in Preston County with a watershed area of approximately 17.022 square miles (10,893.77 acres) and an average flow of approximately 6.36 cfs. The widths of the stream vary along its reach, 3 to 20 feet with an average of 12 feet. Stream bed substrate is comprised of mainly boulder and cobble,

bedrock is more prominent in the upper reaches and gravel components increase towards the mouth.

Squires Creek, a perennial stream, is in Preston County with a watershed area of approximately 5.283 square miles (3,381.34 acres) and an average flow of approximately 4.91 cfs. The widths of the stream vary along its reach, 3 to 20 feet with an average of 12 feet. Stream bed substrate is comprised of mainly boulder and cobble, bedrock is more prominent in the upper reaches and gravel components increase towards the mouth.

Raccoon Creek, a perennial stream, is in Preston County with a watershed area of approximately 18.435 square miles (11,798.48 acres) and an average flow of approximately 5.803 cfs. The widths of the stream vary along its reach, 3 to 20 feet with an average of 12 feet. Stream bed substrate is comprised of mainly boulder and cobble, bedrock is more prominent in the upper reaches and gravel components increase towards the mouth.

Existing Conditions

i. Pre-Dosing (before 2011)

AMD impacts to Three Fork Creek are primarily from Squires Creek (Table 1), Birds Creek (Table 2), and Raccoon Creek (Table 3) and their tributaries. These tables depict the water quality at the variance tributary mouths prior to the AML Three Fork Creek Restoration Project. A TMDL was approved for the Tygart Valley River which includes the Three Fork Creek watersheds by the EPA in 2016. According to the approved TMDL report, Squires Creek, Bird's Creek, Raccoon Creek and Three Fork Creek are impaired for pH, Aluminum, and Iron. In 2010, a partnership between AML, WVU, and Save the Tygart, a local watershed group, was developed to restore Three Fork Creek to its Pre-mining conditions. The restoration objectives of the partnership were to improve water chemistry and aesthetics in the Three Fork Creek mainstem to conditions that could support recreational opportunities, while restoring aquatic life. To date, four lime dosers have been placed in headwater tributaries and have produced positive results since. Benthic macro-invertebrate and fish surveys since 2011 have shown immense improvement when compared with pre-dosing surveys.

Site Description	Date	Field pH	T Al mg/l	T Fe mg/l
Squires Creek at mouth	10/19/2000	2.90	11.11	2.87
Squires Creek at mouth	6/23/2009	3.70	6.65	4.31
Squires Creek at mouth	7/6/2009	3.40	9.46	3.04
Squires Creek at mouth	7/27/2009	3.50	12.70	2.99
Squires Creek at mouth	9/1/2009	3.90	9.93	1.94
Squires Creek at mouth	10/5/2009	3.90	10.60	1.71
Squires Creek at mouth	3/18/2010	3.50	7.86	9.51
Squires Creek at mouth	7/28/2010	3.50	9.85	1.86

Table 1. Squires Creek mouth

Site Description	Date	Field pH	T Al mg/l	T Fe mg/l
Birds Creek at mouth	7/6/2009	3.90	9.60	0.42
Birds Creek at mouth	7/27/2009	4.00	12.40	0.27
Birds Creek at mouth	9/1/2009	4.40	9.41	0.14
Birds Creek at mouth	10/5/2009	4.70	10.40	0.18
Birds Creek at mouth	3/18/2010	3.90	7.21	1.83
Birds Creek at mouth	7/28/2010	4.10	9.27	0.18

Table 2. Birds Creek Mouth

Site Description	Date	Field pH	T Al mg/l	T Fe mg/l
Raccoon Creek @ mouth	10/19/2000	4.80	4.85	0.41
Raccoon Creek at mouth	7/6/2009	4.00	9.26	0.40
Raccoon Creek at mouth	7/27/2009	3.80	9.95	0.36
Raccoon Creek at mouth	9/1/2009	4.10	11.10	0.32
Raccoon Creek at mouth	10/5/2009	4.10	11.20	0.30
Raccoon Creek at mouth	3/18/2010	3.80	6.32	6.12
Raccoon Creek at mouth	7/28/2010	4.50	5.33	0.23

Table 3. Raccoon Creek mouth

ii. Post Dosing (after 2011)

The following existing conditions will serve as instream interim criteria while this variance is in place. It's important to note, the existing conditions include the last nine (9) months, since April 2019, of post-dosing mouth data for Squires Creek, Birds Creek, and Raccoon Creek (Tables 4,5, and 6). For Squires Creek, pH range of 4.47-9.0, 5.34 mg/L total iron, and 5.97 mg/L dissolved aluminum; for Bird's Creek, pH range of 5.54-9.0, 2.47 mg/L dissolved aluminum, and for Raccoon Creek, 3.73 mg/L total iron. Alternative restoration measures, as described in the variance application submitted by OSR shall be used to maintain and improve existing conditions in these waters during the variance period. Conditions will be evaluated and reported upon during each triennial review throughout the variance period. This variance shall remain in effect until action by the Secretary to revise the variance or until July 1, 2031, whichever comes first.

SITE_DESC	SAMPLE_DATE	FPH	D_AL	T_FE
Squires Creek Mouth	4/17/2019	5.16	1.78	2.13
Squires Creek Mouth	5/8/2019	7.45	0.06	4.1
Squires Creek Mouth	6/3/2019	6.81	0.03	4.9
Squires Creek Mouth	6/12/2019	7.46	0.04	3.6
Squires Creek Mouth	7/26/2019	6.29	0.03	5.31
Squires Creek Mouth	8/16/2019	7.56	0.03	4.07
Squires Creek Mouth	9/11/2019	7.4	0.03	2.61
Squires Creek Mouth	10/15/2019	7.56	0.33	1.85
Squires Creek Mouth	11/14/2019	7.73	0.03	3.01

Squires Creek Mouth	12/16/2019	4.47	4.06	2.87
Squires Creek Mouth	1/14/2020	4.51	5.97	5.34
Squires Creek Mouth	2/4/2020	5.11	2.03	4.64

Table 4. Squires Creek Post-Treatment Data Since April 2019-January 2020.

SITE_DESC	SAMPLE_DATE	FPH	D_AL	T_FE
Birds Creek Mouth	4/17/2019	6.6	0.04	0.32
Birds Creek Mouth	5/8/2019	7.73	0.18	0.49
Birds Creek Mouth	6/3/2019	7.13	0.12	0.62
Birds Creek Mouth	6/12/2019	7.58	0.07	0.51
Birds Creek Mouth	7/26/2019	6.85	0.03	0.41
Birds Creek Mouth	8/16/2019	7.82	0.14	0.18
Birds Creek Mouth	9/11/2019	7.56	0.05	0.07
Birds Creek Mouth	10/15/2019	7.65	0.03	0.11
Birds Creek Mouth	11/14/2019	7.69	0.03	0.44
Birds Creek Mouth	12/16/2019	5.54	2.47	0.74
Birds Creek Mouth	1/14/2020	6.2	0.08	0.78
Birds Creek Mouth	2/4/2020	6.17	0.12	0.82

Table 5. Birds Creek Post-Treatment Data Since April 2019-January 2020.

SITE_DESC	SAMPLE_DATE	FPH	D_AL	T_FE
Racoon Creek Mouth	4/17/2019	7.22	0.01	0.78
Racoon Creek Mouth	5/8/2019	7.52	0.04	2.82
Racoon Creek Mouth	6/3/2019	7.38	0.02	3.73
Racoon Creek Mouth	6/12/2019	7.48	0.03	2.95
Racoon Creek Mouth	7/26/2019	7.53	0.03	1.15
Racoon Creek Mouth	8/16/2019	7.57	0.03	0.87
Racoon Creek Mouth	9/11/2019	6.92	0.03	0.19
Racoon Creek Mouth	10/15/2019	7.52	0.03	0.16
Racoon Creek Mouth	11/14/2019	8.26	0.09	2.76
Racoon Creek Mouth	12/16/2019	7.86	0.03	1.03
Racoon Creek Mouth	1/14/2020	7.5	0.03	1.37
Racoon Creek Mouth	2/4/2020	7.42	0.03	2.94

Table 6. Raccoon Creek Post-Treatment Data Since April 2019-January 2020.

III. Restoration Goals

Through the Abandoned Mine Lands Program's (AML) Three Fork Creek Watershed restoration Project, the restoration goal has been met for 17.5 miles of the Three Fork Creek Mainstem. OSR plans to partner with AML and continue the ongoing restoration of the Three Fork Creek Mainstem to its designated stream usage by decreasing the water quality impairment from AML and Bond Forfeiture (BF) coal mine discharges within the watershed. The Three Fork Creek restoration will continue to improve water

quality, aquatic life and recreational opportunities, such as fishing, kayaking, and swimming, as well as stream aesthetics.

IV. NPDES Permits Subject to Stream Variance

A. Maps 2, 3 and 4 depict current Bond Forfeiture (BF) discharges in the Three Fork Creek Watershed, and number of NPDES outlets.

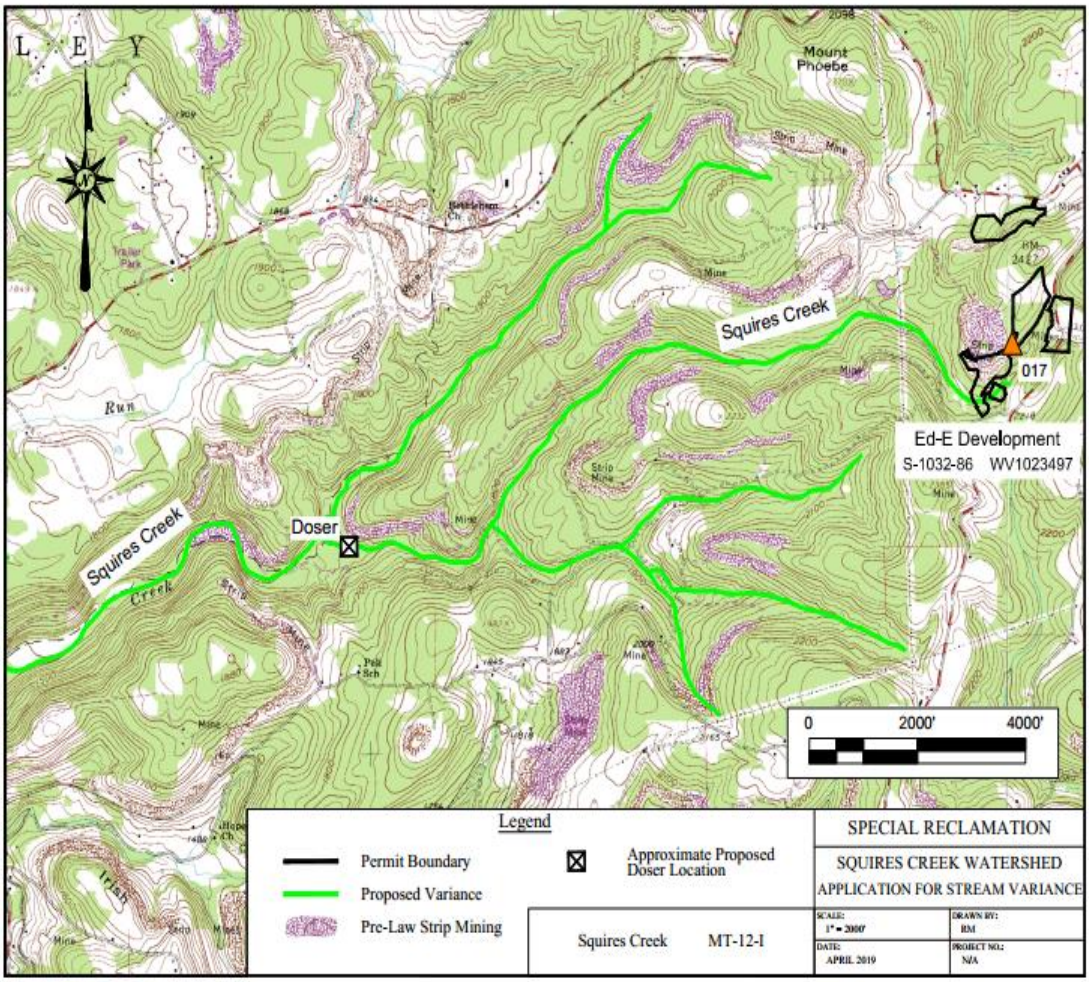
i. **Preston Energy O-1035-87/O-43-85** (WV1023471) – two (2) active treatment sites using lime dosing units. Each site has one (1) NPDES outlet. Both sites have a combined average flow of 0.3717 cfs.

ii. **Ed-E S-1032-86** (WV1023497) – an active treatment site using a lime dosing unit (recently upgraded) with one (1) NPDES outlet. This site which has an average flow of 0.1086 cfs.

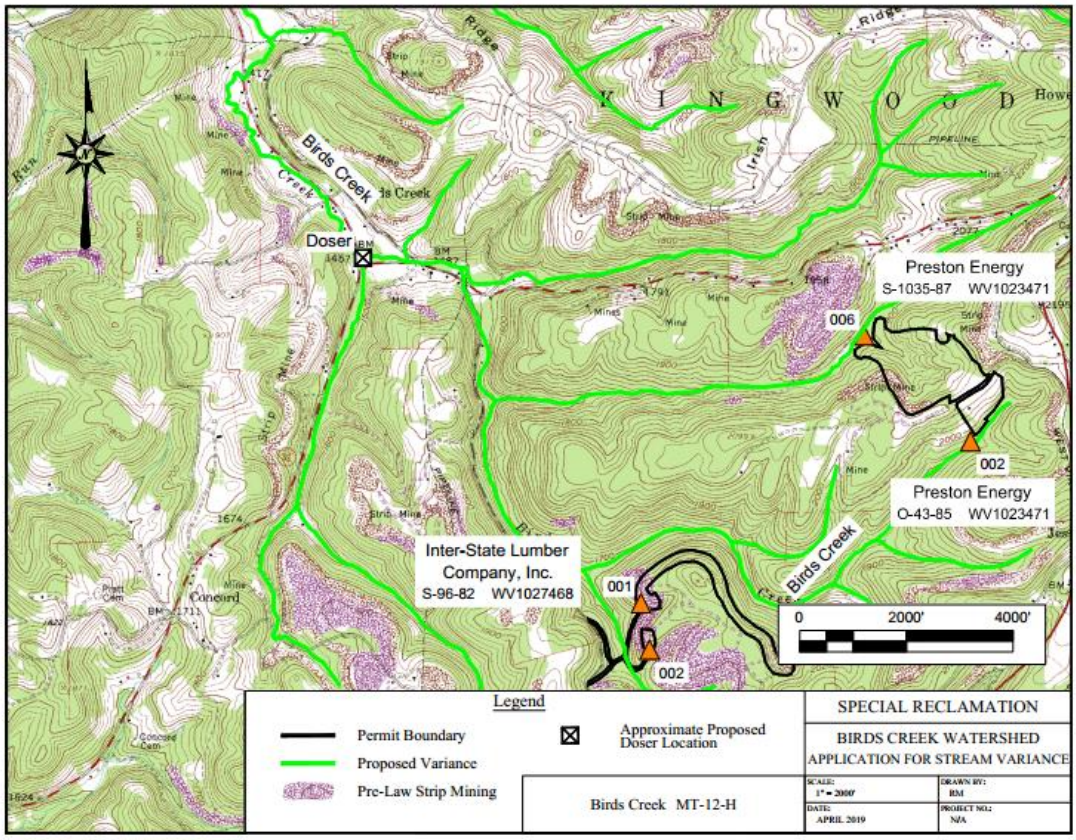
iii. **Interstate Lumber S-96-82** (WV1027468) – a passive treatment site with one (1) NPDES outlet. This site does not discharge.

iv. **Interstate Lumber S-52-83** (WV1027476) – an active treatment site with one (1) NPDES outlet. This site has an average flow of 0.2330 cfs.

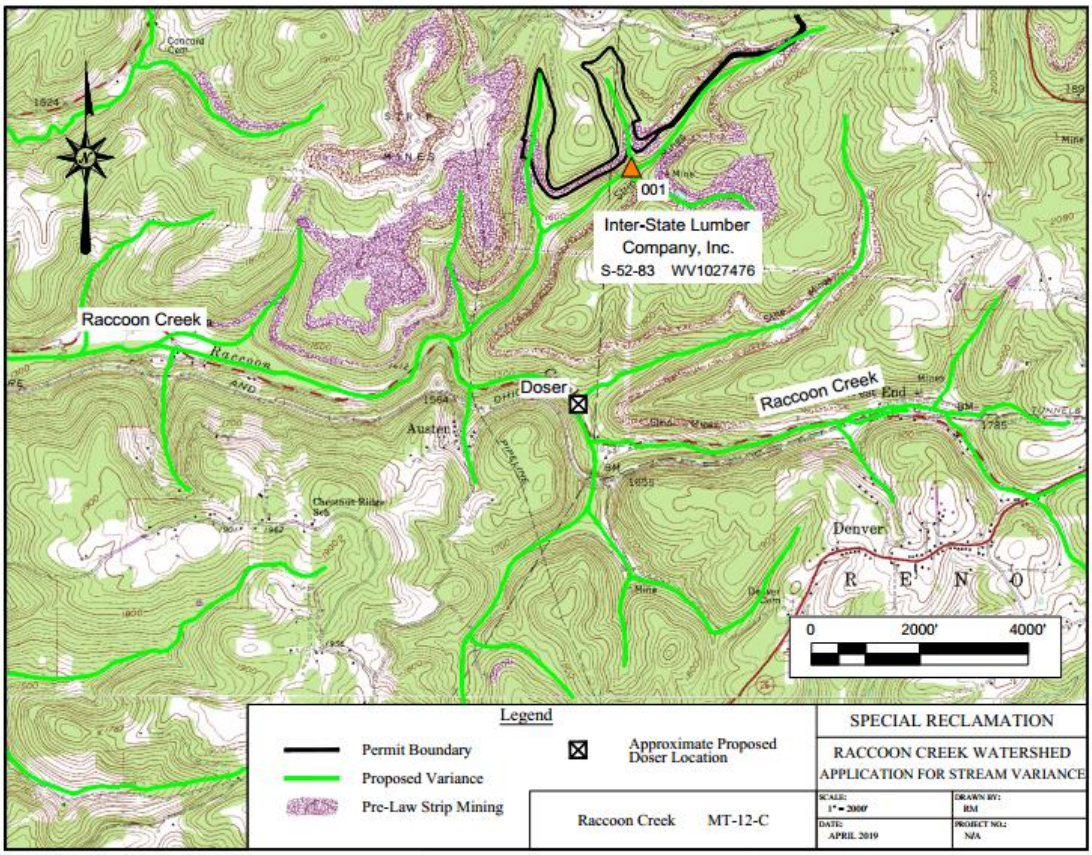
v. **Interstate Lumber S-39-82** (WV1027522) - a proposed site "To be Constructed" (TBC) with two (2) NPDES outlets.



Map 2. U.S.G.S 7.5 minute Quad, current BF with NPDES outlets in Squires Creek



Map 3. U.S.G.S 7.5 minute Quad, current BF sites with NPDES outlets in Birds Creek



Map 4. U.S.G.S 7.5 minute Quad, current BF sites with NPDES outlets in Raccoon Creek.

V. Rationale

To improve and restore AMD impaired watersheds for future generations, it's imperative to combine resources. As mentioned earlier, combining resources between the two offices will ensure effective and efficient operation of watershed restoration efforts. Furthermore, cost sharing will allow the AML program to explore restoration options in other watersheds that are impaired by pre-law mine drainage. Due to the volume of impaired water resources in the Three Fork Creek watershed from pre-law abandoned coal mines, continuing water treatment at bond forfeiture sites has no measurable impacts on receiving stream water quality, therefore a waste of time and money. So, the rationale is; by applying for variances in Squires Creek, Birds Creek, and Raccoon Creek, monies saved by turning off OSR sites in theses drainages will be better utilized for operation and maintenance at WVDEP in-stream doser facilities. Ultimately, these variances will aid in the long-term continuation of the Three Fork Creek Restoration Project.

Acid Mine Drainage (AMD) from AML sources are 90%, 61% and 96% of the loadings for Squire's Creek, Bird's Creek, and Raccoon Creek respectively. The remaining 10%, 39% and 4% would be attributed to OSR BF sites (Map 5).

OSR has constructed six (6) active treatment sites and three (3) passive treatment sites within the Three Fork Creek Watershed. Two (2) active treatment sites, Ed-E, S-10-81

and VMS Limited, S-1045-87 discharge into high quality streams and will remain in operation as active treatment systems (Map 6). VMS, S-1045-87 also has two (2) passive sites with NPDES outlets that will remain. OSR has seven (7) NPDES outlets in the Three Fork Creek watershed, that will be subject to the stream variance. The total capital cost for water treatment construction for the above listed permits subject to the stream variance was approximately $2.1 million. OSR has spent approximately $1.1 million to date for operations and maintenance (since revocation), or roughly $45,000 annually. Without an alternative permitting structure, OSR will spend an additional $800,000 to construct a new active treatment site with operational cost exceeding $50,000 annually. As mentioned earlier, an alternative permitting structure will allow restoration in the Three Fork Creek watershed to continue long-term.

Water Treatment will continue at sites where OSR discharges into high quality trout streams.

In the Spring of 2018 WVDEP AML and OSR staff conducted a brief water quality analysis of the South Fork of Bird's Creek, above the AML in-stream doser. The analysis was conducted to determine if OSR's Preston Energy site (O-1035-87/O-43-85), which has high iron/acidity loadings, had any changes to water quality when the site was NOT being treated with hydrated lime. Table 8 depicts water quality from April through June 2018 at varying flows, low, medium, and high. In two (2) sampling events, at low and high flows, the acidity, iron, and aluminum levels were higher with treatment on, rather than off. One (1) sampling event at medium flow on 5/12/18 and 4/9/18 respectively, showed acidity, iron, and aluminum higher with treatment off, rather than on. The other medium flow sampling event on 5/3/18 and 5/9/18, showed iron and aluminum levels higher with treatment on, but acidity levels were lower with treatment on.

Date	Treatment	Flow (cfs)	Flow (gpm)	pH	Fe (mg/l	Al (mg/l)	Acidity (mg/l)
04/06/18	on	27.11 (High)	12167.81	3.80	0.82	4.74	54
05/15/18	off	32.76 (High	14703.70	3.82	0.59	3.49	29
05/03/18	on	5.26 (Medium)	2360.85	3.50	0.95	7.14	65
05/09/18	off	9.6 (Medium)	4308.78	3.80	0.64	5.27	71
05/21/18	on	8.87 (Medium)	3981.13	3.70	0.56	5.44	42
04/09/18	off	13.45 (Medium)	6036.78	3.60	1.04	6.75	73
06/05/18	on	2.34 (Low)	1050.26	3.70	0.68	9.39	76
06/18/18	off	2.98 (Low)	1337.52	3.76	0.44	6.67	61

Table 8. Preston Energy analysis.

In the Fall of 2018 and winter of 2019 WVDEP AML/OSR staff collected water quality grab samples and flows upstream of each active doser on Squires, North Fork Birds Creek, South Fork Birds Creek and Raccoon Creek (Map 9). The analysis was conducted to show the severity of AMD in each of these watersheds and the continued need for the Three Fork Creek Restoration Project. Each site was sampled five (5) times from October 2018 through February 2019. Table 9 shows water quality analysis for each upstream sample. Sample Number 441 – South fork Birds Creek upstream doser

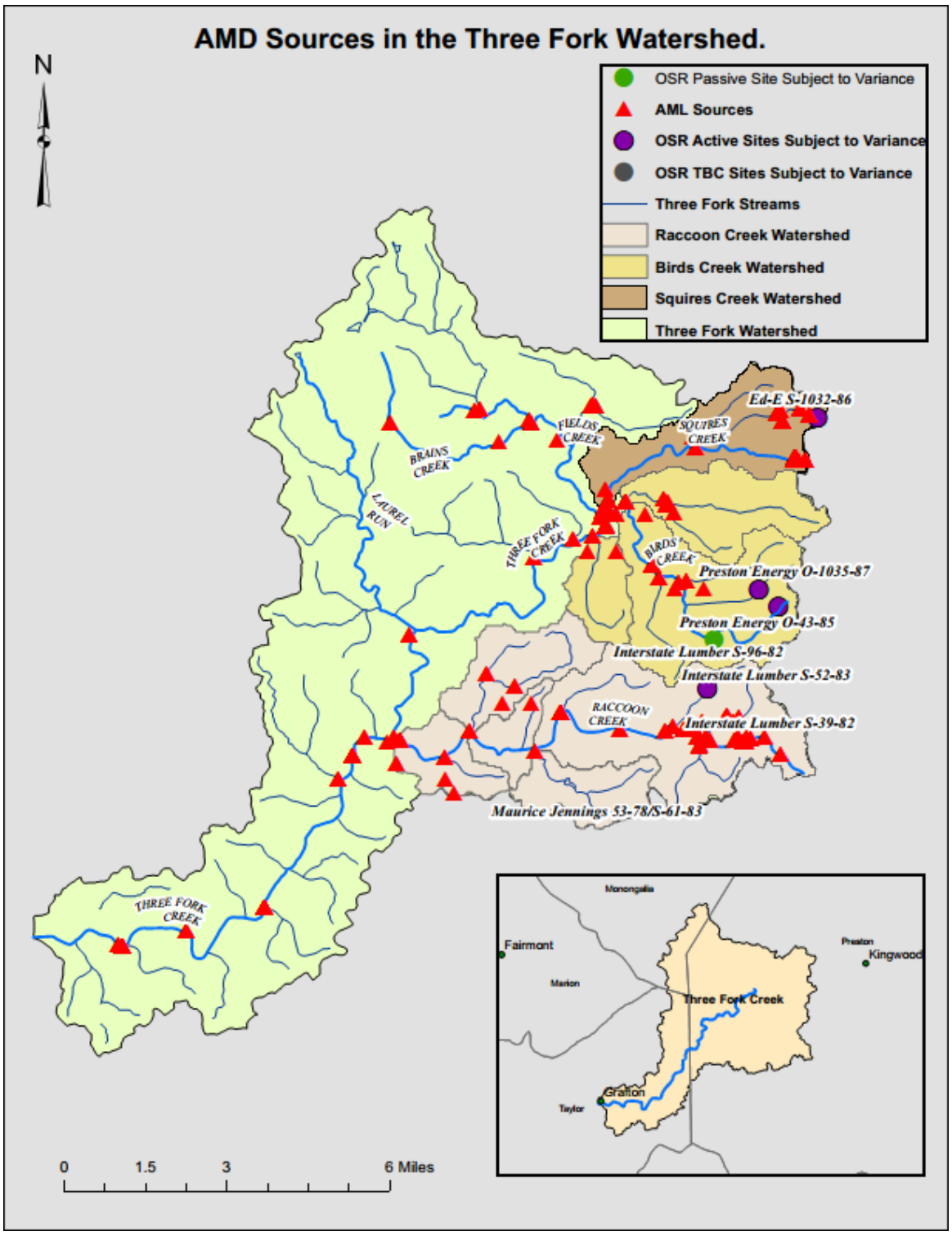
effluent showed 4,100.76 lbs./day of acidity, 44.8 lbs./day of iron, and 321 lbs./day of aluminum. Sample number 47- North Birds Creek upstream doser effluent showed 2,152.78 lbs./day of acidity, 33.32 lbs./day of iron, and 171.15 lbs./day of aluminum. Sample number 51 - Squires Creek upstream doser effluent showed 3,586.35 lbs./day of acidity, 278 lbs./day of iron, and 295 lbs./day of aluminum. Sample number 66 - Raccoon Creek upstream doser effluent showed 2,134 lbs./day of acidity, 220 lbs./day of iron, and 277 lbs./day of aluminum.

Sample ID	Site Description	Date	Flow (cfs)	pH	T Al (mg/l)	T Fe (mg/l)	Acid (mg/l)
441	South Birds Creek U.S. doser effluent	10/10/2018	5.2605	3.50	7.14	0.95	65.00
47	North Fork Birds Creek U.S. doser effluent	10/10/2018	2.7823	3.34	8.52	1.64	84.00
51	Squires Creek U.S. doser effluent	10/10/2018	3.2285	2.94	12.60	9.62	200.00
66	Raccoon Creek U.S. doser effluent	10/10/2018	3.6819	3.49	14.90	11.60	116.00
441	South Birds Creek U.S. doser effluent	10/31/2018	13.9900	3.72	4.28	0.61	85.00
47	North Fork Birds Creek U.S. doser effluent	10/31/2018	10.3200	3.71	3.65	0.80	65.00
51	Squires Creek U.S. doser effluent	10/31/2018	7.4720	3.09	8.30	7.80	62.00
66	Raccoon Creek U.S. doser effluent	10/31/2018	10.0700	4.85	4.39	3.59	48.00
441	South Birds Creek U.S. doser effluent	12/3/2018	14.4800	3.75	4.76	0.59	59.00
47	North Fork Birds Creek U.S. doser effluent	12/3/2018	10.0000	3.77	3.66	0.68	52.00
51	Squires Creek U.S. doser effluent	12/3/2018	8.5900	3.05	7.93	7.88	102.00
66	Raccoon Creek U.S. doser effluent	12/3/2018	11.2700	4.90	4.36	3.14	28.00
441	South Birds Creek U.S. doser effluent	12/20/2018	12.4200	4.15	4.87	0.68	44.00
47	North Fork Birds Creek U.S. doser effluent	12/20/2018	8.8720	3.99	4.09	0.78	36.00
51	Squires Creek U.S. doser effluent	12/20/2018	7.2710	3.17	9.48	9.96	121.00
66	Raccoon Creek U.S. doser effluent	12/20/2018	9.0410	4.69	5.16	3.79	29.00
441	South Birds Creek U.S. doser effluent	2/4/2019	8.0430	3.93	6.15	0.90	57.00
47	North Fork Birds Creek U.S. doser effluent	2/4/2019	4.8390	4.22	5.04	0.90	52.00
51	Squires Creek U.S. doser effluent	2/4/2019	3.8610	2.81	8.92	7.34	119.00
66	Raccoon Creek U.S. doser effluent	2/4/2019	8.4520	4.44	7.38	6.55	58.00

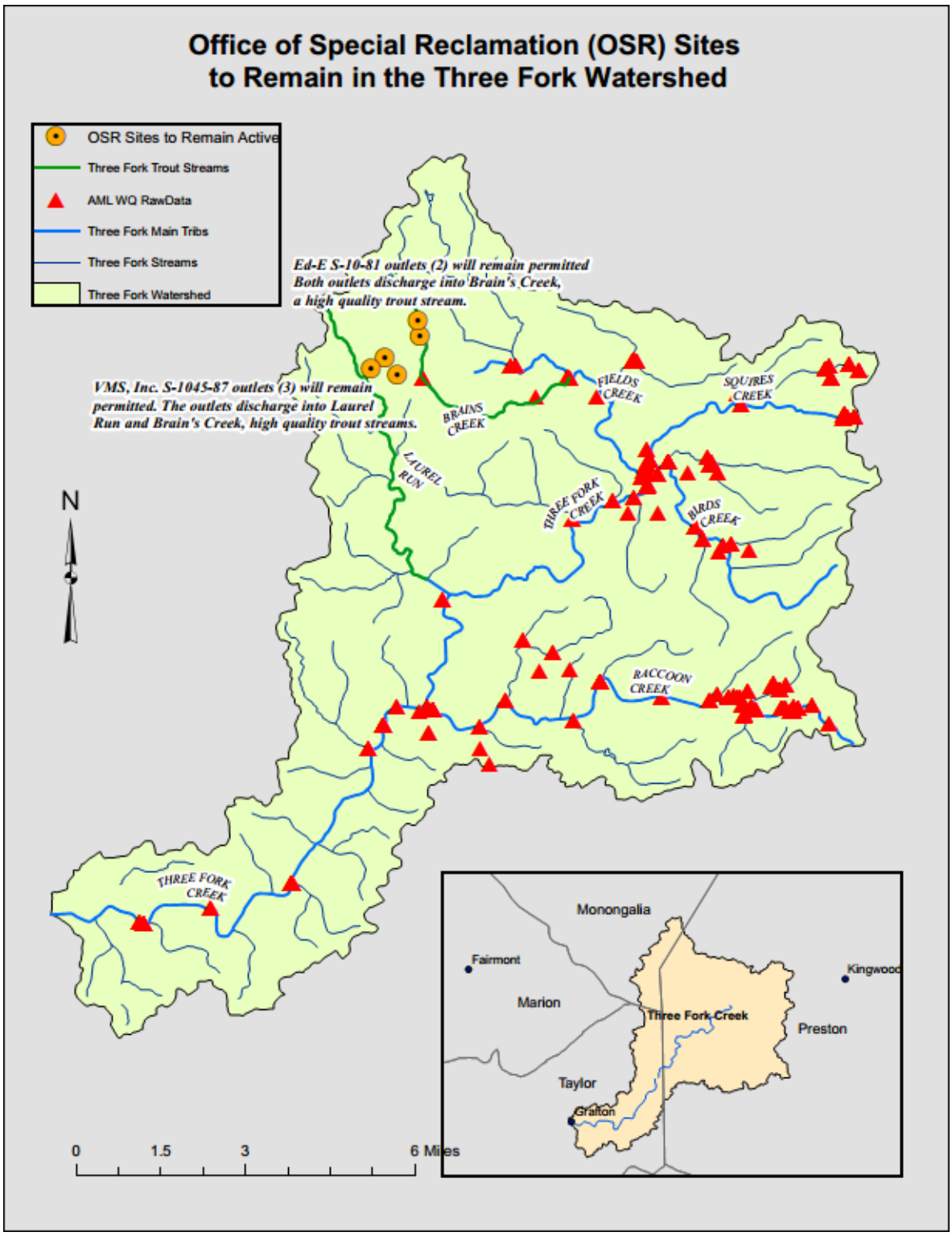
Table 9. Pre-dosing analysis. Oct 2018-Feb 2019.

The goals of the overall Three Fork Watershed Restoration Project are to:

- ***Continue to improve water chemistry and aesthetics to support recreational water activities in the Three Fork Creek mainstem, and***
- ***Continue to restore benthic macro-invertebrates and fish in the Three Fork Creek mainstem.***
- ***Better utilize OSR/AML funds for the continued improvement of the Three Fork Watershed aquatic environment.***



Map 5. AMD sources in the Three Fork Creek watershed.



Map 6. OSR Sites to remain in the Three Fork Creek watershed.

VI. 2010 Three Fork Creek Watershed Restoration Project

As mentioned previously, the Three Fork Creek Watershed Restoration Project was initiated through a combined effort of AML, West Virginia University (WVU) and the Save the Tygart watershed group. The goal of the project was to return the Three Fork Creek mainstem to its designated stream usage by decreasing the water quality impairment of multiple pre-SMRCA coal mine discharges within the watershed. Objectives for obtaining this goal were to:

- Improve water chemistry and aesthetics to support recreational water activities in the Three Fork Creek mainstem, and
- Restore benthic macro-invertebrates and fish in the Three Fork Creek mainstem.

WVU conducted an in-depth study to determine feasible alternatives to reach the established goal based on pre-SMRCA mine discharge information and water quality/quantity data collected and provided by AML. The Save the Tygart watershed group collected additional water quality data. Options included both passive and active treatment, and "at-source" and "in-stream." Various forms of at-source AMD treatment have been constructed throughout the state in the past. While many of these resulted in small localized AMD reductions, none produced measurable watershed-wide water quality improvements. In addition, most forms of at-source AMD treatment failed after a few years due to armoring eliminating contact with limestone, or clogging restricting the hydraulic flow through a treatment system. Based on historical attempts and conditions within the Three Fork Creek watershed, (numerous discharges with high metals and low pH, steep topography, and narrow valleys), achieving successful results with the traditional approach of applying at-source AMD treatment to individual pre-SMCRA mine discharges was questionable. A new cost-effective approach to treating multiple discharges was necessary to achieve the desired watershed improvement.

Ultimately, it was determined that in-stream, active treatment was the most viable option for treating Three Fork Creek. Although the most expensive alternative because of the elevated level of acidity on the mainstem, an active treatment system using in-stream lime dosers was determined to be the preferred alternative. For this project, AML described a doser as:

An in-stream water powered mechanism that relays an alkaline material from an attached storage silo into a discharge channel, where the material is added to the receiving stream to increase alkalinity.

The study also recommended the number and location of dosers required to neutralize the acid load in the watershed. Water quality sampling of Three Fork Creek identified Raccoon Creek, North Fork Birds Creek, South Fork Birds Creek and Squires Creek as the major contributors of acid mine drainage (AMD) to the stream. To neutralize the acid load in the Three Fork Creek mainstem, dosers were recommended on each of these tributaries in locations as far into the headwaters of these tributaries as possible, while maintaining adequate year-round flow.

A. Construction/Operation

Construction of the dosers was initiated in July 2010. Each doser includes an intake located on the edge of the stream that diverts water from the stream to the doser via an underground pipe, the actual doser mechanism enclosed in a steel building, a steel lime storage silo, and an outlet leading to the stream. Two types of dosers were utilized: one using a water-powered tipping bucket to dispense lime at each tip, and three using a water wheel to turn an auger, dispensing lime. Each system was completed and actively treating water by April 2011 (Figure 2).

Most of on-site difficulties surfaced following the completion of the construction phase of the project. Utilizing in-stream treatment requires constant maintenance and adjustments due to the dynamic conditions of the individual tributaries. AML conducts routine sampling and adjustments of the doser systems twice per week, while volunteers from the Save the Tygart watershed group partner by sampling the stream once per week.

B. Challenges

On-site difficulties include:

- Types of treatment material to utilize: AML tried three types of material: granulated lime (CaO), a smaller diameter granulated lime, and hydrated lime (Ca(OH)2). Each reacted differently depending on the site and weather conditions. Ultimately, the smaller diameter granulated lime worked best.

- Stream Flow: The constant fluctuations in stream flow require routine adjustment to the treatment systems to maintain steady water quality downstream.

- Major storm events: Swift, high streams move sediment, boulders, and debris changing the stream channel and at times damaging the doser system.

- Intakes and Lines: Leaves, sediment and other debris, normally carried through the stream channel, can clog the intake, not allowing enough water to flow into the system. Iron buildup in the lines themselves has created water flow issues as well.

- Mine Discharges: It appears that the flow from mine discharges peak two to three days after a storm event due to the water infiltrating into and out of the mine workings.

- Cold Weather: The granulated lime initially utilized during warmer seasons does not provide the same amount of neutralization/chemical reaction when the water temperature drops. AML utilized hydrated lime during the winter months, though this material is much more difficult to handle than

granulated lime. Another problem experienced during the winter months is freezing, which shut systems down on occasion.

- Health and Safety: During treatment, the hydrated lime created a dust plume inside the doser enclosure. Respiratory and eye protection was required during entry into the building to check, make adjustments, and clean the system.

Figure 2. Squires Creek doser

C. Results

In August of 2009, the Watershed Assessment Branch (WAB) of the West Virginia Department of Environmental Protection (WV DEP) initiated a study to assess and monitor the biological health of Three Fork Creek. The following information focuses primarily on Three Fork Creek mainstem and presents results of biological surveys conducted by WAB through 2014. However, in the summer of 2019, WAB conducted an updated biological monitoring report involving the collection of fish and benthic macroinvertebrates, with an emphasis on comparing pre- and post-treatment data. Habitat and water quality information is also discussed in the report. A copy of the 2019 Three Fork Watershed Status Report can be found at:

https://dep.wv.gov/WWE/watershed/wqmonitoring/Pages/SpecialStudiesonwaterquality.aspx

WATER CHEMISTRY

Pre-construction stream sampling was conducted by AML staff, WVU and the Save the Tygart watershed group, while post-construction sampling is conducted by AML staff and the local watershed group. The WVDEP's Office of Water Resources Watershed Assessment Branch (WAB) also placed continuous monitors in the mainstem to record pH values. Pre-construction lab analyses of water samples showed that acidity gradually decreased, and alkalinity increased toward the mouth of Three Fork Creek, probably due to the influx of good quality streams. However, the average alkalinity never exceeded the acidity prior to dosing. After dosing began, the reverse was observed. The median pH increased at each sampling point.

Additional variables analyzed include: Total Iron, Total Aluminum, Total Manganese, Total Magnesium, Total Suspended Solids, Total Dissolved Solids, Calcium, Conductivity and Sulfates. A post-construction decrease was observed for all measured variables except for Iron, and total suspended solids (Table 10).

Average Pre-Construction Chemistry from 7/2009 to 7/2010 and Average Post Construction Chemistry from 11/2011 to 6/2013

Site Description	Flow cfs	Field pH	Acidity mg/l	Alk mg/l	SO4 mg/l	TDS mg/l	TSS mg/l	T Al mg/l	T Ca mg/l	T Fe mg/l	T Mg mg/l	T Mn mg/l
Three Fork Creek mouth (Pre)	57.17	5.25	24.00	2.17	178.00	251.83	2.33	1.43	45.30	0.33	12.27	0.90
Three Fork Creek mouth (Post)	129.33	7.27	5.03	20.51	95.23	161.83	33.33	0.66	37.2	0.57	7.51	0.28

Table 10. Pre and Post Construction/Dosing Analysis.

FISH COMMUNITY AND BENTHICMACROINVERTEBRATE SURVEYS

Pre-construction benthic macro-invertebrate and fish surveys were conducted by WAB in September 2010. Post-construction surveys were conducted in September 2012, approximately 17 months after the dosers officially started treating water. Benthic surveys consisted of the kick-net sampling method and fish surveys used the electroshocking method. Pre-construction and post-construction surveys were conducted at the same four locations along the mainstem of Three Fork Creek.

The benthic macro-invertebrate survey found diminished populations at all four locations during the pre-construction survey. The number of benthic taxa (or benthic groups) and EPT taxa (Ephemeroptera-mayfly, Plecoptera-stonefly, and Trichoptera-caddisfly, each of which are sensitive to pollution) is indicative of the water quality. During the 2010 survey, WAB identified eight taxa and three EPT species. Both improved during the 2012 survey: 15 total taxa and eight EPT taxa were identified.

Potentially the most dramatic improvement witnessed during this study was the fish community response to AMD treatment (Figure 3). Pre-treatment fish community samples revealed that fish were unable to utilize the mainstem of Three Fork Creek. The stream was essentially dead, and no fish community even existed. Following treatment

of AMD, a relatively diverse fish community was re-established. In one year of treatment, Three Fork Creek went from having one fish collected among the four sample stations, to having 2,221 fish collected among the sample stations, representing 21 species of predator and prey species. Not only did the fish community respond well to initial treatment, it expanded further upstream and out of unimpacted tributaries in the subsequent years. After 8 years of treatment, the fish community has become well established throughout the watershed and appears to have become comparatively stable.

Figure 3. Net of fish captured during 2012 fish survey.

AESTHETICS AND EMBEDDEDNESS

During weekly pH checks through the watershed, AML staff noticed that the iron staining found on most rocks in the stream has slowly been disappearing from the both the tributaries and the mainstem of Three Fork Creek, improving the aesthetics of the stream. Embeddedness, which can be defined as the degree to which fine sediments surround the larger substrate material, increased in the upper reaches of the watershed, but decreased in the lower 9.6 miles. The embedded material consists of a mixture of algal growth, organic debris, metal precipitate, and inorganic silt particles.

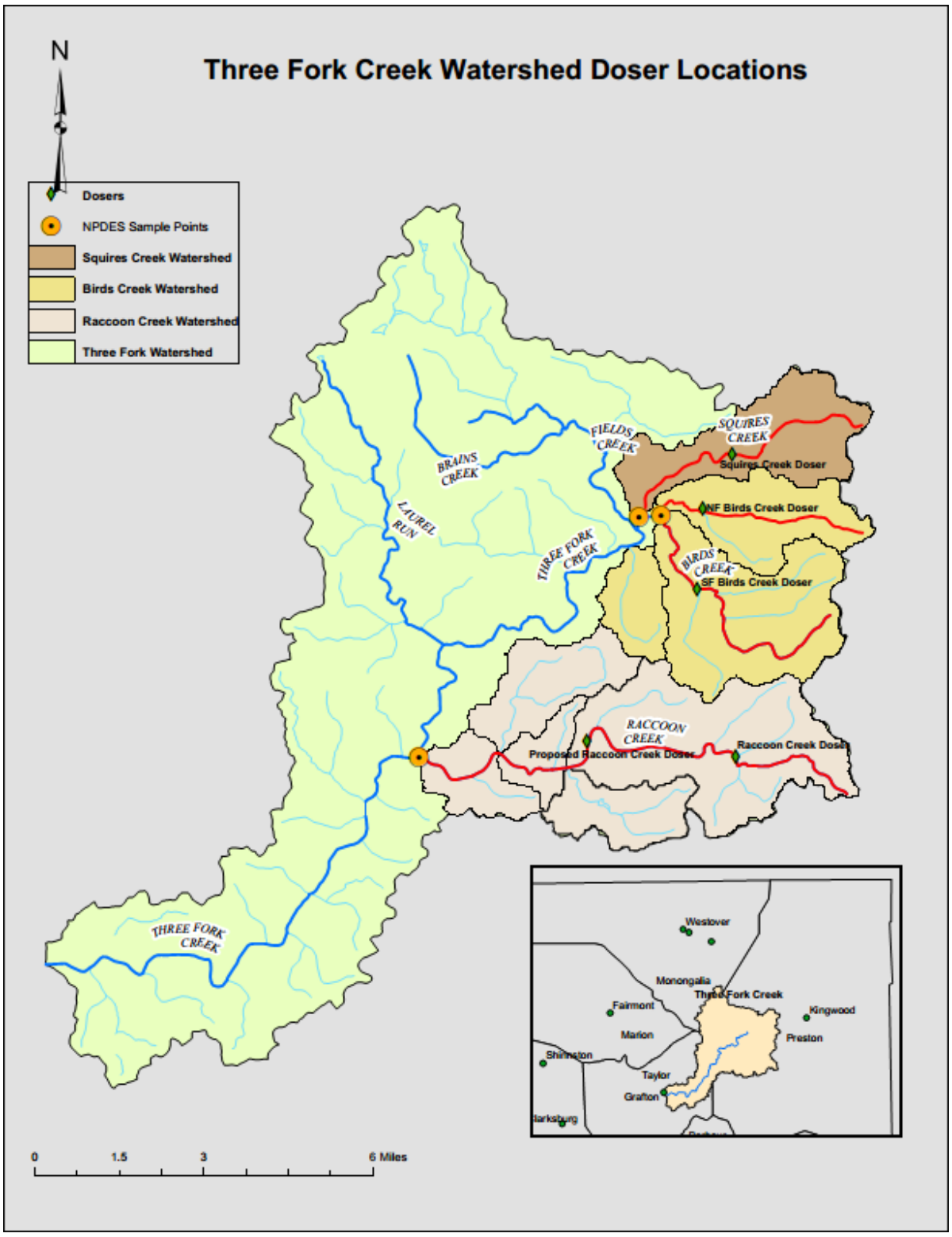
RECREATIONAL OPPORTUNITIES

In the nine years since the dosers began treatment in the Three Fork Creek Watershed, the local residents have begun to once again utilize the stream for recreation. Camping and swimming have resumed along portions of the stream. Recreational fishing on the stream has also increased, with local residents reporting success while fishing

throughout most of the stream. Also, over the past ten years, whitewater paddling has increased on Three Fork Creek's class III rapids.

D. Final Plans

It is anticipated that the challenges described above will be remedied upon full implementation of new and upgraded in-stream dosers. All parties involved in the restoration project over the last 7 years; WVDEP-OSR/AML, WVDEP-WAB and STT, are very encouraged by the results of the Three Fork Creek in-stream restoration project to date.



Map 7. Three Fork Creek doser locations.

VII. Treatment during term of the variance

The four (4) permanent in-stream dosers will be upgraded to include Automated Lime Slurry Systems with back-up generators. The Lime Slurry will be produced on-site and will dispense a highly soluble (31-35%) hydrated lime slurry directly into the impaired

waterways. All doser sites are near public water which will be used as make-up water to produce the lime slurry for treatment. These in-stream dosing sites will have a communication link to OSR's T&T treatment facility's PLC (Programable Logic Controller) which will give the OSR and AML remote monitoring capabilities for parameters such as exceedances in pH, power outages, and lime level in the silos. Dosing rates will be regulated by pH sensors placed downstream of the doser. The sensor will measure the pH of the stream and send a signal back to the doser that will enable the dosing rate to increase or decrease accordingly. Alternatively, dosing rates may be regulated by flow meters.

VIII. Variance Terms

A. Term of Variance

This variance will be in place for 10 years to protect the existing 17.5 miles of the Three Fork Creek watershed, which has already been restored through AML's efforts. WVDEP will conduct a required Water Quality Standards Triennial Review every three years. As stated in the variance language, DEP will evaluate conditions during each triennial review to determine if the alternative measures are having the desired impact. Each Triennial Review will provide an opportunity to review and update the interim water quality standards.

B. Determination of Highest Attainable Condition and Interim Criteria

The highest attainable interim criteria used in this variance was determined by examining existing in-stream conditions at the proposed watershed permit compliance points, which are at the mouths of Squires Creek, Birds Creek and Raccoon Creek. These points had average flow measurements of 7.62 cfs, 24.88 cfs and 34.50 cfs respectively. For Squires Creek, the interim limits as outlined in the variance application are pH (4.0 – 9.0), total iron (5.34 mg/L), and total aluminum (6.12 mg/L), the interim limits for Birds Creek are, pH (6.0 – 9.0), total iron (0.78 mg/L), total aluminum (4.23mg/L), and the interim limits for Raccoon Creek are pH (7.0-9.0), total iron (3.73 mg/L) and total aluminum (2.71 mg/L). The extent of the water quality improvements after the relinquishment of the BF sites will be determined during the initial period of the 10-year variance. Since AML began treating in 2011, the mouths of each of the variance tributaries have met and exceeded the above parameters. In other words, the water quality has been better than the above parameters. Therefore, use of the existing in-stream conditions as interim criteria, at least until a Triennial Review can be done to update the interim criteria, ensures compliance.

IX. Monitoring and Assessment

Ten (10) locations in the Three Fork Creek watershed will be used for monitoring and assessing the restoration target (Map 8).

A. Surface water quality monitoring

Water quality and fish and benthic surveys will utilize AML's monitoring plan since the implementation of the Three Fork Creek Restoration Project (Table 10). Additionally, to

determine the efficacy of the AMD treatment in the Three Fork Creek watershed, water quality samples (grab) will be collected monthly at 11 locations for a period of two (2) years following approval of the Three Fork Creek Variance. This information is fundamental in managing the Instream dosers and permanent treatment facilities and is needed to address questions vital to the long-term environmental integrity of the watershed. Specifically, grab samples will be collected at locations upstream of the dosers and at the tributary mouths. Water quality sampling techniques will follow OSR's and AML's standard operating procedures (SOP) that adhere to scientifically sound, quality-assured field methods.

Station Name	Water Quality	Sonde	Substrate	Benthic Mac	Fish
Three Fork Creek					
South Fork Birds Creek near mouth	monthly				
North Fork Birds Creek at mouth	monthly				
Birds Creek at mouth	monthly	yes	yes	yes	yes
Squires Creek at mouth	one time	yes	yes	yes	yes
Three Fork Creek Ck d.s. Birds Ck and Fields Ck	monthly		yes	yes	
Three Fork Creek Ck u.s. of Martins Run @ mp 17.5	monthly		yes	yes	yes
Raccoon Ck u.s. Little Raccoon Ck @ mp 3.4	monthly		yes	yes	
Raccoon Creek at mouth	monthly	yes	yes	yes	yes
Three Fork Creek Ck d.s. Raccoon Ck @ mp 9.62	monthly		yes	yes	yes
Three Fork Creek at Thornton @ mp 5.7	monthly		yes	yes	yes
Three Fork Creek near mouth @ mp 0.4	monthly	yes	yes	yes	yes

Table 10. Three Fork Creek sampling stations.

Field parameters will include: temperature (°C), dissolved oxygen (ppm), specific conductance (µS/cm), and total dissolved solids (TDS) (mg/L) using a YSI 556 multi-parameter probe (Yellow Springs Instruments, Yellow Springs, OH, USA), and turbidity via transparency tube. Stream discharge will be measured using the area-velocity technique with an OTT MF pro Flow Meter. Additionally, grab water samples will be collected at each site and stored on ice until analysis at a laboratory approved by the WVDEP. Parameters to be analyzed include: pH, alkalinity, acidity, conductivity, sulfates, and total suspended solids along with total and dissolved metals (iron, magnesium, aluminum, calcium, and manganese).

Additionally, in-stream data loggers located at the mouths of the Squires Creek, Birds Creek, and Raccoon creeks will record pH, conductivity, and temperature at 1-hour intervals. Data will be downloaded monthly during water quality grab sample events.

Photographs will be taken of the stream and substrate at each water sampling location during scheduled sampling events and catalogued by date.

B. Benthic macroinvertebrate and fish sampling

To determine the efficacy of the AMD treatment and overall stream health of the Three Fork Creek watershed, habitat assessments, benthic macroinvertebrate and fish surveys will be conducted. Habitat assessments and benthic macroinvertebrate surveys will be conducted every six (6) months for a period of two (2) years at the variance tributary mouths and select locations in Three Fork Creek (Map 8). After two (2) years, benthic sampling will be conducted on a yearly basis. Fish surveys will be conducted at variance tributary mouths and select locations in Three Fork Creek six (6) months following start-up of the permanent treatment systems, then one (1) year (18 months), and every two (2) years thereafter (Map 8). Survey and collection procedures will follow the WVDEP's Watershed Assessment Branch's (WAB) protocol. The WAB's protocol can found at: http://www.dep.wv.gov/WWE/watershed/Pages/WBSOPs.aspx

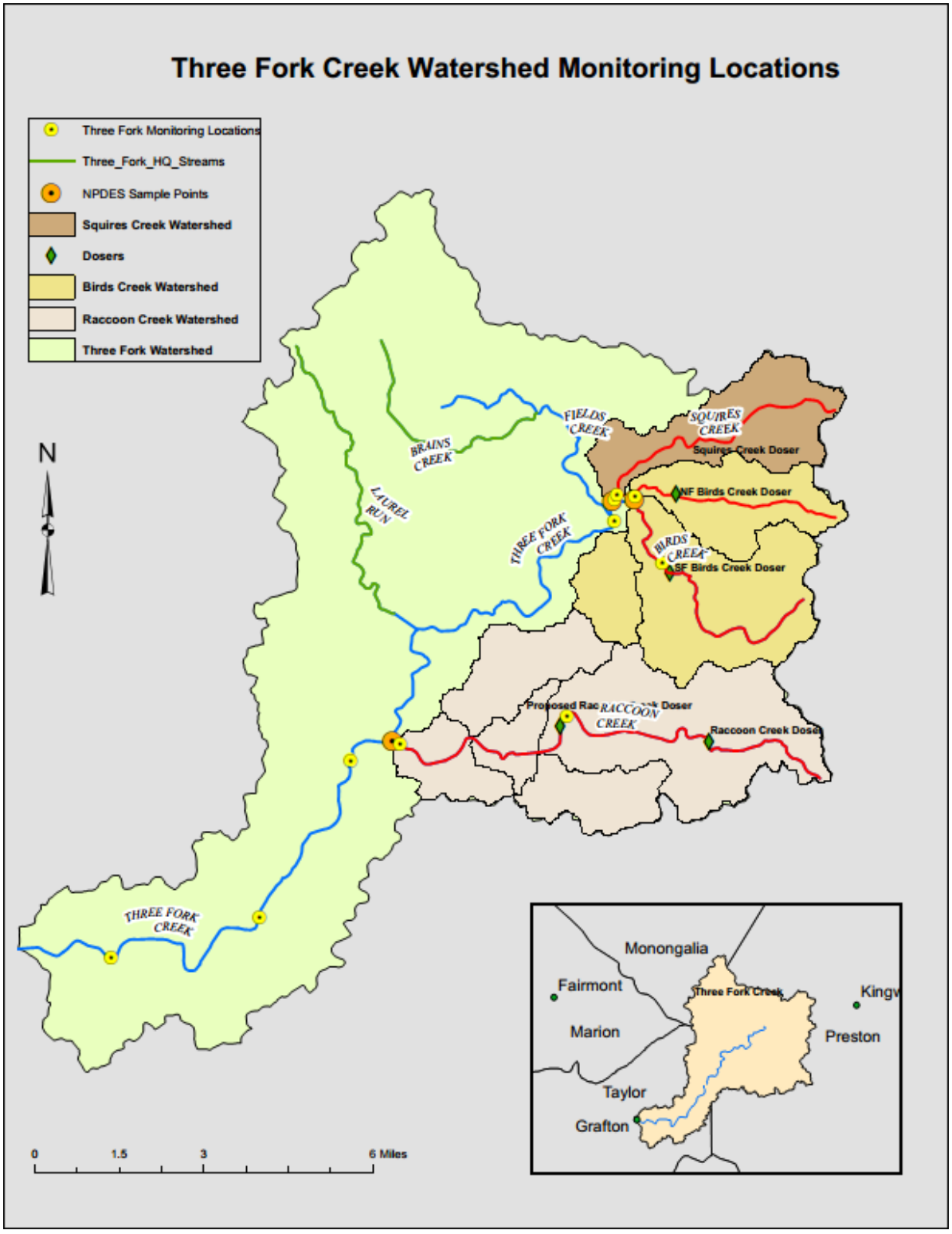
Note: OSR and AML will collaborate on the water quality sampling, habitat assessment and benthic macroinvertebrate surveys. WAB will conduct the fish surveys, with assistance from OSR and AML personnel.

X. Watershed Permit

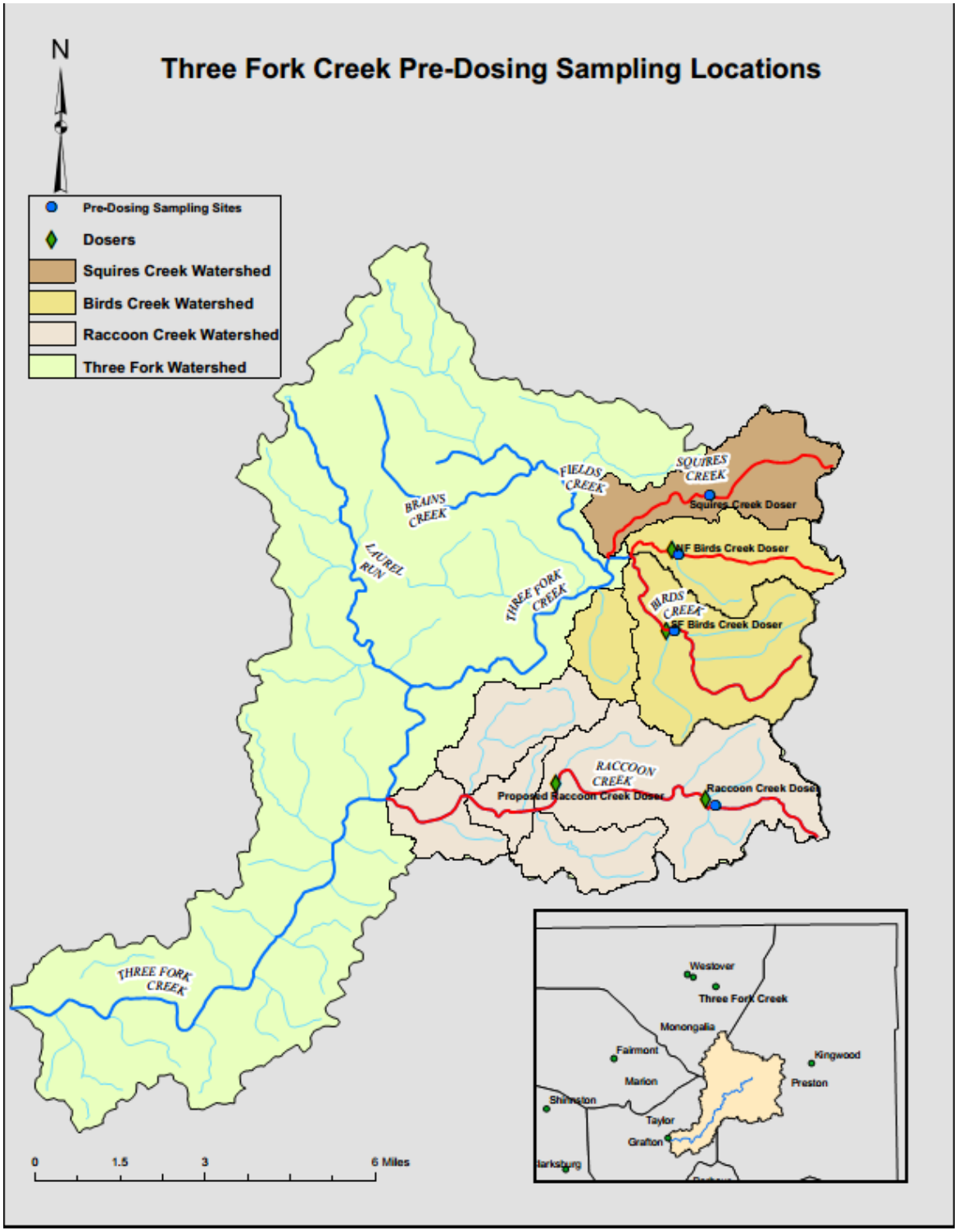
OSR will obtain NPDES permits at the mouths of Squires Creek, Birds Creek and Raccoon Creek. These instream NPDES permits will supersede all individual OSR site NPDES permits covered under the variance. It is anticipated that the initial in-stream permit limits will be equal to the instream interim criteria established in the variance application (for Squires Creek, pH (4.0-9.0 s.u.), 5.34 mg/L total iron, and 6.12 mg/L total aluminum; for Birds Creek, pH (6.0-9.0 s.u.), 0.78 mg/L total iron, and 4.23 mg/L total aluminum, and for Raccoon Creek pH (7.0-9.0 s.u.), 3.73 mg/L total iron, and 2.71 mg/L total aluminum. Upon each triennial review, as required by the variance, the stream conditions and compliance history shall be reviewed, and the in-stream limits shall be adjusted appropriately, but under no circumstances may they be made worse than the original criteria as established in the variance without justification and approval by the DEP.

A. Baseline Monitoring

Prior to the Three Fork Creek restoration project, AML and WAB collected water quality samples, benthics, and fish according to the proposed monitoring and assessment plan described above.



Map 8. Proposed monitoring and assessment plan for the Three Fork Creek Watershed.



Map 9. Oct 2018-Feb 2019 Pre-Dosing sampling locations.