ACID MINE DRAINAGE ABATEMENT AND TREATMENT PLAN

FALL RUN WATERSHED

12 DIGIT HUC: 050301060303

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Ohio Department of Natural Resources
Division of Mineral Resources Management
Abandoned Mine Land Program

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Acknowledgements

The United States Army Corp of Engineers, Ohio Environmental Protection Agency, and the ODNR Division of Mineral Resources Management Abandoned Mine Land Program met in 2002 to address the Acid Mine Drainage and pre-law coal mining impacts to Fall Run, a tributary to Wheeling Creek in Belmont County. It was the data collection, analysis, and preliminary design concepts of this dedicated group of professionals which led to the creation of this abatement and treatment plan. As a result, work can now begin to restore Fall Run to a healthy stream.

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INTRODUCTION

AMDAT Plan Development

Abandoned Mine Land (AML) problems in the coal bearing region of Ohio include watersheds that are impacted by acid mine drainage (AMD). Title IV of the Surface Mining Control and Reclamation Act (SMCRA) of 1977 establishes grants to states to address AML problems and allows states to set aside 30% of grants to remediate AMD. In response to SMCRA, the Ohio Revised Code 1513.37 (E) provides the authority to fund the Ohio Department of Natural Resources (ODNR) Division of Mineral Resources Management (DMRM) AMD program. The ODNR DMRM identifies and prioritizes mine impacted watersheds and develops Acid Mine Drainage Abatement and Treatment Plans (AMDAT) in order to implement remediation projects in streams or rivers that can be expected to improve to meet state biological water quality standards (Kinney and McCament, 2010).

Purpose

The purpose of the Rose Valley/Fall Run AMDAT Plan is to identify, characterize, and prioritize all of the AMD sources in the Fall Run Watershed. Furthermore, this report will assess the biological impacts that result from these sources and determine the potential biological recovery in Fall Run. This AMDAT report will also prioritize the AMD sources and identify treatment projects that will likely achieve biologic improvement in Fall Run. From 2009 to 2012, the DMRM conducted a watershed characterization that included collecting chemical, biological, and stream habitat data to evaluate the severity of AMD impacts in Fall Run. This report summarizes the findings from this period.

This report also encapsulates earlier data and findings from a 2002/2003 joint study conducted by US Army Corps of Engineers (USACE), ODNR- DMRM AML, and the Ohio EPA (OEPA). Cost benefit analyses are also included in order to determine the feasibility of meeting the water quality targets for biologic restoration.

Study Area

Identification of the Hydrologic Unit; Fall Run Watershed Characteristics

Fall Run is located within the Wheeling Creek Watershed in Colerain Township, Belmont County Ohio (Figure 1). It is a sub-watershed located within the Cox Run–Wheeling Creek 12 Digit Hydrologic Unit Code (HUC) **(**Table 1**).** It drains south and enters Wheeling Creek at Crescent Road just east of the town of Maynard. Fall Run is almost totally underlain by an abandoned underground mine, BT-124. There has been extensive surface mining in the area including both C- and D-permits. The area also shows the presence of pre-law disturbed areas. The abandoned underground mine drainage and exposed coal refuse in and surrounding the stream produces the AMD which impacts Fall Run.

Figure 1: Cox Run-Wheeling Creek Watershed Map from "ERIN" Watershed

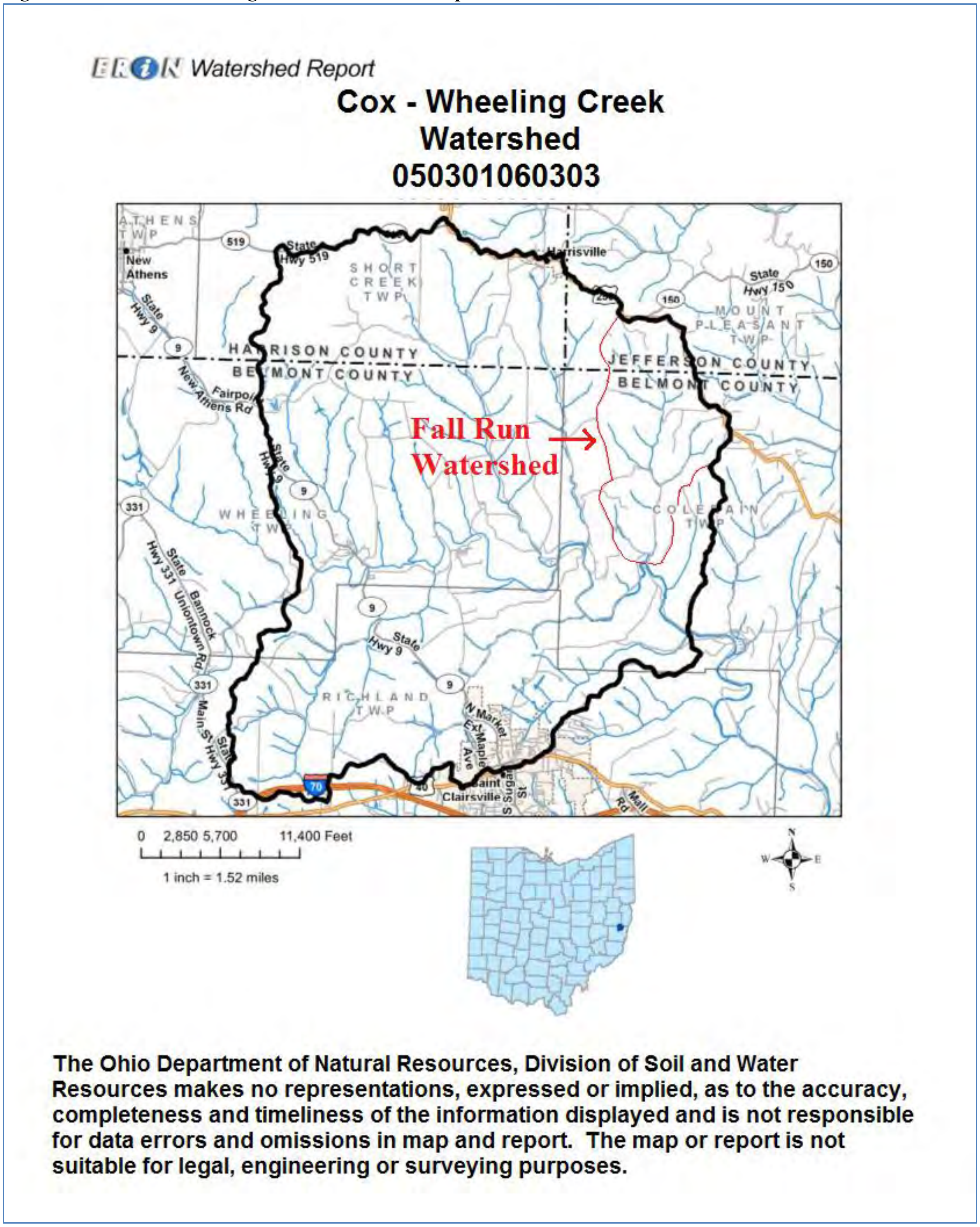


Table 1: Fall Run Hydrologic Unit Code

Name	Fall Run Watershed, Ohio
Tributary to	Wheeling Creek
Drainage Area	2,470 acres (3.86 sq. miles)
Perennial Length	3.4 miles
Main Tributaries	Hunkey Hollow Run, Grey's Ridge Run
12-Digit HUC Code	050301060303 (Cox Run-Wheeling Creek 12-HUC)
14-Digit HUC Code	05030202010010; 05030202010030
Location	Belmont County, Jefferson County
USGS Quadrangle (7 ½ Minute)	Dillonvale, Lansing

Belmont County is located in the unglaciated Allegheny Plateau Physiographic Province. The county has an area of approximately 535 square miles. The area has high relief with incised valleys with broad hilltops. The highest elevation in Belmont County is 1,397 feet at Galloway's Knob and the lowest is 625 feet at Powhatan Point on the Ohio River (Rubel, et al. 1981). The mean annual total precipitation (1961-1990) for Belmont County is 43.00 inches (OSU AEX-480.07). The average annual temperature for the county is 51º F. Colerain Township has a total land area of 25.2 square miles (65.1 km^2) and the maximum elevation is 1,109 feet (338 m).

Urban and industrial influences in the county are concentrated along the Ohio River. Land development is occurring along the Interstate 70 corridor. The development of Marcellus and Utica shales for gas and oil production is also an increasing presence in Belmont County. Agriculture accounts for more than 35 percent of land use and woodland comprises more than 50 percent of the land cover in the Wheeling Creek Watershed (USGS Streamstats Table 2).

Table 2: Land Use Classification within Cox Run-Wheeling Creek Watershed

2009		
Category	**Acres**	**%**
Agriculture	9241.7	36.74
Water	75.9	0.30
Urban	2297.6	9.13
Forest	13536.3	53.81
Barren	2.3	0.01
Shrub/Scrub	3.1	0.01
Total Acres:	**25156.9**	**100.00**

Geology and Mining History

Belmont County has an extensive system of dissected drainage patterns (Rubel, et al. 1981) and is characterized by broad, rounded ridges with narrow steep-sided valleys. The county is underlain by a gently dipping (18 ft/mile) monoclinic structure composed of sedimentary rocks (Berryhill, 1963). There are localized areas of steeper dips trending southeast at 70 ft/mile. The Monongahela formation consists of interbedded sandstones, siltstones, limestone, shale, clay and most of the upper coal measures (Berryhill, 1963). The Monongahela units are found in western Belmont County and in deep valleys.

The stratigraphy in the area of Rose Valley and Fall Run contains a large section of limestone which is almost half the strata's thickness. Fall Run was named after a series of small waterfalls that developed upon these resistant limestone beds in the upper stream section. Lower Fall Run stream channel is eroding laterally. The considerable sediment load from the stream erosion and the old strip mines is entering Wheeling Creek. The elevation range from headwaters to mouth of Fall Run is 530 feet and the highest elevation point in the watershed 1340 feet above sea level located east of US Route 250 and State Route 150 (Appendix A of this document contains the Fall Run Engineering Technical Report Appendix C, Section IV Geotechnical). The lowest elevation of Fall Run is 810 feet at the mouth.

The Pittsburgh Coal No.8 coal was mined extensively in Colerain Township. Hilltops in the township contain the No. 9 or Meigs Creek Coal. The average thickness of the No. 8 coal in Fall Run is five feet and was opened in several locations (Stevenson, 1878). Table 3 below shows the typical Pittsburgh coal measure found in Maynard and in the area of Fall Run (Brown, 1888):

Table 3: Typical Pittsburgh No.8 coal measure in Maynard and Rose Valley, Belmont County

Bedding Plane	Thickness
Roof Coal	~ 18 in
Soapstone	2-15 in
Bone Coal Coal	3 in 18 in
Bearing in Place	7 in
Coal	18 in
Thin Parting	½ in
Coal	12 in
Clay (exposed)	8 in

(Please note: "Soapstone" is a term for thin gray shale found in the coal measure, not the metamorphic rock)

Belmont County is Ohio's all-time leading coal producer. Over half of the state's coal production is from Belmont County with over 800 million tons produced to date, mostly from the Pittsburgh (No. 8) coal (Geofacts No. 14, OGS). Peak coal production in Belmont County occurred during the ten-year period from 1916 through 1926.

Mining of the Pittsburgh No. 8 coal in Belmont County increased rapidly after the extension of the Cleveland, Lorain and Wheeling Railroad to Martins Ferry in 1888. The railroad expanded in response to the demand from the nation's booming coal-fueled railroad system, steel making process, and fledgling coal-fired electric generating plants. Coal became the industrial and domestic fuel of choice.

The Lorain Coal and Dock Company Crescent Mines Bt-124 map, dated 1913 and certified 1931, showed the Pittsburgh No. 8 coal deep mine workings in the vicinity of Fall Run. The mine map for Bt-124 identified an unusually large number of drift openings that, along with some of the workings, were encountered during strip mining.

The amount of acid produced by spoil banks depends on how the operator handled the overburden. Most of the spoil banks along lower Fall Run have the material placed immediately above the coal. It is high in acid-producing sulfides and was placed on top of the near barren western slopes.

The second most important coal of the Monongahela formation is the nearly 3.5 foot-thick Meigs Creek No.9 which was strip-mined by Marietta Coal Company under permit number D-2077. The No. 9 coal occurs about 80 feet above the Pittsburgh No.8 coal. The No. 9 coal is exposed in the road cut and the stream bank just upstream of the first bridge in Colerain Township road 561 near 977 feet in elevation.

The largest period of oil and gas production in Belmont County was prior to 1920. A small oil pool in the Mississippian Berea sandstone about 1700 feet beneath the Pittsburgh No. 8 coal is shown in the vicinity of the radio towers about a mile south of Crescent (Berryhill-reference no. 3). No oil or gas production fields are shown in Fall Run drainage basin on ODNR's website or the Gas and Oilfields of Appalachian Region Map.

AMD Formation and the Effects on Stream Health

AML areas typically contain exposed geologic acid-forming materials from mining activities, both on the surface and underground. Mining activities that occurred prior to current reclamation laws (SMCRA) have exposed these acid-forming materials to air and water, which forms AMD in adjoining water bodies. Impacted waters typically have a low pH, and elevated acidity, metal, and sulfate concentrations. These complex contaminants lead to an overall degradation of water quality, biological communities, and ecological functions in streams. In fresh water, mine drainage can lead to elevated dissolved metal concentrations, and thus, extreme variations in ionic concentrations, which can significantly affect the distribution and productivity of biological organisms (Allan and Castillo, 2009). Metal precipitants can also form in streams receiving mine discharges with elevated metal concentrations. These metal precipitants, particularly ferric iron and aluminum hydroxides, can impair aquatic life habitat by decreasing the availability of dissolved oxygen, coating gills and body surfaces, smothering eggs, and clogging the interstitial spaces of available substrate making it uninhabitable for benthic organisms (Hoehn and Sizemore, 1977).

State of Ohio and National Water Quality Standards

Ohio water quality standards contain numerical criteria designed to measure and/or protect aquatic life. There are five aquatic life use designation categories that use biological integrity to classify the health of a stream reach (Table 4). Stream degradation sources are identified and targeted for restoration so that a stream can meet the highest use designation possible. In the coal bearing region of Ohio, most AMD impacted streams have been assigned the Modified Warmwater Habitat or the Limited Resource Water designated use.

Table 4: Ohio Water Quality Standards; Aquatic Lfe Use Designations

Category	Description
EWH - Exceptional Warmwater Habitat	the most biologically productive and diverse aquatic community
WWH - Warmwater Habitat	“typical” warm water assemblage of aquatic organisms
MWH - Modified Warmwater Habitat	streams with extensive physical habitat modifications that can only support pollution tolerant aquatic species
LRW - Limited Resource Water	streams that have been irretrievably altered; only extremely pollution tolerant assemblages of aquatic life can be supported
CWH - Coldwater Habitat	waters which support assemblages of cold water organisms

**Ohio EPA, 1987a, 1987b, 1989a, 1989b, 2006a, 2006b*

The U.S EPA has recommended national water quality criteria for the protection of aquatic life pursuant to Section 304(a) of the Clean Water Act (CWA). These criteria are meant to provide guidance for states in adopting water quality standards and are meant to protect “the vast majority of the aquatic communities in the United States” (U.S. EPA, 2013). Table 5 includes a summary of the water quality parameters typically associated with AMD that are included in these criteria. Recommended concentration limits are an estimate of the "highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect" (U.S. EPA, 2013).

Table 5: U.S. EPA Recommended National Water Quality Criteria for Protection of Aquatic Life; AMD Parameters (U.S. EPA, 2013)

Parameter	Limit
Iron[1]	1 mg/l
Aluminum (pH 6.5-9)[2]	0.75 mg/l
Alkalinity[3]	20 mg/l
pH	6.5-9 S.U.

[1]iron value is a "Criterion Continuous Concentration" (CCC), which is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect.
[2]aluminum value is expressed in terms of total recoverable metal in the water column and is a Criteria Maximum Concentration (CMC), which is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect.
[3]alkalinity limit of 20 mg/l is a broad reaching minimum value. In watersheds where the alkalinity is naturally lower (un-impacted reaches) the criterion suggests alkalinity cannot be lower than 25% of the natural concentrations.

Sampling and Analysis Methods

Biological

The ODNR DMRM AMD program follows OEPA biological criteria (OEPA, 1987a, 1987b, 1989a, 1989b, 2006a, 2006b) to determine the severity of mine drainage impacts, to determine whether or not a stream is attaining its designated use, and to measure biological improvements once remediation projects are implemented. Criteria for the Western Alleghany Plateau (WAP) are used since AMD watersheds in Ohio fall within this ecoregion. Biological data collection and scoring methods (Table 6) include the Index of Biotic Integrity (IBI) and Modified Index of

Well Being (MiWB) for fish, and the Qualitative Habitat Evaluation Index (QHEI) for the assessment of stream physical habitat (Rankin 1989; Ohio EPA 2006). OEPA biological criteria also include the Invertebrate Community Index (ICI), which is used in studies to assess macro-invertebrate communities in streams. However, the DMRM AMD program utilizes the macro-invertebrate Aggregated Index for Streams (MAIS) to assess macro-invertebrate communities (Smith and Voshell, 1997; Johnson 2007) in mine impacted watersheds. The MAIS is less costly and less time consuming, and a MAIS score of >12 correlates well with the ICI WWH criteria in AMD impacted streams (Kinney, 2006; Johnson, 2009).

Table 6: Biological Indices used to determine Aquatic Life Use Designation

Metric/Index	Description
IBI - Index of Biotic Integrity	multi metric index that measures fish species richness and diversity
MiWB - Modified Index of Well Being	metric that incorporates fish abundance and diversity to represent assemblage quality
ICI - Invertebrate Community Index	multi metric index representing aquatic macroinvertebrate community integrity
QHEI - Qualitative Habitat Evaluation Index	a qualitative measure of in stream habitat that is important to aquatic life
MAIS - Macroinvertebrate Aggregated Index for Streams	rapid bioassessment that measures aquatic invertebrate richness, diversity, and trophic function

Ohio Water Quality Standards Biocriteria

An effective bioassessment method in AMD streams of the WAP

IBI and QHEI data are collected and sent to OEPA for evaluation and final metric scoring. MAIS samples are collected, processed, and scored by ODNR-DMRM personnel. Table 7 shows biological criteria scores that are expected at the various levels of AMD impacts. Table 8 indicates scores that meet WWH criteria. Habitat assessments (QHEI) are performed at all fish sampling locations to document if habitat is impaired from AMD or other land uses. The statewide criteria for the QHEI is 60 or greater for habitat suitable for supporting WWH fisheries (Table 9). QHEI is not included in the ranking of impacts. However, habitat quality is used to determine the potential recoverability of a stream if AMD is remediated.

Table 7: AMDAT Guidelines for Evaluating Severity of AMD Impacts on Stream Ecology and Habitat

Index	No Detectable Mine Drainage Impact	Minimal Mine Drainage Impact	Moderate Mine Drainage Impact	Severe Mine Drainage Impact
MAIS	≥ 12		8-11	0-7
IBI*	≥ 44		24-43	< 24
QHEI	≥ 60			

** IBI scores listed above are for wading sites. All Fall Run sample sites were wading sites.*

Table 8: Biological criteria for the Western Allegheny Plateau (WAP) Ecoregion

Site Type Index	IBI Headwaters	IBI Wading	MiWb Wading	ICI	MAIS	QHEI
EWH Habitat	≥50	≥50	≥9.4	≥46		
WWH Habitat	≥40/≥44	≥38/≥44	≥7.9-8.8/≥8.4-8.8	≥36-41	≥12	≥60
MWH (Mine Affected)	24	24	5.5	30		
LRW Habitat	18	18	4.5-5.8	8		

Table 9: General narrative ranges assigned to QHEI scores. Ranges vary slightly in headwater streams (≤20 sq. mi) vs. larger streams

Narrative Rating	QHEI Range	
	Headwaters	Larger Streams
Excellent	≥ 70	≥ 75
Good	55 to 69	60 to 64
Fair	43 to 54	45 to 59
Poor	30 to 42	30 to 44
Very Poor	< 30	< 30

**Reproduced from QHEI Manual (Rankin, 1989)*

Chemical

The DMRM follows OEPA chemical sampling methods and quality assurance procedures for all water quality monitoring (OEPA, 2012). Specifically, the DMRM AMD program conducts watershed investigations following the Field Methods for Watershed Characterization manual (Bowman et al. 2006). A phased sampling approach is used to prioritize sources based on acidity and metal loads:

- **Phase I:** the collection of field data at the mouths of tributaries and downstream of tributaries in the mainstem. Once AMD subwatersheds are identified, a Phase I reconnaissance is conducted in those basins as well. Pictures are taken and locations are recorded using a global positioning system (GPS) unit.
- **Phase II:** the collection of grab samples and flow measurements in tributaries and selected mainstem sites. Seasonal flow variation is accounted for when possible. Phase II sampling is conducted in the mainstem and subwatersheds. This data is used to determine acid and metal concentrations and loadings from tributaries and mainstem locations.
- **Phase III:** sampling discrete AMD sources for abatement strategy purposes. In some cases, phase II data provides adequate data to characterize chemical conditions and flow rates of sources in order to provide conceptual designs and cost estimates.

Field data such as pH, specific conductivity, temperature, dissolved oxygen (DO), Oxidation-Reduction Potential (ORP), and acidity/alkalinity are collected with a YSI 556 multi-parameter datasonde and a HACH digital titrator (where needed). Grab samples are collected and analyzed by the DMRM laboratory for Group II analysis. Flow measurements along with chemical samples are collected at all sites when possible in order to determine loadings and thus prioritize mine drainage sources at different flow regimes. Flows are collected using a Marsh McBirney flow meter, a Baski flume, a bucket and stopwatch, or using drainage area flow comparisons with a nearby USGS gauge.

FALL RUN SITE DESCRIPTION AND IDENTIFICATION OF AMD IMPACTS

Mass Balance Sampling

Mass balance sampling was performed to identify all tributaries and sources of AMD to Fall Run. A mass balance sampling uses quantitative techniques to identify the chemical and hydrological characteristics of a watershed (Semkin, et.al.1994). Frequently AMDAT recommendations are based on one round of high and low flow sampling and data collection. The sources of AMD are identified and ranked then treatment scenarios are recommended. Fall Run has had a number of sampling rounds over a few years' time which provides a more long-term representation of the flows and concentrations of metals, alkalinity, and acidity in the watershed.

US Army Corp of Engineers Water Quality Investigation, 2002-2003

The 1996 Water Resources Development Act (WRDA) Section 206 authorized the US Army Corp of Engineers (USACE) to restore aquatic ecosystems and participate in cost sharing with non-federal sponsors. In February 2002, representatives from the USACE and ODNR DMRM met to conduct a joint field reconnaissance of the lower section of Fall Run (Appendix B).

The goal of the investigation was to identify all the sources of AMD impact to the stream and collect data to be used in the planning and design of a watershed restoration project to improve water quality. Following the two-day field reconnaissance, a sampling plan was established that would quantify the water chemistry of the Fall Run mainstem and AMD sources. Remediation strategies were established after the completion of the data collection and analysis.

The OEPA conducted an assessment of the biology and physical habitat of the Fall Run Watershed. The OEPA also conducted the water quality investigation and prepared reports for the USACE and DMRM with the results. The *Biological and Physical Habitat Study of Fall Run (Wheeling Creek Watershed) Belmont County* (OEPA Report EAS/2002-12-9) was completed December 2002 (Appendix C). A supplemental report, *Development of Total Recoverable Iron Targets for Fall Run* (Appendix D), was completed April 2003.

Nineteen sampling sites were selected along the Fall Run mainstem and its two main tributaries, Hunkey Hollow and Grey's Ridge Run, as well as any AMD sources that were identified. Wheeling Creek was sampled both up- and downstream of the confluence with Fall Run to determine if Fall Run was impacting the larger stream.

The USACE completed a *Water Quality Report Draft for Fall Run* in September 2004 which documented the OEPA's water quality results from the February 2002 to April 2003 sampling events (Appendix E). The report identifies and prioritizes the main AMD sources to Fall Run. It also makes recommendations for passive treatment scenarios for Fall Run. In 2004, the WRDA Section 206 funding was cut and this project was shelved.

ODNR DMRM Data Collection 2009-2011

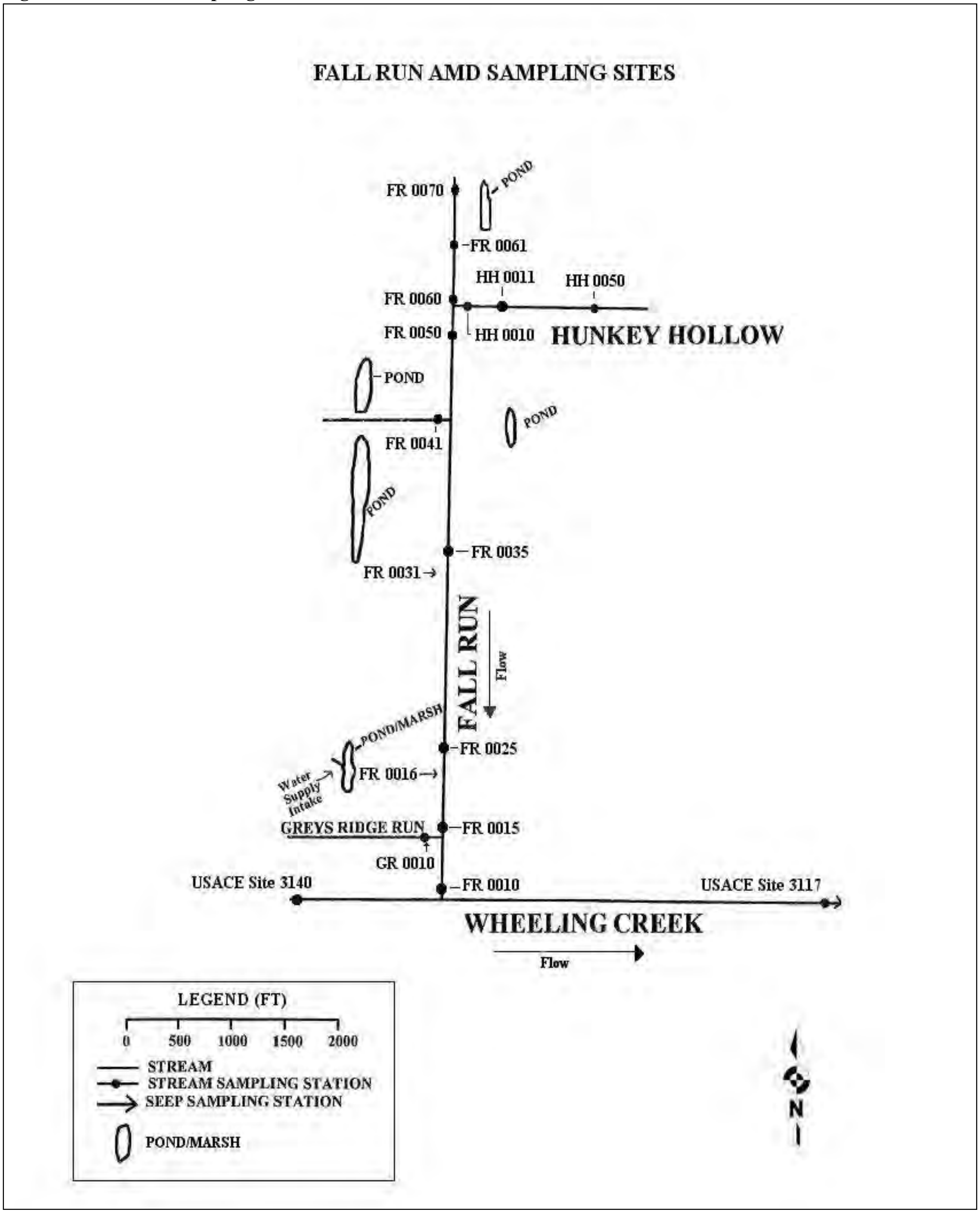
In 2010, DMRM received correspondence from USACE that possible funding would be re-allocated for Fall Run. With regards to this information, DMRM AML decided to move forward with project development in the watershed. AML personnel sampled Fall Run in October and December of 2009 and in June of 2011 to collect current high flow and low flow data. This data was combined with the OEPA/USACE 2002-2003 data (Appendix F). The original sample sites IDs have been re-designated to AML watershed IDs, i.e. FR-xxxx (Table 10). An aerial map of the AMDAT Sites is located in Appendix G. All samples were collected using procedures outlined in the *Field Methods for Watershed Characterization Manual* (Bowen, et al. 2006). The Fall Run sampling site schematic (Figure 2) shows the spatial relationship of the AMD sources to each other and their effect on the mainstem. The sampling strategy employed by both OEPA and DMRM is the mass balance approach. Again, the mass balance is a method of studying chemical variations in the concentration of streams by taking measurements along a river at different points above and below confluent tributaries and point sources.

Currently the OEPA is working on the Total Maximum Daily Load (TMDL) report for the Central Ohio River Tributaries (CORT) which includes Cross, Short, and Wheeling Creek Watersheds. The TMDL will estimate the pollutant loads from various sources within the target basins and characterize contaminant loadings (OEPA2010 Study Plan CORT Watershed). The study will gather biological, chemical and physical data for the designated water bodies.

Table 10: Fall Run ODNR and corresponding USACE sample sites with coordinates

ODNR Site ID	River Mile, RM	Latitude	Longitude	USACE Site ID	Site Location
FR0010	0.05	40.1219	-80.8624	EWO 2400	Fall Run (FR) at Mouth
FR0015	0.11	40.1223	-80.8617	EWO 2401	Fall Run; upst. Grey's Run, dnst. FR0016 seep
FR0016	0.21	40.1226	-80.8614	EWO 2403	Right bank seep enters FR 1,100 ft. upst. of mouth
FR0025	0.25	40.1228	-80.8609	No EWO #	Fall Run upst. Of Grey's Run; upst. Of FR0016 seep
FR0031	0.55	40.1285	-80.8607	EWO 2424	Right bank seep enters FR 2,990 ft. upstm of mouth
FR0035	0.61	40.1291	-80.8603	EWO 2422	Fall Run; upst. of FR0031 seep
FR0041	0.80	40.1316	-80.8604	EWO 2418	Unnamed trib enters FR 4,225 ft. upst. from mouth
FR0050	1.09	40.1356	-80.8586	No EWO #	Fall Run bdnst. confluence with Hunkey Hollow (HH)
FR0060	1.11	40.1364	-80.8590	EWO 2420	Fall Run upst. Confluence with Hunkey Hollow
FR0061	1.23	40.1376	-80.8598	EWO 2423	Deep mine discharge into FR; upst. HH
FR0070	1.36	40.1388	-80.8607	No EWO #	Fall Run upst. of AMD impacts
GR0010	0.02	40.1223	-80.8621	EWO 2402	Grey's Run Mouth
HH0010	0.005	40.1363	-80.8584	EWO 2425	Hunkey Hollow Mouth
HH0011	0.09	40.1373	-80.8559	EWO 2430	Right bank seep to HH at culvert
HH0050	0.24	40.1378	-80.8550	EWO 2435	Hunkey Hollow upst. AMD impacts

Figure 2: Fall Run Sampling Schematic

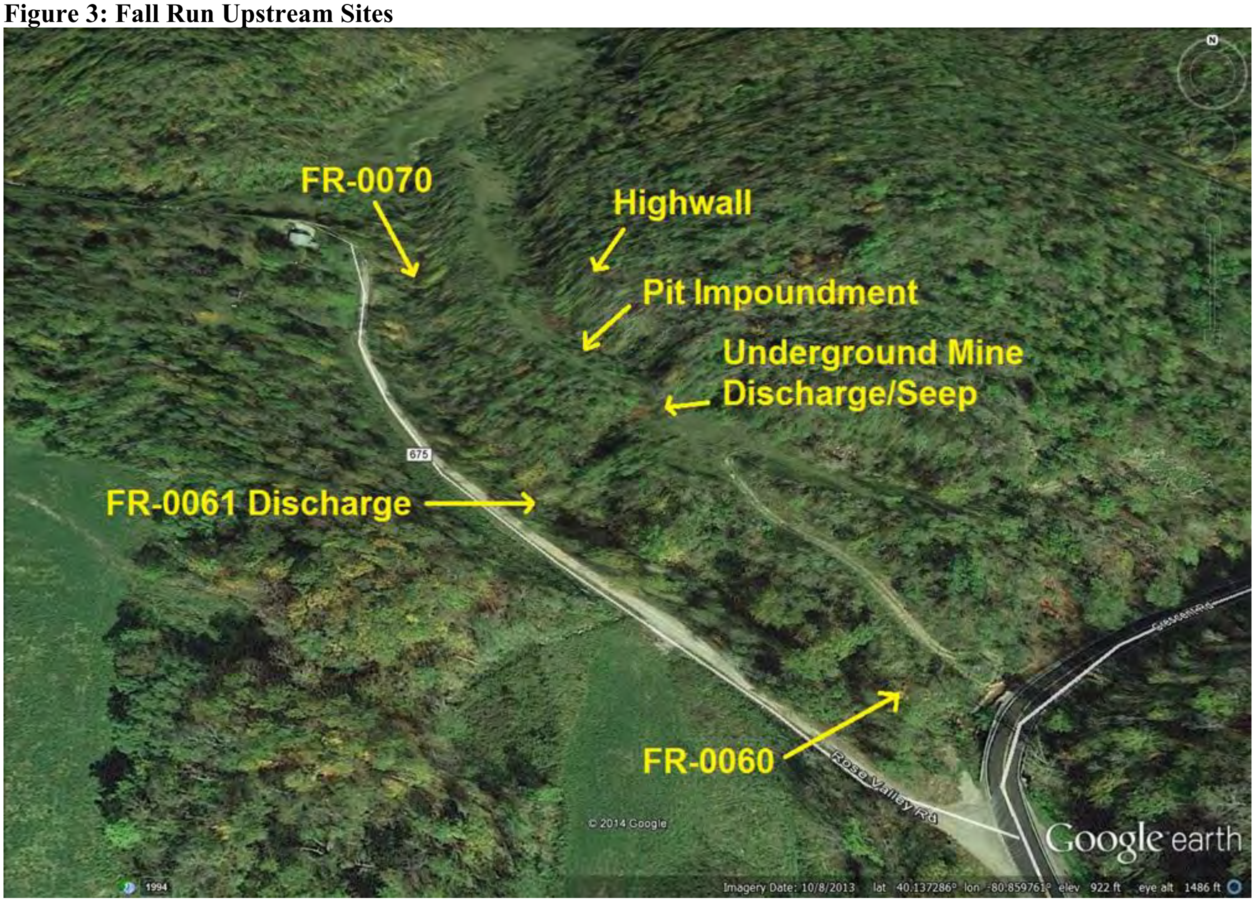


Fall Run Upstream (FR-0070, FR-0061, FR-0060)

FR-0070

The upstream area of Fall Run contains both the best water quality of the watershed and one of the largest iron loaders to the stream (Figure 3). The most upstream sample point in Fall Run is FR-0070. The averaged flow for FR-0070 was 426 gallons per minute (gpm). It is above the main AMD impacts and shows minimal affects from mining.

Figure 3: Fall Run Upstream Sites



FR-0061

The most significant AMD influence to Fall Run is FR-0061which is approximately 750 feet downstream of FR-0070. It is located 1.2 river miles (RM) upstream from the confluence of Fall Run and Wheeling Creek. The iron precipitate from this source affects Fall Run downstream to the mouth. The source of the drainage is a discharge from the Pittsburgh #8 cropline seep. There is also a #8 Pittsburgh coal pit impoundment which is adjacent to the highwall.

Water drains from the southern end of the impoundment and combines with the underground mine discharge. The combined mine water then flows over a small 20-foot waterfall (Figure 4). The bedrock is limestone which is resistant to erosion and creates the fall. AMD from FR-0061 then enters the mainstem of Fall Run and is responsible for 34-57% of the iron loading to the stream depending on discharge.

FR-0060

Site FR-0060 is a mainstem sample point which is downstream of FR-0061and upstream of the mouth of Hunkey Hollow (HH-0100). It gives a good measurement of the impact from FR-0061 to Fall Run.

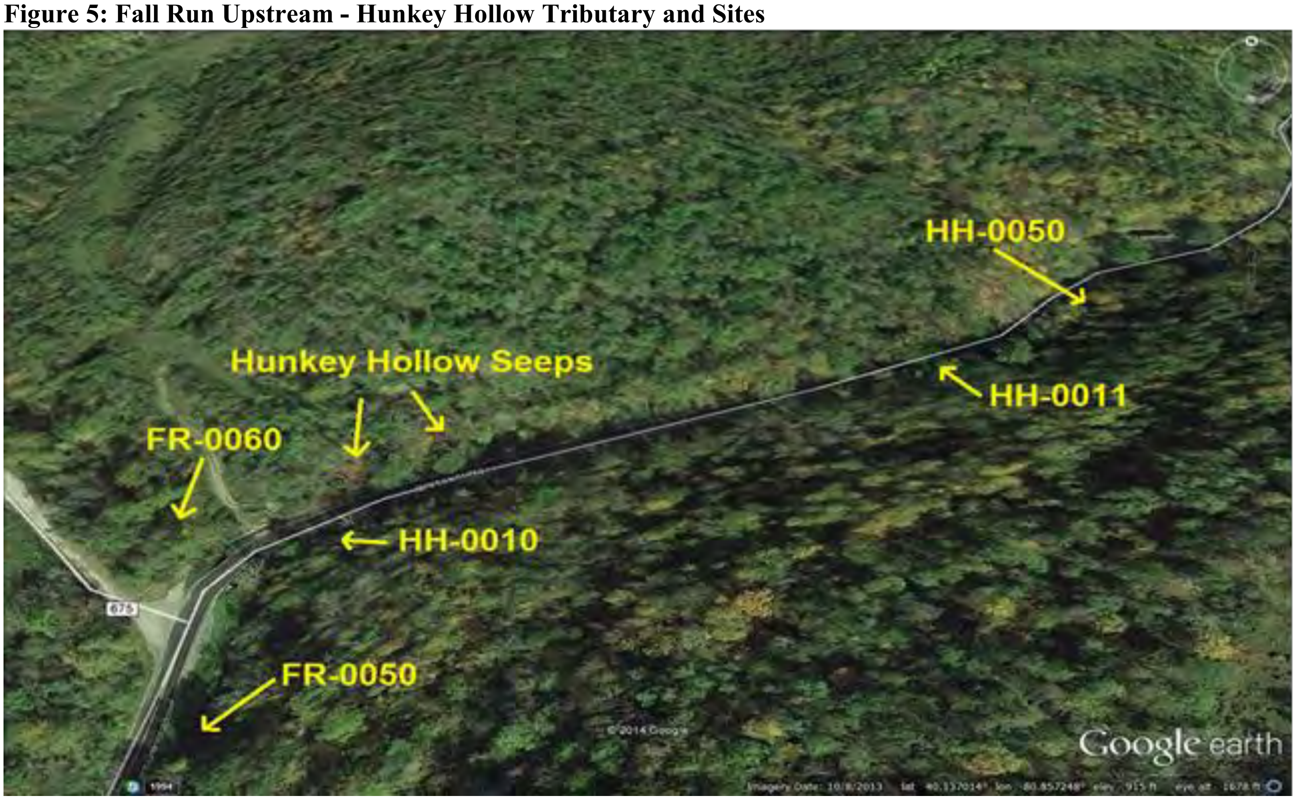
Figure 4: FR-0061 AMD Waterfall before entering Fall Run

Hunkey Hollow (HH-0010, HH-0011, HH-0050)

HH-0050 and HH-0010

Hunkey Hollow is the most upstream of two tributaries flowing into Fall Run. Its mouth is located downstream of FR-0061 and flows into Fall Run from the northeast at 1.1 RM. Hunkey Hollow (Figure 5) is a small stream with an average flow at its mouth (HH-0010) of 12.82 gpm. Hunkey Hollow actually provides an average of 475.8 lb/day of the alkalinity to Fall Run. The alkalinity results from the tributary flowing through the thick limestone rock layer found throughout the area.

Figure 5: Fall Run Upstream - Hunkey Hollow Tributary and Sites



HH-0011

The next sampling site in the Hunkey Hollow tributary was HH-0011. It is located 150 feet upstream from the Hunkey Hollow mouth. This site was the same sample station as the OEPA site EWO 2428. HH-0011 contains AMD originating from 350 feet of seepage along the bench cut on the hillside. This is the east side of the same hill from which the FR-0061 crop cut drainage originates. There is also a last cut pond along the bench which adds water to the seeps. The pond has not been sampled to verify the water quality, but AMD is evident by the large amount of iron precipitate present.

Fall Run (FR-0050, FR-0041, FR-0035, FR-0031)

FR-0050

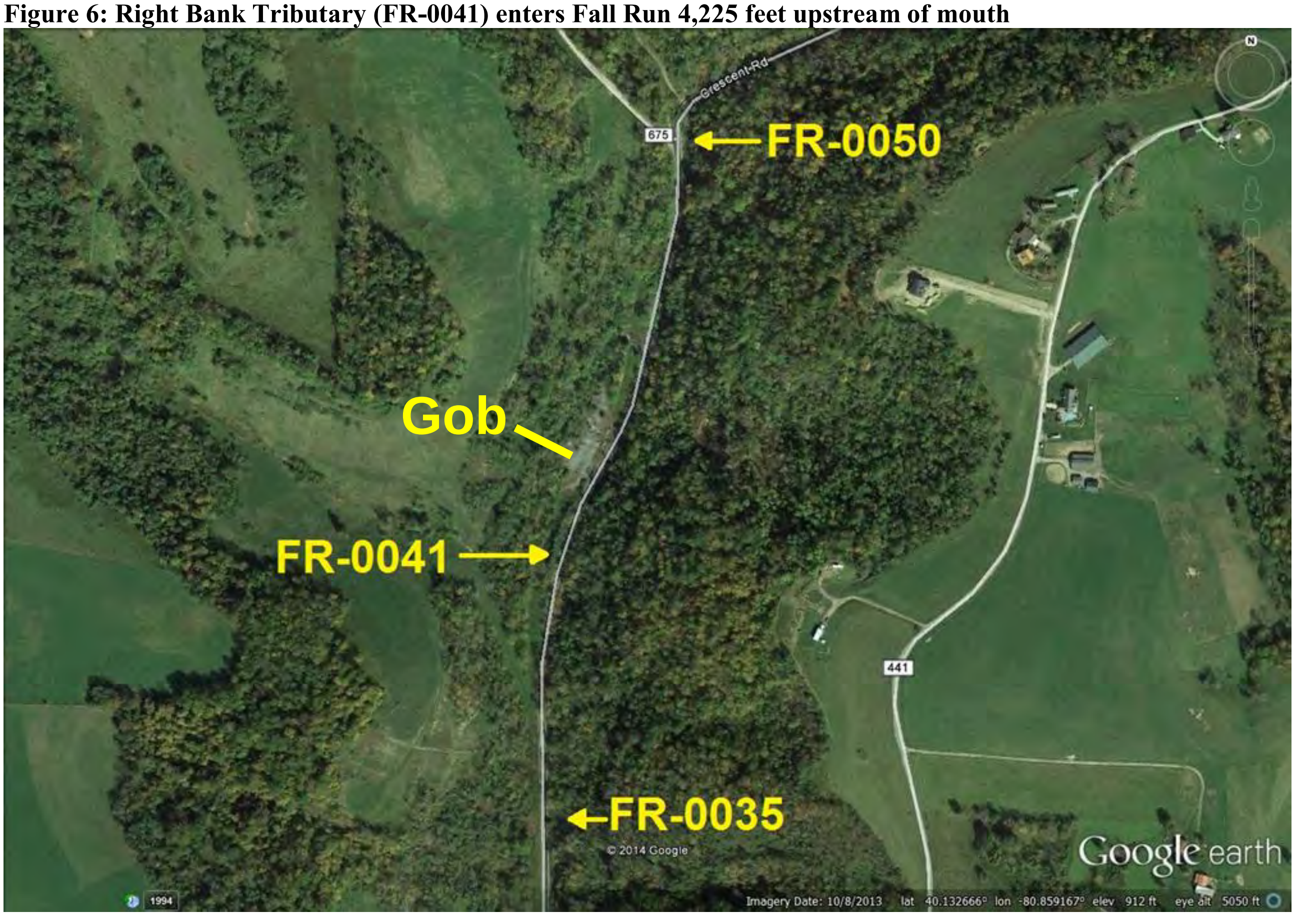
Mainstem sample FR-0050 is located just below the mouth of Hunkey Hollow (Figure 6). The average flow at this mainstem sample point was 275 gpm.

FR-0041

An unnamed tributary enters the mainstem from the west about 4,225 feet (0.8 miles) upstream from the mouth of Fall Run. The tributary has been designated FR-0041 and drains two ponds upslope from the road. A culvert directs the tributary water into the mainstem. During high flow, FR-0041 is the number one acid loader to Fall Run and the third highest iron loader. During low flow FR-0041 is ranked four out of six for both acid and iron loading.

There is also a large gob pile along the "river left" descending bank (looking downstream) from RM 1.1 to RM 0.8. Fall Run flows through the gob and is undercutting the bank and destabilizing it. There have been landslides from this gob bank into the stream causing turbidity and habitat disruption.

Figure 6: Right Bank Tributary (FR-0041) enters Fall Run 4,225 feet upstream of mouth



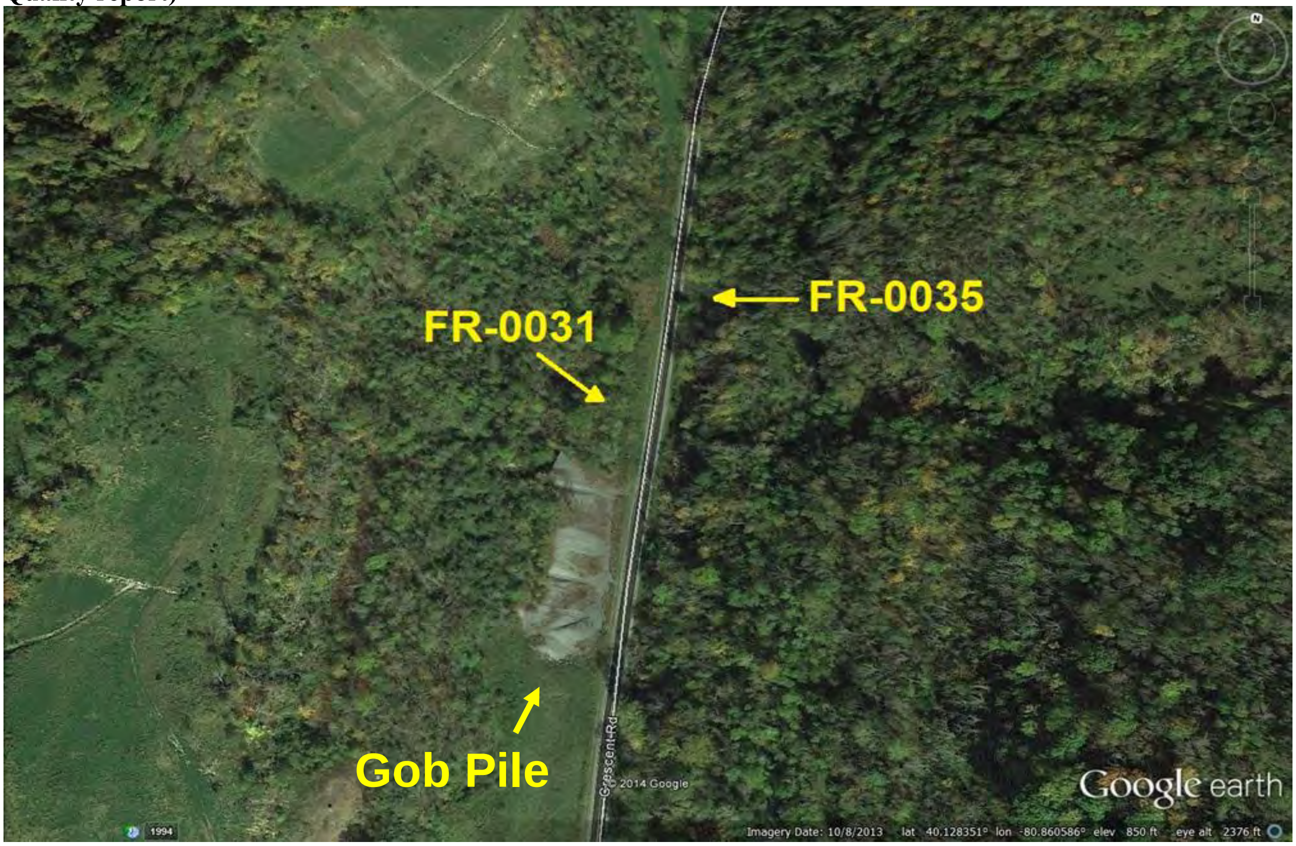
FR-0035

Mainstem sample site FR-0035 is upstream of FR-0031 (refer to Figure 6 above) and was only sampled once on June 14, 2011 which was a medium flow regime. At this site, Fall Run flows through a large spoil bank. There is a large pond upslope from the left descending bank. Water from this impoundment may percolate through the impounding gob and seep into the stream from the left descending bank.

FR-0031

FR-0031 is an AMD source at RM 0.6 upstream from the mouth of Fall Run. It is located along the “river right” bank (looking downstream) of Fall Run between RM 0.5 and RM 0.8 where there is a stretch of gob piles, wetlands, ponds and ditches (OEPA, 2003). The seeps and flow are collected in a culvert which runs under the road and empties into Fall Run with an average flow of 36.64 gpm. The location of the site in relation to Fall Run is shown on an aerial photograph in Figure 7.

Figure 7: Discharge FR-0031 and Mainstem sample site FR-0035 at 0.6 RM (USACE/OEOA, 2002 Water Quality report)

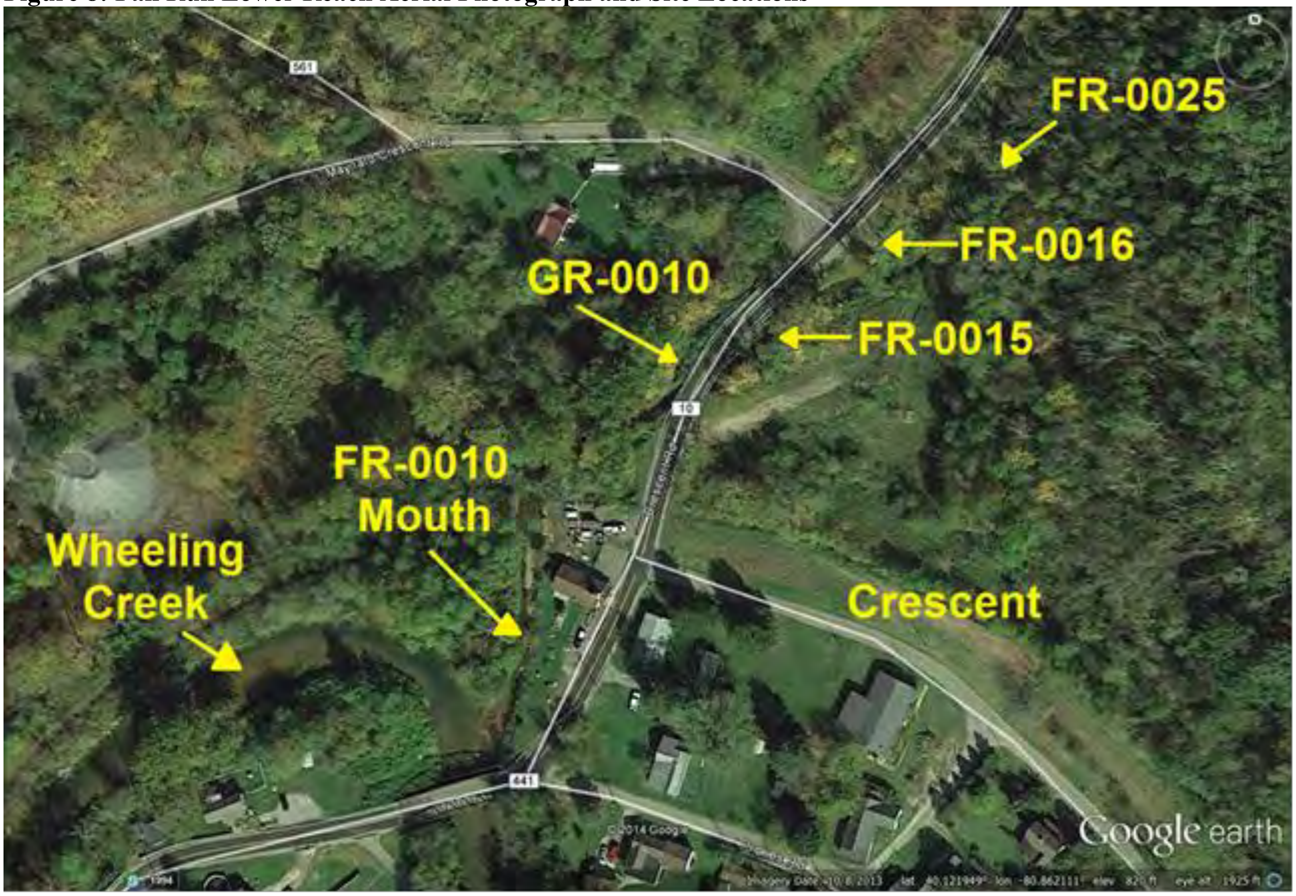


Lower Reach of Fall Run FR-0025, FR-0016, FR-0015, GR-0010

FR-0025

The sample sites in the lower reach of Fall Run are shown in Figure 8. FR-0025 is a mainstem site located 0.3 miles downstream of source FR-0031and is upstream of FR-0016 and the confluence of Grey's Ridge Run. This site was sampled twice in 2009 (October 19 and December 22).

Figure 8: Fall Run Lower Reach Aerial Photograph and Site Locations



FR-0016

FR-0016 is a seep which originates from the Pittsburgh # 8 coal crop line on the west side of the stream. The average flow from FR-0016 is approximately 19 gpm. Water from the seep enters Fall Run about 1,100 feet upstream of the mouth. Flow from the seep enters a culvert which drains into the mainstem. This is where flow and water samples were collected.

FR-0015

The next mainstem site sampled was FR-0015 which is located downstream of FR-0016 and is about 600 feet upstream of the confluence with Fall Run's second tributary, Grey's Ridge Run. The average flow at this point was 834 gpm.

GR-0010

Grey's Ridge Run is a right bank tributary (looking downstream of mainstem) which enters Fall Run about 550 feet upstream of the mouth. The tributary originates on the south side of a hill along Robinson Hollow Road (Township Road 561) just above the town of Crescent. The data was collected by the bridge over Grey's Ridge Run.

On the eastern side of the hill (west side of Crescent Road) seeps emerge from the Pittsburgh #8 crop line. This area contains a 350 foot-long bench that ranges from 50 to 100 feet wide. There is also an extraction pond and wetland which contains a large amount of iron oxide precipitates. Furthermore, a spring discharges above the coal crop line and feeds the wetland. During the 2002-2003 OEPA/USACE investigation a weir was installed to measure the discharge coming from the pond/wetland area. The average flow from the weir was 44 gpm. These AMD seeps are likely responsible for the spike in iron and acidity at FR-0015 in the mainstem.

Landslides have occurred on the western side of the ridge and the eastern slope is also unstable. Water penetrates into the slope and creates a high risk for more landslide problems. DMRM

AML Public Health and Safety (PH&S) program is currently designing a project to address the slope instability.

Mouth of Fall Run (FR-0010)

The mouth of Fall Run drains into Wheeling Creek in the town of Crescent (Refer to Figure 8). The mean annual discharge (MAD) for the Fall Run watershed is 1,732 gpm (3.86 cfs) (USGS, 2001). The left hand chart in Table 11 lists the discharge for Fall Run at each sampling date. The right hand side sorts the discharge from low to high flow. The flow has been converted to a percentage of the mean annual discharge. The range from 25% to 65% MAD is often the range of flow considered when designing treatment systems.

Table 11: Fall Run Mean Annual Discharge and Measured Discharge (USGS, 2001)

Date	Flow GPM	Flow cfs	% Mean Annual Discharge (1732 GPM, 3.86 cfs)	
8/27/2002	139.13	0.310	8.03	Low Flow
9/18/2002	147.66	0.329	8.52	
10/19/2009	173.56	0.387	10.03	
7/17/2002	224.40	0.500	12.95	
12/22/2009	408.42	0.910	23.58	
10/28/2002	421.87	0.940	24.35	~25%
6/27/2002	529.58	1.180	30.57	
1/31/2003	587.57	1.310	33.95	
6/14/2011	599.26	1.335	34.59	
11/25/2002	641.34	1.430	37.05	
12/23/2002	1083.45	2.416	62.59	~65%
4/21/2003	1829.17	4.079	105.68	
3/24/2003	3123.87	6.966	180.47	High Flow

Biological Impairment

In 2002 the Ohio Environmental Protection Agency conducted a survey of the Fall Run watershed and prepared a report (OEPA Report EAS/2002-12-9) for the Ohio Department of Natural Resources, Division of Mineral Resources Management and the U.S. Army Corps of Engineers entitled "Biological and Physical Habitat Study of Fall Run (Wheeling Creek Watershed)" (refer to Appendix C).

The study was conducted using the methods of the OEPA biocriteria monitoring program. All physical habitat and biological field, laboratory, data processing, and data analysis methodologies and procedures adhere to those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 1989a) and Biological Criteria for the Protection of Aquatic Life, Volumes I-III (Ohio Environmental Protection Agency 1987a, 1987b, 1989b, 1989c), and The Qualitative Habitat Evaluation Index (QHEI): Rationale, Methods, and Application (Rankin 1989, 1995). For the habitat assessment the QHEI was used, the Invertebrate Community Index (ICI) was used for the macroinvertebrate assessment, and the Index of Biotic Integrity (IBI) was used to assess the fish assemblages.

In total eight sites were surveyed that included three sites in the mainstem of Fall Run, one site in Grey's Ridge Run, two sites in Hunkey Hollow, and two sites in Wheeling Creek. A summary of the results of the EPA study is found in Table 12.

Table 12: OEPA 2002 Fall Run Biological Sampling Results

River Mile Fish/Invert.	IBI	MIwb	ICI	QHEI	Attainment Status	Site Location
Wheeling Cr. (2002) ***Western Allegheny Plateau (WAP) – LRW (existing)/WWH recommended)***						
12.3/12.3	38*	6.3*	42	76	PARTIAL	Upst. Fall Run
12.2/12.2	41ns	6.4*	40	76	PARTIAL	Dnst. Fall Run
Fall Run (2002) ***Western Allegheny Plateau (WAP) – WWH (existing and recommended)***						
1.3/1.3	34*	NA	G	69	PARTIAL	Upst All AMD sources
1.2/1.2	28*	NA	F*	63.5	NON	Dnst. AMD sources
0.1/0.1	41ns	NA	34ns	58	FULL	Upst. Grey's Ridge Run
Trib. To Fall Run (RM 1.12) (2002) ***Western Allegheny Plateau (WAP) - Undesignated***						
(a.k.a Hunkey Hollow Run)						
0.25/0.25	26(P)	NA	G	58	-	Upst known AMD sources
0.05/0.05	28(F)	NA	MG	57.5	-	Dnst. AMD Sources
Trib. To Fall Run (RM 0.08) (2002) ***Western Allegheny Plateau (WAP) – Undesignated***						
(a.k.a Grey's Ridge Run)						
-/0.05	-	-	MG	-	-	Near Mouth

Ecoregion Biocriteria: Western Allegheny Plateau (WAP)
(from OAC 3745-1-07, Table 7-16)

INDEX	WWH	EWH	MWH
IBI-Headwater	44	50	30
IBI-Wading	44	50	24
MIwb-Wading	8.4	9.4	5.5
ICI	36	46	30

* Significant departure from ecoregion biocriteria; poor and very poor results are underlined
ns Non-significant departure from ecoregion biocriteria ($\leq$ 4 IBI and ICI units, $\leq$ 0.5 MIwb units).
NA MIwb not applicable at headwater stream sites

OEPA Narrative Ratings:
G Good
MG Marginally Good
F Fair
P Poor

The OEPA study showed communities affected by AMD impacts. Warmwater Habitat (WWH) was partially attained in the mainstem of Fall Run upstream from the known AMD sources (RM 1.3). However, conditions declined below the AMD seeps and both fish and macroinvertebrates showed a lowering of biological community quality (RM 1.2). Macroinvertebrates were assessed as "good" upstream of the AMD and performing at ecoregional expectations but were only in the "fair" range at RM 1.2 and was considered in nonattainment of the WWH use. At both sites, fish were not in attainment. The difference in IBI scores between the two sites was considered significant and reflected a negative effect from the intervening mine seeps. At the mouth of Fall Run the fish and macroinvertebrates have modestly recovered and are in full attainment of the WWH use. While communities were considered in full attainment, both the IBI score and the ICI score fell within the range of non-significant departure of the Western Allegheny Plateau biocriteria and indicated a marginal achievement of ecoregional expectations. No significant impacts to Wheeling Creek were observed due to the AMD from Fall Run which was reflected in the partial attainment status of the fish and macroinvertebrate communities found downstream and upstream of Fall Run. An absence of nearly all mayfly taxa showed an imbalance in the macroinvertebrate community which has been found to be characteristic of impacts due to widespread mining land uses in southeastern Ohio watersheds.

Fall Run tributaries were assessed as marginally good to good and reflected conditions near what would be expected in small Class 3 Primary Headwater Habitat (PHWH) streams. Although the tributaries performed as expected, impacts on the fish and macroinvertebrate communities from AMD sources were readily apparent.

In 2009 a biologist from DMRM conducted macroinvertebrate sampling within Fall Run at selected sites to reevaluate the data collected by OEPA in the 2002 study. This survey was undertaken to evaluate the current conditions in Fall Run and to compare the results to those generated by the 2002 OEPA study. Appendix G shows the bio sample site locations on an aerial of the watershed. The Macroinvertebrate Aggregate Index for Streams (MAIS) methodology was utilized to assess the current biological condition and any pertinent changes.

Seven sites were chosen that closely corresponded to the sites completed by OEPA in 2002. A list of sites is presented in Table 13. Figure 9 shows the schematic location of each MAIS sampling site and corresponding OEPA site. It is important to note that that the sample site designations for the biologic sampling do not correspond to the chemical sample site names. In fact, the MAIS sites FR0041 and FR0050 are actually in Hunkey Hollow and not in Fall Run which is the reason the river miles are 0.05 and 0.25 when compared to the mainstem river mile measurements.

Table 13: ODNR DMRM 2009 MAIS Sampling Results

Sampling Site	Location	River Mile	MAIS	Narrative
WC010	Wheeling Cr upst Fall Run	12.3	9	Poor
WC009	Wheeling Creek dnst Fall Run	12.2	11	Poor
FR0020	Fall Run Mouth	0.10	10	Poor
FR0040	Fall Run dnst AMD	1.2	12	Good*
FR0070	Fall Run upst AMD	1.3	14	Good
FR0041	Hunkey Hollow Mouth	.05	7	Very Poor
FR0050	Hunkey Hollow upst AMD	.25	10	Poor[1]

* Score is representative of WWH but is likely skewed due to the occurrence of one single stonefly taxa.

1 Score likely higher than the result. The sample was overloaded with Gamarridae due to oversampling the rootwad habitat

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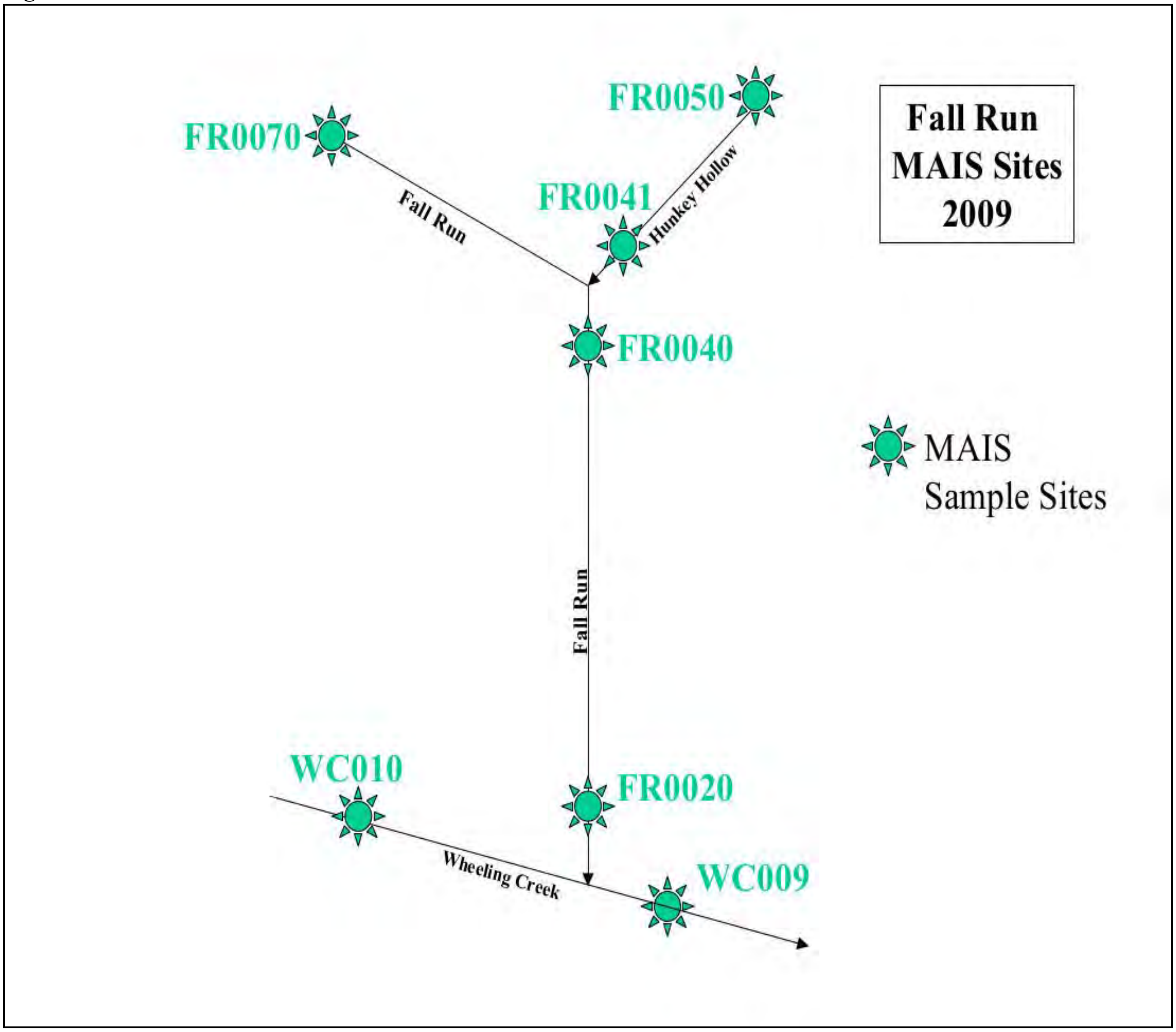
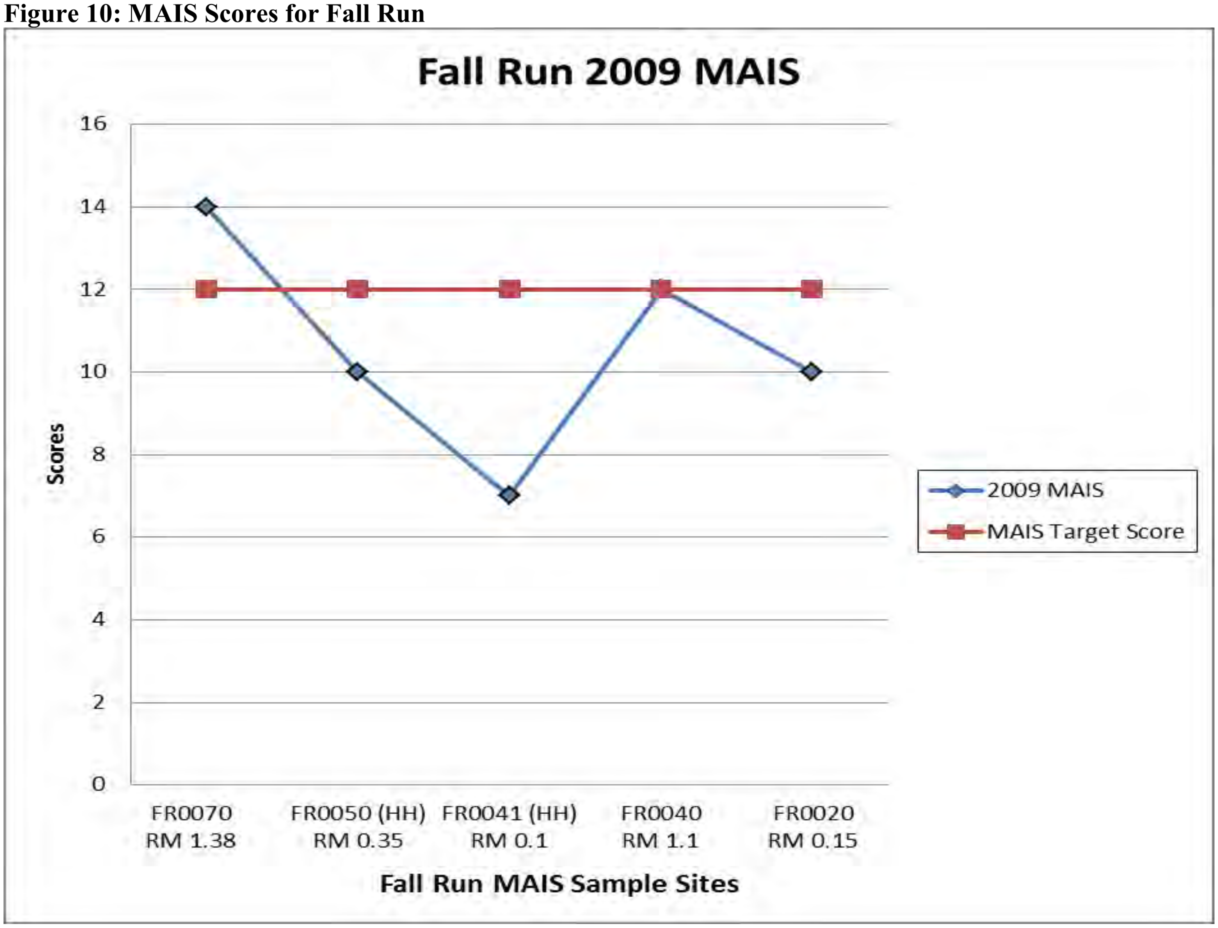
Figure 9: Fall Run 2009 MAIS Site Locations



Results from the ODNR DMRM MAIS sampling (Appendix H) closely reflect the results of the OEPA study. The MAIS shows a stream slightly but definitely impacted by AMD. The Fall Run mouth site (FR0020) does not score representative of WWH (12) but did meet full attainment in 2002. The mouth (FR0020) scored a 10 in 2009 (Figure 10) suggesting that the stream mouth has degraded slightly. Just downstream of the AMD (FR0040) the MAIS score of 12 suggests that it meets WWH criteria. Upon further review of the data it is believed that the score was unjustly elevated due to the presence of a single highly tolerant stonefly family. The stonefly family is present in Fall Run upstream of the AMD impacts and has likely washed into the sampling site FR0040. FR0040 is therefore likely impacted to the level seen at FR0020 and reflected in the 2002 OEPA study at RM 1.2.

Figure 10: MAIS Scores for Fall Run



The mouth of Hunkey Hollow Run (FR0041) exhibited the most impact with a MAIS score of 7. The substrate at the time of sampling was severely embedded with iron precipitate limiting the available habitat for macroinvertebrates. The two sites upstream of the AMD impacts FR0050 and FR0070 both have a high number of intolerant taxa. FR0070 scores a 14 suggesting it meets WWH criteria. FR0050 had a similar taxonomic make up but was heavily skewed due to the presence of a high number of Gamarridae. This high number of amphipods is a result of oversampling the rootwads present at FR0050 and lowered the score to a 10. Given this, and the fact the intolerant taxa numbers are high, the site likely meets WWH criteria for macroinvertebrates.

Given the high habitat scores present within the mainstem of Fall Run, the presence of intolerant taxa in areas not impacted by AMD and the slightly lowered scores seen from the AMD impacts, a full recovery of the WWH aquatic life use is very likely with the successful treatment of the AMD discharge upstream of RM 1.2 (FR0040). The substrates present are currently limited by iron precipitation. It is possible that if the iron precipitate was eliminated from the substrate that Fall Run could meet the EWH life use designation.

Water Chemistry and Loadings

Variability in water quality at different flow regimes ("high," "medium/median," and "low") can help determine the critical flow when biological degradation likely occurs and the "critical" flow for remediation strategies (i.e. the flow regime where the majority of biological impairment occurs). As discussed in the previous section, flow regimes were determined by using flow results at Fall Run RM 0.05 (the mouth) to calculate the percentage of mean annual discharge for each sampling event. Mean annual discharge (MAD) was estimated using the drainage area for Fall Run (Table 14). For streams in the Western Alleghany Plateau, which includes Fall Run, a discharge of 1.027 cfs (cubic feet per second) per square mile of watershed is typically equivalent to the MAD (Koltun and Whitehead, 2001).

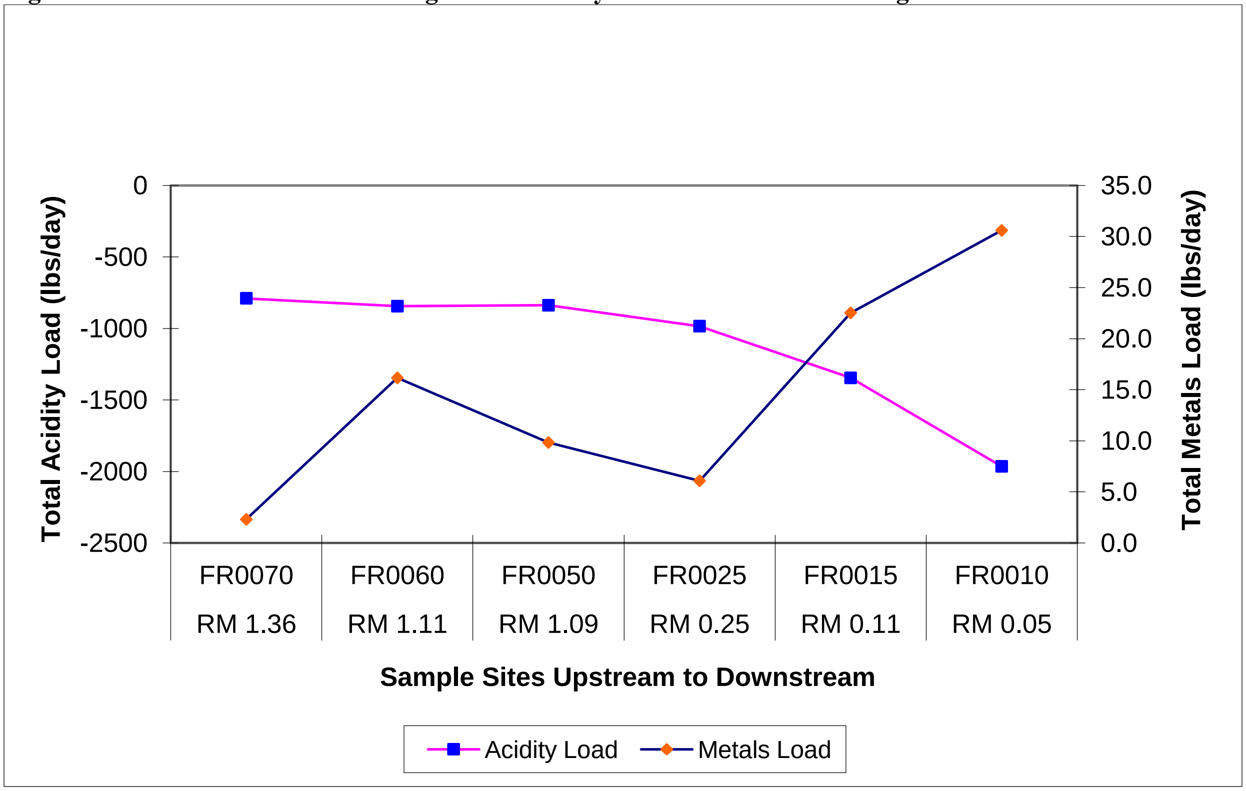
Table 14: Fall Run Phase II Chemical Water Quality Monitoring Flow Regimes

Sample Date	Flow Regime	Sample Site	Drainage Area (sq miles)	Flow (cfs)	% Mean Annual Discharge
8/27/2002	low	Fall Run @ mouth	3.83	0.310	8.09
6/27/2002	medium	Fall Run @ mouth	3.83	1.180	30.81
3/24/2003	high	Fall Run @ mouth	3.83	6.966	181.89

Data collection and chemical analysis of Fall Run were performed by the OEPA/USACE during 2002/2003 and by ODNR DMRM in 2009 and 2011. The concentrations of acidity, alkalinity, and metals (iron, aluminum, and manganese) from all sampling events were used with discharge measurements to calculate high, low, average and median loadings. A loading is the amount of material that a transporting agent, such as a stream, a glacier, or the wind, can carry at a given time. In this report loadings are measured in pounds per day (lb/day). All the pertinent data was used in loading calculations in this report.

Figure 11 shows the average measured acidity and metals loadings for the mainstem of Fall Run. The graph shows that during average discharge, Fall Run has negative acidity or more simply, it is net alkaline. The stream actually increases in alkalinity as it flows downstream. The graph also shows the average total metals loading increases at the mainstem sites FR-0060 and from FR-0015 to FR-0010 (the mouth of Fall Run).

Figure 11: Fall Run Mainstem Average Total Acidity and Total Metals Loadings



Acidity and Alkalinity Loads

Total acidity is related to the pH (proton activity), alkalinity, dissolved CO_2, and dissolved concentrations of Fe, Mn, and Al in mine drainage (Cravotta and Kirby, 2004). Most of the acidity in Fall Run is created from the oxidation of metal ions. Net acidity is defined as the total acidity minus the total alkalinity. To determine net acidity, the acidity in the water must be calculated first using dissolved metal concentrations. Unfortunately, no filtered (dissolved) samples were taken at any sampling event. Since the dissolved concentrations of the metals are needed to calculate acidity, only the total acidity measured in the lab is used in this report.

Alkalinity is the capacity of an aqueous solution to neutralize or "buffer" an acid. After reviewing the measured acidity versus measured alkalinity in the samples, it is evident that Fall Run is net alkaline (Table 15). This means that the acidity in the stream is buffered by the carbonate alkalinity produced from the large amount of limestone in the rock strata. Because of the high concentration of alkalinity, the mainstem Fall Run has pH measurements consistently between 7.5 and 8.

Table 15: Fall Run Acidity/Alkalinity High, Low, Average, and Median Flow Concentrations and Loadings

HIGH FLOW Upstream to Downstream

Site ID	Location	pH	SC uScm	Flow GPM	Flow CFS	Acid Conc. mg/L	Alkalinity Conc. mg/L	Total Acidity Load lb/day	Alkalinity Load lb/day
FR0070	Mainstem	8.24	1234	968.17	2.157	4.9	210.7	56.8	2443.47
FR0060	Mainstem	8.23	2471	1078.30	2.403	6.9	202.0	88.7	2608.86
FR0050	Mainstem	8.09	1532	361.20	0.805	8.7	244.0	12.1	1008.35
FR0025	Mainstem	7.94	2240	442.97	0.987	6.0	255.0	31.8	1353.06
FR0015	Mainstem	8.24	3440	2861.55	6.376	6.9	248.4	235.0	8515.46
FR0010	Mainstem	8.09	3401	3123.87	6.966	6.9	211.6	257.1	7923.77
FR0061	Source	7.58	4510	58.344	0.130	19.6	189.5	13.7	132.47
HH0010	Source	8.09	2001	402.57	0.897	3.9	173.0	18.9	834.04
FR0041	Source	7.76	2710	44.88	0.100	41.1	19.8	22.1	10.65
FR0031	Source	7.80	5110	62.83	0.140	19.6	207.5	14.7	156.21
FR0016	Source	7.90	4235	44.88	0.100	9.8	267.2	5.3	143.66
GR0010	Source	8.10	2548	262.32	0.585	4.9	242.4	15.4	761.61

LOW FLOW Upstream to Downstream

Site ID	Location	pH	SC uScm	Flow GPM	Flow CFS	Acid Conc. mg/L	Alkalinity Conc. mg/L	Total Acidity Load lb/day	Alkalinity Load lb/day
FR0070	Mainstem	7.25	815	8.98	0.02	0.0	128.2	0.0	23.65
FR0060	Mainstem	6.97	889	39.94	0.089	0.0	154.0	0.0	73.68
FR0050	Mainstem	7.71	1136	162.47	0.362	2.8	233.0	16.9	474.85
FR0025	Mainstem	7.84	1782	210.94	0.470	0.0	154.0	16.2	659.47
FR0015	Mainstem	7.09	1142	197.47	0.440	3.5	189.0	0.0	447.07
FR0010	Mainstem	7.60	1463	139.13	0.310	1.5	180.0	0.0	299.98
FR0061	Source	6.54	1333	14.81	0.033	3.2	212.0	1.1	6.21
HH0010	Source	7.62	1079	24.68	0.055	1.9	238.0	2.9	64.23
FR0041	Source	6.08	1499	1.80	0.004	10.4	194.0	1.6	1.49
FR0031	Source	6.61	1820	18.40	0.041	8.2	275.0	2.7	4.06
FR0016	Source	7.11	1690	4.49	0.010	7.1	284.0	1.4	11.02
GR0010	Source	7.20	1037	5.39	0.012	4.6	266.0	1.9	16.45

AVERAGE FLOW Upstream to Downstream

Site ID	Location	pH	SC uScm	Flow GPM	Flow CFS	Acid Conc. mg/L	Alkalinity Conc. mg/L	Total Acidity Load lb/day	Alkalinity Load lb/day
FR0070	Mainstem	7.90	1013	335.60	0.748	4.9	216.4	29.0	793
FR0060	Mainstem	7.72	1366	348.71	0.777	6.8	207.1	37.0	817
FR0050	Mainstem	7.87	1336	274.94	0.613	5.7	238.3	16.0	781
FR0025	Mainstem	7.89	2011	366.66	0.817	5.6	223.7	27.0	965
FR0015	Mainstem	7.89	1931	785.33	1.750	7.9	214.0	109.0	2096
FR0010	Mainstem	7.90	2294	762.25	1.699	5.4	218.2	18.0	1958
FR0061	Source	6.96	2827	26.31	0.059	59.1	90.9	17.6	36.90
HH0010	Source	7.83	1546	192.91	0.0.43	11.8	213.6	11.2	475.38
FR0041	Source	7.11	2065	12.82	0.03	11.8	213.6	7.7	12.63
FR0031	Source	7.14	3726	36.64	0.086	54.6	114.9	17.9	56.14
FR0016	Source	7.56	3027	18.91	0.068	10.8	237.5	3.3	54.88
GR0010	Source	7.85	1725	122.70	0.273	5.8	224.2	5.5	386.13

MEDIAN FLOW Upstream to Downstream

Site ID	Location	pH	SC uScm	Flow GPM	Flow CFS	Acid Conc. mg/L	Alkalinity Conc. mg/L	Total Acidity Load lb/day	Alkalinity Load lb/day
FR0070	Mainstem	7.86	1100	279.11	0.622	4.9	223.3	22.7	751
FR0060	Mainstem	7.72	1350	253.12	0.564	6.9	201.5	38.8	664
FR0050	Mainstem	7.86	2035	301.10	0.671	5.6	238.0	16.9	859
FR0025	Mainstem	7.86	2035	326.95	0.729	6.2	258.0	24.0	1006
FR0015	Mainstem	7.83	1400	548.57	1.222	7.3	216.0	84.8	1435
FR0010	Mainstem	7.81	1950	529.58	1.180	5.4	211.6	18.8	1389
FR0061	Source	6.58	2295	21.99	0.049	19.6	50.9	13.7	9.69
HH0010	Source	7.57	1690	85.79	0.191	3.92	218.09	6.50	240.86
FR0041	Source	7.06	2235	9.87	0.022	33.3	94.2	6.7	13.17
FR0031	Source	7.67	2810	34.64	0.077	17.1	107.1	12.5	54.90
FR0016	Source	7.42	2915	16.83	0.038	10.2	251.0	2.8	54.80
GR0010	Source	7.78	1440	30.05	0.067	5.8	266.5	2.9	93.12

***Mainstem and Source sites are listed from upstream to downstream**
GR - Grey's Ridge Run; HH - Hunkey Hollow

The high flow (Figure 12) measurements were taking from a wet spring in 2003. Even with low concentrations, the loadings will be high if discharge is high. The high flow acidity increases from 56.79 lb/day at FR-0070 to 257.10 lb/day at FR-0010 (Figure 12), a four-fold increase, but alkalinity also increases from 1443 to 7923 lb/day (Figure 13). This large alkalinity buffers any acidity in the stream.

Figure 12: Fall Run Acidity Load during High, Low, and Average Flow

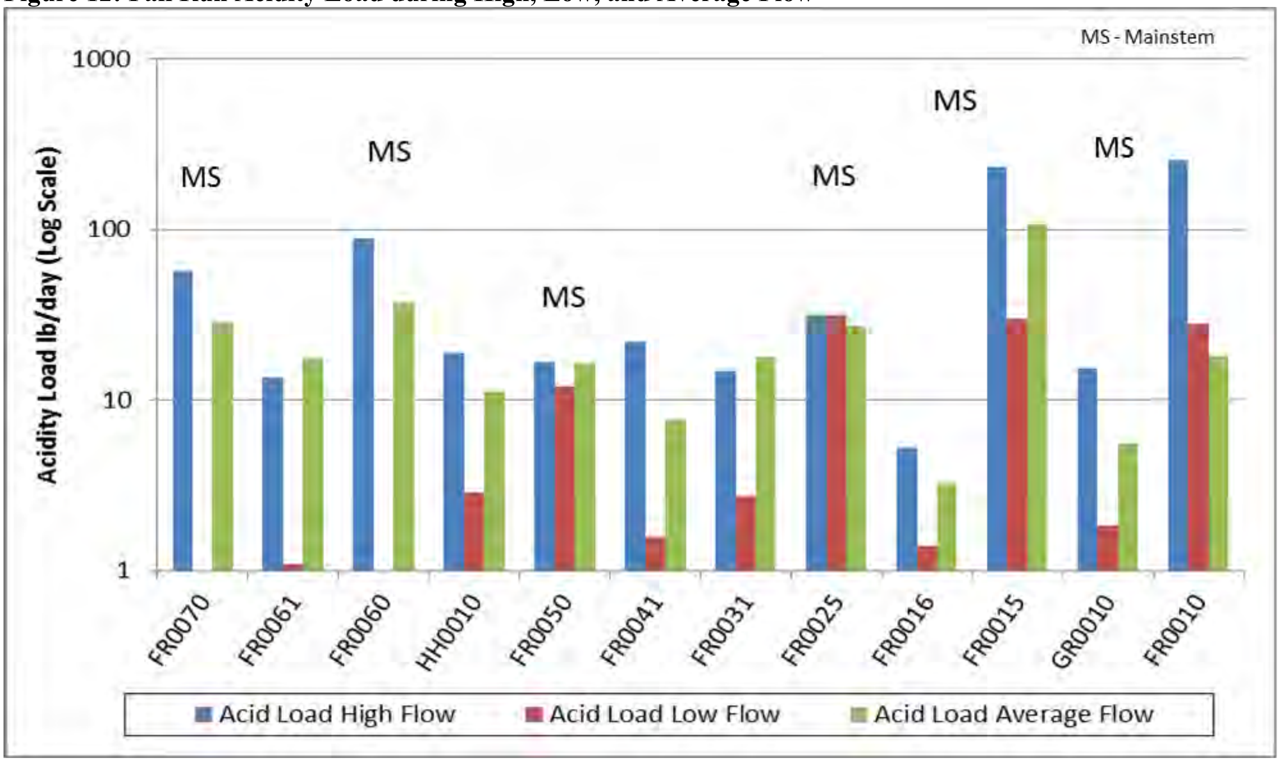
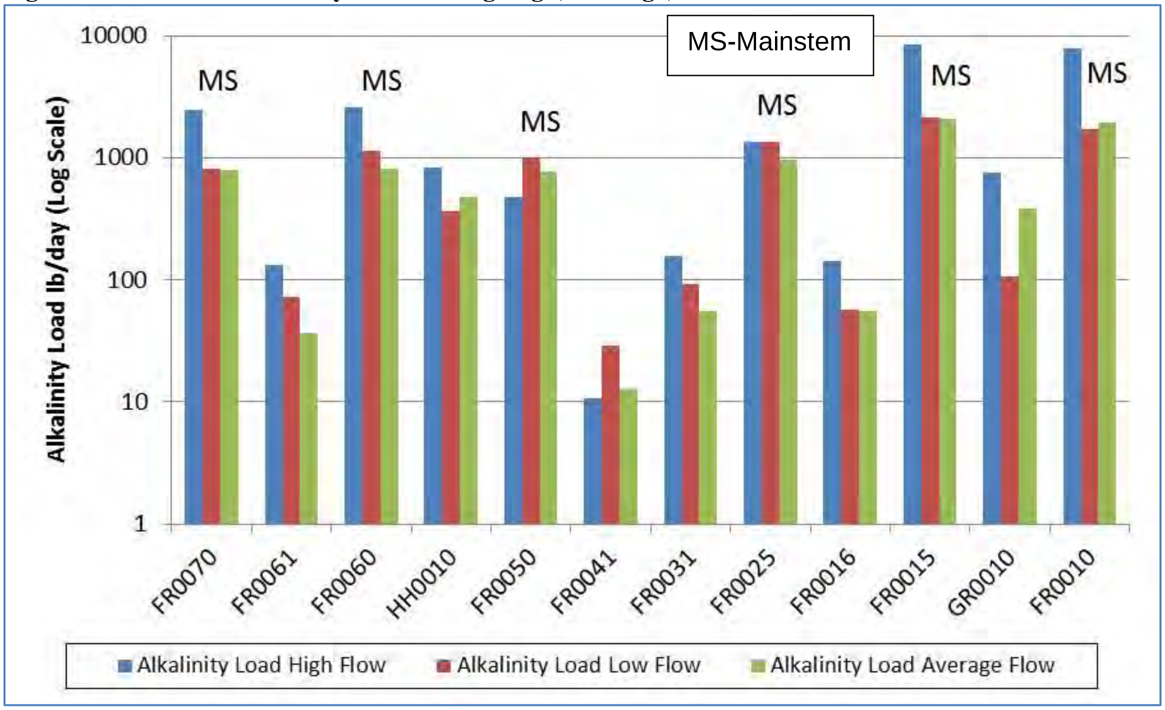


Figure 13: Fall Run Alkalinity Load during High, Average, and Low Flow



While acidity levels are low in Fall Run and will not be the focus of treatment, it is important to identify and quantify the acid sources of Fall Run. The sources of acidity to Fall Run are ranked by average, high, and low flow loadings (Table 16).

Table 16: Acidity Percentage of High, Low, and Average Flow Loadings

Parameter	Rank	Source Site	Avg. Flow Load lb/day	%	Source Site	High Flow Load lb/day	%	Source Site	Low Flow Load lb/day	%
Acidity	1	FR0031	18	28	FR0041	22	25	HH0010	2.91	25
	2	FR0061	18	28	HH0010	19	22	FR0031	2.73	24
	3	HH0010	11	18	GR0010	15	16	GR0010	1.85	16
	4	FR0041	8	12	FR0031	15	16	FR0041	1.57	14
	5	GR0010	5	9	FR0061	14	15	FR0016	1.40	12
	6	FR0016	3	5	FR0016	5	6	FR0061	1.09	9
Mainstem Mouth, FR0010 Total			63			257			28.28	

Below figures 14, 15, and 16 show the data from Table 15 in pie charts. The visual representation of the acid producing tributaries and seeps for each flow regime provide a quick and clear comparison between sites and loads. It also identifies which sites may be considered for future lower priority projects in the watershed.

Figure 14: Fall Run AMD Sources High Flow Acidity Load

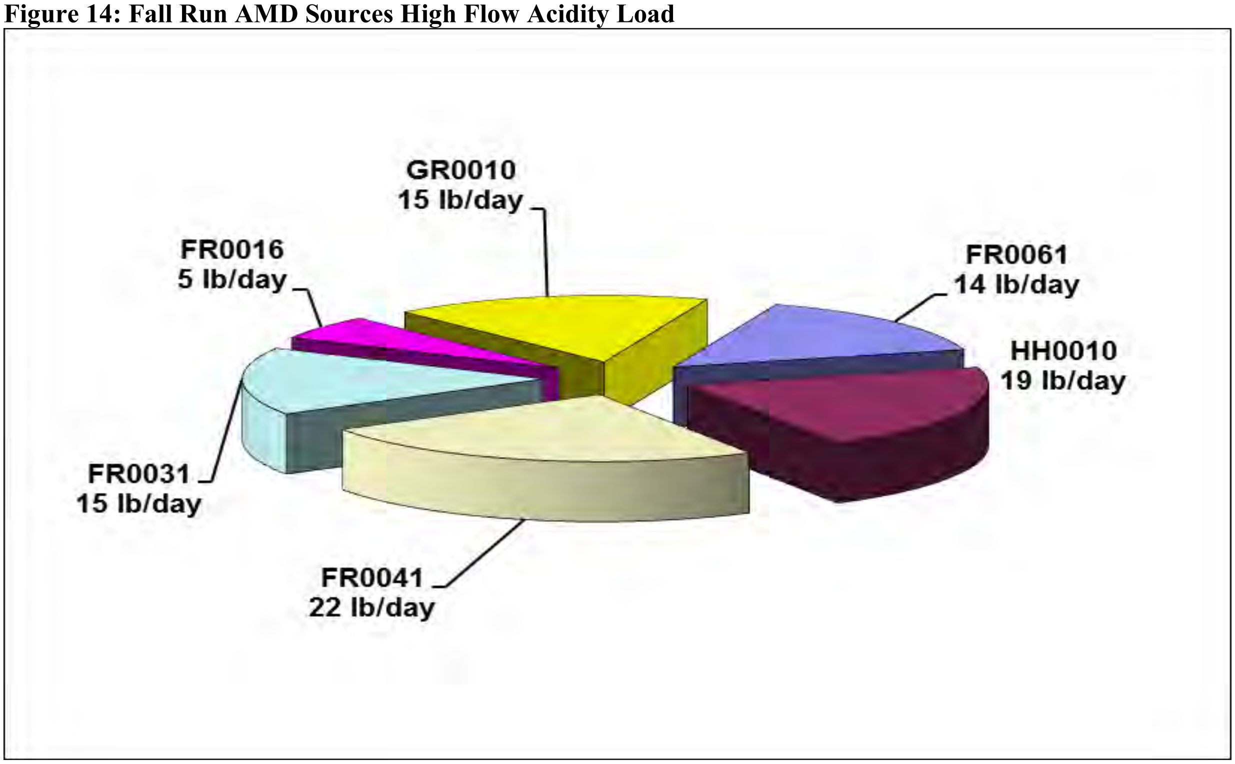


Figure 15: Fall Run AMD Sources Low Flow Acidity Load

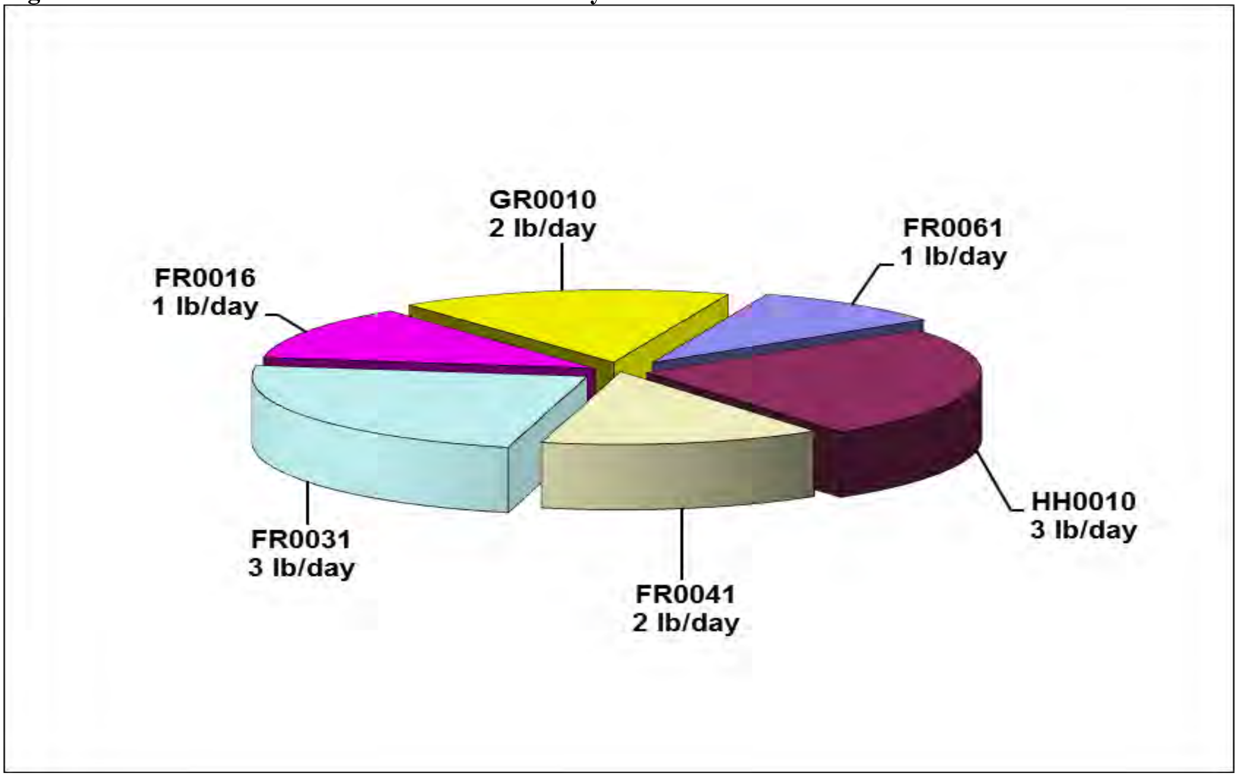
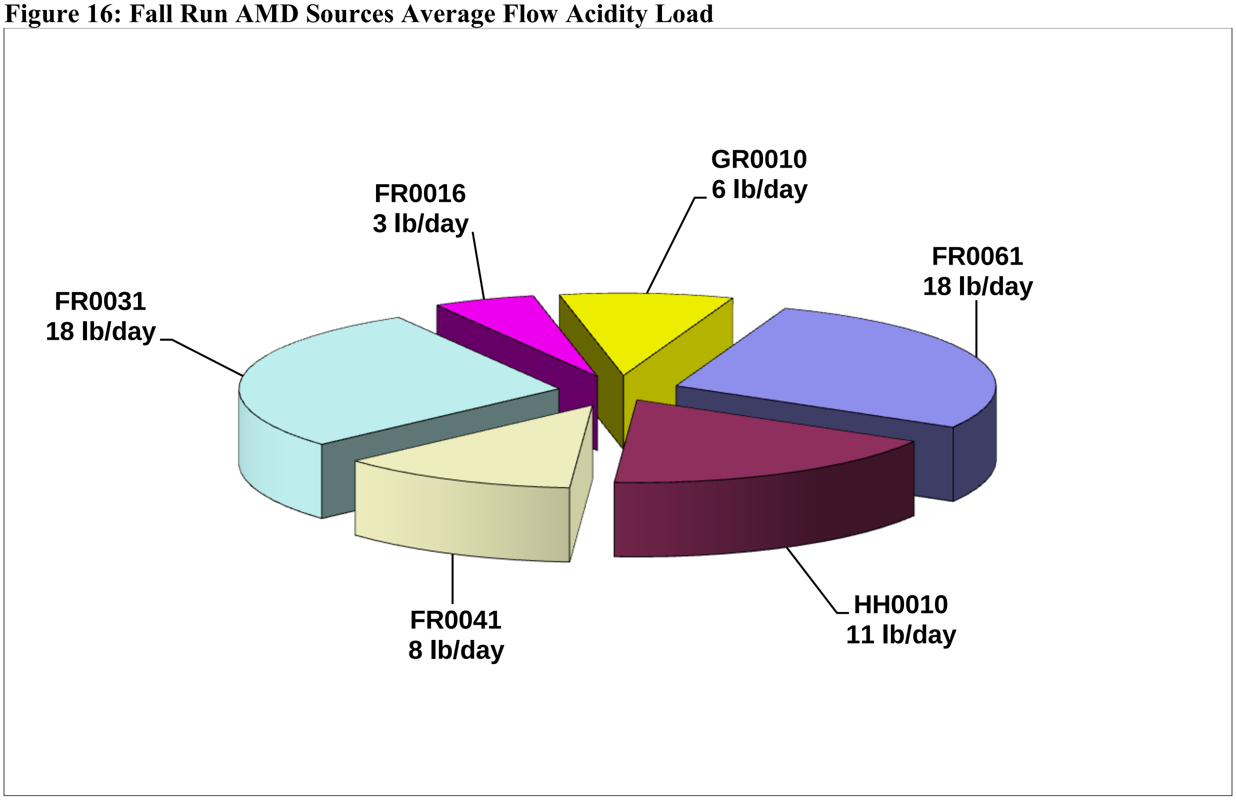


Figure 16: Fall Run AMD Sources Average Flow Acidity Load



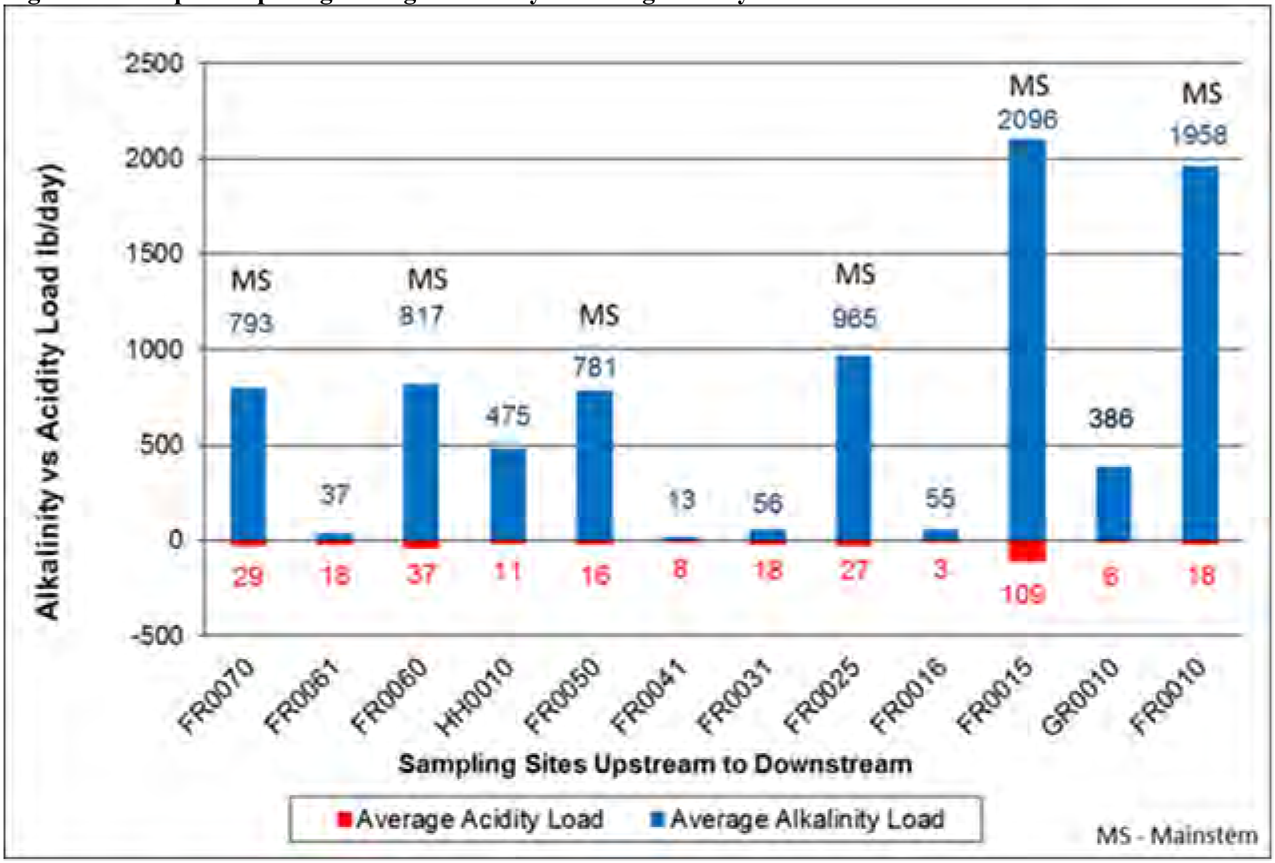
The mainstem of Fall Run itself is highly alkaline, but the tributaries and sources also add alkalinity. The top three ranking alkalinity sources for each flow regime are listed in Table 17. Hunkey Hollow, Grey's Ridge, FR-0031 during high and average flow regimes and FR-0016 during low flow provide most of the alkalinity to the mainstem.

Table 17: Alkalinity Percentage of High, Low, and Average flow Loadings

Parameter	Rank	Source Site	Avg. Flow Load lb/day	%	Source Site	High Flow Load lb/day	%	Source Site	Low Flow Load lb/day	%
Alkalinity	**1**	HH0010	475	47	HH0010	834	41	HH0010	64	63
	2	GR0010	386	38	GR0010	762	37	GR0010	16	12
	3	FR0031	56	5	FR0031	156	8	FR0016	11	11
	4	FR0016	55	5	FR0016	144	7	FR0061	6	8
	5	FR0061	37	4	FR0061	133	6	FR0031	4	5
	6	FR0041	13	1	FR0041	11	1	FR0041	1	1
Mainstem Mouth, FR0010 Total			1022			2039			300	

A comparison of Fall Run's average acidity and alkalinity loads is shown in Figure 17. The alkalinity is at least one order of magnitude greater than the acidity during all flow regimes. At its mouth (FR-0010), Fall Run has an average alkalinity of 1958 lb/day. This is an average gain 1165 lb/day from the upstream site of FR-0070.

Figure 17: Graph comparing average alkalinity to average acidity in Fall Run



Iron Loads

The main impact to Fall Run is the metal load, specifically, iron. At neutral pH iron precipitates and coats the substrate of Fall Run. As discussed previously in the Biological Impairment section, this reduces the habitat available to aquatic macroinvertebrates. Table 18 contains the metal concentrations and loadings for high, low, and average flows for the mainstem and sources.

Table 18: Fall Run Metals High, Low, and Average Flow Concentrations and Loadings

HIGH FLOW Upstream to Downstream

Site ID	Location	pH	Flow GPM	Flow CFS	Fe mg/L	Alum mg/L	Mn mg/L	Fe Load lb/day	Alum Load lb/day	Mn Load lb/day	Total Metal Load lb/day
FR0070	Mainstem	8.24	968.17	2.157	0.25	0.14	0.06	2.90	1.62	0.66	5.18
FR0060	Mainstem	8.23	1078.30	2.403	1.08	0.11	0.08	13.95	1.42	1.05	16.42
FR0050	Mainstem	8.09	361.20	0.805	0.68	0.08	0.21	2.94	0.35	0.28	3.57
FR0025	Mainstem	7.94	442.97	0.987	2.13	0.00	0.21	11.3	0.00	1.10	12.4
FR0015	Mainstem	8.24	2861.55	6.376	2.95	0.96	0.12	101.12	32.91	4.25	138.27
FR0010	Mainstem	8.09	3123.87	6.966	2.31	1.13	0.14	86.51	42.32	5.17	134.00
FR0061	Source	7.58	58.344	0.130	114.0	0.50	1.79	42.17	0.18	0.44	42.79
HH0010	Source	8.09	402.57	0.897	0.67	0.08	0.05	3.23	0.39	0.26	3.87
FR0041	Source	7.76	44.88	0.100	18.30	11.90	0.50	9.84	6.40	0.27	16.50
FR0031	Source	7.80	62.83	0.140	117	0.75	0.23	51.29	0.56	0.17	17.60
FR0016	Source	7.90	44.88	0.100	0.36	0.05	0.06	0.19	0.03	0.03	0.25
GR0010	Source	8.10	262.32	0.585	0.21	0.10	0.02	0.66	0.31	0.05	1.03

LOW FLOW Upstream to Downstream

Site ID	Location	pH	Flow GPM	Flow CFS	Fe mg/L	Alum mg/L	Mn mg/L	Fe Load lb/day	Alum Load lb/day	Mn Load lb/day	Total Metal Load lb/day
FR0070	Mainstem	7.25	8.98	0.02	0.14	0.19	0.05	0.02	0.02	0.22	0.26
FR0060	Mainstem	6.97	39.94	0.089	4.47	0.20	0.06	2.14	0.10	0.04	2.27
FR0050	Mainstem	7.71	162.47	0.362	3.63	0.00	0.06	7.06	0.00	0.41	7.48
FR0025	Mainstem	7.84	210.94	0.470	0.25	0.00	0.21	0.64	0.00	0.39	1.03
FR0015	Mainstem	7.09	197.47	0.440	0.18	0.20	0.10	0.42	0.47	0.31	1.20
FR0010	Mainstem	7.60	139.13	0.310	0.23	0.25	0.10	0.39	0.42	0.10	0.92
FR0061	Source	6.54	8.98	0.020	21.30	0.05	0.39	7.05	0.0	0.11	7.16
HH0010	Source	7.62	23.34	0.055	0.52	0.08	0.05	0.87	0.06	0.49	3.61
FR0041	Source	6.08	1.80	0.004	14.88	0.40	0.22	0.32	0.01	1.02	1.35
FR0031	Source	6.61	18.40	0.041	16.92	0.20	0.54	3.73	0.04	1.06	4.83
FR0016	Source	7.11	4.49	0.010	1.30	0.20	0.08	0.07	0.01	0.47	0.55
GR0010	Source	7.20	5.39	0.012	1.55	0.24	0.04	0.10	0.02	0.10	0.21

AVERAGE FLOW Upstream to Downstream

Site ID	Location	pH	Flow GPM	Flow CFS	Fe mg/L	Alum mg/L	Mn mg/L	Fe Load lb/day	Alum Load lb/day	Mn Load lb/day	Total Metal Load lb/day
FR0070	Mainstem	7.90	335.60	0.748	0	0	0.12	0.94	0.74	0.25	1.93
FR0060	Mainstem	7.72	348.71	0.777	2	0	0.12	9.25	0.64	0.46	10.35
FR0050	Mainstem	7.87	274.94	0.613	2	0	0.14	7.18	0.12	0.40	7.71
FR0025	Mainstem	7.89	366.66	0.817	1	0	0.21	5.97	0.00	0.75	8.26

FR0015	Mainstem	7.89	785.33	1.750	3	0	0.18	24.80	1.74	1.53	27.81
FR0010	Mainstem	7.90	762.25	1.699	2	0	0.15	22.81	3.71	1.40	27.92
FR0061	Source	6.96	335.60	0.75	70.70	0.15	1.13	17.86	0.28	0.04	18.18
HH0010	Source	7.83	192.91	0.430	3.02	0.22	0.22	3.61	0.32	0.26	4.19
FR0041	Source	7.11	353.98	0.778	0.77	0.19	15.25	3.21	0.81	0.08	4.10
FR0031	Source	7.14	38.47	0.086	49.55	0.37	0.68	22.85	0.17	0.26	23.28
FR0016	Source	7.56	18.91	0.068	2.11	0.05	0.25	0.77	0.02	0.04	0.83
GR0010	Source	7.85	446.91	0.978	0.17	0.04	2.17	0.89	0.20	0.48	1.57

MEDIAN FLOW Upstream to Downstream

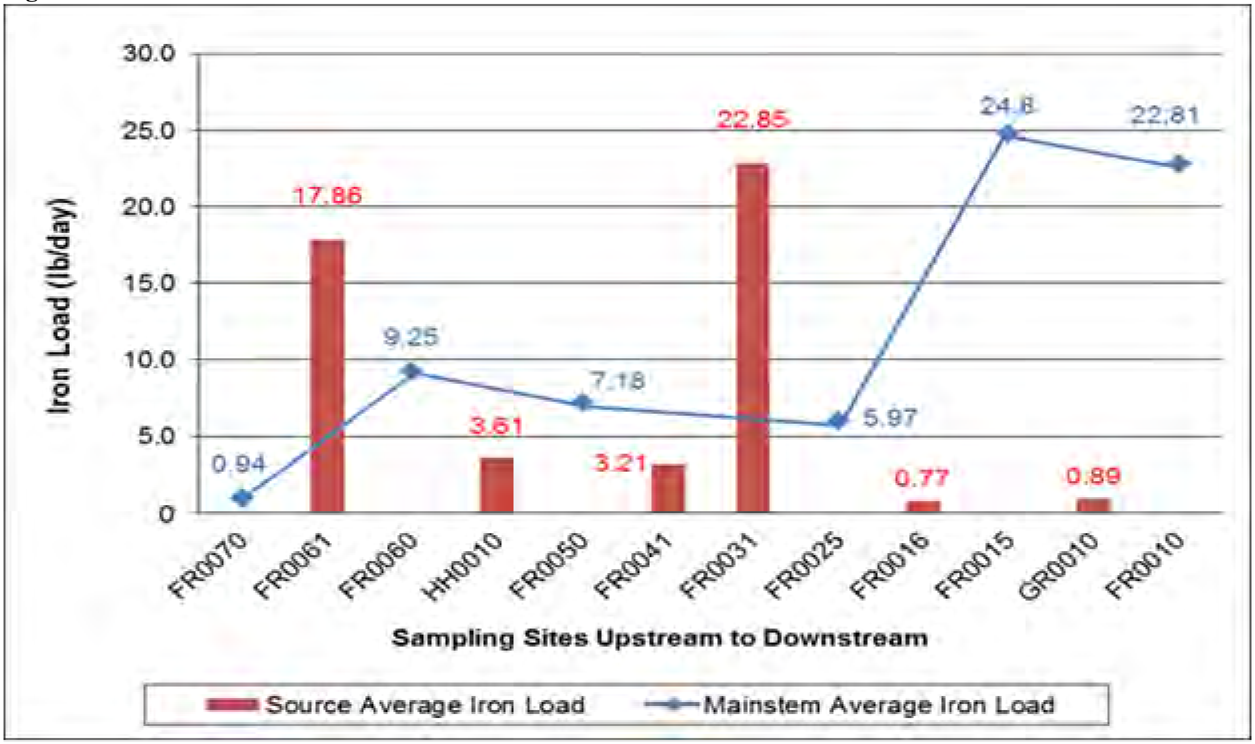
Site ID	Location	pH	Flow GPM	Flow CFS	Fe mg/L	Alum mg/L	Mn mg/L	Fe Load lb/day	Alum Load lb/day	Mn Load lb/day	Total Metal Load lb/day
FR0070	Mainstem	7.86	279.11	0.622	0	0	0.06	0.69	0.36	0.16	1.21
FR0060	Mainstem	7.72	253.12	0.564	4	0	0.13	11.79	0.33	0.38	12.50
FR0050	Mainstem	7.86	326.95	0.729	2	0	0.15	7.06	0.00	0.41	7.48
FR0025	Mainstem	7.86	326.95	0.729	2	0	0.21	5.97	0.00	0.75	6.72
FR0015	Mainstem	7.83	548.57	1.222	2	0	0.13	12.61	0.78	1.05	14.44
FR0010	Mainstem	7.81	529.58	1.180	1	0	0.14	8.31	1.01	0.87	10.19
FR0061	Source	6.58	21.99	0.049	80.0	0.07	1.12	15.17	0.03	0.29	15.49
HH0010	Source	7.57	85.79	0.191	2.54	0.20	0.18	2.84	0.29	0.18	3.31
FR0041	Source	7.06	9.87	0.022	19.80	1.87	0.52	2.34	0.22	0.06	2.62
FR0031	Source	7.67	34.64	0.077	51.94	0.12	0.65	21.50	0.05	0.25	21.80
FR0016	Source	7.42	16.83	0.038	0.67	0.05	0.21	0.14	0.01	0.03	0.18
GR0010	Source	7.78	30.05	0.067	0.25	0.14	0.04	0.09	0.05	0.01	0.15

***Mainstem and Source sites are listed from upstream to downstream**

GR - Grey's Ridge Run; HH - Hunkey Hollow

The percentage of iron during high flow (Table 16) at the mouth of Fall Run is about 86 lb or 81.7% of the metal load. The low flow total metal load including iron is negligible at less than one lb/day. During average flows, iron at the mouth, FR-0070, is 0.94 lb/day. By the time Fall Run reaches its mouth at FR-0070 it gains 17.04 lb/day (Figure 18). Iron concentrations initially increase just upstream of FR-0060. The iron increases again at the mainstem site FR-0015. The iron load at the mouth doesn't represent the total iron contributed to Fall Run because some of the iron has precipitated by the time the water reaches the mouth.

Figure 18: Fall Run Mainstem vs. Source Iron Loads



The sources and tributaries contributing iron to of Fall Run are identified in Table 19 and ranked according to flow regime loadings. The pie charts found in Figures 19, 20, and 21 show the visual representation of these loading ranks and percentages. During high flow the metal loadings in Fall Run mainstem, between FR-0025 and FR-0015, increased from 12.4 to 134.0 lb/day. The large amount volume of flow greatly increased the loading quantity.

Table 19: Iron Percentage of High, Low, and Average Flow Source Loadings

Parameter	Rank	Source Site	Avg. Flow Load lb/day	%	Source Site	High Flow Load lb/day	%	Source Site	Low Flow Load lb/day	%
Iron	**1**	FR0031	22.85	47	FR0031	16.86	37	FR0061	9.55	57
	2	FR0061	17.76	36	FR0061	15.45	34	FR0031	3.73	22
	3	HH0010	3.61	7	FR0041	9.84	21	HH0010	3.06	18
	4	FR0041	3.21	7	HH0010	3.23	7	FR0041	0.32	2
	5	GR0010	0.89	2	GR0010	0.66	1	GR0010	0.10	1
	6	FR0016	0.77	2	FR0016	0.19	0	FR0016	0.07	0
Mainstem Mouth, FR0010, Total			49.09			86.51			23.24	

Figure 19: Fall Run AMD Sources High Flow Iron Load

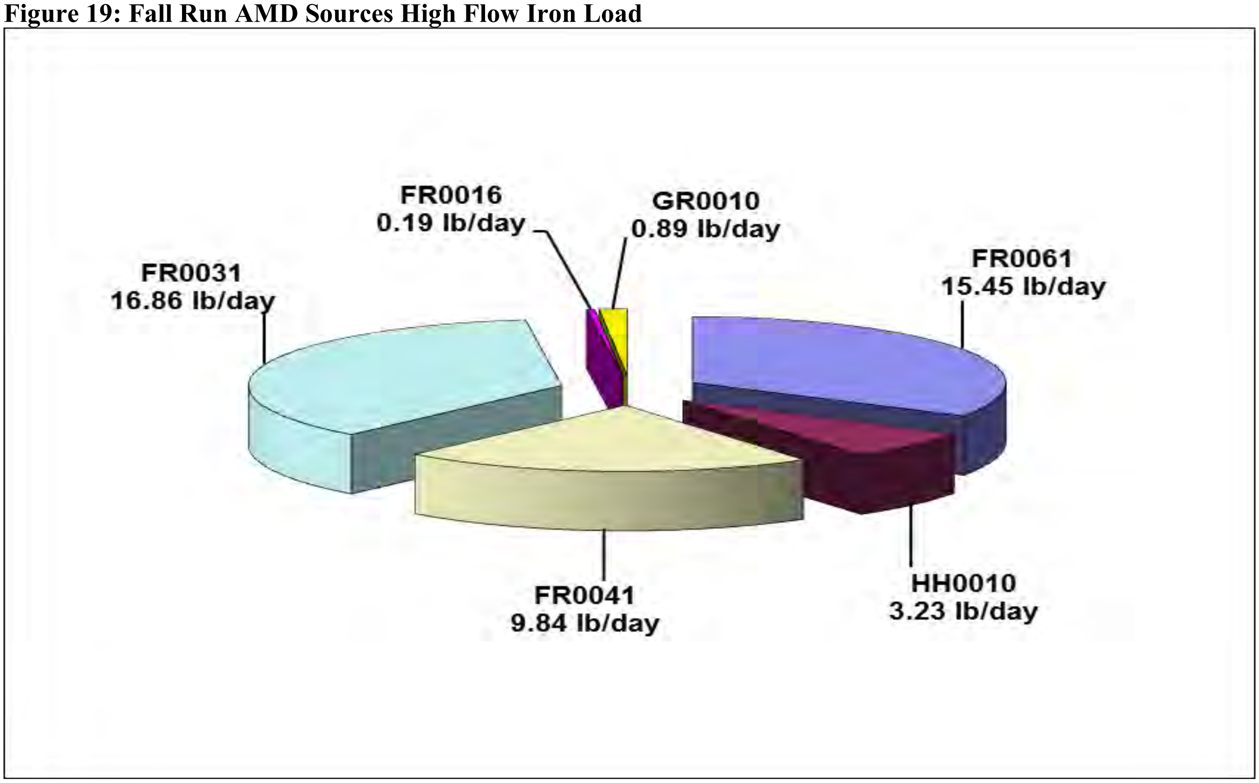


Figure 20: Fall Run AMD Sources Low Flow Iron Load

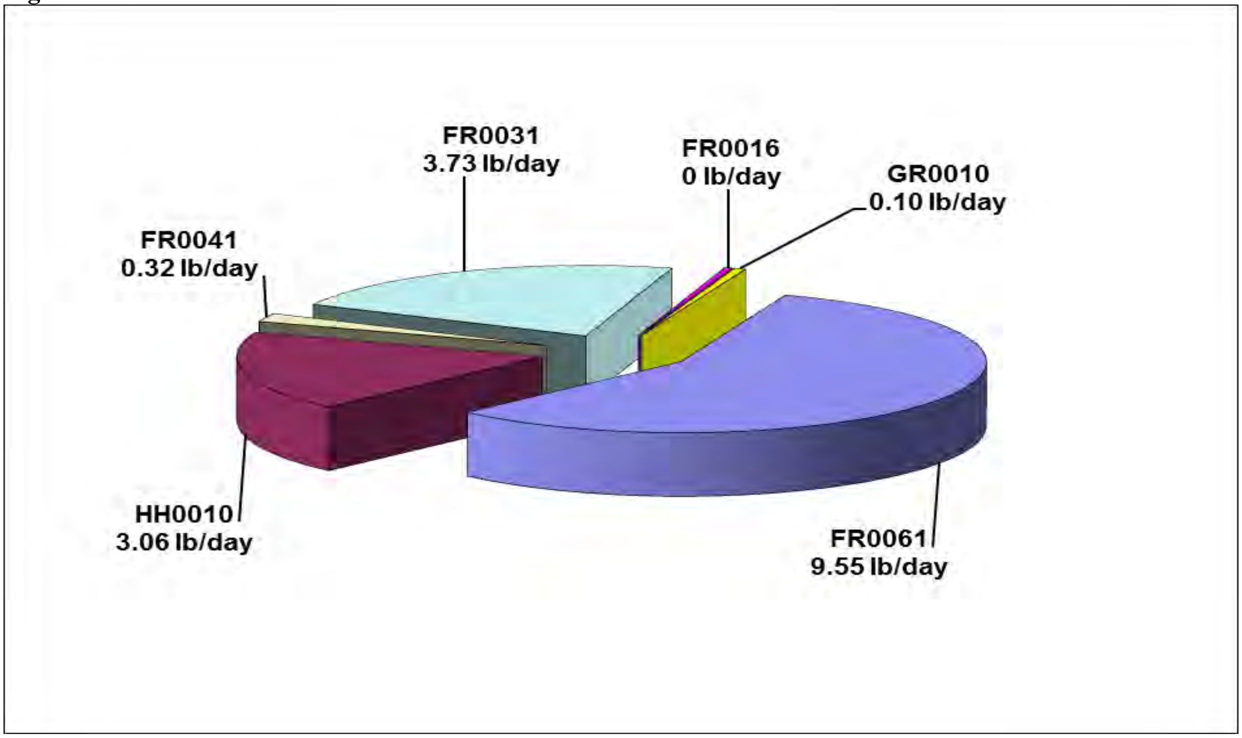
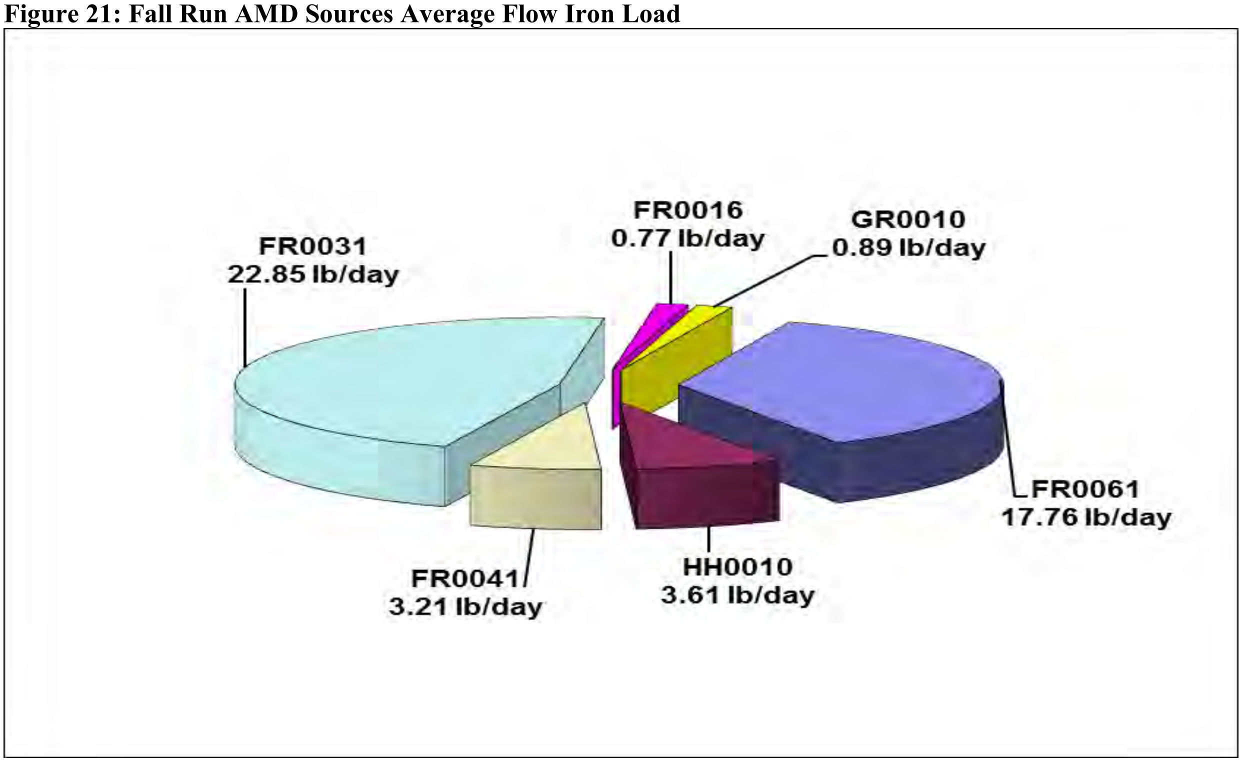


Figure 21: Fall Run AMD Sources Average Flow Iron Load



The low flow graph (Figure 22) shows much lower loadings for iron. During low flow and high flow there was an increase of iron upstream of FR-0060. This indicates that the AMD source discharged consistently during both high and low flow. Conversely, the spike in iron between FR-0025 and FR-0015 only occurred during high flow. The iron loading during low flow didn't spike which infers that the source didn't discharge or wasn't significant.

Figure 22: Mainstem Iron Loadings for all flow regimes

The peak acidity and metals loadings occurred during low flow between FR-0060 and FR-0050. The mouth of Hunkey Hollow (HH) is located in this location. The metals load decreased significantly downstream at FR-0025, but the acidity load remained high until it approached the mouth of Fall Run. The graph indicates another source of high metal between FR-0050 and FR-0025.

FALL RUN RESTORATION STRATEGIES AND TREATMENT SCENARIOS

Chemical Water Quality Targets

The upstream portion of Fall Run showed low impact from mining as demonstrated by the water chemistry and loadings at FR-0070. The water chemistry of the upstream portion of Hunkey Hollow, specifically site HH-0050, also shows minimal AMD influence. These two sites can be used to determine target goals for water chemistry improvement in the stream by looking at the combined or mixed water chemistry (Table 20).

Table 20: Average Flow and Loadings (FR-0070, FR-0061, FR-0060 and HH-50, HH-0011, HH-0010)

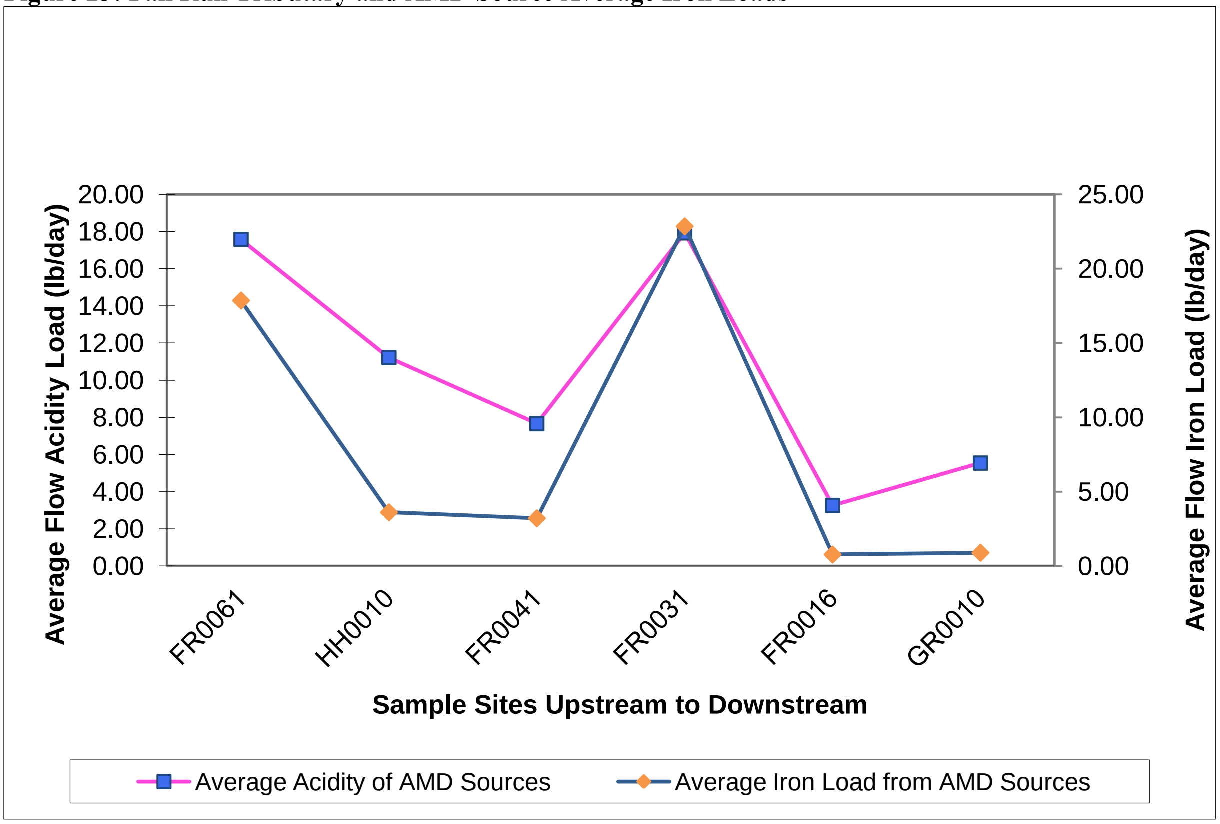
Site	Flow GPM	Flow cfs	pH Lab	Fe Load lb/day	Mn Load lb/day	Al Load lb/day	Acid Load lb/day	Alkalinity Load lb/day
FR0070 (main)	426.57	0.950	7.84	1.12	0.30	0.89	28.79	1004.78
FR0061 (source)	26.31	0.059	6.58	17.86	0.28	0.04	17.58	36.90
FR0060 (main)	348.71	0.78	7.72	9.25	0.46	0.64	37.36	816.96
HH0050 (main)	120.14	0.268	7.92	0.69	0.05	0.54	7.61	310.79
HH0011 (source)	5.01	0.011	7.05	1.65	0.06	0.03	1.47	13.48
HH0010 (main)	192.91	0.430	7.62	3.61	0.26	0.32	11.22	475.38

A simplified way to find the resulting chemistry of two waters is to "mix" them. This is done by adding the concentrations or loadings of each together (Table 21). The averaged mixed iron load of FR-0070 and FR-0050 is approximately 1.8-2.0 lb/day (Figure 23). The averaged mixed acidity load is 36.39 lb/day. This gives a general loading for each parameter and a general treatment goal.

Table 21: Flow and Loadings for mixing average FR-0070 and HH-0050

Site	Flow GPM	Flow cfs	pH Lab	Fe Load lb/day	Mn Load lb/day	Al Load lb/day	Acid Load lb/day	Alkalinity Load lb/day
FR0070 (main)	426.57	0.950	7.84	1.12	0.30	0.89	28.79	1004.78
HH0050 (main)	120.14	0.268	7.92	0.69	0.05	0.54	7.61	310.79
MIX (average)	546.71	1.22	~ 8.0	1.82	0.35	1.43	36.39	1315.58

Figure 23: Fall Run Tributary and AMD Source Average Iron Loads



Without a reference reach or stream in the watershed then another way to determine water quality goals is to calculate the target reduction of iron and acid by 90% of the average loads. Table 19 above shows that the average iron and acid coming from the source FR-0061 and the Hunkey Hollow seeps. Adding the average FR-0061 and Hunkey Hollow seep iron loads together gives a total of 20.78 lb/day. Adding the average acid loadings of each together, the total combined acidity is 21.19 lb/day. A 90% reduction in average iron would remove 19.6

lb/day entering the mainstem. Reduction in metals, specifically iron, is the key to improving water quality and the biotic community in Fall Run.

Abatement Area FR-0061 and HH-0010

The addition of the AMD effluent from source FR-0061 increased the load of iron in Fall Run from 1.82 lb/day to an approximate average of 10 lb/day at mainstem site FR-0060. The iron load of FR-0061 was 17.86 lb/day, but seven or eight pounds of the iron precipitates before flowing into the mainstem.

The seeps along Hunkey Hollow are situated along the bench from which FR-0061 originates. The proximity of the two sources allows for the possibility that both discharges can be treated in the same passive system. Hunkey Hollow discharges into Fall Run at HH-0010. The average iron load from HH-0010 was about 3.61 lb/day. Together with FR-0061, an average combined load of 21.47 lb/day and a maximum combined load of 56.89 lb/day were added to the mainstem.

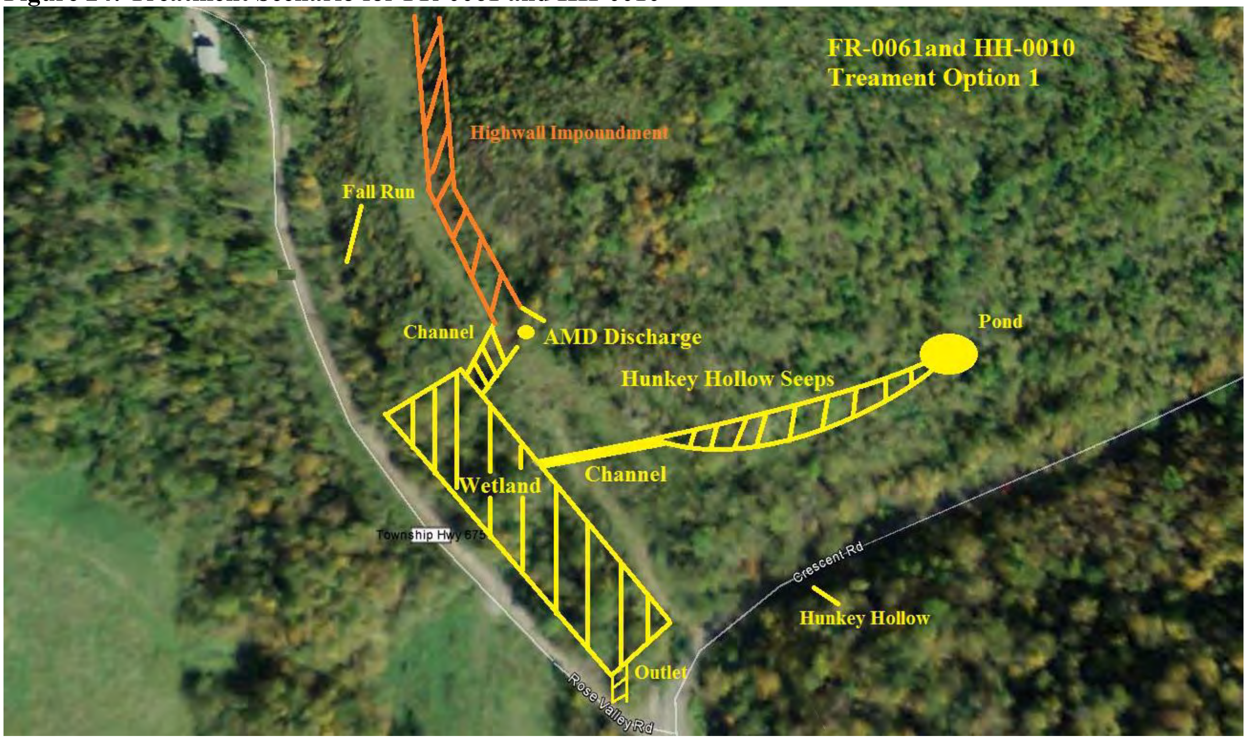
The combination of FR-0061 and HH-0010 was responsible for 46% of the average acidity load and 43% of the average iron load to Fall Run. During high flow the two sites deposited 36% of the acidity and 40% of the iron load. More significant was that the two sites discharged 39% of the acidity and 75% of the iron load to the stream during low flow conditions. Therefore, site FR-0061, with the addition of the Hunkey Hollow seeps, is the highest priority in the watershed.

Treatment

The option chosen to treat FR-0061 and the Hunkey Hollow seeps was a wetland cell and is shown in Figure 24. The design would combine flows from both sources into one treatment system. The AMD discharge is currently mixing with the water from the highwall impoundment and flowing over a small waterfall. It then enters Fall Run. The seeps along Hunkey Hollow flow downslope and enter a roadside ditch and flows into the tributary.

The discharge from FR-0061 will be collected in an open channel then will enter a treatment wetland cell. On the Hunkey Hollow (southeastern) side of the bullnose, the last cut impoundment will be drained. The Hunkey Hollow seeps will be collected and routed by pipe into the FR-0061 wetland for treatment. AMD flowing through the wetland will have lower velocity and allow greater aeration. The iron will settle out and deposit before entering Fall Run. The wetland will be constructed with limestone berms over which the discharge will flow to create the aeration. The combined flow will exit the southern end of the wetland by an open channel and enter Fall Run above the Hunkey Hollow confluence.

Figure 24: Treatment Scenario for FR-0061 and HH-0010



Cost/ Benefit Analysis

Preliminary engineering costs for collecting water flowing from FR-0061 and Hunkey Hollow and treating the combined effluent in a constructed treatment wetland is $424,850 (Appendix I). The Project is known as Rose Valley Road, Belmont County Restoration Project BL-Co-53. The long-term operation and maintenance costs will be calculated before the project is constructed in 2014.

Based on the overall 90% reduction of iron load, completion of the Rose Valley Road project should remove approximately 19.6 lb/day of iron from the mainstem of Fall Run or 3.6 tons/year. This is an overall reduction of 42% of the total iron to Fall Run. The final iron load entering the mainstem from the completed project should be less than 2 lb/day.

This amount of iron reduction should contribute to the amelioration of the downstream substrate. This will benefit macroinvertebrate and fish species by creating a healthier microhabitat. The recovery of 1.2 stream miles will increase the status of Fall Run to WWH. The project will also provide improvement to 480 feet of Hunkey Hollow. The cost of recovery is $314,703.37 per stream mile.

Abatement Area FR-0031

The second area that should be considered for remediation is FR-0031 at RM 0.6. AMD is draining from a bench cut and mixing with water from a small tributary which then enters Fall Run via a culvert under Crescent Road (Figure 25). As a loader of iron and acidity to Fall Run, it ranks in the top three during all flow regimes. The 2002 USACE/OEPA Water Quality report outlines a treatment design.

Figure 25: Site FR-0031 with location of pit impoundment and gob piles on 2013 Aerial

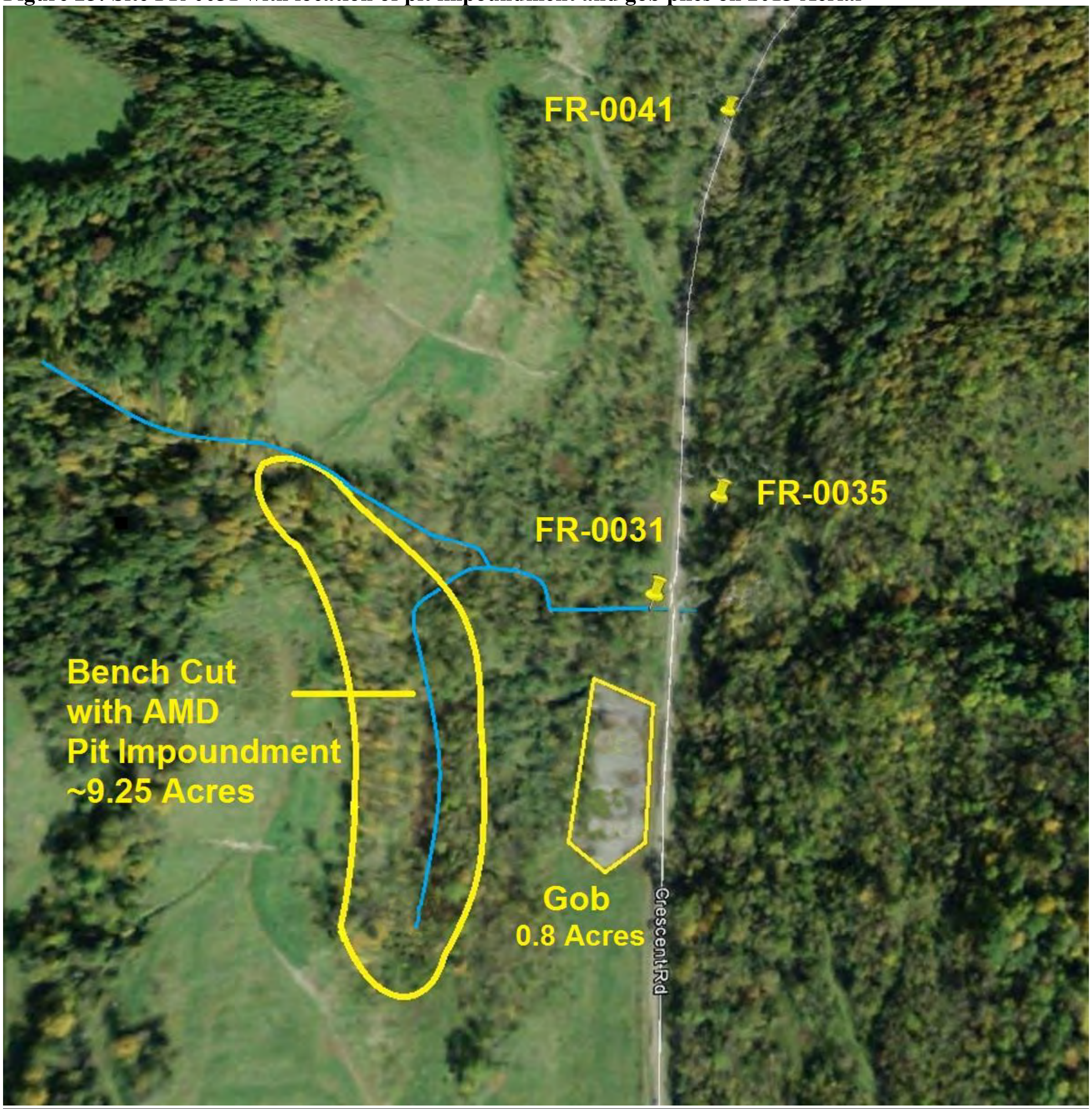
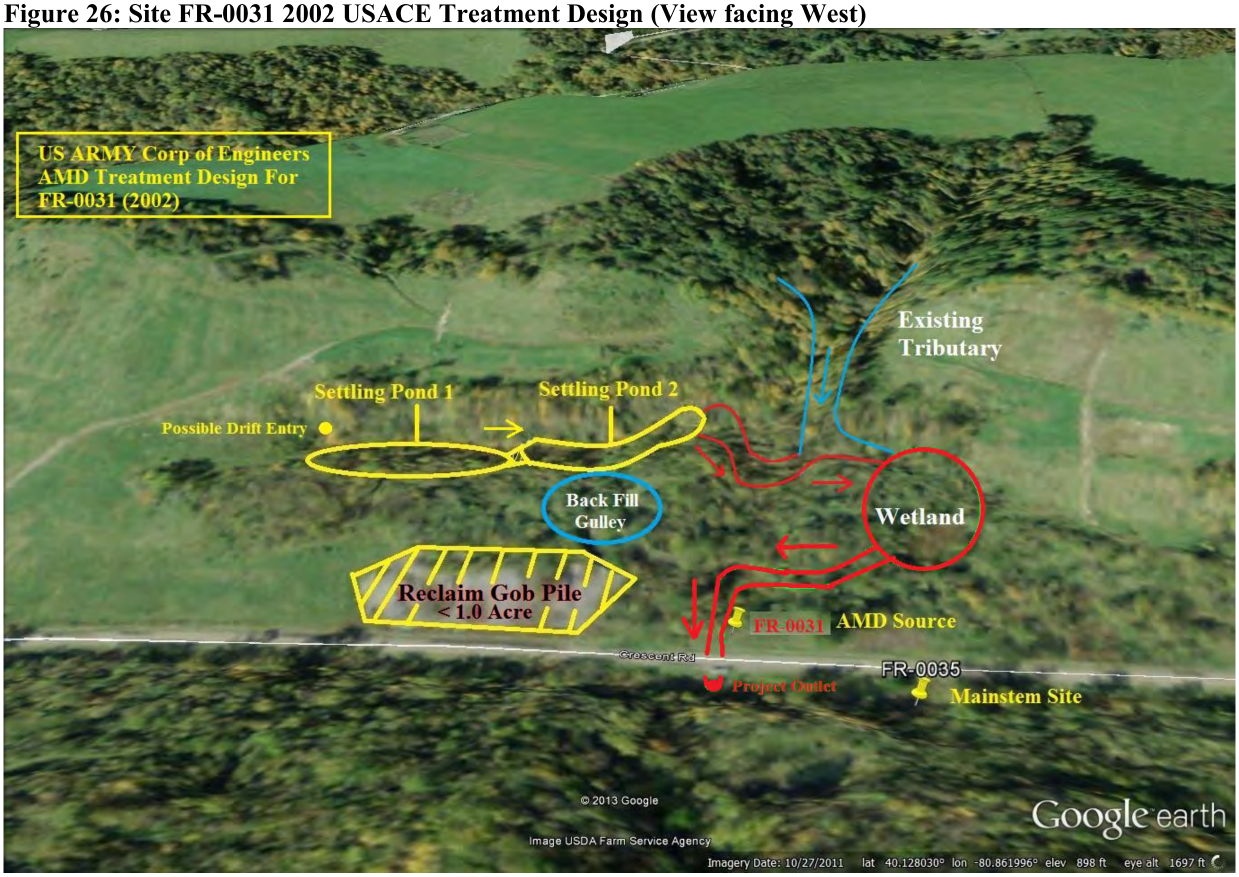


Figure 26 shows a simplified drawing of the USACE design for FR-0031. Two consecutive settling ponds drain into the tributary. The water then flows into a wetland for treatment. The water exiting the wetland enters into an open channel then discharges to Fall Run through a culvert. An acre-size gob pile down slope of the ponds will be reclaimed and a gulley area will be back-filled to keep the water from the ponds from flowing out.

Figure 26: Site FR-0031 2002 USACE Treatment Design (View facing West)



Cost/Benefit Analysis

The treatment system for FR-0031 has a preliminary engineering cost of $683,735 (Appendix J). This cost estimate includes construction and additional items such as mapping, drilling and design. This would be the second AMD project in the watershed. This project may be pursued if the expected load reductions from the Rose Valley Road Project (FR-0061/HH seeps) are not realized. This site impacts the lower 0.6 miles of the mainstem. It will have to be determined whether the benefit of constructing the FR-0031 project is justified by the potential cost. The long-term operation and maintenance costs should be calculated and added to project cost as well before a final decision is made.

Based on a reduction of 90% of the average iron load, the completion of the FR-0031 project should remove an average of 20.65 pounds of iron a day or 3,753 tons a year. The current average acid load is 17.93 lb/day. A 90% reduction would remove 16.14 pounds per day or 1,945 tons of acid per year from the lower half of Fall Run.

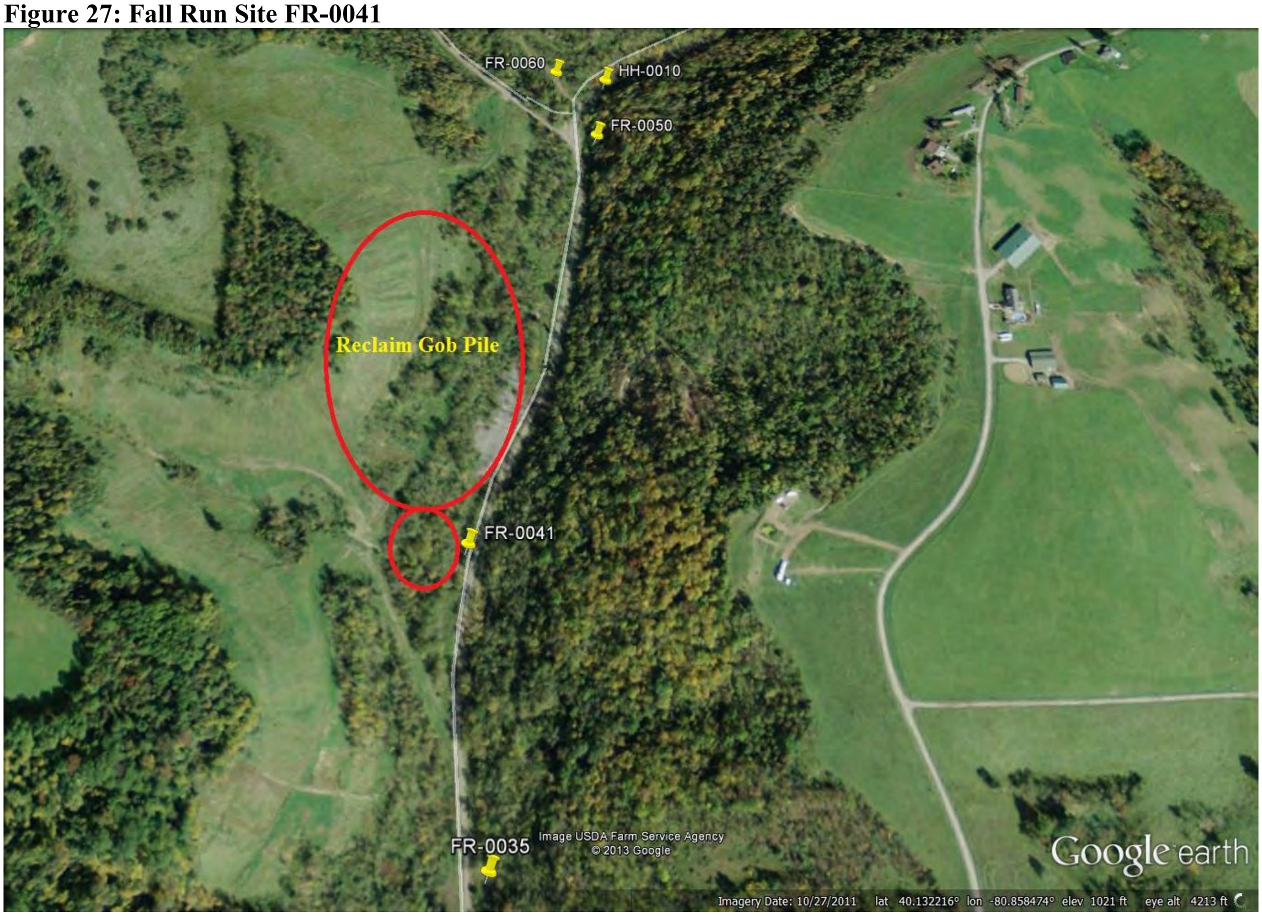
Abatement Area FR-0041

This area is located between the mainstem sample sites FR-0035 and FR-0050 (Figure 27) on the right descending bank. This site produces the highest acid load to Fall Run during high flow regimes. It is the third highest iron producer during high flow as well. Drainage from this site enters Fall Run at RM 0.8.

In the 2002 report by the US Army Corp of Engineers and the Ohio EPA, it was determined that the extraction pit on the bench above the discharge has good water quality. There is also a large gob pile deposited on the bench. During high precipitation water percolating through the gob pile creates the high acidity and high iron discharge to Fall Run. The recommendation for FR-0041 is to grade, cover, and reseed the gob piles which are contributing AMD to this site.

Further evaluation of this site will be decided after the FR-0061 project and the project at FR-0031 have been completed and the resultant water quality improvement has been assessed.

Figure 27: Fall Run Site FR-0041



Additional Areas of Concern

Other potential problem areas in the Fall Run watershed have been identified. These areas may deliver varying levels of impact to the mainstem, but none are considered priority sites for this investigation.

The upper middle section of stream between the confluence of Hunkey Hollow and River Mile 0.8 is experiencing sedimentation from gob piles on both banks. The left bank is experiencing undercutting by the stream. This may create slope instability and gob sliding into the streambed.

At River Mile 0.7 a 150-foot-long pond is located up the left descending bank. It is impounded by a large gob pile. The pond discharges into Fall Run. This flow mixes with some AMD on the slope, but the iron concentration is low, ~1.6 mg/l, and the discharge is less than 0.5 lb/day.

Once the priority projects that are recommended in this document have been completed, stream recovery will be evaluated to determine if restoration goals have been attained. If goals haven't been reached then a study of the remaining impact sites will be conducted to determine if further work in the watershed will provide additional recovery. The cost benefit ratio will be reviewed to establish if further work justifies continued project development and execution.

Public Health and Safety Projects between Fall Run Mouth and RM 0.3

There is water quality and landslide concerns from seeps and extraction pits along the bullnose Pittsburgh coal crop line on the west side of Fall Run. AMD is seeping into a pond which gradates into a cattail marsh which is depositing large amounts of iron precipitate. The water discharges over the gob and continues to flow downslope. Water is also percolating through the gob destabilizing the slope and adding to the sedimentation of the mainstem. A weir was placed during the USACE/OEPA investigation and an average flow of 44 gpm and 0.8lb/day of iron were measured. The west side of the bullnose above Grey's Ridge Run has experienced landslides in the past as well.

The AMD impact to Fall Run is small, but a destabilized slope has a high risk of sliding. Because of this potential hazard, ODNR DMRM AML Public Health and Safety program (PH&S) is designing a project to remediate the slope instability in 2014. This project may also improve the water quality at FR-0015 in the mainstem. A small gob pile is located northwest of Crescent and is adjacent to a wetland. This area is also being considered for reclamation.

LONG TERM MONITORING

A monitoring schedule is proposed in Table 22 to evaluate the actual environmental benefit realized from each project undertaken and to determine if any further projects should be attempted. The most effective approach to accomplish this is to complete pre-construction and post construction chemical and biological sampling at key points along the mainstem. At the minimum, chemical sampling should be performed at each project's final discharge point.

Monitoring should continue for future potential project areas. Chemical data should continue to be collected at FR-0041, FR-0016, FR-0015, and GR-0010. All originally sampled biological sites will continue to be sampled annually.

Table 22: Suggested Long Term Monitoring Sites for Proposed Projects

Site	Location	Chemical	Biological	Description
FR-0061	FR-0070	X	X	Mainstem
	HH-0010	X	X	Tribuatry Mouth
	FR-0061	X		Final Discharge
	FR-0050	X		Mainstem
FR-0031	FR-0035	X	X	Mainstem
	FR-0025	X	X	Mainstem
	FR-0031	X		Final Discharge
	FR-0010	X	X	Fall Run Mouth

POTENTIAL FUNDING SOURCES

Ohio Department of Natural Resources, Division of Mineral Resources Management

- *Federally Funded Abandoned Mine Land Program*: Federal excise taxes on coal are returned to the State of Ohio for reclamation of abandoned mine land sites that adversely affect the public's health and safety.

- *Acid Mine Drainage Set-Aside Program*: Up to thirty percent of Ohio's federal excise tax monies are set aside for acid mine drainage abatement. Priority is given to leveraging these funds with watershed restoration groups and other government agencies.

- *State Abandoned Mine Land Program*: State excise taxes on coal and industrial minerals are dedicated to reclamation projects that improve water quality in impacted streams. Priority is given to leveraging these funds with partners.

Office of Surface Mining (OSM), Reclamation and Enforcement

- *Direct grants to watershed groups*: A grant process for directly funding citizen watershed group efforts to restore acid mine drainage impacted streams on a project basis.

Environmental Protection Agency

- EPA Section 319 Non-point Source Grant Program: Funding is available for planning, education and remediation of watershed pollution problems including acid mine drainage.
- Office of Water – Watershed Protection and Flood Prevention/PL566 Program: This program provides technical and financial assistance to address resources and related economic problems on a watershed basis that address watershed protection, flood prevention, water supply, water quality, erosion and sediment control, wetland creation and restoration, fish and wildlife habitat enhancement, and public recreation. Technical assistance and cost sharing with varied amounts are available for implementation of NRCS-authorized watershed plans.

United States Army Corps of Engineers

- *Section 905b* – Water Resource Development Act (86): Recent additions to the Army Corps conventional mission include a habitat restoration grant program for the completion of feasibility studies and project construction where a federal interest can be verified. A principle non-federal sponsor must be identified for this cost-share program.

- *Flood Hazard Mitigation and Ecosystem Restoration Program/Challenge 21*: Flood hazard assistance restoration of riparian ecosystems is provided in in flood-prone areas. For cost-share between federal and local governments the federal share is 50 percent for studies and 65 percent for project implementation. The maximum federal allocation is $30 million according to Section 206 Aquatic Ecosystems Restoration Project under the Water Resources.

- *Development Act of 1996*. This act contains an annual appropriation of $25 million. The maximum federal cost-share is $5 million with 100% federal funding for study costs; 35% of the study costs are recovered from the non-federal sponsor during the first year. Both programs have a 65/35 cost-share ratio during construction.

United States Fish and Wildlife Service

- *Partners for Fish and Wildlife Program*: This program assists private landowners by providing technical and financial assistance to establish self-sustaining native habitats.

- *Clean Water Action Plan Fund*: The purpose of this fund is to restore streams, riparian areas and wetlands resulting in direct and measurable water quality improvements.

- *Five Star Challenge Restoration Grants*: The purpose of this program is to provide modest financial assistance to support community-based wetland and riparian restoration projects that build diverse partnerships and foster local natural resource stewardship.

Ohio Division of Wildlife

- *Wildlife Diversity Fund*: This fund financially assists with research, surveys (biological or sociological), management, preservation, law enforcement, education, and land acquisition.

- *Lindbergh Foundation Lindbergh Grants*: This program financially assists organizations that are making significant contributions toward the balance between technology and nature through the conservation of natural resources. The Lindbergh Grants provide a maximum grant of $10,580. The program is considered a provider of seed money and credibility for pilot projects that subsequently receive larger sums from other sources.

- *Turner Foundation Water/Toxins Program*: The program wants to protect rivers, lakes, wetlands, aquifers, oceans and other water systems from contamination, degradation, and other abuses; to stop further degradation of water-dependent habitats from new dams, diversions and other large infrastructure projects; to reduce wasteful water use via conservation; to support efforts to improve public policies affecting water protection, including initiatives to secure pollution prevention and habitat protection.

Muskingum Watershed Conservancy District (MWCD)

- Partners in Watershed Management Program: MWCD provides funding to assist state agencies, IRS Section 501 groups, and other organizations involved in programs or projects related to watershed management and water quality improvements in the Muskingum River watershed.

CONCLUSION

The initial 2002-2003 investigation by the United States Army Corp of Engineers and the Ohio Environmental Protection Agency indicated an impact to the Fall Run watershed from pre-law coal mine drainage. The current investigation conducted by ODNR DMRM supports the findings of the earlier study. The challenge of treating Fall Run is the high iron load. The precipitated iron coating the substrate indicates that a metal retention strategy would be the most effective treatment. The restoration goal for Fall Run is to return 1.2 miles of stream from the mouth to WWH.

The AMD source FR-0061 at RM 1.2 is the highest priority in the watershed. Furthermore, the iron and acidity contributed by the Hunkey Hollow seeps just downstream of the FR-0061 impact degrades this section of the mainstem even more. MAIS scores drop downstream of the combined impacts of Fall Run 0061 and the mouth of Hunkey Hollow from 14 to 12. The treatment strategy for this site combines the discharges and seeps from both sites into one treatment system with the goal of metal precipitation and retention.

With the completion of this project, treating both FR-0061 and the Hunkey Hollow seeps, the average iron load will be reduced by almost 45% or 21 lb/day and the average acid load by 45% or almost 30 lb/day. The goal is to raise MAIS scores from 12 to 14 at sample site FR-40 and from 7 to 10 at FR-0041 at the mouth of Hunkey Hollow.

The success of the FR-0061 and Hunkey Hollow seep treatment project will be evaluated post-construction. If it is determined that more recovery is needed to return Fall Run to WWH then the next project constructed would be FR-0031. The cost benefit analysis will determine if the project will be developed and go to construction. This project will reduce the average acidity load to Fall Run by 28-30% or 18 lb/day. The post construction iron reduction should be approximately 47% or 23 lb/day. This project would further support biological recovery in the mainstem.

The third project recommended would reduce high flow acid load to the mainstem of Fall Run. Site FR-0041is a source control project which would reclaim coal refuse and spoil. FR-0041 is the number one acid loader during high flow. It discharges 25% or 22 lb/day of acid into the mainstem. During average flow, it is ranked fourth at 12% or 7.7 lb/day of the acid load. It is tied with Hunkey Hollow as the third highest iron loader during average flow, 7% or 3lb/day. At high flow regimes it is still ranked third for iron load at 21% or 10 lb/day.

In its current condition Fall Run is close to meeting water quality and biological criteria for a good quality stream. After extensive data collection and analysis by USACE, OEPA, and ODNR over a ten-year period it is believed that Fall Run can meet the criteria for Warmwater

Habitat and achieve a 90% reduction in iron and acidity loading. With a minimum number of remediation projects, Fall Run can achieve the established recovery goals and once again become a healthy tributary to Wheeling Creek.

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- *Appendix A:* Field Parameters: pH, water temperature, conductivity and dissolved oxygen collected at 19 sites during water quality surveys from February 2002 to April 2003 for the Fall Run Ecosystem Restoration project.
- *Appendix B:* Fall Run flows, total aluminum, iron, sulfates, acidity (total & hot),

alkalinity magnesium and daily load calculations.
- *Appendix C:* Fall Run Engineering Technical Appendix C, Section IV Geotechnical Report

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