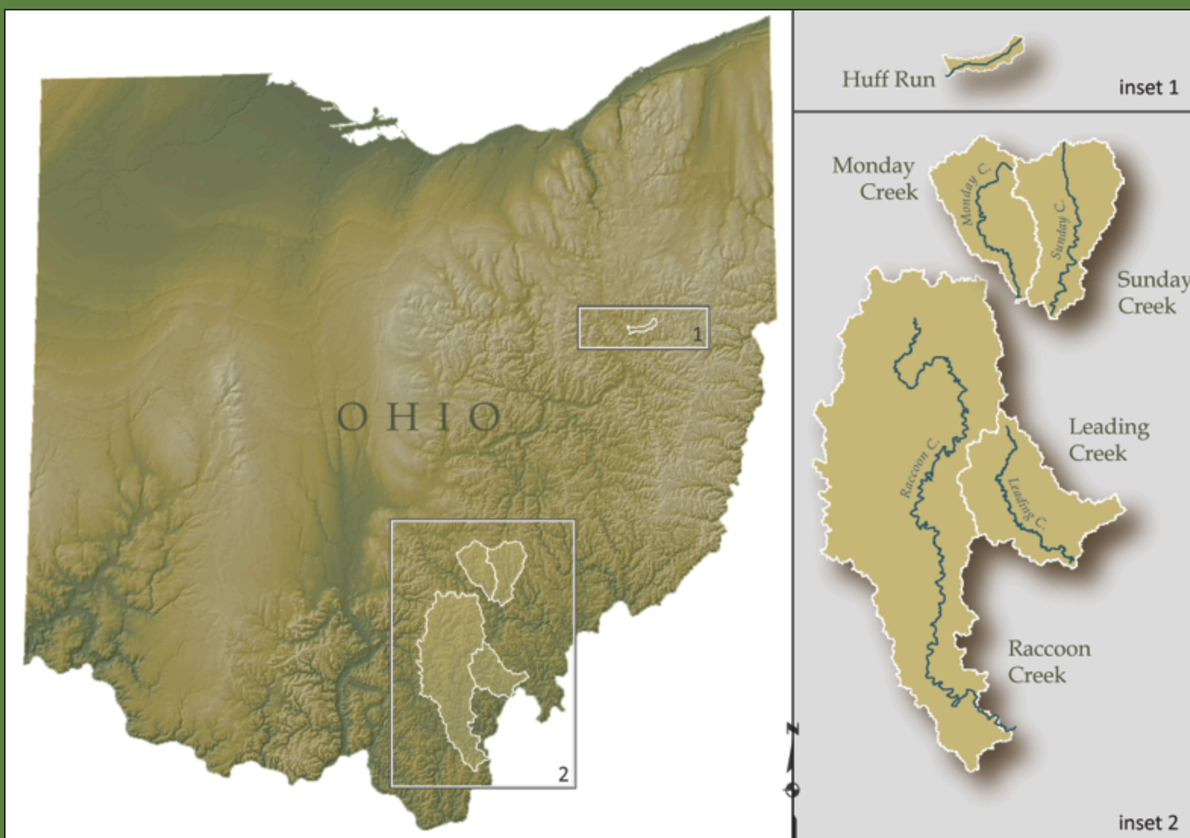
2015 STREAM HEALTH REPORT

AN EVALUATION OF WATER QUALITY, BIOLOGY, AND ACID MINE DRAINAGE RECLAMATION IN FIVE WATERSHEDS: RACCOON CREEK, MONDAY CREEK, SUNDAY CREEK, HUFF RUN, AND LEADING CREEK.



CREATED BY:
VOINOVICH SCHOOL OF LEADERSHIP AND PUBLIC AFFAIRS
AT OHIO UNIVERSITY
JENNIFER BOWMAN AND KELLY JOHNSON

6-30-2016

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Specific AMD project entry forms used for report 2015 can be found at (watersheddata.com)

Section IV on the website shows the completed NPS data entry form for each individual AMD project in pdf format. These reports include all information gathered about the site description, contact, monitoring plan, design and reclamation information, average water quality data (pH, net acidity, and discharge) at long-term monitoring stations, complete list of pre and post reclamation water quality and biology data, and if applicable; photos, water quality and biology reports, and site map. These reports are available to download as pdf reports from the NPS monitoring website www.watersheddata.com under the ‘Reports Tab’.

Acknowledgements

The Stream Health Report is a collective effort by many dedicated watershed professionals. This project would not have come together without the dedication and support of our watershed partnership. I would like to thank and acknowledge the following people for their input and contributions towards this project:

Ohio Department of Natural Resources – Division of Mineral Resources Management (ODNR-MRM) - Ben McCament, Kaabe Shaw, Tammy Richards, Chad Kinney, Jeff Calhoun and Mary Ann Borch for funding, data collection, guidance, and being a supporter and partner in this project.

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Monday Creek: Nate Schlater and Tim Ferrell
Sunday Creek: Michelle Shively
Huff Run: Marissa Lautzenheiser
Leading Creek: Jim Freeman
I would like to thank the watershed groups for their cooperation and patience in this project for doing everything from data collections, participation in trainings, gathering historical data, data validation and verification, and data entry on top of their busy work schedules.

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Ohio University Biological Sciences - Kelly Johnson – conducting the MAIS training, macroinvertebrate laboratory identification, biological data analysis, macroinvertebrate data collection, method development, and guidance.

Voinovich School – Steve Porter (GIS and data analysis), Elkan Kim (watersheddata.com), Lindsey Siegrist (graphic design), Kyoung Lim (assistant programmer), Natalie Kruse (research) and Ryan Kline (Voinovich School Scholar).

ABSTRACT

The Voinovich School of Leadership and Public Affairs at Ohio University created an evaluation system to track changes in chemical and biological data for the following watersheds: Monday Creek, Sunday Creek, Raccoon Creek, Huff Run and Leading Creek. The annual monitoring and reporting system was developed for the Ohio Department of Natural Resources Division of Mineral Resources Management (ODNR-DMRM) in 2005 to track progress towards the targets of the state's 2005 Non Point Source (NPS) management plan for acid mine drainage (AMD) on an annual basis. ODNR-DMRM is committed to tracking chemical and biological changes in the watersheds where active AMD abatement and treatment reclamation is planned and implemented.

The NPS annual reporting website (www.watersheddata.com) integrates water quality and biology data from watershed groups' with project status details including: maps, graphs, charts, photos, and printable reports to address the progress with respect to AMD treatment and reclamation. Water-quality and biological trends are compared through time at long-term monitoring stations and acid load reductions are measured at AMD reclamation project discharges. Incremental changes in pH, net alkalinity, iron, and aluminum are reported along stream reaches within key restoration areas, identified by river mile and sample site IDs.

Total number of stream miles impaired by acid mine drainage were evaluated during 1994-2001 and are considered the baseline conditions for this study, 341 stream miles were impacted at that time. Each year the number of stream miles surveyed that suggest they are meeting Warmwater Habitat (WWH), based on their fish and macroinvertebrate index scores, are recorded. As of 2010, 47 stream miles of the 175 miles assessed suggest they meet full attainment of the Warmwater Habitat Status. In addition to tracking the number of stream miles meeting their fish and macroinvertebrate target levels, incremental water-quality changes are also tracked, pH values show 172 miles of the 183 miles monitored met the pH 6.5 water quality standard in 2015.

Net alkalinity, iron, aluminum, pH, and macroinvertebrates were evaluated annually from 2006-2015. Incremental changes from year to year can be tracked using these indicators. Net alkalinity and pH values have improved from 2006 to 2015. The family-level biological indicator, Macroinvertebrate Aggregated Index for Streams (MAIS), were measured annually from 2006 to 2015, there have been slight fluctuations seen within each watershed, detailed in the biology section for each watershed. Macroinvertebrate data across all watersheds in 2015 indicated good results, most notable are the continued improvements seen in the West Branch of Sunday Creek, and mainstem of Monday Creek.

INTRODUCTION

The Nonpoint Source (NPS) Monitoring Project was created by the Voinovich School of Leadership and Public Affairs at Ohio University in 2005 and funded by the Ohio Department of Natural Resources Division of Mineral Resources Management (ODNR-MRM). This project was developed to address the targets set forth for Abandoned Mine Drainage in the State of Ohio's Non Point Source (NPS) Management Plan 2005-2010. www.epa.state.oh.us/dsw/nps/NPSMP/ET/amdjumppage.html Abandoned Mine Drainage is one of the six NPS pollutants listed as a key issue to address in Ohio to improve water quality. This plan is no longer active, however the ODNR-DMRM, watershed partners, and university researchers continue to monitor the effects of acid mine drainage and reclamation in the region. This report reflects the works of this partnership at the federal, state, and local level working together to improve water quality in the Appalachian coal region of Ohio.

As a result of the NPS Monitoring Project, an on-line reporting system, www.watersheddata.com, has been created to track environmental changes in five watersheds: Raccoon Creek, Monday Creek, Sunday Creek, Huff Run and Leading Creek. These five watersheds represent where active AMD reclamation projects are being constructed. Chemical water quality and biological data trends have been evaluated at the project level, watershed level, and collectively to monitor the changes in water quality as a result of AMD reclamation. The website provides a repository of information related to acid mine drainage reclamation and water quality including reports of: AMD reclamation projects and watersheds water quality trends. All water quality data can be viewed, entered, edited, mapped and downloaded for each watershed.

REPORTS

All AMD project descriptions are compiled in a separate document containing pertinent static information describing the AMD project, titled “Collection of Acid Mine Drainage (AMD) Reclamation Projects in the Coal-Bearing Region of Ohio”. This will eliminate redundancy in printing static project specific information each year. This report is available online at watershedata.com as well as with all partner organizations.

The “AMD project collection” report includes: a chronological collection of all projects completed since late 1990s. The ‘AMD project collection’ report displays general information about the AMD issues prior to reclamation and the AMD project description. Specifically the ‘AMD project collection’ report includes: pre and post construction photos, description of AMD problem, design and construction information, costs, contractors, dates of construction, identification of project discharge, map of site (optional), and pre-water quality data at project discharge. ‘AMD project collection’ report is a compilation of all projects completed since the late 1990s in chronological order including all past archived reports. This report is a stand-alone document. Each year, the newly completed project reports are simply added to the collection.

The “Annual Stream Health” report contains the dynamic yearly chemical and biological data that changes each year. This report includes the chemical and biological water quality data analysis for all target stream reaches within the five key watersheds. Stream reaches are identified as: Raccoon Creek Mainstem, Hewett Fork, Little Raccoon Creek, Monday Creek Mainstem, Sunday Creek Mainstem, West Branch of Sunday Creek, Huff Run, and Thomas Fork (Leading Creek). Data from these stream reaches are analyzed each year for changes and trends in pH, net alkalinity, iron, aluminum, and macroinvertebrates. Yearly trends of acid loading and metal loading reduction from each AMD project discharges are also displayed in this report. Long-term monitoring data, family-level macroinvertebrate data, and pre/post project discharge data collected by watershed groups and DMRM staff are utilized to generate the graphs of water quality trends along the stream reaches. However, 2015’s annual health report does not contain yearly chemical or macroinvertebrate trend data for Sunday Creek mainstem or West Branch, due to a lack of water quality data. Similarly, Little Raccoon Creek was not evaluated for macroinvertebrate yearly trends in 2015.

To track the overall health of Raccoon Creek, Monday Creek, Sunday Creek, Leading Creek and Huff Run, the watersheds where acid mine drainage reclamation is active, chemical data were collected annually since 2005 (2009 in Leading Creek). Biological data are collected annually for family–level macroinvertebrates (MAIS) and every 3-5 years for fish (IBI, Index of Biotic Integrity). Baseline conditions were established during the time period of 1997-2001 with historic data. 2010 fish and macroinvertebrate data suggest a total of 47 miles of stream meet the use attainment criteria for WWH, with 51 stream miles evaluated. Over 158 miles were evaluated for MAIS and 54 miles for IBI. These data were collected to compare these indices to the biological health targets of 12 for MAIS and IBI scores of 44/40 for wadable/boatable streams. Stream miles that improved in biological health from baseline to 2010 are shown in Figure 1. 18.4 miles were improved in the Raccoon Creek watershed and 5.3 miles improved in West Branch of Sunday Creek from 2005 to 2010.

Biological fish data collected from 2010 to 2015 suggest the following areas highlighted in green (Figure 1) may meet warm water habitat (30 miles in Raccoon Creek and 5 miles in Sunday Creek). These green highlighted areas are conditional and will be evaluated after more biological data is collected as part of the OEPA TMDL being conducted in Raccoon Creek 2016-2017. Additional macroinvertebrate and fish data in the West Branch of Sunday Creek will be collected to confirm the warm water habitat condition (Figure 2).

Other significant incremental water changes are also tracked and described in this report; for example, acid and metal loading reductions, pH and net alkalinity improvements. These incremental changes track progress toward the overarching goal of meeting targets. Incremental changes are tracked in the acid mine drainage project level reports and in the watershed level reports.


Raccoon Creek

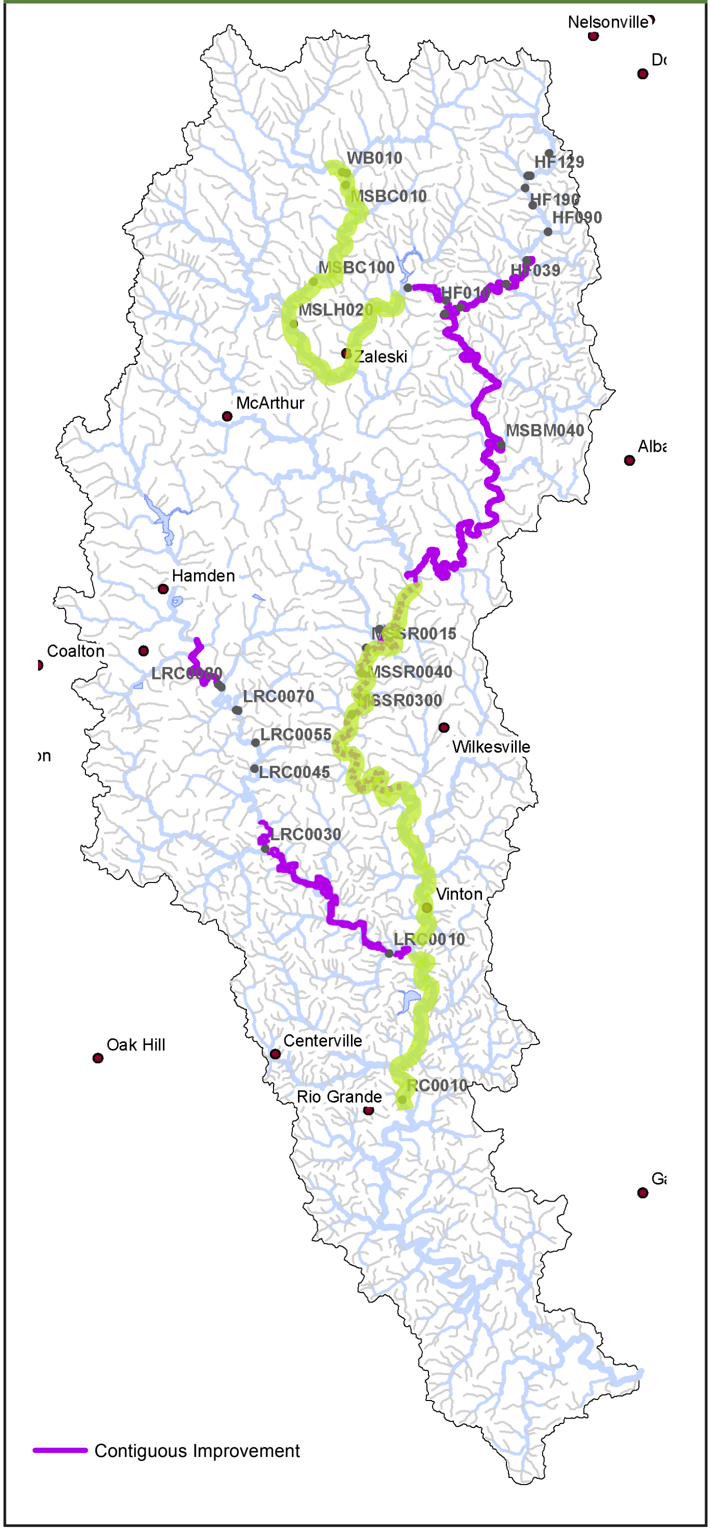

Sunday Creek


Huff Run


Monday Creek

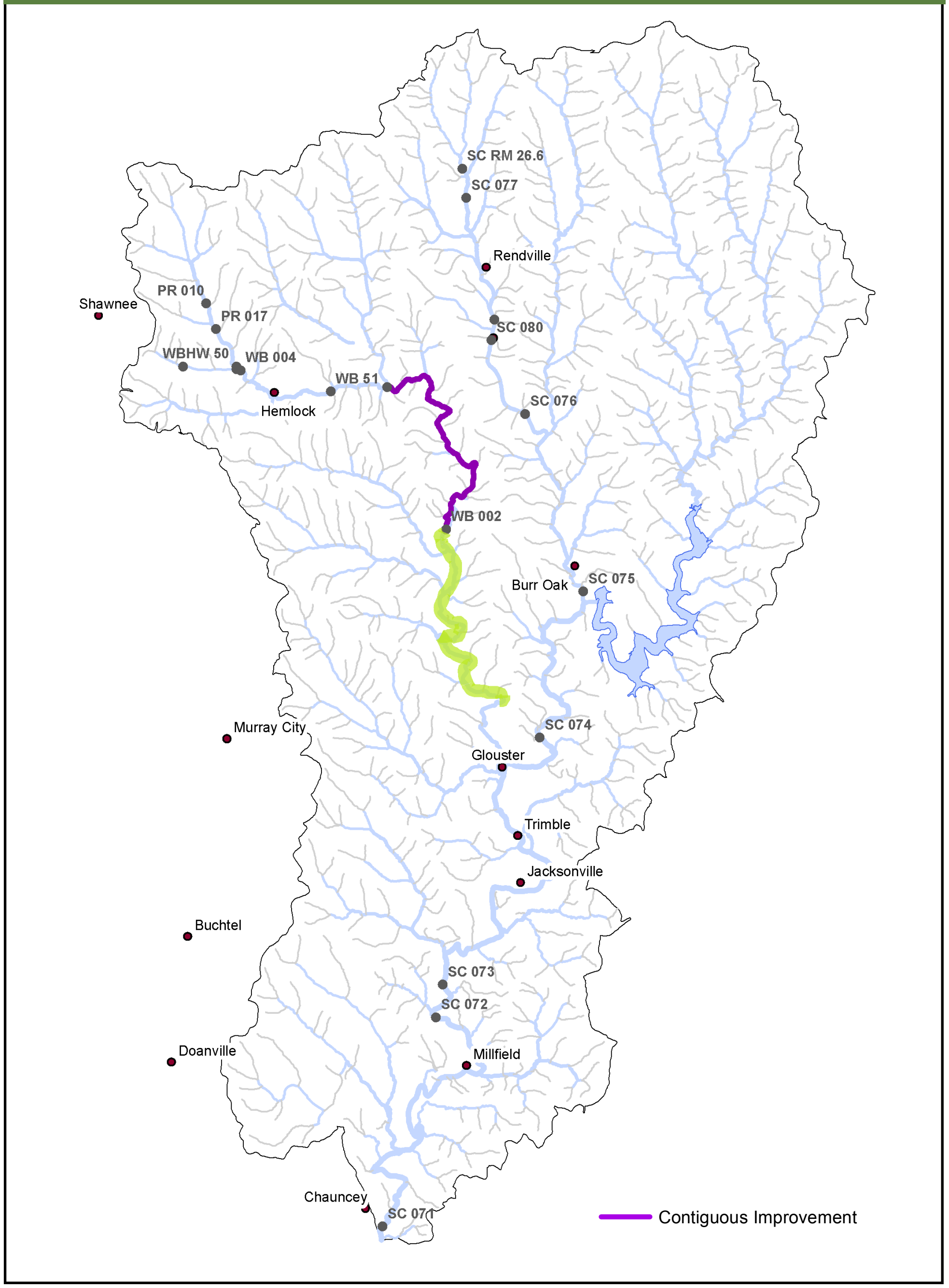

Leading Creek

Figure 1: Biological health improvements in Raccoon Creek from baseline (1997) to 2015.



Condititional improvement 2010-2015 in green highlight.

Figure 2: Biological health improvement in Sunday Creek West Branch from 2005 to 2015.



Conditional improvement 2010–2015 in green highlight.

Table 1. Summary of results for each of the five watersheds evaluated in 2005 to 2015: Raccoon Creek, Monday Creek, Sunday Creek, Huff Run, and Leading Creek.

Watershed	Total number of completed projects	Total costs	Total acid load reduction lbs/day	Total stream miles improved in 2005/2010 to meet IBI & MAIS Biological stream health targets	Stream miles that met the pH target	Total stream miles monitored
Raccoon Creek	20	$14,521,361	5,866	23.3/18.42 (41.7)	115	117
Monday Creek	18 (plus 5 subsidence projects, costs are not included)	$7,197,808	2,551	0/0	23	32
Sunday Creek	12 (7 of 10 are subsidence projects)	$2,618,273	352	0/5.26 (5.26)	15	15
Huff Run	14	$5,308,353	1,095	0/0	10	10
Leading Creek	2	$728,481	661	NA/0	9	9
Total	66	$30,374,277	10,173	23.3/23.7 (47.0)	172	183

Reductions

Total to date acid load reductions = 10,173 lbs/day

Costs

Total to date reclamation costs = $30,374,277

RACCOON CREEK
WATERSHED REPORT

Reductions

Total acid load reduction = 5,866 lbs/day

Total metal load reduction = 962 lbs/day

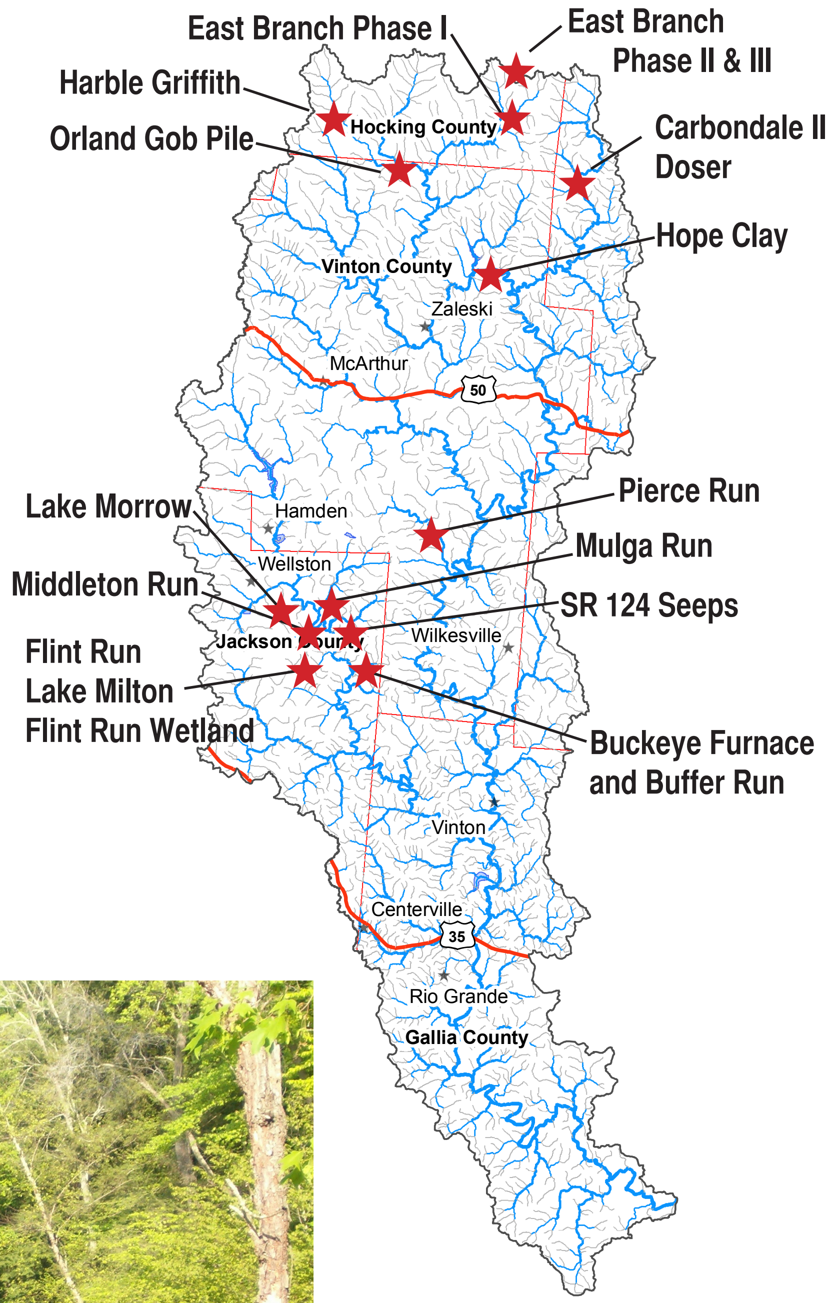
Data derived using the Stoertz Water Quality Evaluation Method (Kruse et al., 2014)

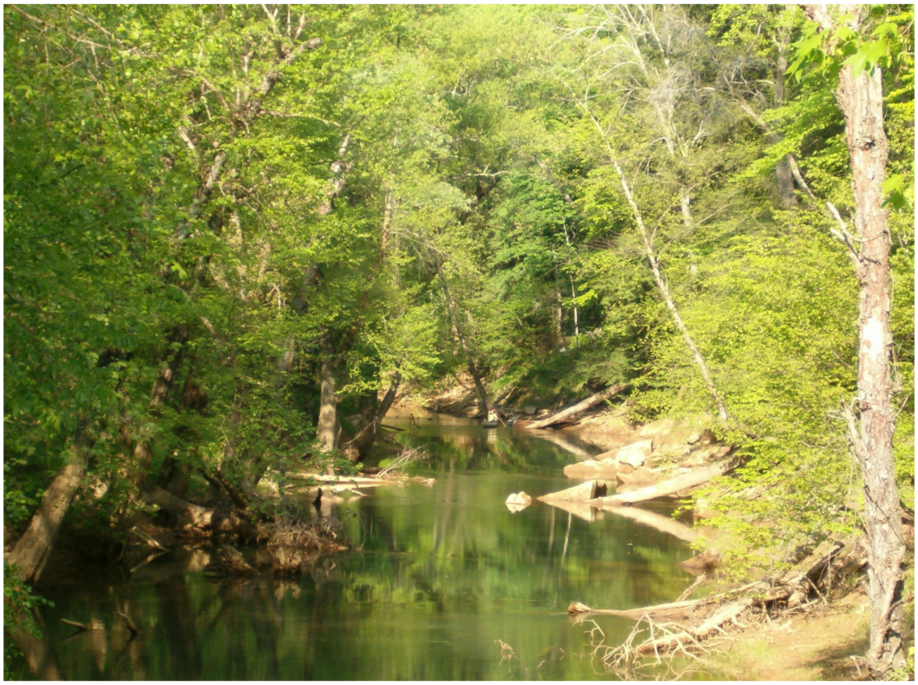
Cost

Design = $1,905,243

Construction = $12,616,118

Total Costs through 2015 = $14,521,361





Raccoon Creek near Moonville, Photo by Ben McCament

Timeline of the Raccoon Creek Watershed Project Milestones and AMD Projects

1980s	• Formation of Raccoon Creek Improvement Commitee (RCIC): Grassroots citizen group to address water quality issues in Raccoon Creek
Early 1990s	• RCIC invites citizens from all six counties to join efforts
Late 1990s	• Formation of Raccoon Creek Watershed Partnership,a loosely based partnership of agencies to address technical AMD issues
1999	• State Route 124 Strip Pit and Buckeye Furnace Project completed
2000	• Little Raccoon Creek AMDAT completed • Watershed Coordinator position funded for six years
2001	• Headwaters AMDAT completed • State Route 124 seeps project completed
2002	
2003	• Mulga Run project completed • Middle Basin AMDAT completed • Completed management plan for Raccoon Creek Watershed
2004	• Carbondale II project completed
2005	• Middleton Run-Salem Road project completed
2006	• Raccoon Creek Water Trail Association formed Mission to Establish a water trail on Raccoon Creek • Flint Run and Lake Milton Projects completed, Watershed Coordinator three year extension funded
2007	• Raccoon Creek Partnership formed 501 (c) 3 • Waterloo Aquatic Education Center opened
2008	• East Branch Phase I AMD Project
2009	• Pierce Run AMD Project began • East Branch Phase II Project began
2010	• East Branch Phase II completed
2011	• East Branch Phase III completed
2012	• Water Trail map created by Ohio University Environmental Studies student, Karla Sanders • Orland Gob Pile and Harble Griffith Reclamation Projects completed • Pierce Run AMD treatment project completed
2013	• Raccoon Creek Water Trail maps were distributed, West Branch Harble Griffith 319 Grant was completed, and 2 new families of mayflies documented in the watershed
2014	• Middleton Run II – Reclamation and Lake Morrow Projects complete
2015	• Flint Run Wetland Enhancement Project complete; 4-acre metal retention wetland

Raccoon Creek Projects

Acid mine drainage reclamation projects completed in the Raccoon Creek Watershed:

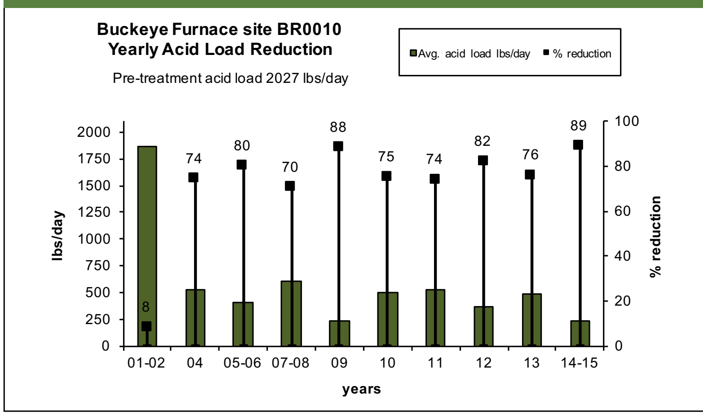
1999	Buckeye Furnace/Buffer Run (BR0010) – Passive SAPS and gob pile reclamation
2001	State Route 124 Seeps (OTF0010) – Surface reclamation and limestone drains
2004	Carbondale II Doser (HF131) – Active calcium oxide doser
	Mulga Run (MR0010) – 2 Steel slag beds and wetland enhancement
2005	*Hope Clay (HC001) – surface reclamation and limestone channels*
	Salem Road/Middleton Run (MiR0021, MiR0032, MiR0090) - limestone channels, steel slag leach beds, J-trenches, surface reclamation, and limestone leach bed
2006	Flint Run East (FR0126) – dewatering strip pits with multiple passive treatments
	Lake Milton (FR0120) – SAPS and steel slag bed
2007	East Branch Phase I (EB210 and EB 160) – 8 steel slags beds, limestone channels, gob pile reclamation, and passive settling ponds
2010-2011	East Branch Phase II & III (EB190) – 4 steel slag beds
2012	East Branch Phase I Maintenance – Valves replace, under drains extended, and new steel slag installed
	Jackson Area AMD Maintenance (Flint Run and Lake Milton) – Under drains extended, new steel slag installed, valves replaced, weir installed, and SAPS intake pipe relocated
2013	Orland Gob Pile (WB050) – Gob pile reclamation with limestone channels
	Harble Griffith (WB094, WB084, WB086) – Surface reclamation, limestone channels, and passive wetland
	Pierce Run (PR0010) – Steel slag bed
2014	Lake Morrow (FR0110) – reclaiming strip pit lakes and spoil
	Middleton Run Reclamation II (MiR0110) – surface reclamation
2015	Flint Run Wetland (FR095) – Wetland Enhancement with limestone berms across the Flint Run Valley

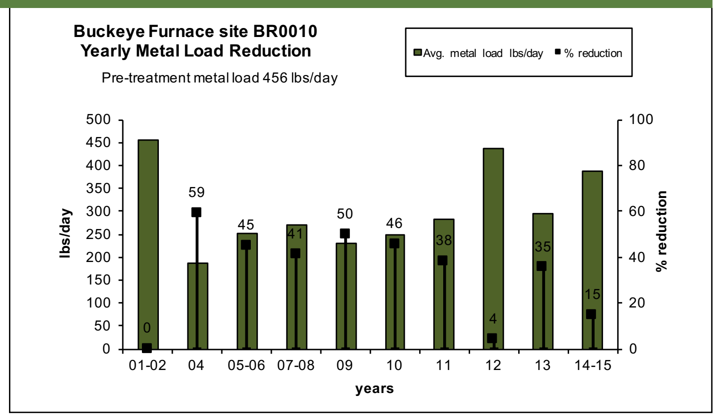
Italicized indicated projects are not actively monitored for acid mine drainage and metal load reduction purposes

Yearly acid and metal load reduction trends per project

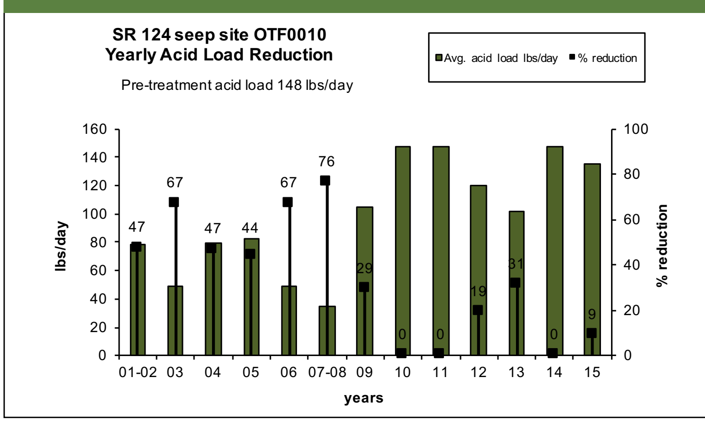
Similar to other environmental best management practices (BMPs), performance of passive acid mine drainage reclamation projects are also expected to decline with time. Active treatment systems are not expected to decline with time but sometimes need to be maintained to perform adequately. Currently, operation and maintenance plans are being designed for each existing system and are planned for future projects. The graphs below show the mean annual acid and metal load reduction using the Stoertz Water Quality Evaluation Method (Kruse et al., 2014) for each year (or group of years) during post-reclamation from the project effluent. From these graphs the rate of decline (and/or improvement) with time of the treatment system is implied. Knowing the rate of decline will aid in the implementation of operation and maintenance plans.

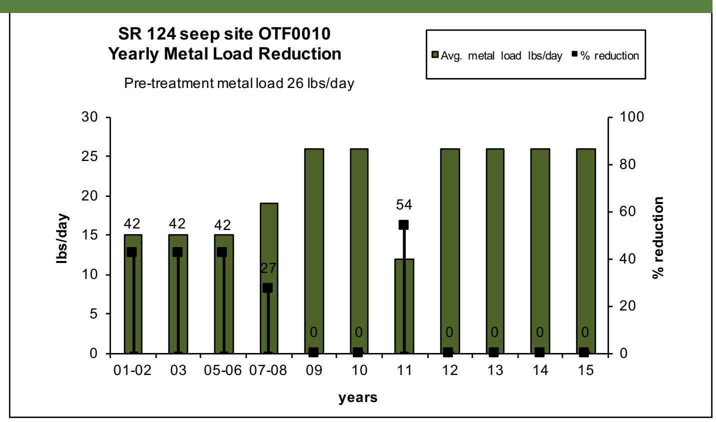
Buckeye Furnace site BR0010



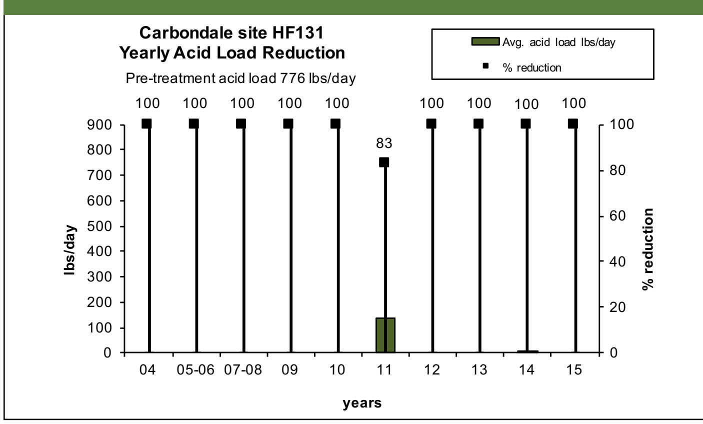


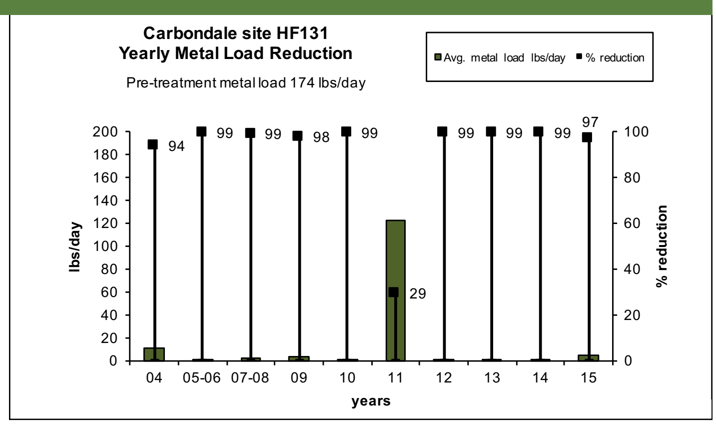
State Route 124 seep site OTF0010





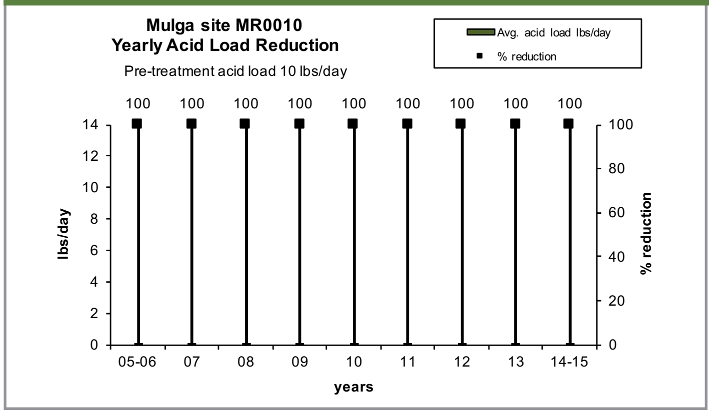
Carbondale site HF131

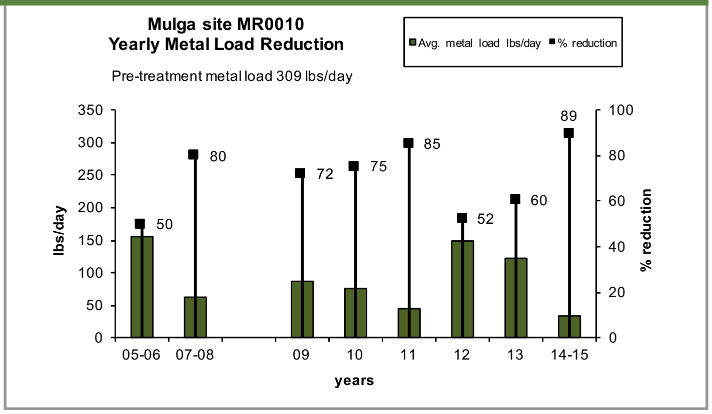




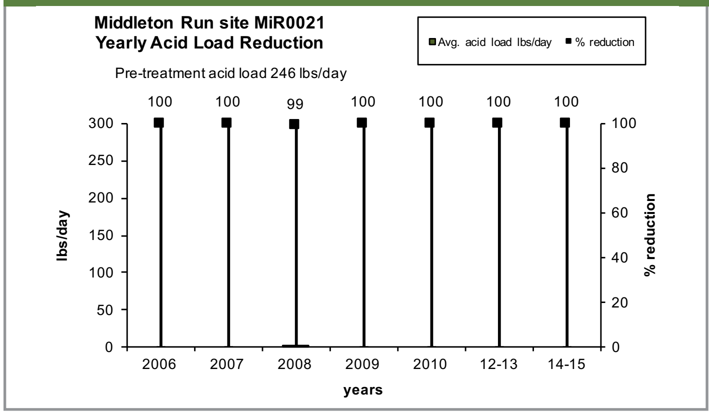
Yearly acid and metal load reduction trends per project

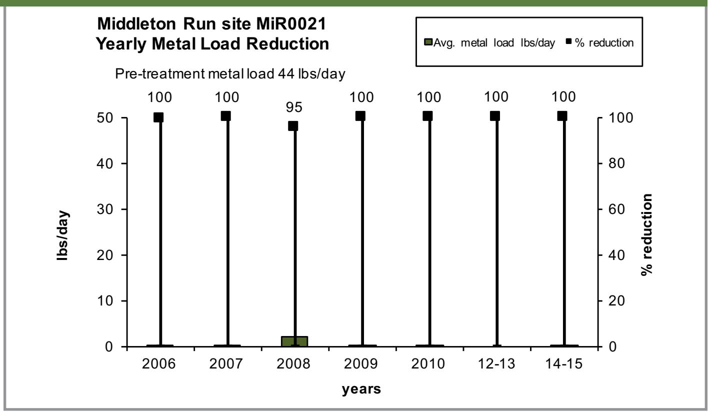
Mulga site MR0010



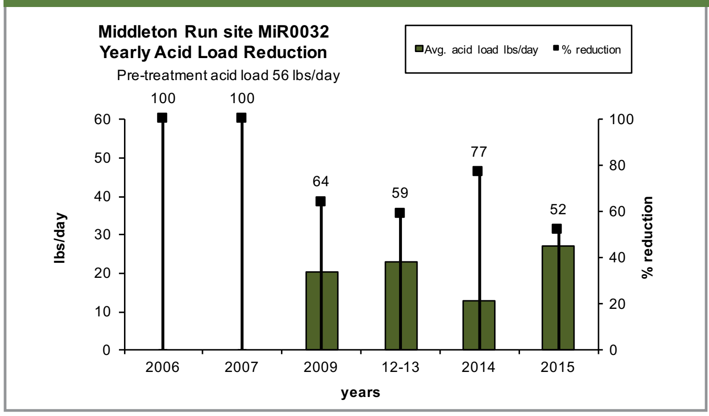


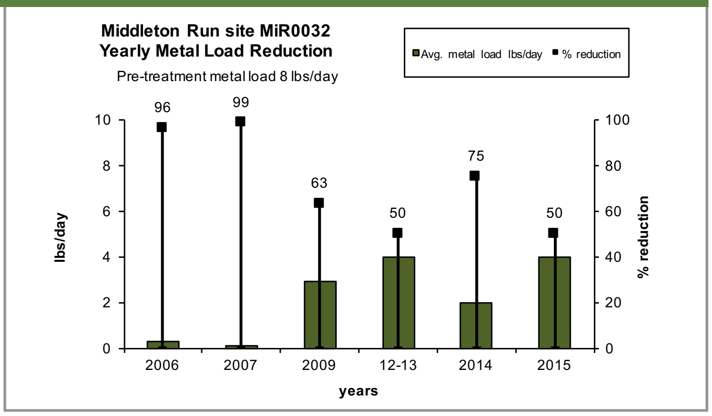
Middleton Run site MiR0021





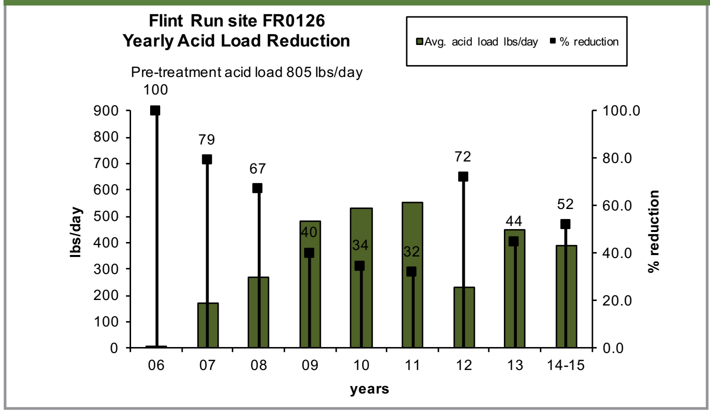
Middleton Run site MiR0032

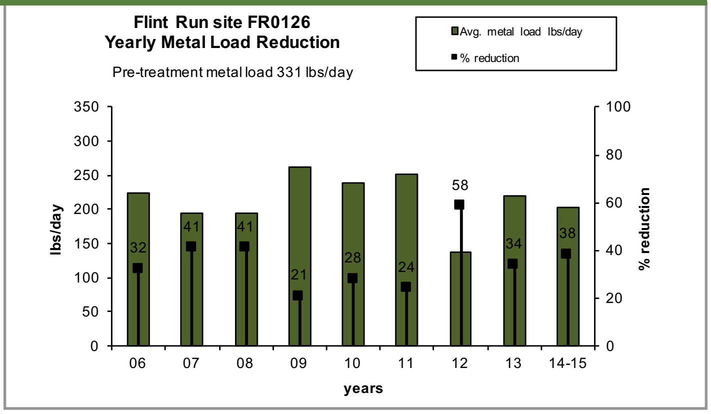




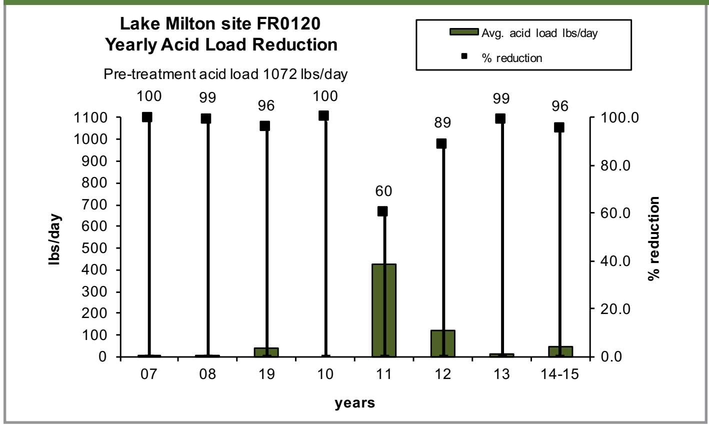
Yearly acid and metal load reduction trends per project

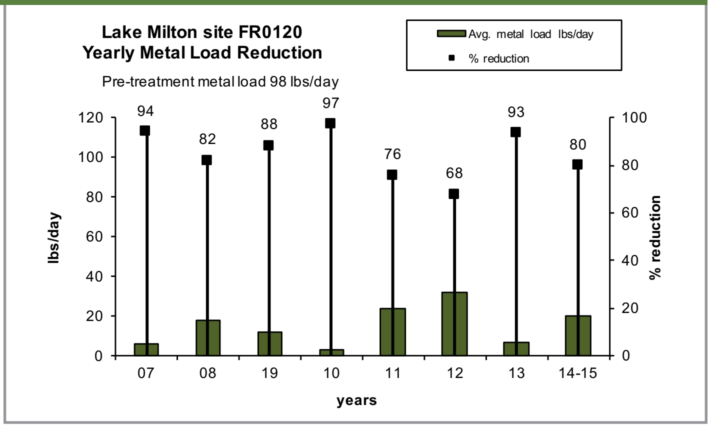
Flint Run site FR0126



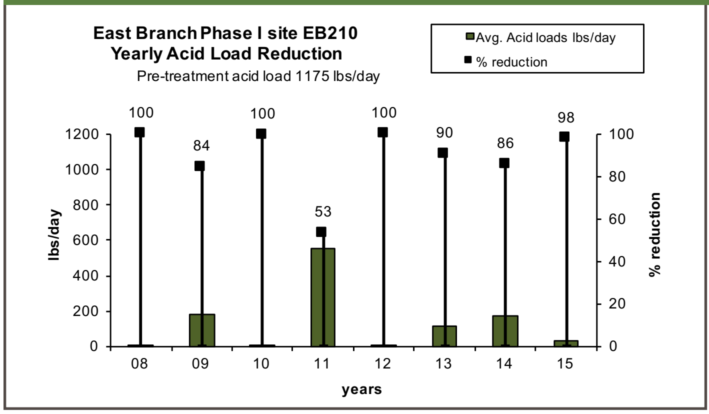


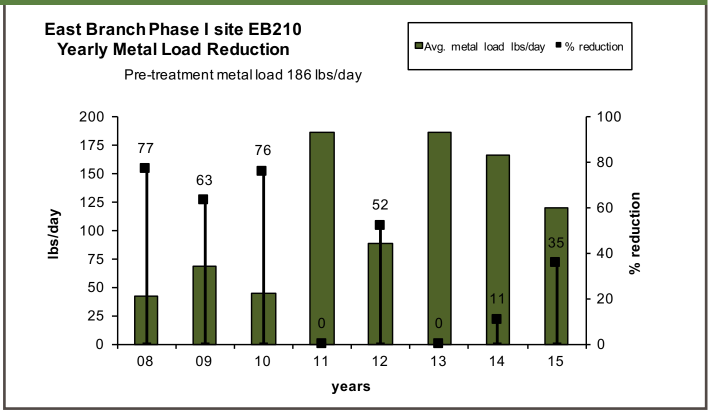
Lake Milton site FR0120





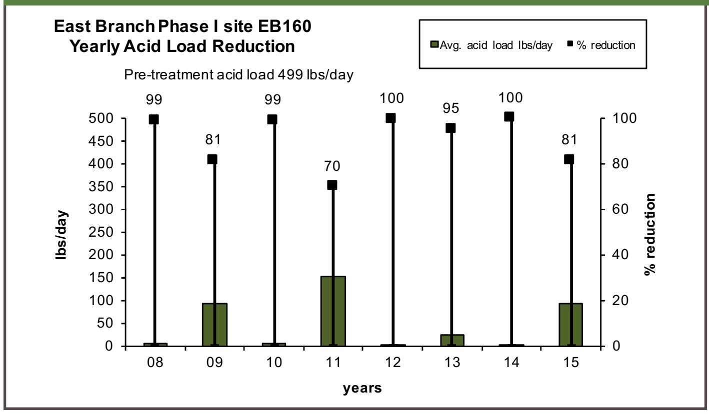
East Branch Phase I site EB210

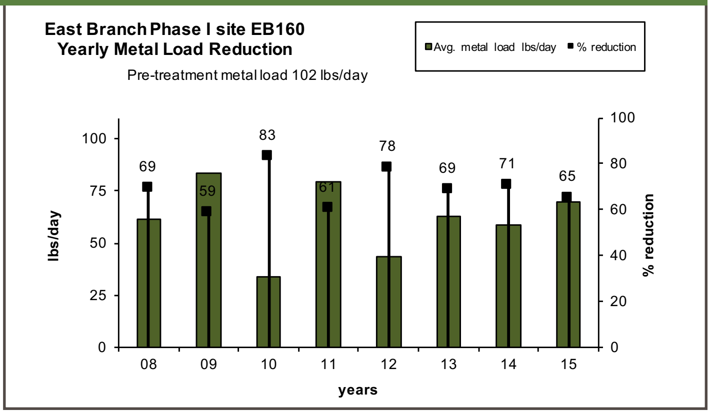




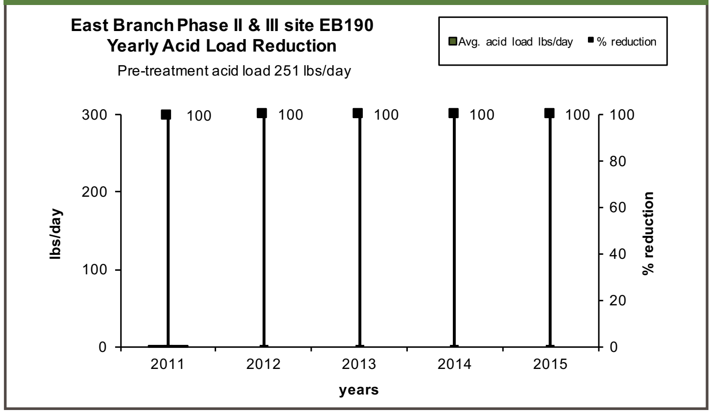
Yearly acid and metal load reduction trends per project

East Branch Phase I site EB160

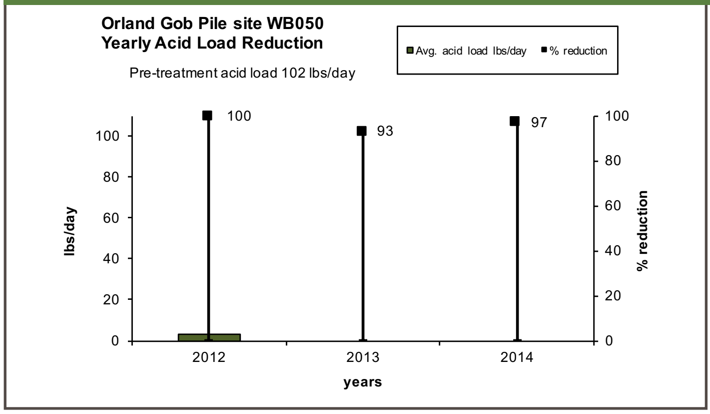


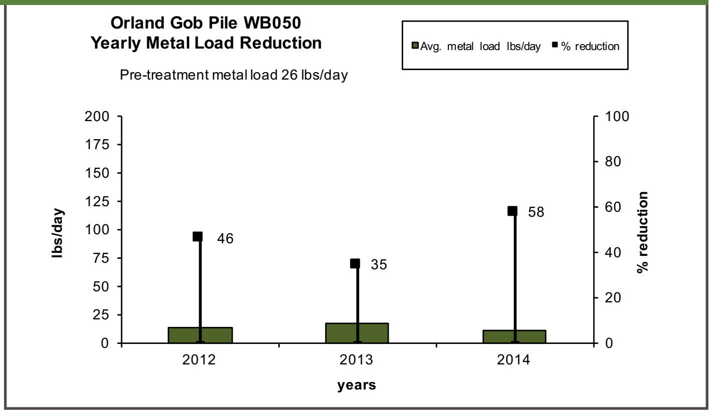


East Branch Phase II & III site EB190



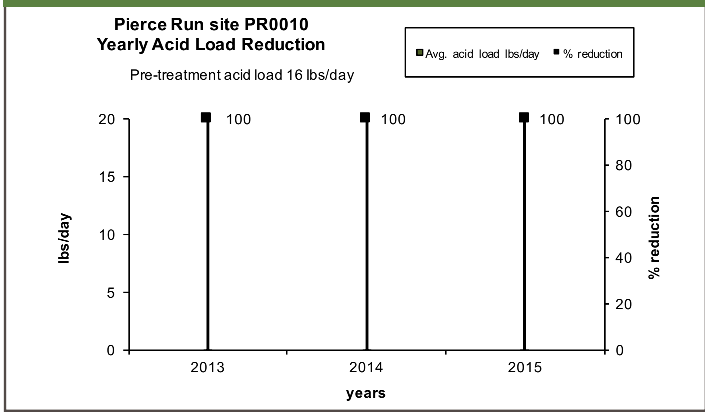
Orland Gob Pile site WB050

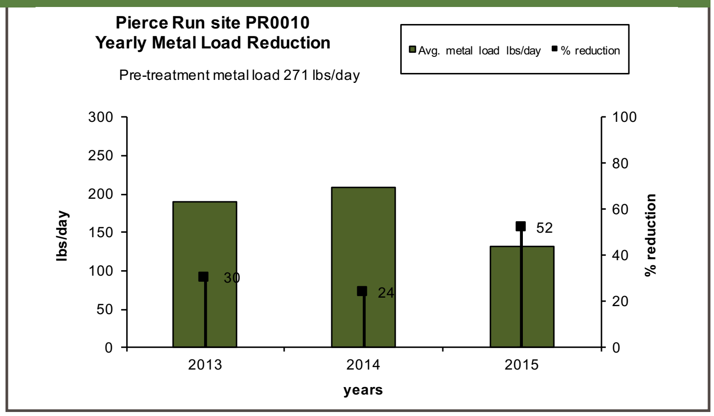




Yearly acid and metal load reduction trends per project

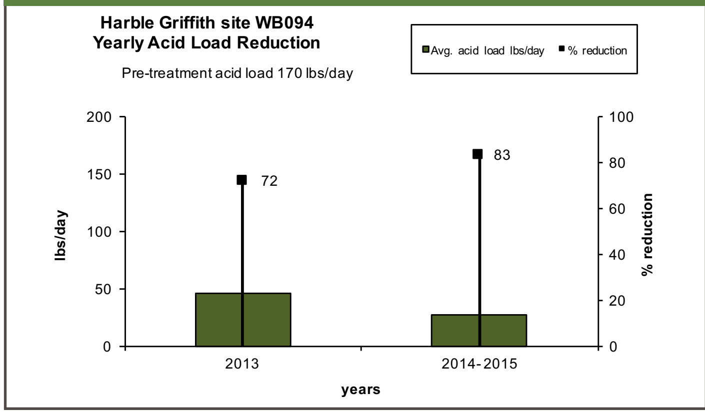
Pierce Run site PR0010*

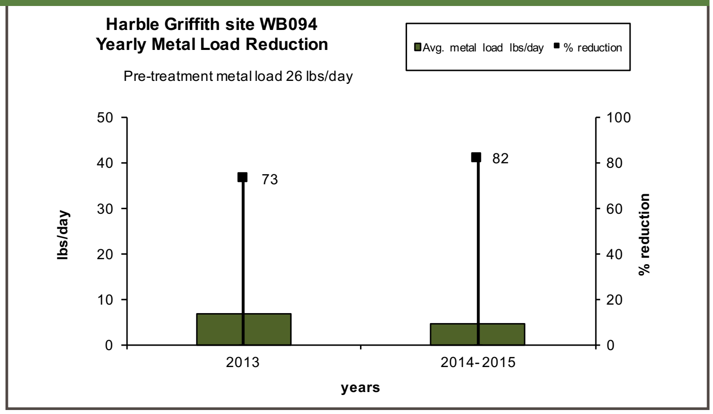




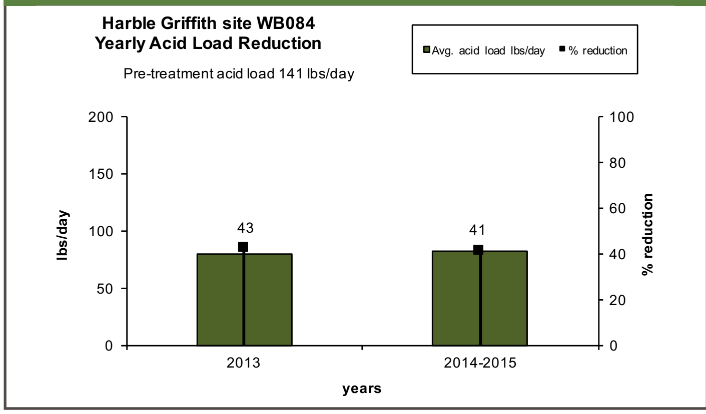
* Waterloo draining alkaline water into Pierce Run, Pierce Run slag bed is clogged

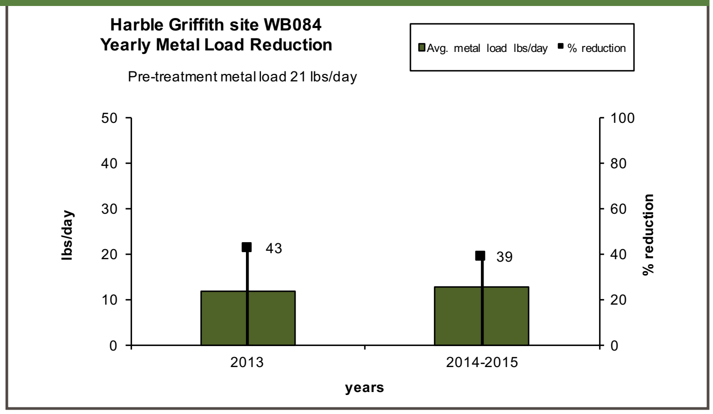
Harble Griffith site WB094





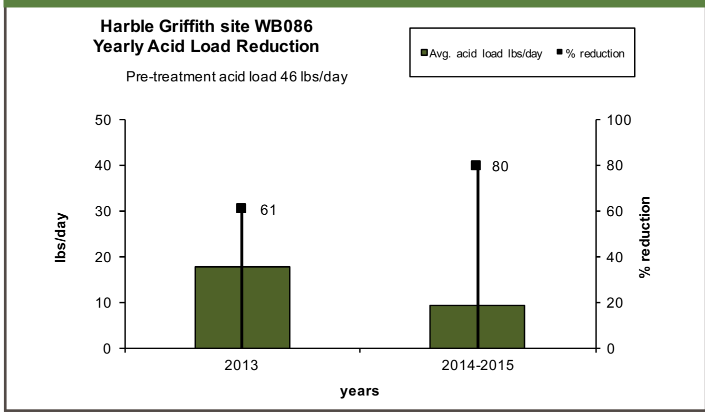
Harble Griffith site WB084

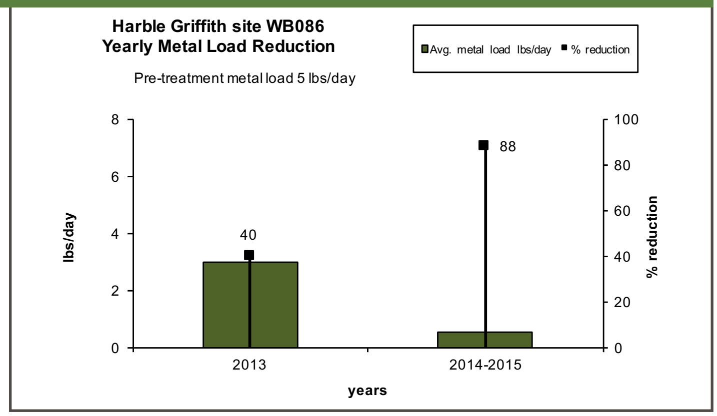




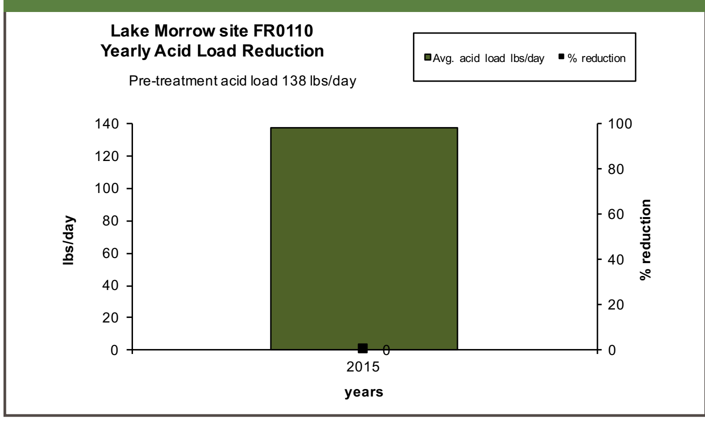
Yearly acid and metal load reduction trends per project

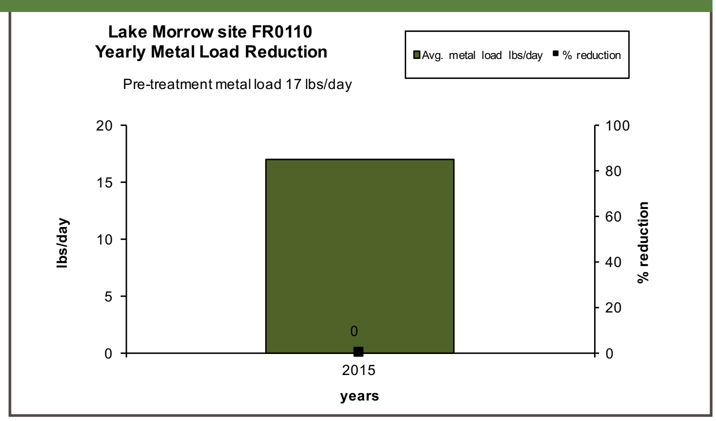
Harble Griffith site WB086



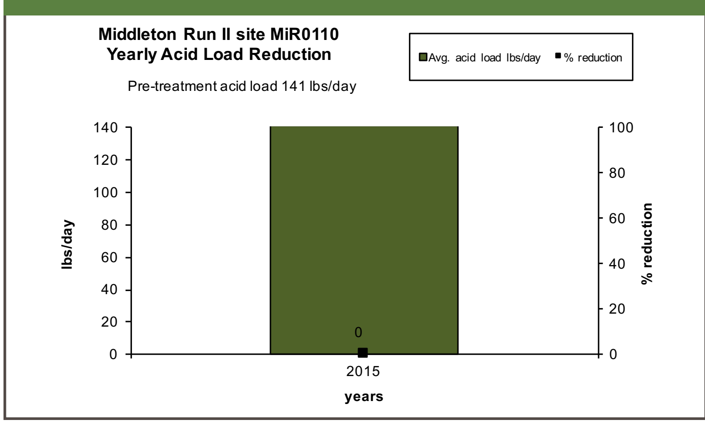


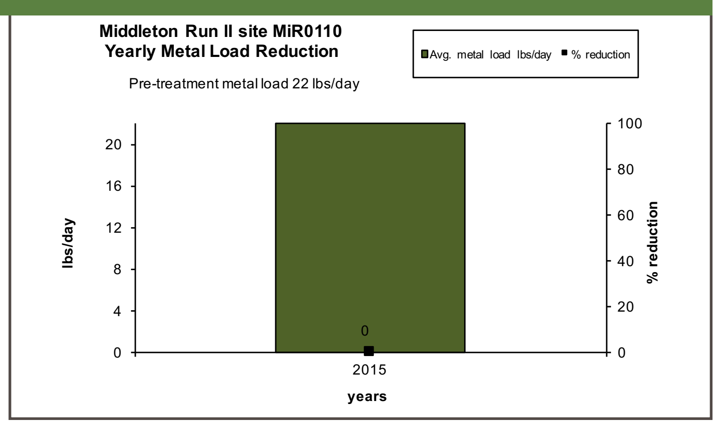
Lake Morrow site FR0110





Middleton Run II site MiR0110





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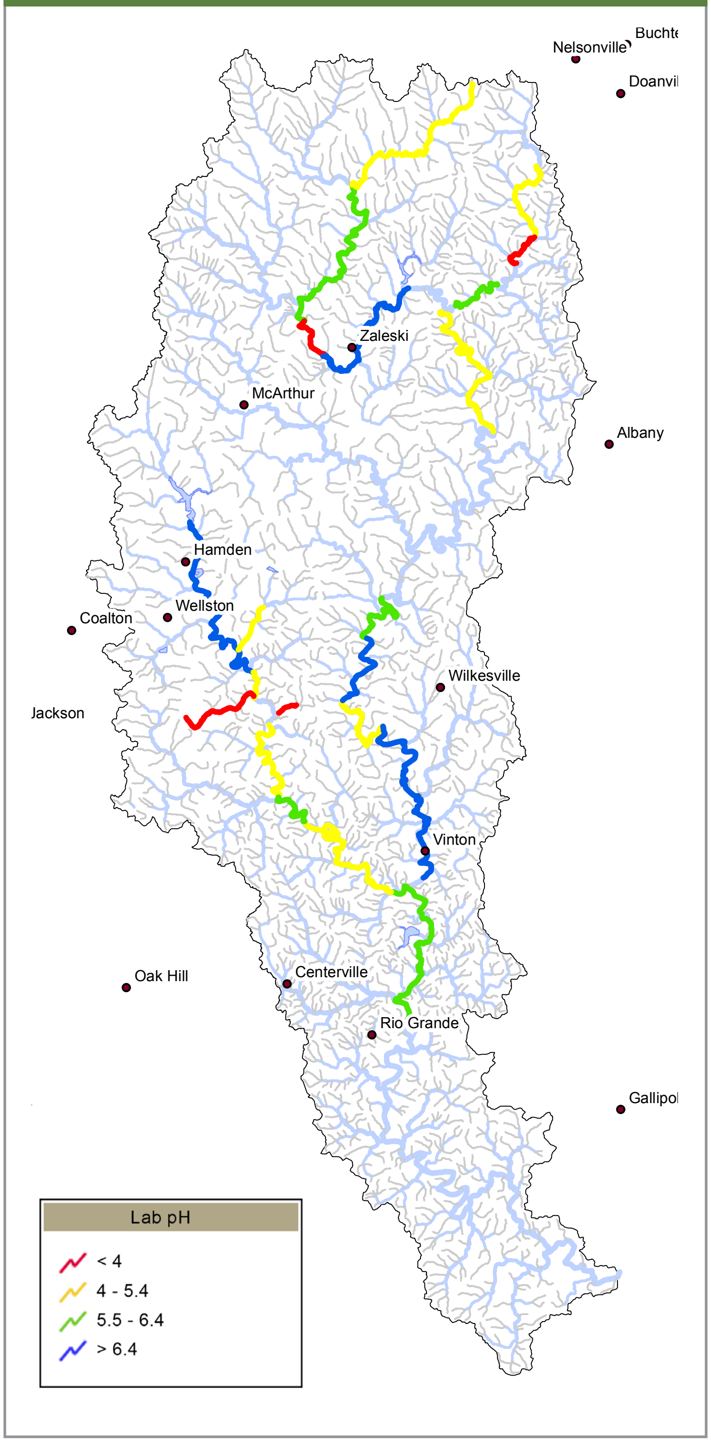
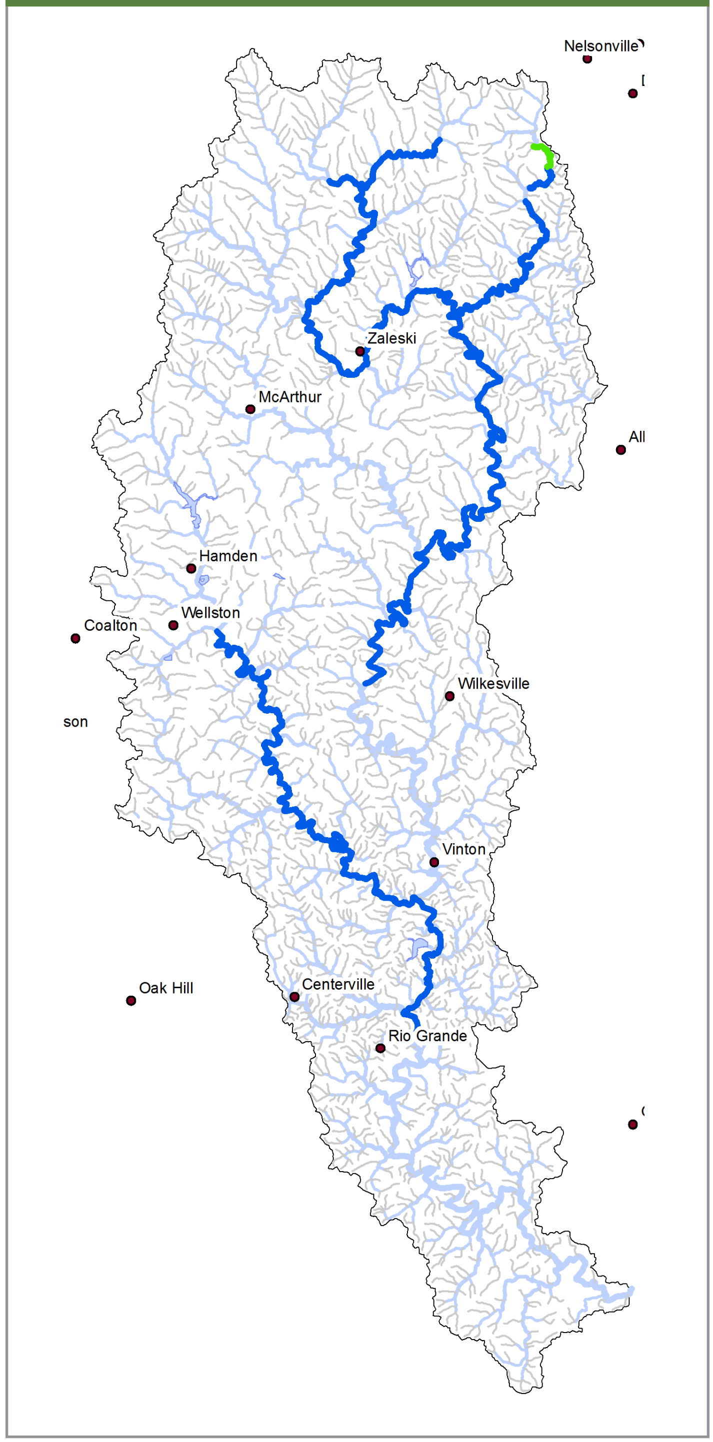
Chemical Water Quality

Raccoon Creek baseline pH



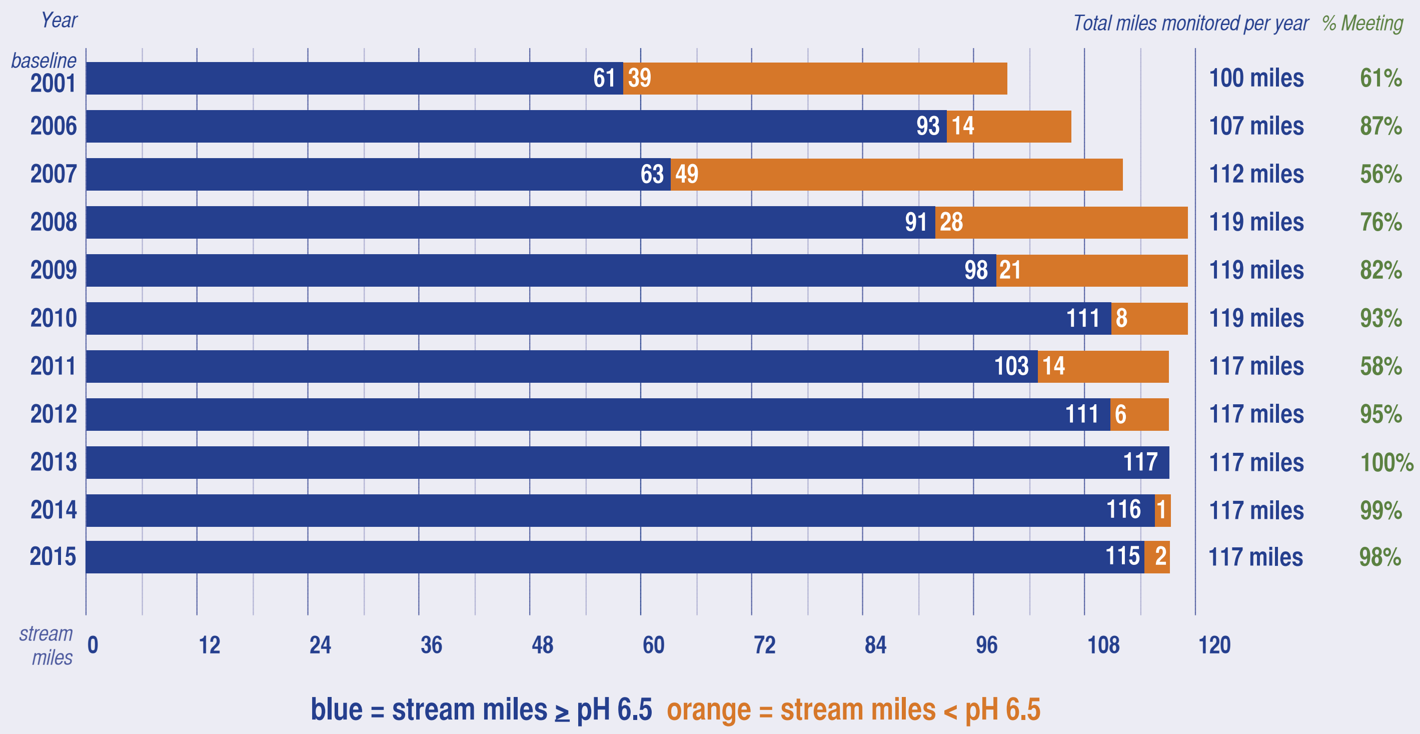
Raccoon Creek 2015 pH



In Raccoon Creek pH values have improved throughout the watershed from baseline conditions (1994-2001) to 2014. Raccoon Creek mainstem, Hewett Fork and Little Raccoon Creek average pH values have increased from a range of 4.0-5.4 during baseline to all meeting the pH target of 6.5 in 2015, except for a section (1.57 miles HF137) upstream of the input to Hewett Fork from the Carbondale doser. Of the miles of stream monitored in 2015, 13.2 river miles in Hewett Fork, 1.6 miles in West Branch, 6 miles in East Branch, all 27 river miles in Little Raccoon Creek (LRC), and all 68 miles along the mainstem of Raccoon Creek met the pH standard (pH >6.5).

There are approximately 117 stream miles monitored each year along the mainstem of Raccoon Creek (downstream to Rio Grande), Little Raccoon Creek, Hewett Fork, and East and West Branch. Each year the number of miles that meet this target fluctuates. Currently in 2015, all but 1.5 of 117 miles of stream miles monitored met the pH target (pH > 6.5).

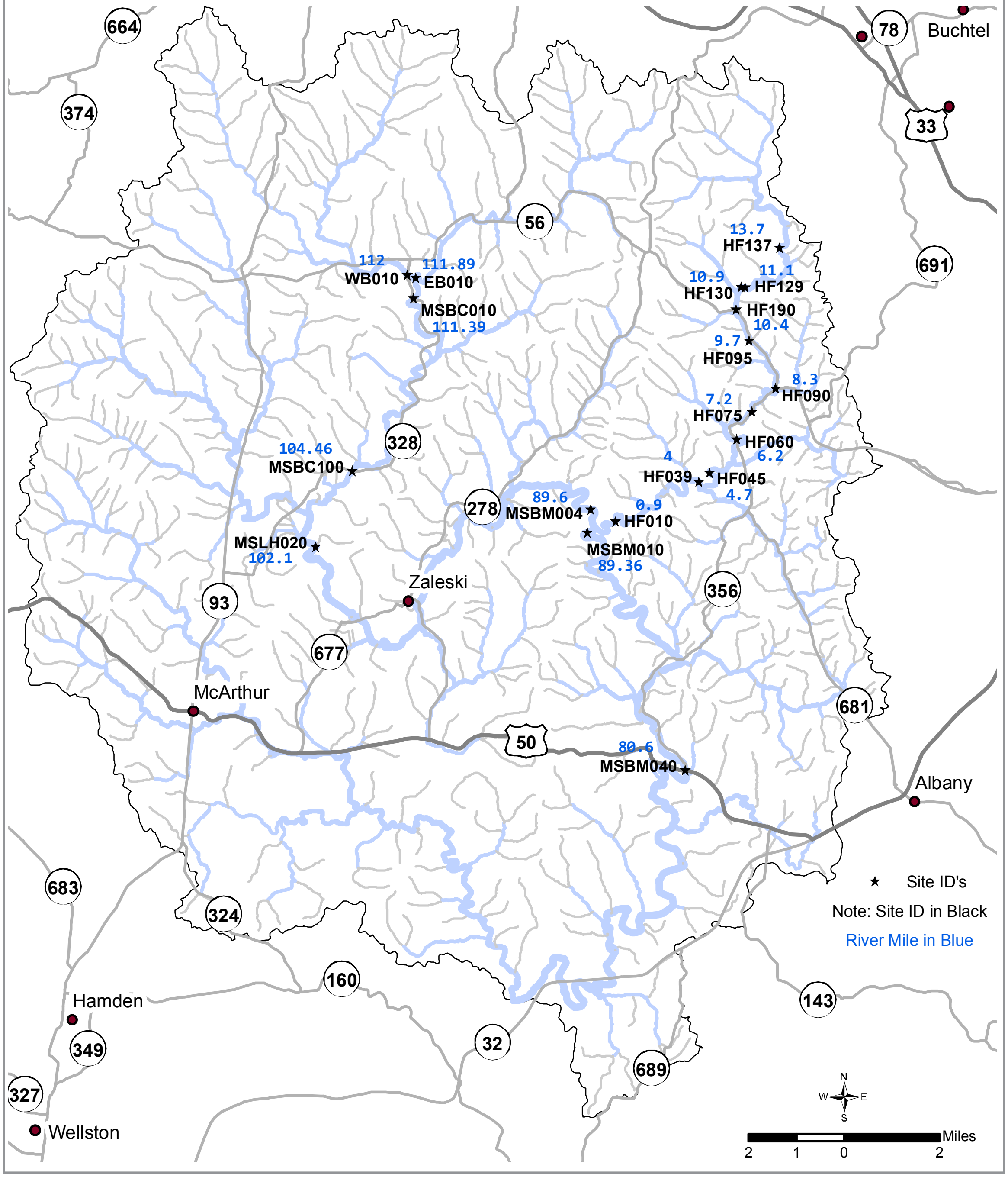
Raccoon Creek total stream miles monitored for pH through time from 2001-2013.



Chemical water quality analysis per stream reach

For purposes of analyzing chemical water quality changes along the mainstem of receiving stream where AMD reclamation projects have been completed, Raccoon Creek has been divided into the following stream segments: Raccoon Creek Mainstem, Little Raccoon Creek, and Hewett Fork. Within these stream reaches, chemical long-term monitoring data is utilized to generate line graphs along the stream gradient from headwaters to the mouth. Along the x-axis named tributaries are shown to illustrate new sources of water entering the mainstem. A list of long-term monitoring sites utilized to generate the graphs with their river miles are shown before each set of stream reach graphs.

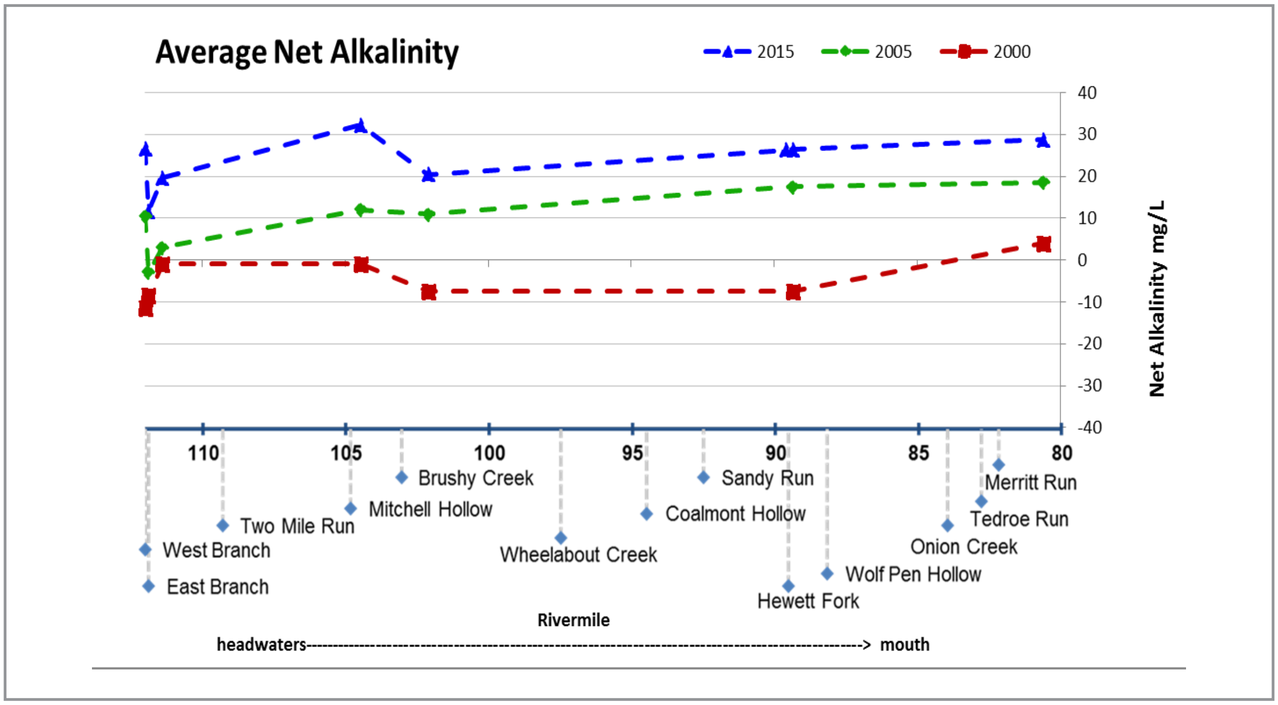
Raccoon Creek Mainstem

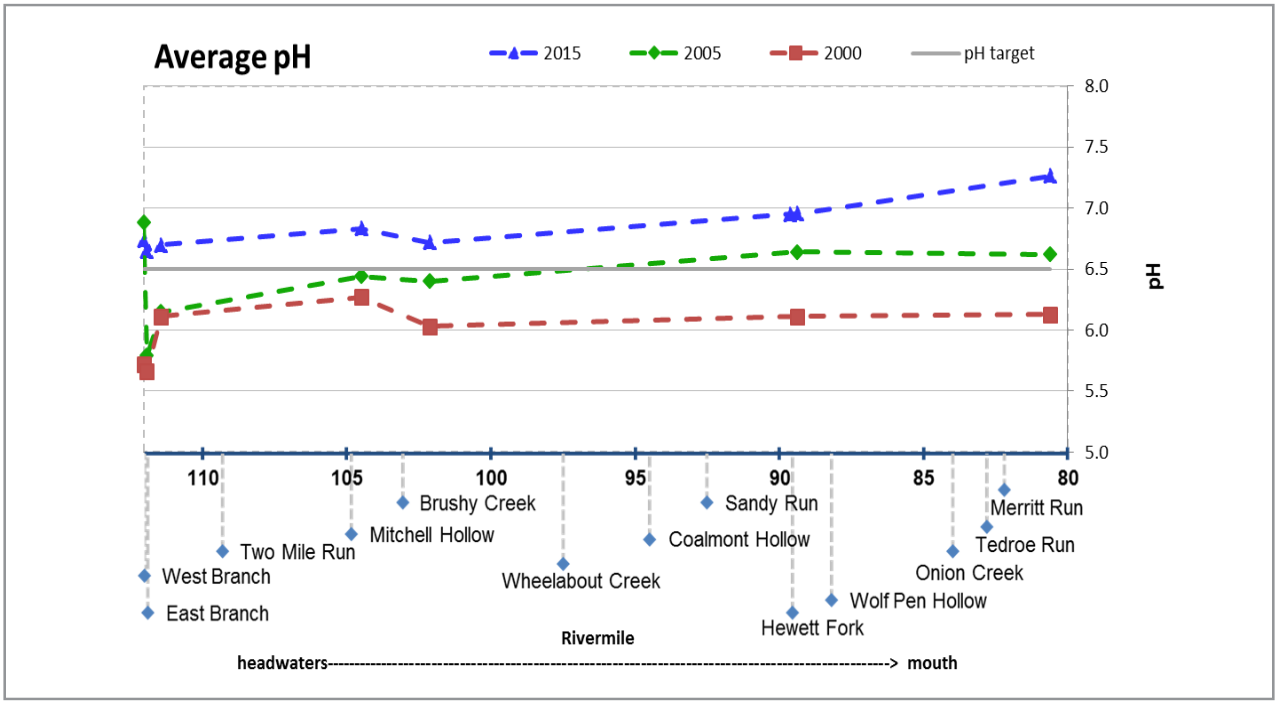


Chemical water quality analysis per stream reach

Raccoon Creek Mainstem

Site ID	WB010	EB010	MSBC010	MSBC100	MSLH020	MSBM004	MSBM010	MSBM040
Rivermile	112	111.89	111.39	104.46	102.1	89.6	89.36	80.6

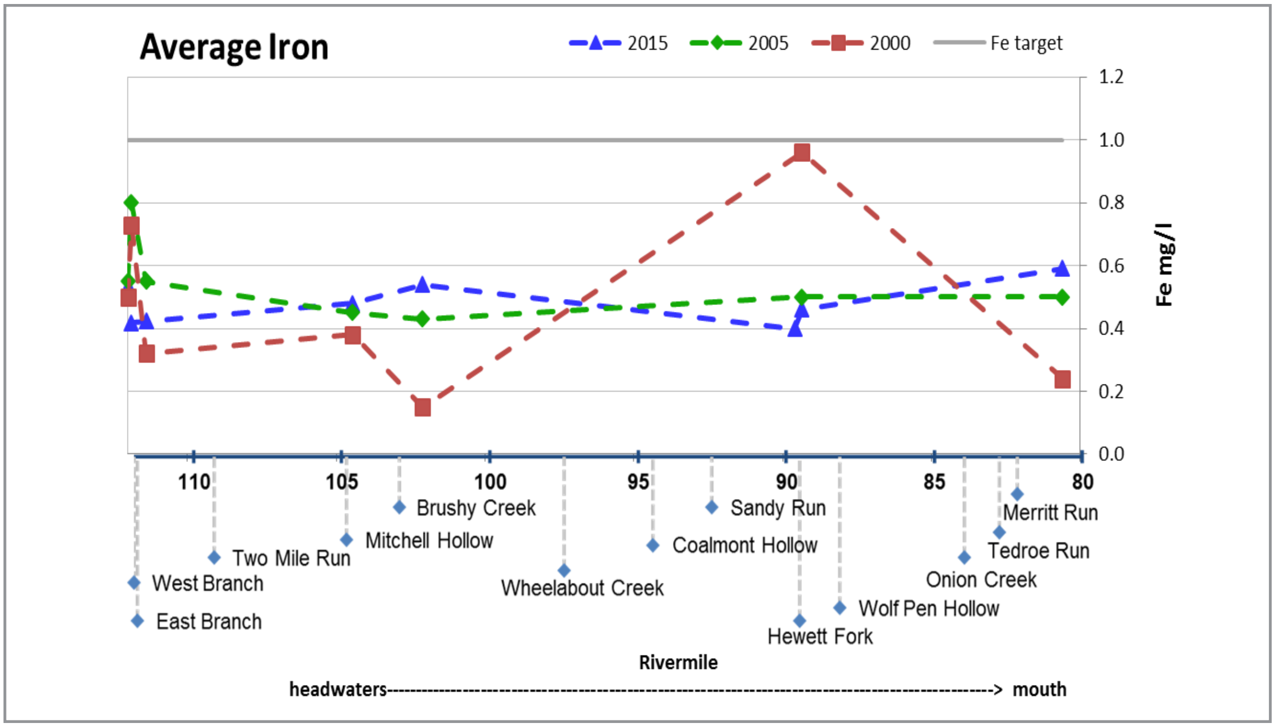


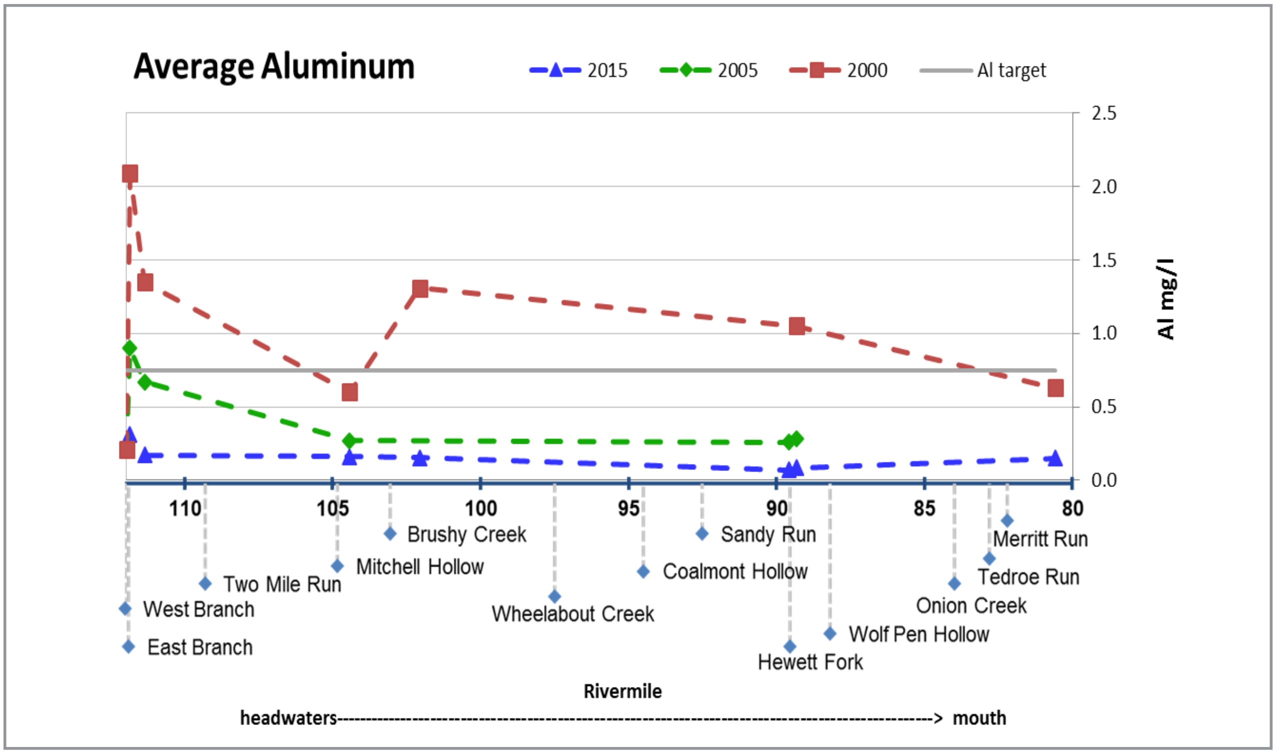


Chemical water quality analysis per stream reach

Raccoon Creek Mainstem

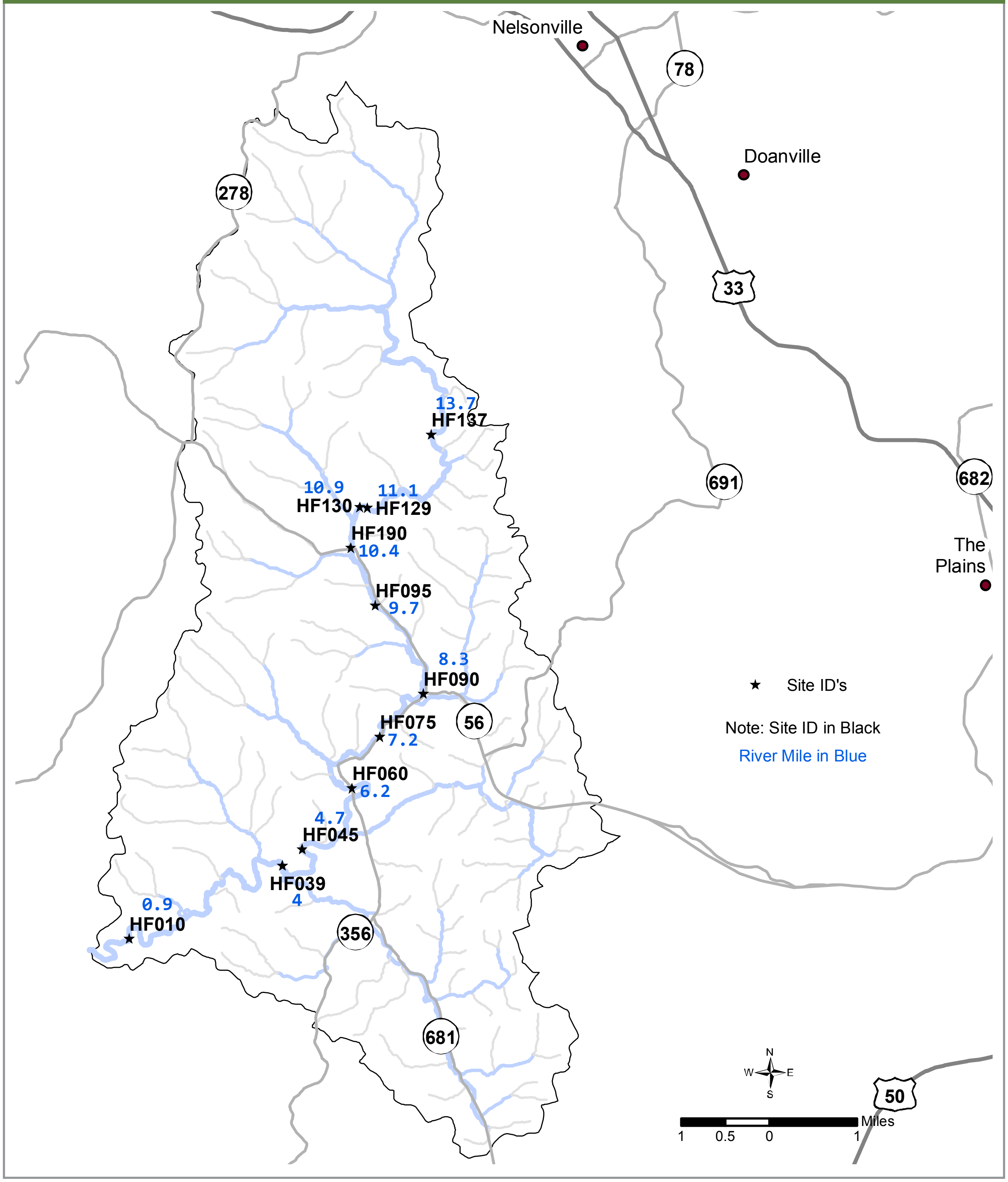
Site ID	WB010	EB010	MSBC010	MSBC100	MSLH020	MSBM004	MSBM010	MSBM040
Rivermile	112	111.89	111.39	104.46	102.1	89.6	89.36	80.6





Chemical water quality analysis per stream reach

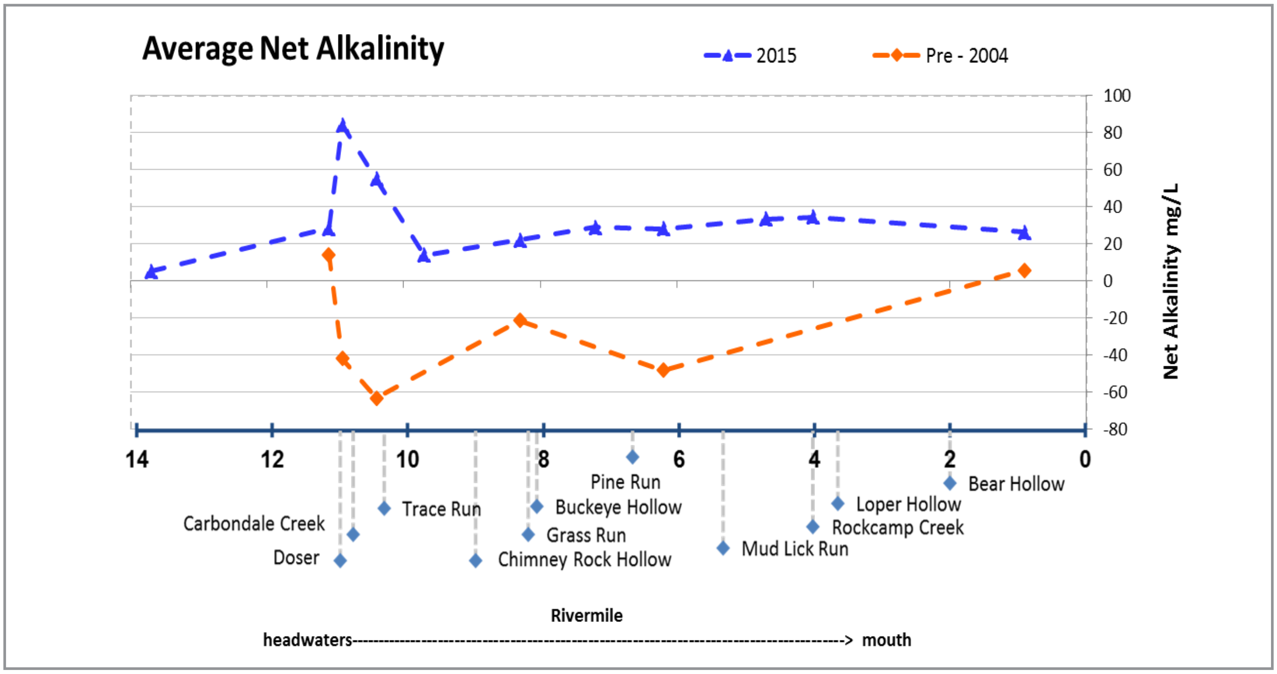
Hewett Fork

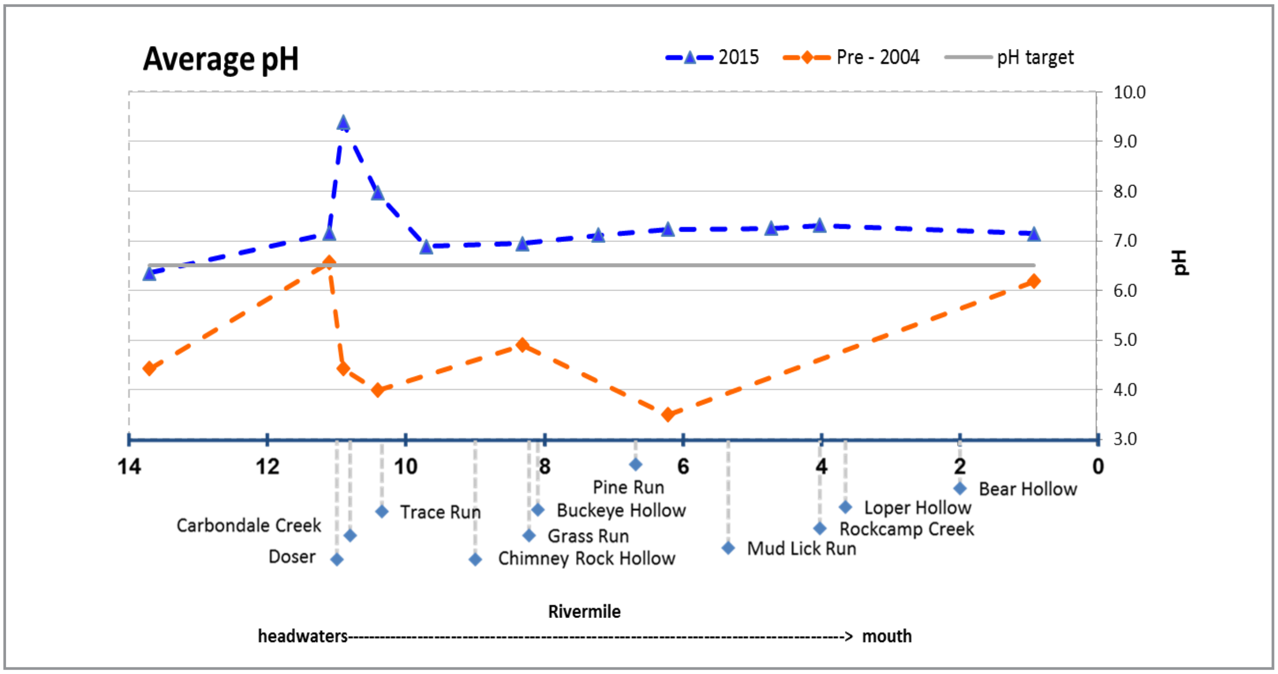


Chemical water quality analysis per stream reach

Hewett Fork											
Site ID	HF137	HF129	HF130	HF190	HF095	HF090	HF075	HF060	HF045	HF039	HF010
Rivermile	13.7	11.1	10.9	10.4	9.7	8.3	7.2	6.2	4.7	4	0.9

Note: Lime Doser installed in 2004 at RM 11



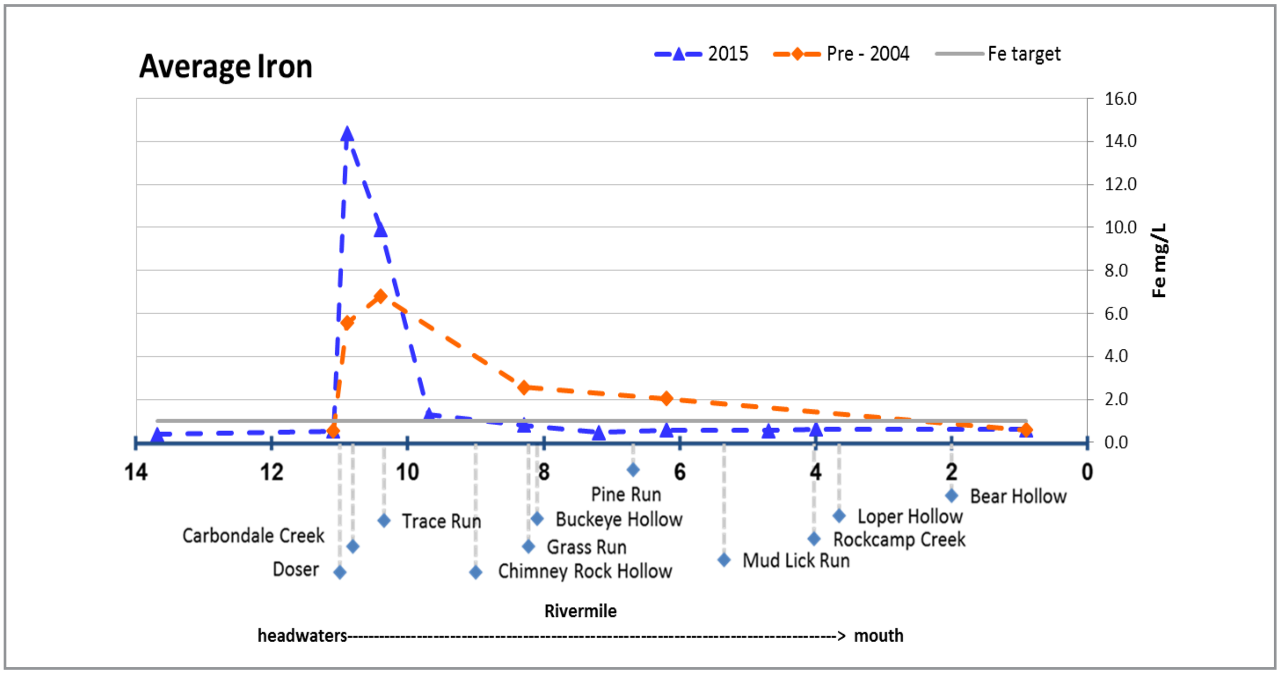


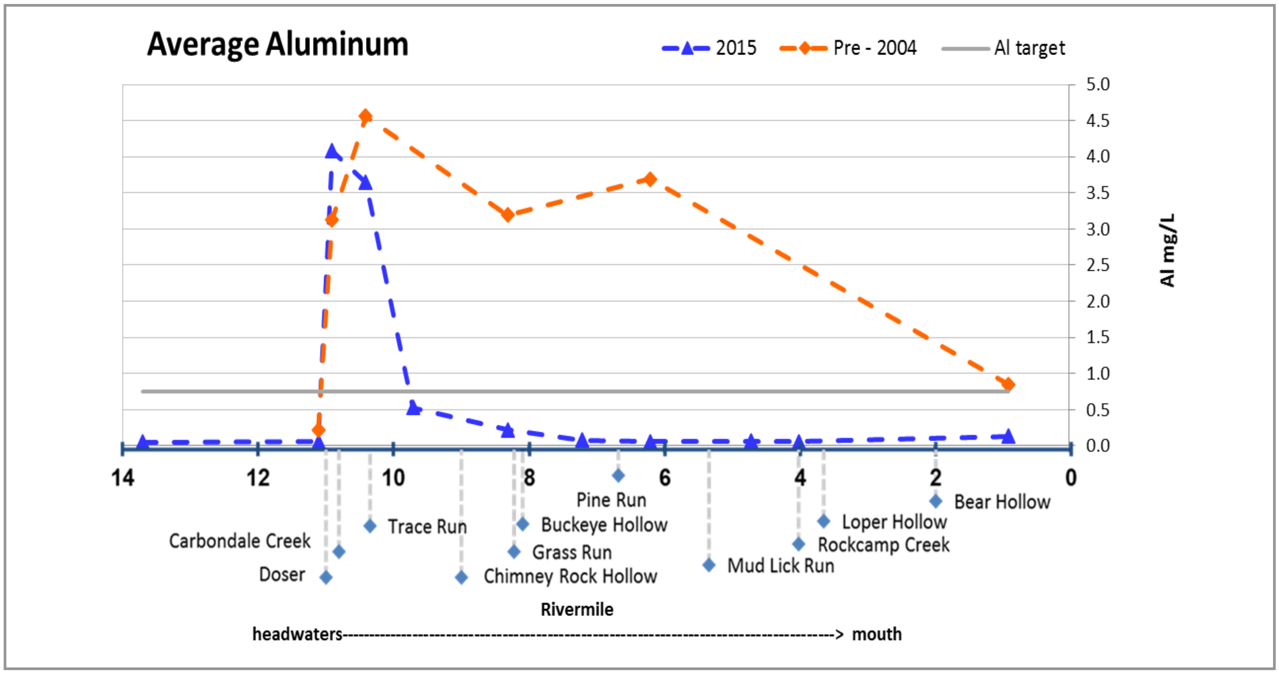
Chemical water quality analysis per stream reach

Hewett Fork

Site ID	HF137	HF129	HF130	HF190	HF095	HF090	HF075	HF060	HF045	HF039	HF010
Rivermile	13.7	11.1	10.9	10.4	9.7	8.3	7.2	6.2	4.7	4	0.9

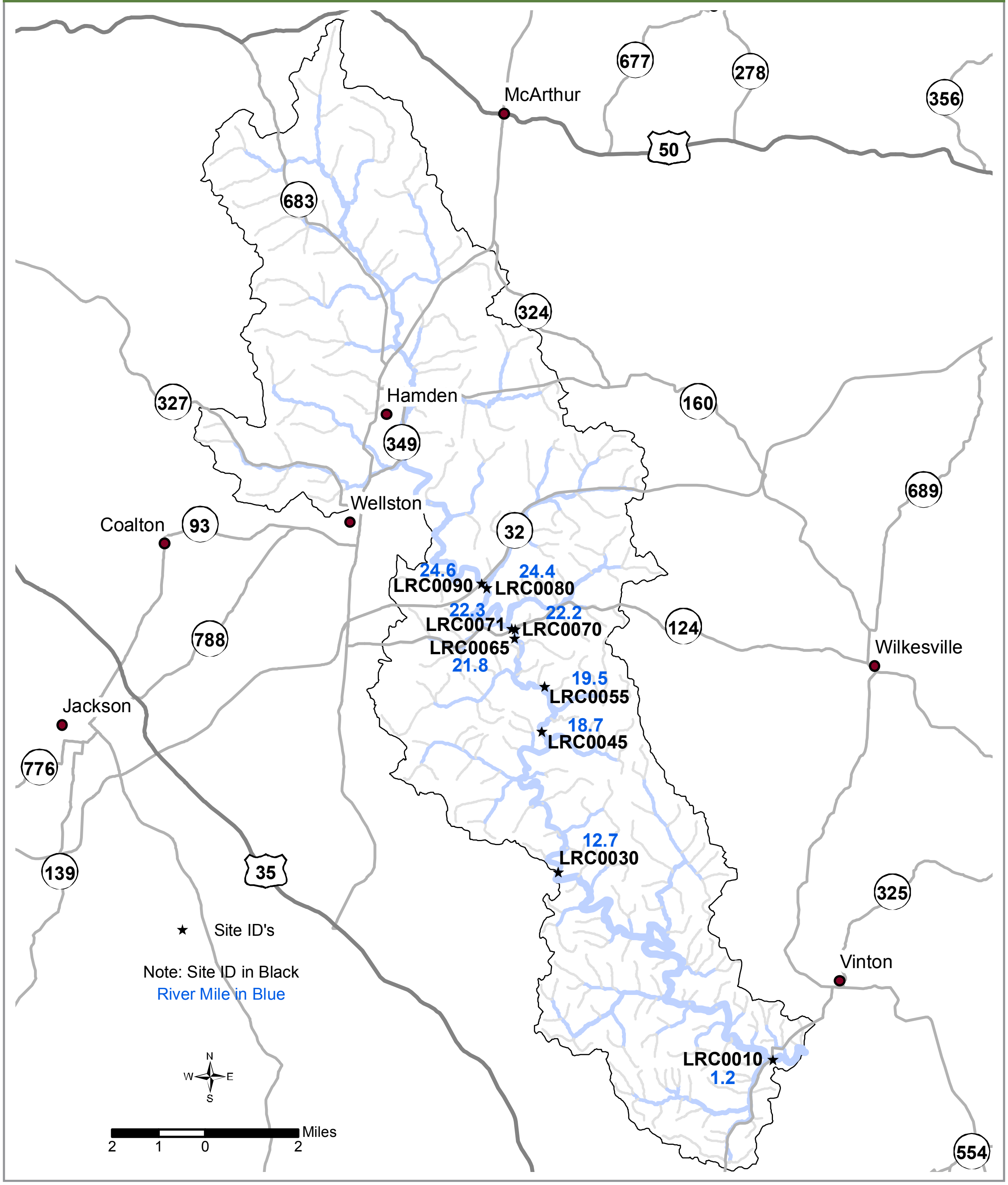
Note: Lime Doser installed in 2004 at RM 11





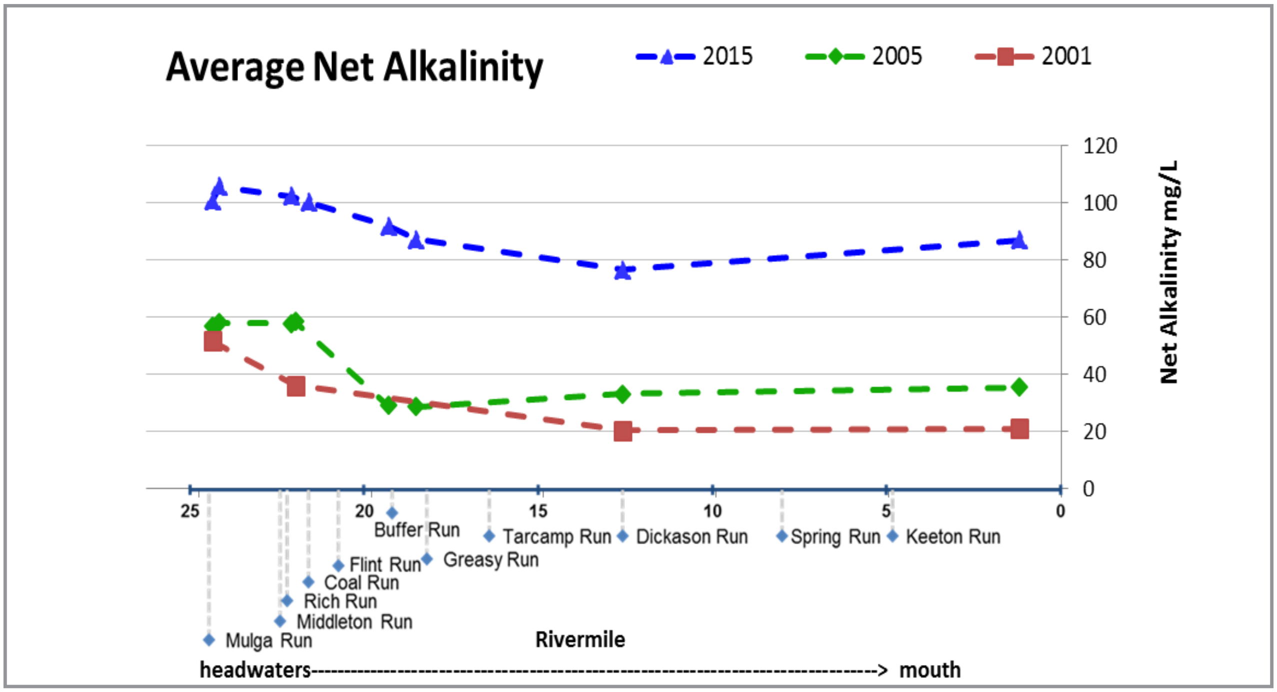
Chemical water quality analysis per stream reach

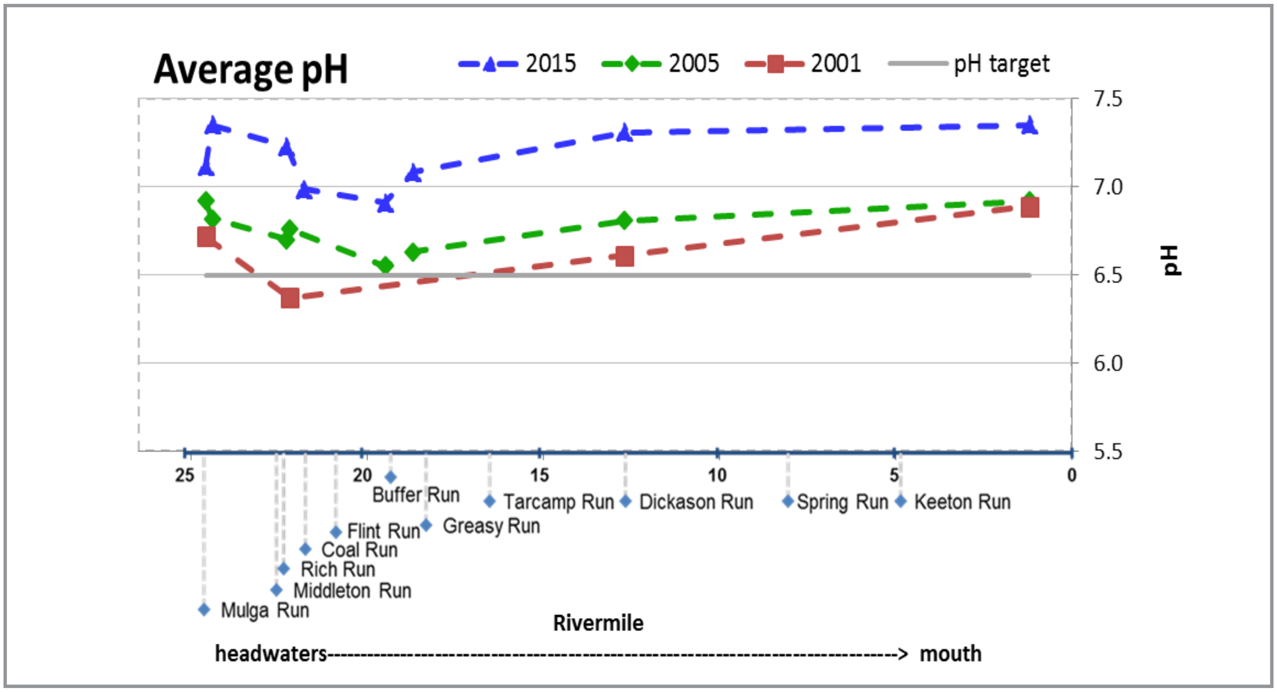
Little Raccoon Creek



Chemical water quality analysis per stream reach

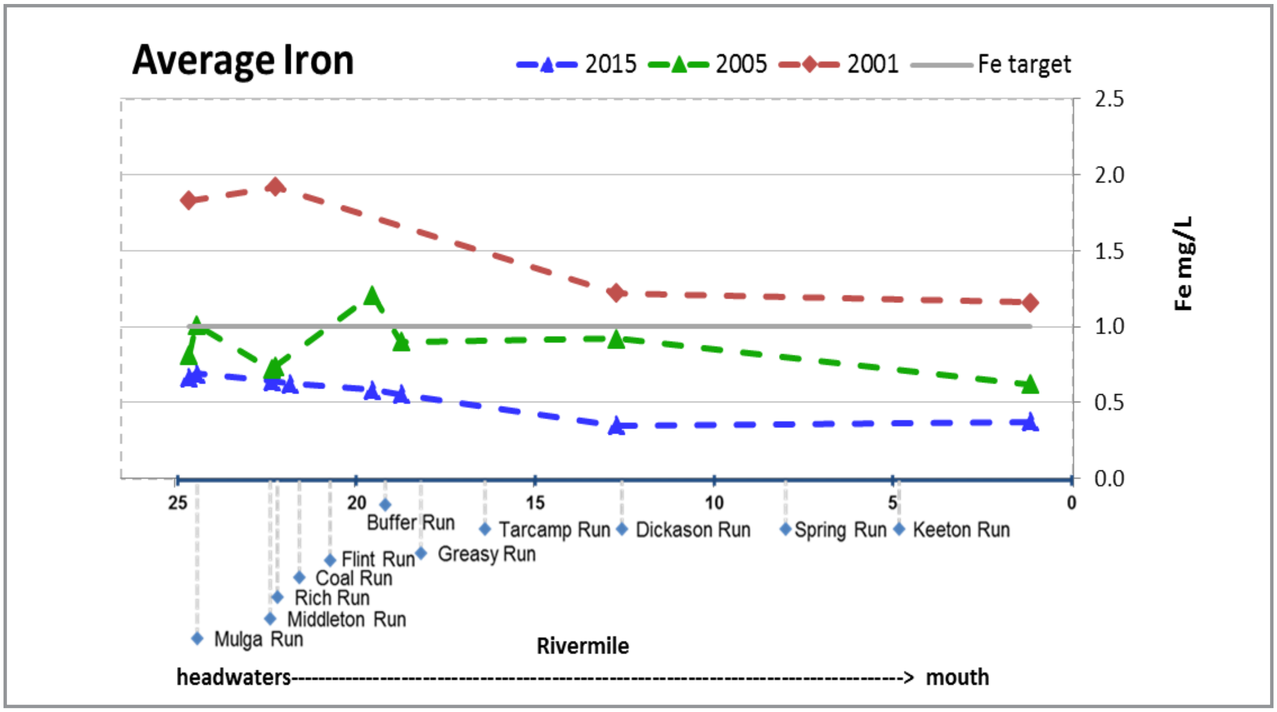
Little Raccoon Creek									
Site ID	LRC0090	LRC0080	LRC0071	LRC0070	LRC0065	LRC0055	LRC0045	LRC0030	LRC0010
Rivermile	24.6	24.4	22.3	22.2	21.8	19.5	18.7	12.7	1.2

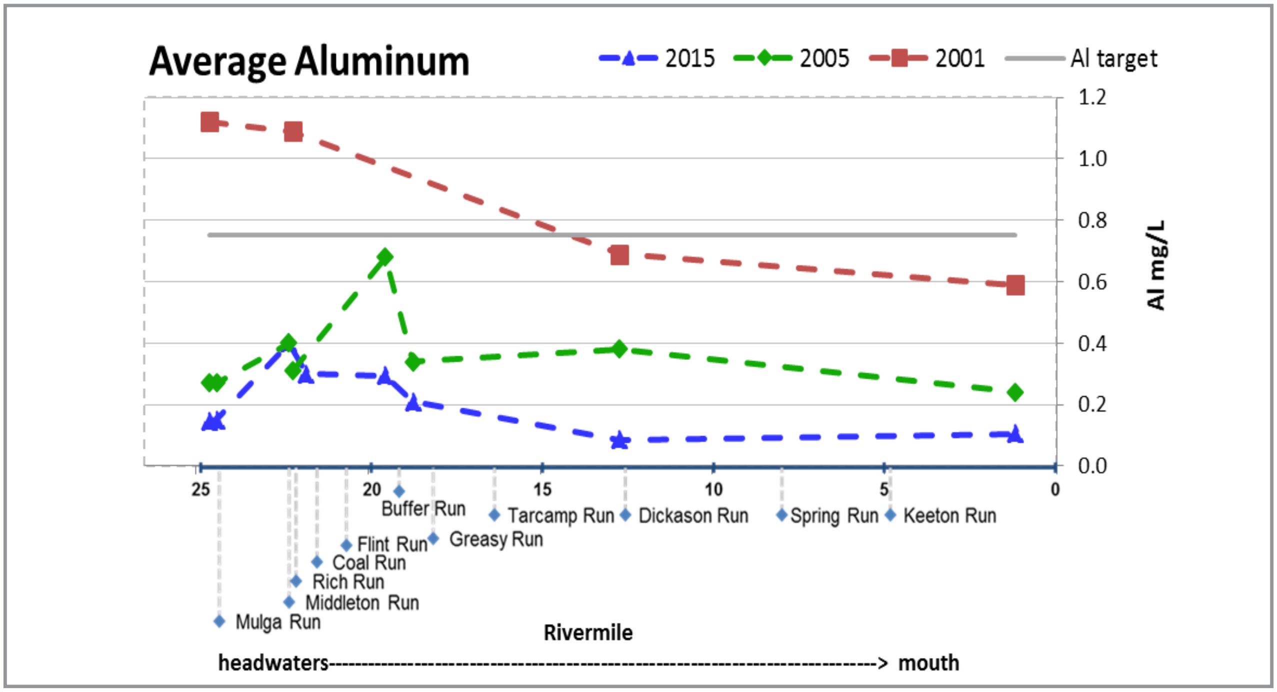




Chemical water quality analysis per stream reach

Little Raccoon Creek									
Site ID	LRC0090	LRC0080	LRC0071	LRC0070	LRC0065	LRC0055	LRC0045	LRC0030	LRC0010
Rivermile	24.6	24.4	22.3	22.2	21.8	19.5	18.7	12.7	1.2





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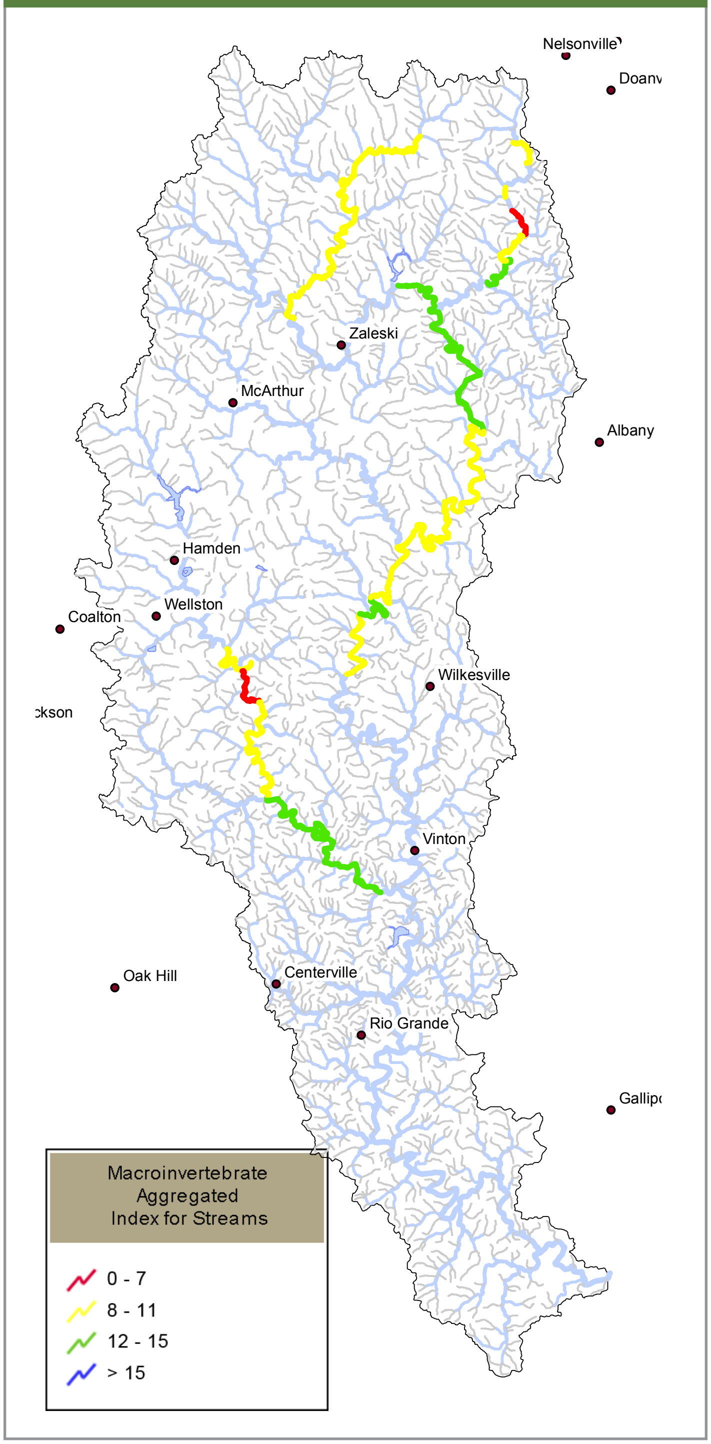
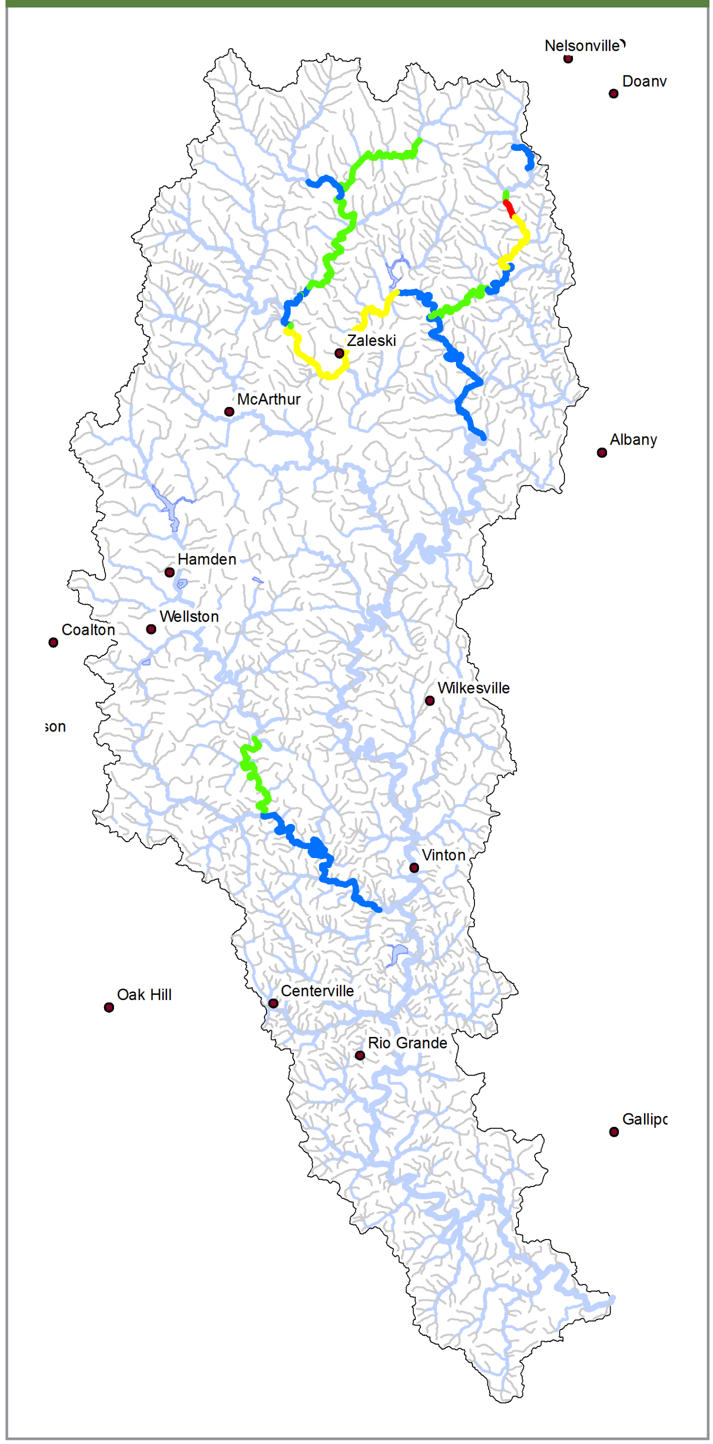
Biological Water Quality

Raccoon Creek baseline MAIS



Raccoon Creek 2015 MAIS

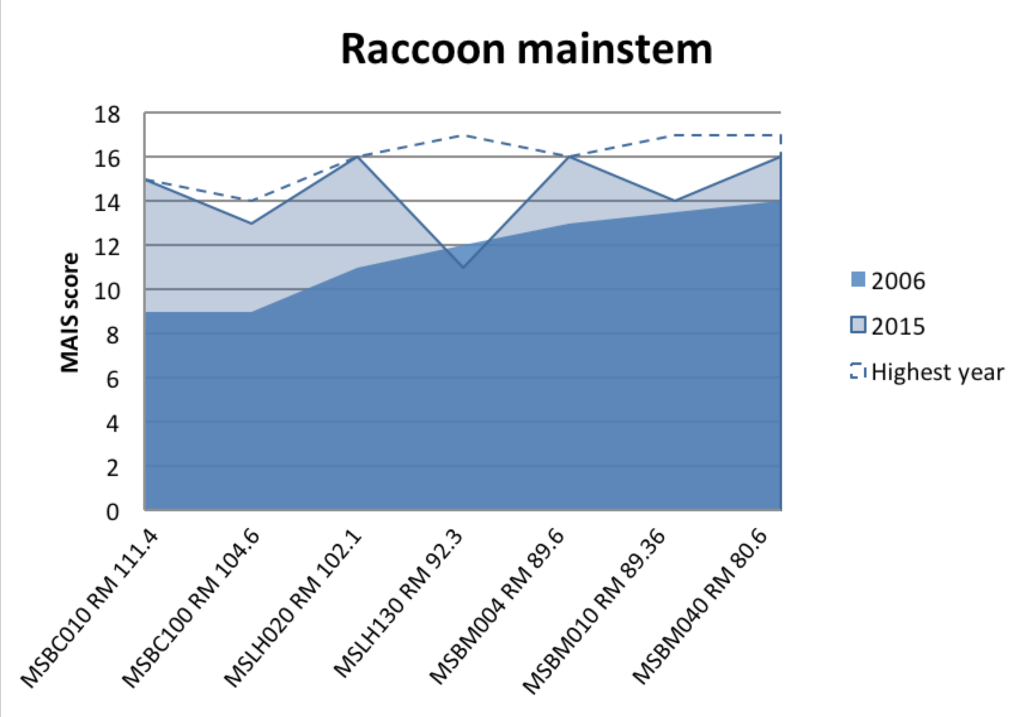


MAIS samples were collected throughout Raccoon Creek in 2015 (excluding Middle Basin sites). These stations have been established as annual monitoring stations for macroinvertebrates. The sites are used to track incremental changes each year.

Raccoon Creek - Mainstem

The thirty or more miles of the Raccoon Creek mainstem are generally of uniformly high quality, with all having met or exceeded the target MAIS score of “12” in recent years (2012, 2013). The upstream sites, which were historically the worst impaired, have improved the most, with a total of 9 river miles fitting the category of ‘statistically improved’. There was an unusually low MAIS score this year at RM 92.3 (“11” when it is usually >”14”), but sites immediately upstream and downstream met or exceeded previous years’ high scores, suggesting that the decline in quality was not widespread.

Figure 1. Area of Degradation



The blue dashed line identifies the highest MAIS score achieved at that site throughout the monitoring time period.

Figure 2. Raccoon Creek - Mainstem - MAIS Regressions

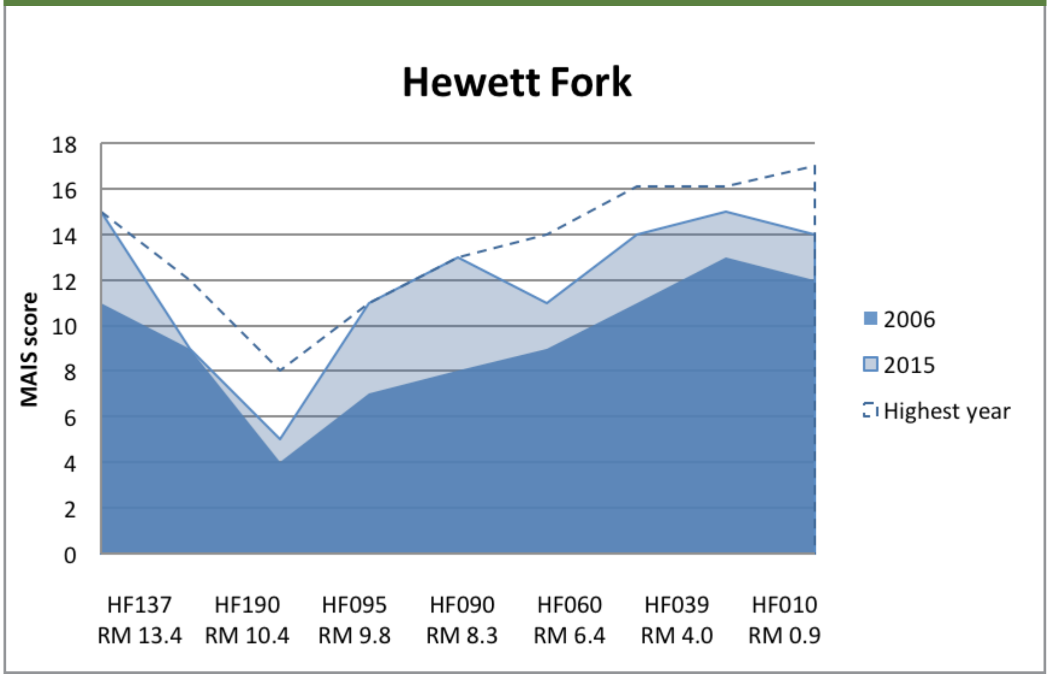
Rivermile		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Linear trends	R sq.	P-value	No. of years
MSBC010	111.4	8	9	12	9	10	12	13	12	13	13	15	**improved**	0.698413	0.002601	11
MSBC100	104.6		9	11	12	9	11	10	14	14	13	13	**improved**	0.512159	0.019951	10
MSLH020	102.1		11	11	10	13	10	11	12	15	15	16	**improved**	0.628993	0.006194	10
MSLH130	92.3		*	*	10	10	17	11	14	13	14	11	no change	0.045918	0.610344	8
MSBM004	89.6		13	14	11	16	12	16	15	14	13	16	no change	0.14026	0.286314	10
MSBM010	89.36		*	12	16	14	17	13	13	13	10	14	no change	0.124675	0.351287	9
MSBM040	80.6		14	14	17	16	12	14	15	14	14	16	no change	0.000659	0.943892	10

**Indicates a score graphed as the mean of sites immediately upstream and downstream that year*

Raccoon Creek - Hewett Fork

In 2015, the biological quality of the eleven mile reach below the Carbondale doser was relatively unchanged relative to previous years. A well-defined 2.5 mile 'mixing zone' downstream of the doser remains impaired but the remainder of the downstream sites show steadily increasing MAIS scores with increasing distance from the doser and mixing zone. Two of the sites in the downstream recovered zone (HF060 and HF045) scored a little lower than usual but it is unknown whether this is an annual variation or a new trend.

Figure 3. Area of Degradation



The blue dashed line identifies the highest MAIS score achieved at that site throughout the monitoring time period.

Figure 4. Raccoon Creek - Hewett Fork MAIS Regressions

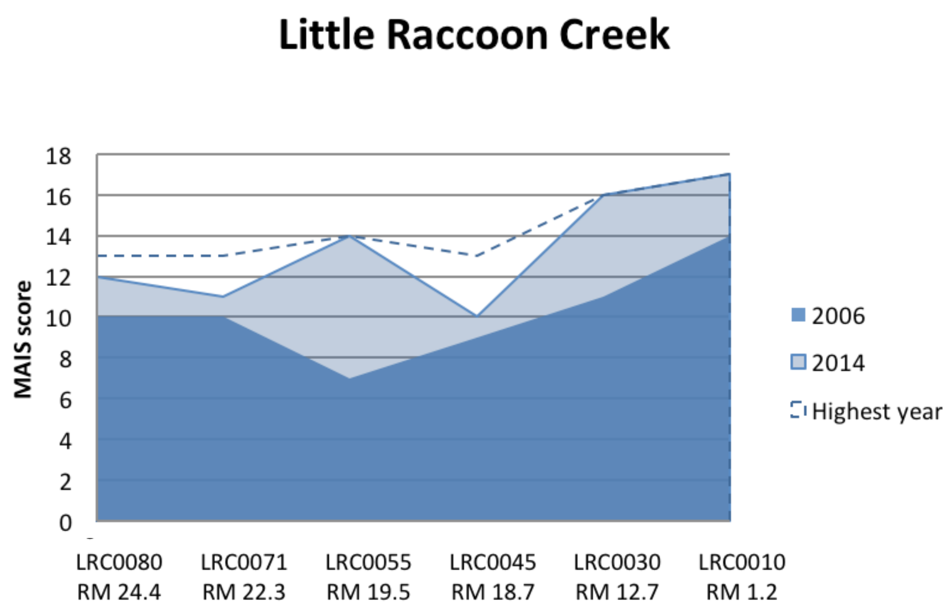
HEWETT FORK	2001	2002	2003	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Linear trends	R square	P-value	No. of years
HF 137 RM 13.4					11	8	9	12	13	11	11	11	13	15	**improved**	0.480852	0.026163	10
HF 190 RM 10.4					9	3	7	6	6	5	8	12	8	9	no change	0.228218	0.162593	10
HF095 RM 9.8					4	3	6	3	3	8	4	4	4	5	no change	0.026515	0.653094	10
HF 090 RM 8.3	2	3	3	5	7	3	5	6	3	6	9	7	11	11	**improved**	0.535079	0.016202	10
HF075					*				12	11	12	13	11	13	no change	0.128571	0.485198	6
HF 060 RM 6.4					9	9	8	10	10	13	11	14	13	11	**improved**	0.572353	0.01132	10
HF045					*				14	15	12	13	16	14	no change	0.022857	0.774949	6
HF 039 RM 4.0					13	13	14	13	13	14	14	16	16	15	**improved**	0.659854	0.004299	10
HF 010 RM 0.9					12	12	15	17	13	16	16	14	16	14	no change	0.178735	0.223514	10

**Indicates a score graphed as the mean of sites immediately upstream and downstream that year.*

Raccoon Creek - Little Raccoon Creek

Little Raccoon Creek biological quality in 2014 was similar to that recorded in previous years. Most sites have improved since 2006, after completion of the six major reclamation projects upstream of RM 19.5 (Mulga Run, Salem Road/Middleton Run, State Rte. 124 seeps, Flint Run East, Lake Milton, and Buckeye Furnace), but the trend is statistically significant at only two of the six long term sites. Two sites earned new high scores in 2014 (RM 19.5 and 12.7), suggesting that the macroinvertebrate communities are still improving. As in the past, sections of the Little Raccoon from approximately RM 18 to 1.2 (more than 16 river miles) achieved target macroinvertebrate scores of ‘12’, indicating that the macroinvertebrate community is probably at or near attainment of WWH status.

Figure 5. Area of Degradation



The blue dashed line identifies the highest MAIS score achieved at that site throughout the monitoring time period.

Figure 6. Little Raccoon Creek - MAIS Regressions

Rivermile	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Linear trends	R sq.	P-value	No. of years
LRC0080 RM 24.4	8	10	11	11	9	9	13	11	11	12	no change	0.354915	0.069156	10
LRC0071 RM 22.3	8	10	10	9	10	10	10	10	13	11	**improved**	0.528981	0.017139	10
LRC0055 RM 19.5		7	*	9	11	12	13	10	11	14	no change	0.340726	0.168853	9
LRC0045 RM 18.7	14	9	12	9	13	11	11	12	11	10	no change	0.041602	0.571926	10
LRC0030 RM 12.7	3	11	13	13	14	14	14	14	15	16	**improved**	0.590644	0.009395	10
LRC0010 RM 1.2	14	14	13	15	17	16	16	16	14	17	no change	0.333333	0.080516	10

**Indicates a score illustrated as the mean of sites immediately upstream and downstream that year*

MONDAY CREEK WATERSHED REPORT

2015 NPS Report - Monday Creek Watershed

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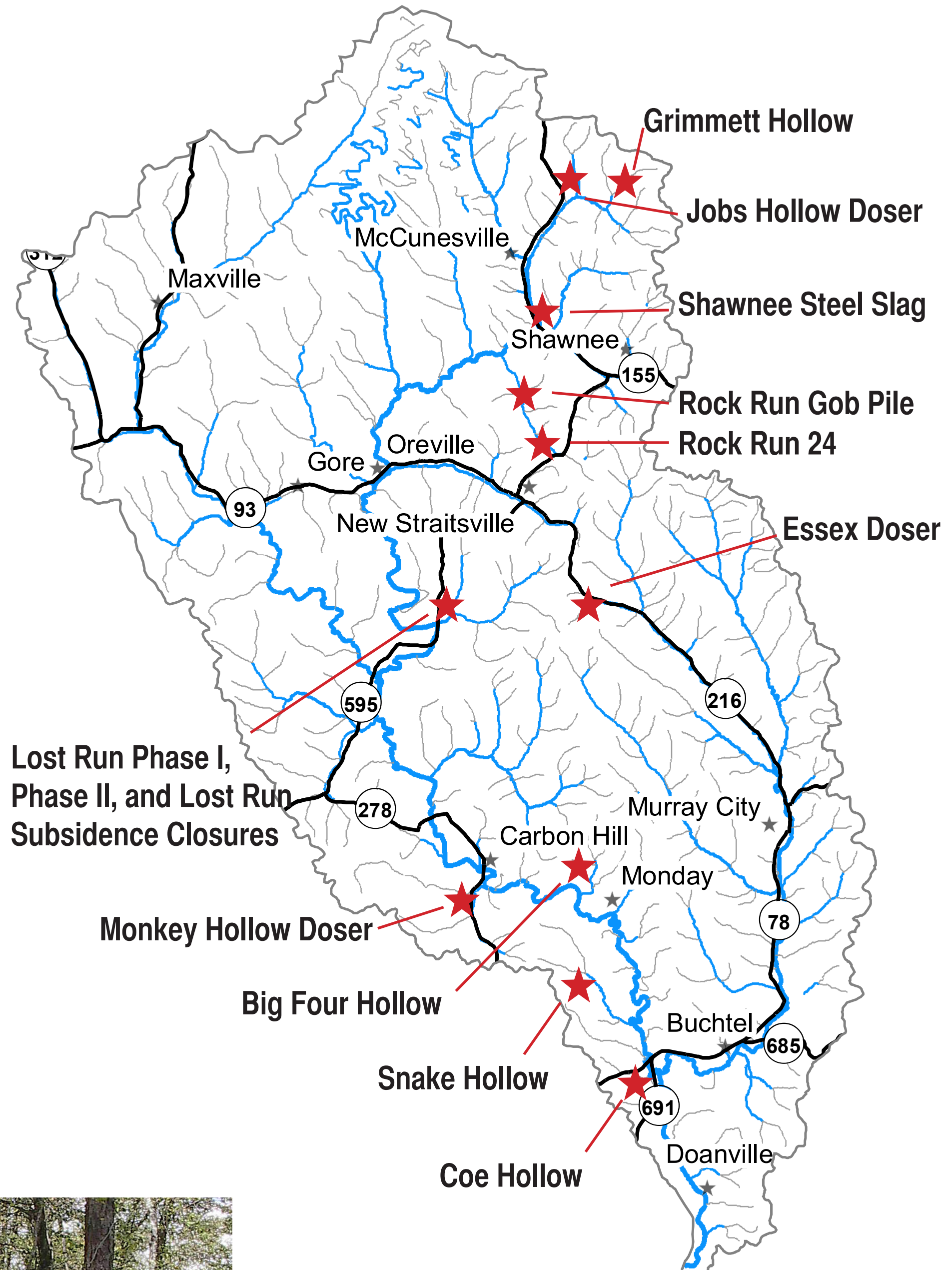
Monday Creek Restoration Project



Reductions

Total acid load reduction 2015 = 2,551 lbs/day

Total metal load reduction 2015 = 338 lbs/day

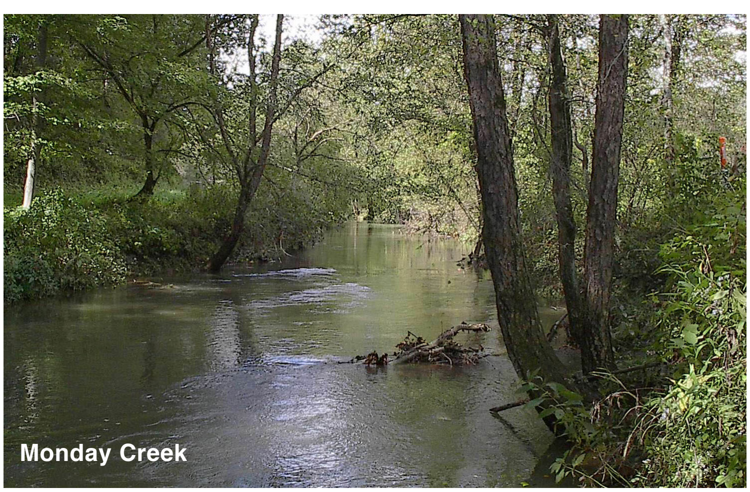
Data derived using the Stoertz Water Quality Evaluation Method (Kruse et al. 2014) (excludes Rock Run Gob Pile Project)

Cost

Design $448,545
(excluding Jobs Doser & Lost Run maintenance and Snake Hollow)

Construction $6,749,264

Total costs through 2015 = $7,197,808


Monday Creek

363,425,000 gallons of stream water per year eliminated from entering into the deep mines as the result of conducting seven stream capture closure projects in Monday creek.

Timeline of the Monday Creek Watershed Project Milestones & AMD Projects

1994

- Formation of Monday Creek Restoration Project

1995

- First stream water quality study on Monday Creek (USFS, CURSML, and USGS)
- OSM awarded MCRP an Appalachian Clean Stream Initiative (ACSI) grant for Rock Run

1996

- Ohio EPA awards Monday Creek with a 319 grant for Rock Run

1997

- “Monday Creek Watershed AMDAT Acid Mine Drainage Abatement and Treatment Plan I” published
- Ohio EPA awards Ohio University with a 319 to treat mine drainage at Rock Run, Brush Fork and seal a subsidence on Goose Run and at Majestic Mine site
- Monday Creek video “Silent Waters: The Story of Monday Creek” is produced

1998

- Grant from CURSML for capping Jobs 13 gob pile

1999

- First Management Plan, “A Comprehensive Plan for the Monday Creek Watershed”, published
- MCRP Office opened in New Straitsville
- OSM awarded ACSI grant for Jobs Hollow doser, Snake Hollow, and Salem Hollow
- Mitigation funds from ODOT awarded to MCRP for reclamation in Big Four Hollow
- “Monday Creek Watershed Acid Mine Drainage Abatement and Treatment Plan II” published
- OSM awarded a Cooperative Agreement for treatment at Rock Run 24

2000

- Ohio EPA awarded a 319 grant for work at Jobs Hollow (Grimmett Site) and Monkey Hollow
- MCRP receives Watershed Coordinator Grant

2001

- Wayne National Forest closed subsidences at Orbiston North, Long Hollow, and Essex Mine

2002

2003

- Jobs 13 gob pile capping is underway.
- Video about Monday Creek entitled “Cool Waters” is released

2004

- Volunteers planted nearly 7,000 Pine on Sunday Creek Coal Company land
- Jobs active alkaline doser installed
- U.S. Forest Service constructed a series of limestone leach beds and channels in Snake Hollow
- Ohio EPA awarded MCRP a 319 grant for work at Lost Run

continued on next page

Timeline of the Monday Creek Watershed Project Milestones & AMD Projects (continued)

2005

- U.S. Army Corps of Engineers Civil Works Review Board approves the Monday Creek Feasibility Study for a favorable Chief of Engineers' Report and inclusion in Water Resources Development Act of 2005 (WRDA '05)

2006

- Acid Mine Drainage Abatement and Treatment (AMDAT) Plan III approved
- Essex Doser (319 grant) is operational
- U.S. Forest Service constructed open limestone channels, closed subsidence and established positive drainage at New Straitsville North area, Monkey Hollow, and Elm Rock area
- The MCRP Watershed Management Plan was fully endorsed by the Ohio DNR and Ohio EPA
- Lost Run Phase I reclamation and OEPA 319 grant was completed

2007

- Ohio EPA awarded MCRP a 319 grant for construction of a steel slag leach bed at Shawnee
- U.S. Forest Service closed subsidences near State Route 216 and Snake Hollow
- The Water Resources Development Act of 2007 is approved, Congress authorizied $21 million for ecological restoration of Monday Creek

2008

- U.S. Forest Service completes reclamation in Valley Junk area
- ODOT mitigation funds in the amount of $200,000 secured for work at Lost Run Phase 2

2009

- ODOT mitigation funds are in place for work in Big Four Hollow and at Rock Run
- U.S. Forest Service completed reclamation work along State Route 278, New Straitsville South area, Lost Run headwaters, Brush Fork, and Coe Hollow.
- Ohio DNR completes phase II of Shawnee steel slag leach bed

2010

- U.S. Forest Service closed subsidences along Snow Fork, Rock Run, and New Straitsville South

2011

- U.S. Forest Service closed subsidences in the Cawthorn area
- Ohio DNR conducted reclamation and needed maintenance at Rock Run
- U.S. Forest Service and ODNR completed reclamation in Sand Run
- Ohio DNR completes construction to minimize sediment transport at Big Four Hollow

2012

- 3 limestone leach beds installed in Big Four Hollow.
- MCRP, Perry Co. Health Department, Village of New Straitsville and watershed residents installed a community garden in New Straitsville.
- Major AMD maintenance projects completed in Lost Run and Jobs Hollow

2013

- Five new fish species found in Monday Creek and the first annual Monday Creek Canoe Float with 54 people in 27 boats!

2014

- The Essex Doser moved to Monkey Hollow and two new species of fish found in the Carbon Hill area: Brown Bullhead and the Banded Darter.

2015

- Monkey Hollow Doser began operating August 26, 2015. This project will help improve 6.5 miles of Monday Creek.
- The Smallmouth Bass (Micropterus dolemieu) was found for the first time in Monday Creek since restoration project. Two other native species were also found, greenside darter (Etheostoma blennioides) and spotted sucker (Minytrema melanops).

Monday Creek Projects

Acid mine drainage reclamation projects completed in Monday Creek Watershed:

1999 Rock Run Gob Pile revamped 2011 (RR02100) – Gob pile reclamation

2001 *Rock Run 24 (RR00820) – Limestone channel*

2003 *Grimmett Hollow (JH09020) – Enhanced wetland with lime and limestone channels*

2004 Jobs Hollow Doser (JH00500) – Active calcium oxide doser

Big Four Hollow (BF00100) – 2 limestone beds and limestone channels

Snake Hollow (SH00100) – Close 9 subsidence features, 2 steel slag beds, enhance wetland, and limestone channels

2006 *Essex Doser (SY00706) – Active calcium oxide doser shutdown in 2008*

Lost Run Phase I (LR01020) – limestone leach beds and limestone channels

2007 Lost Run Phase II (LR00020) – Steel slag beds, limestone leach beds, and limestone channels

Lost Run Subsidence and Portal Closures – closed ten subsidence features

2008 *Shawnee Steel Slag Bed (MC00900) – Steel slag bed, limestone channels, and sand filter*

2010 Jobs Hollow Doser Maintenance II – Clean out of source pond, supply lines, and installed safety cage to hatch and ladder

Coe Hollow (CH00100) – Limestone leach ponds, passive wetlands,, steel slag leach bed, and 2 subsidence features closed

2012 Lost Run II Maintenance – New steel slag installed, additional piping in the underdrain, and improve water delivery to SSLB.

Big Four Hollow LLB (BF00400) – 3 limestone leach beds

2015 Monkey Hollow Doser (MH00100) – Active calcium oxide doser

Italicized indicated projects are not actively monitored for acid mine drainage and metal load reduction purposes

2015 NPS Report - Monday Creek Watershed

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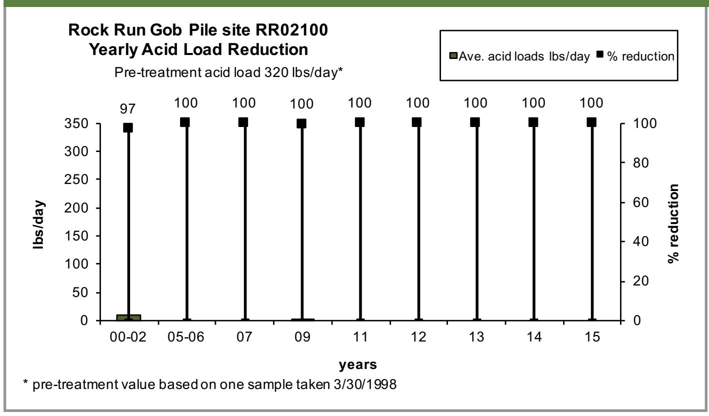
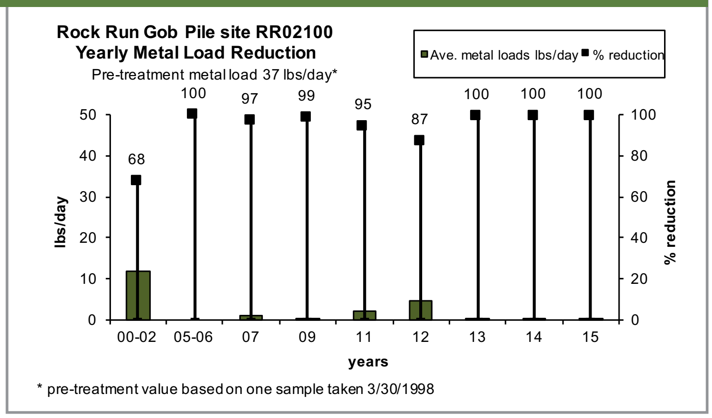
Yearly acid and metal load reduction trends per project

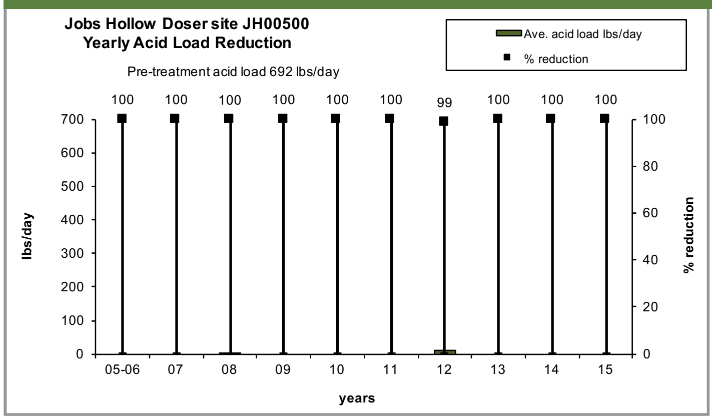
Similar to other environmental best management practices (BMPs), performance of passive acid mine drainage reclamation projects are also expected to decline with time. Active treatment systems are not expected to decline with time but sometimes need to be maintained to perform adequately. Currently, operation and maintenance plans are being designed for each existing system and are planned for future projects. The graphs below show the mean annual acid and metal load reduction using the Stoertz Water Quality Evaluation Method (Kruse et al., 2014) for each year (or group of years) during post-reclamation from the project effluent. From these graphs the rate of decline (and/or improvement) with time of the treatment system is implied. Knowing the rate of decline will aid in the implementation of operation and maintenance plans.

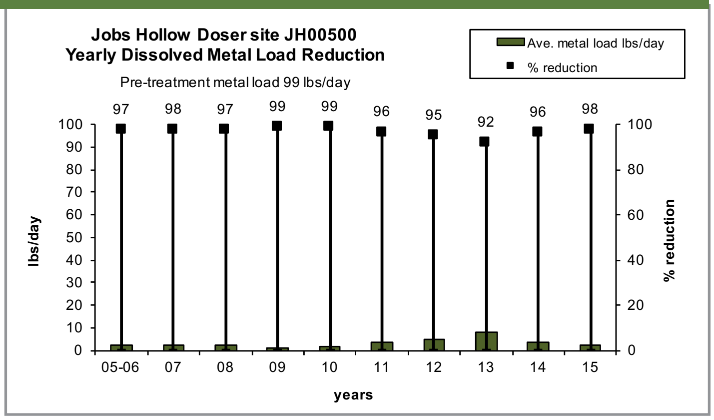
Rock Run Gob Pile site RR02100



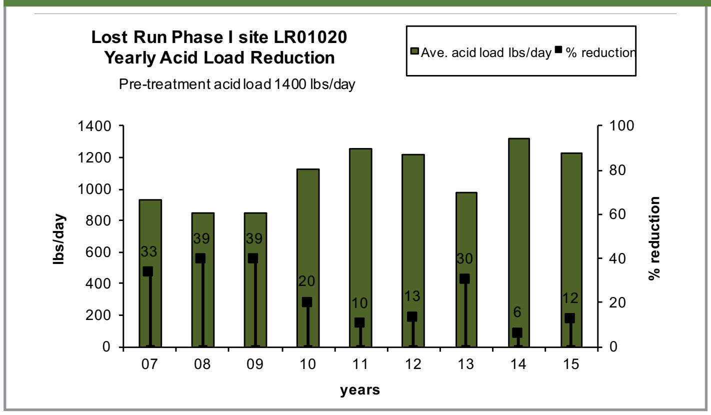


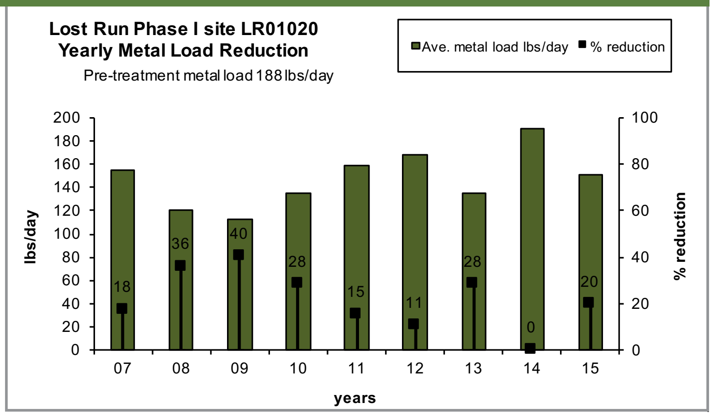
Jobs Hollow Doser site JH00500





Lost Run Phase I site LR01020





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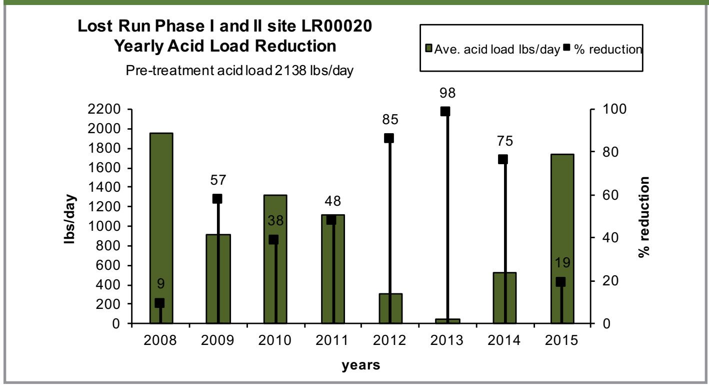
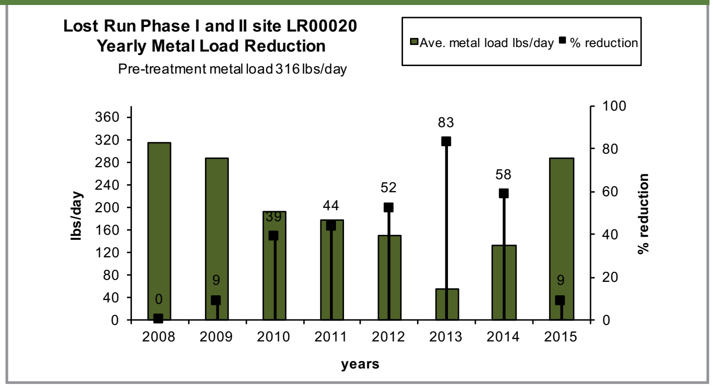
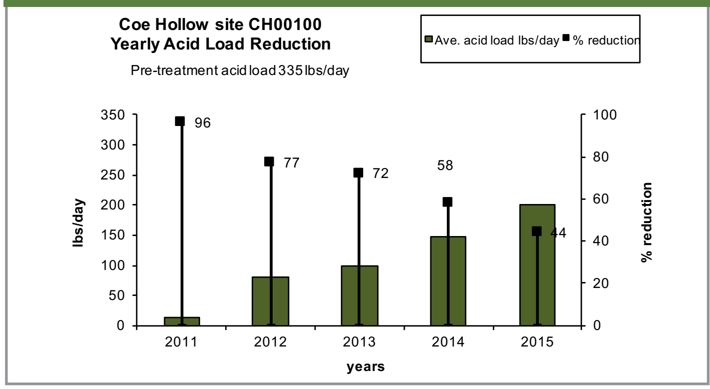
Yearly acid and metal load reduction trends per project

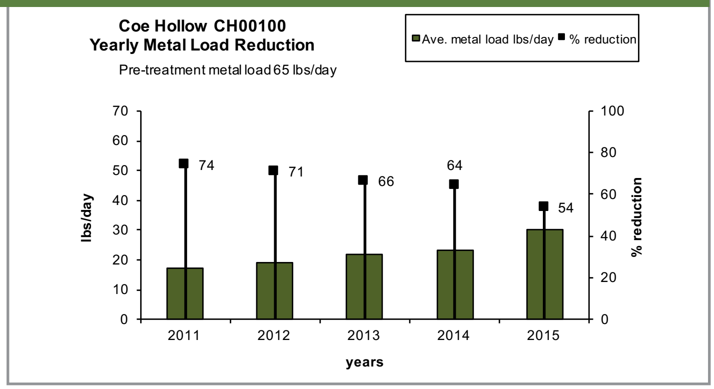
Lost Run Phase I and II site LR00020



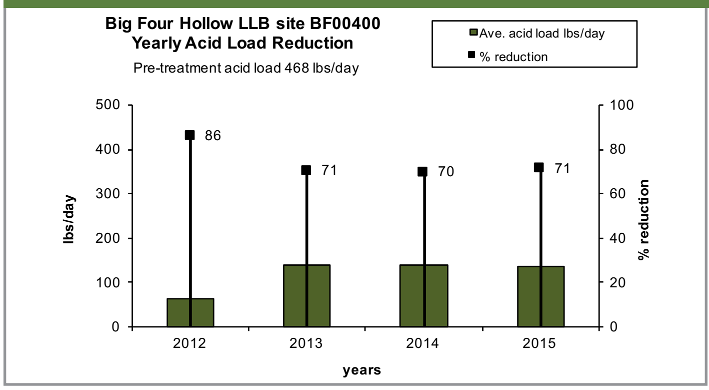


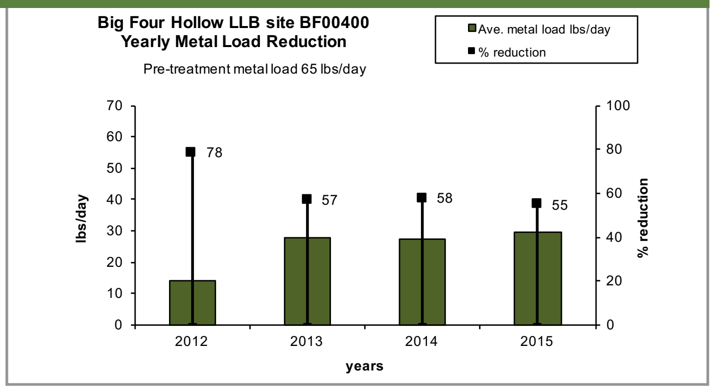
Coe Hollow site CH00100



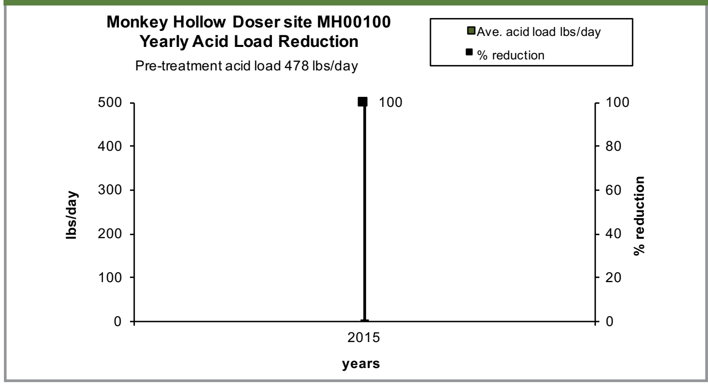


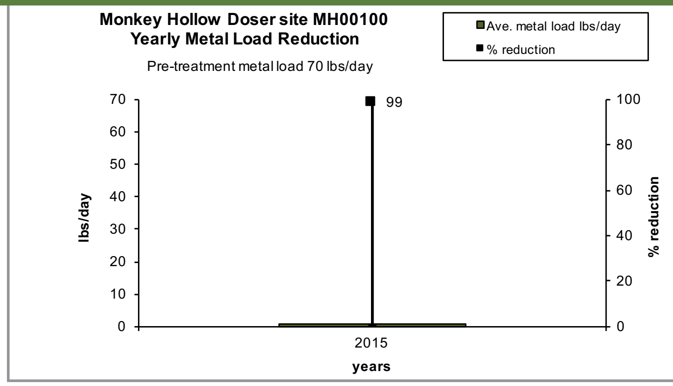
Big Four Hollow LLB site BF00400





Monkey Hollow doser site MH0010





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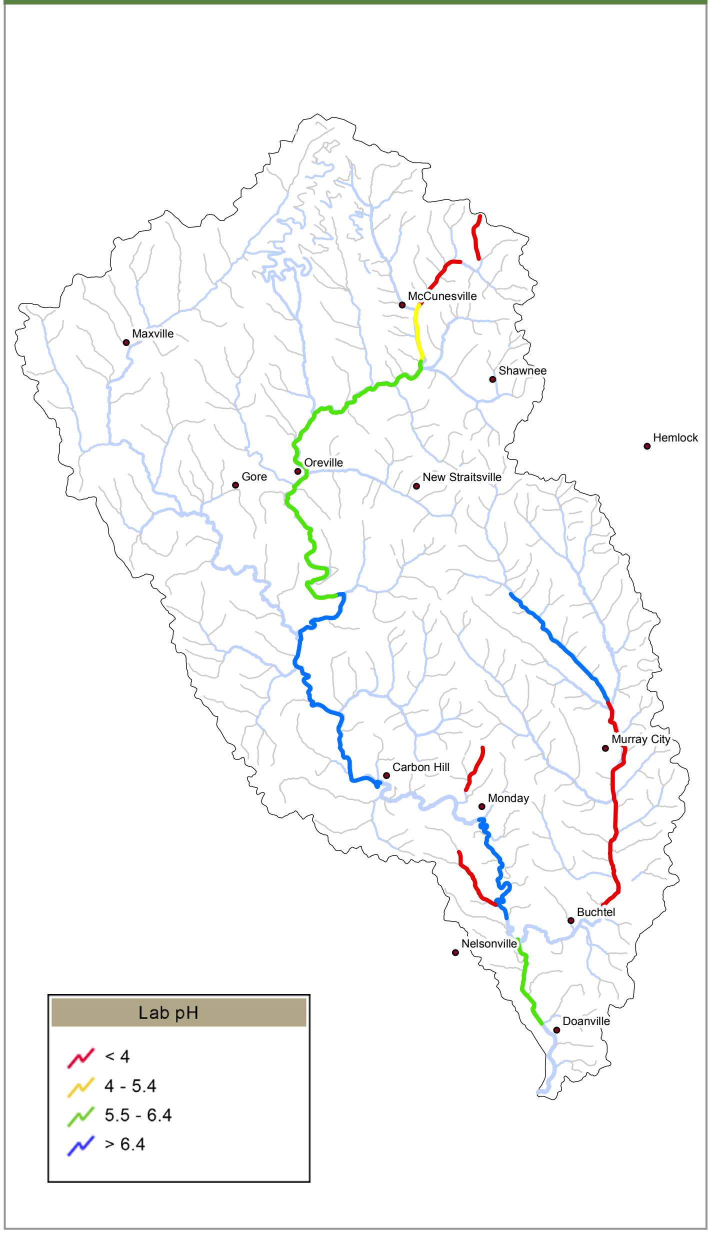
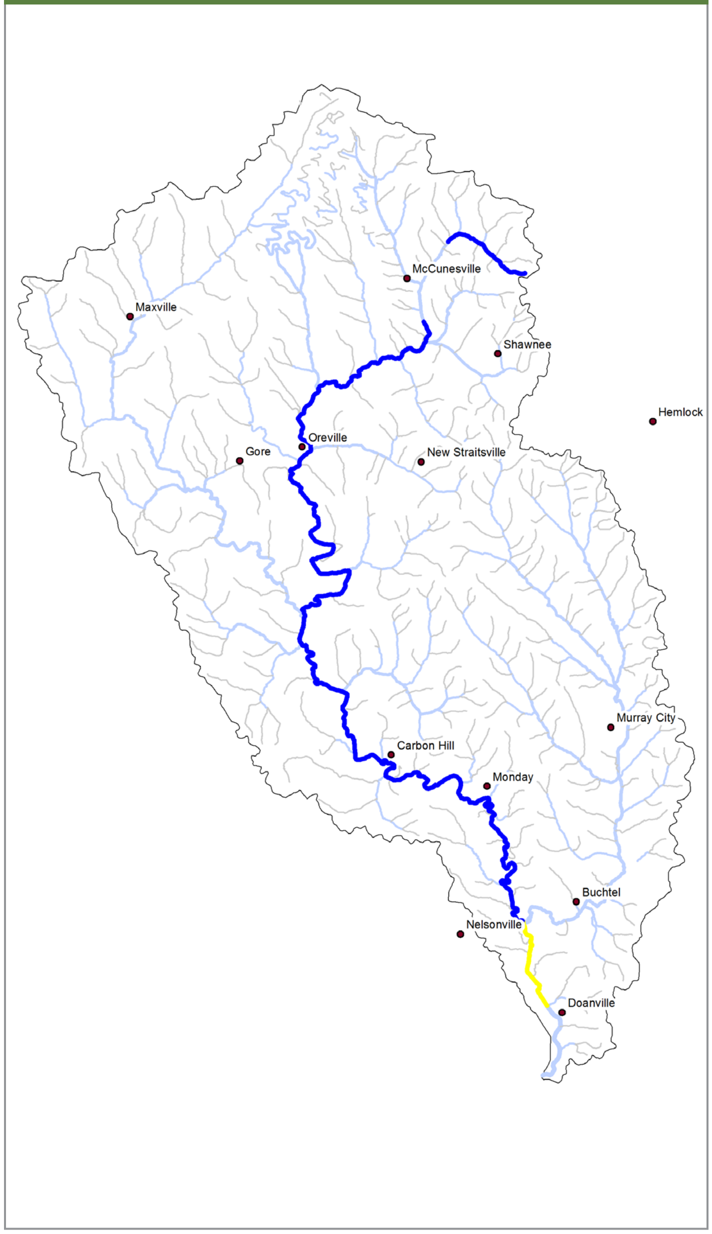
Chemical Water Quality

Monday Creek baseline pH



Monday Creek 2015 pH

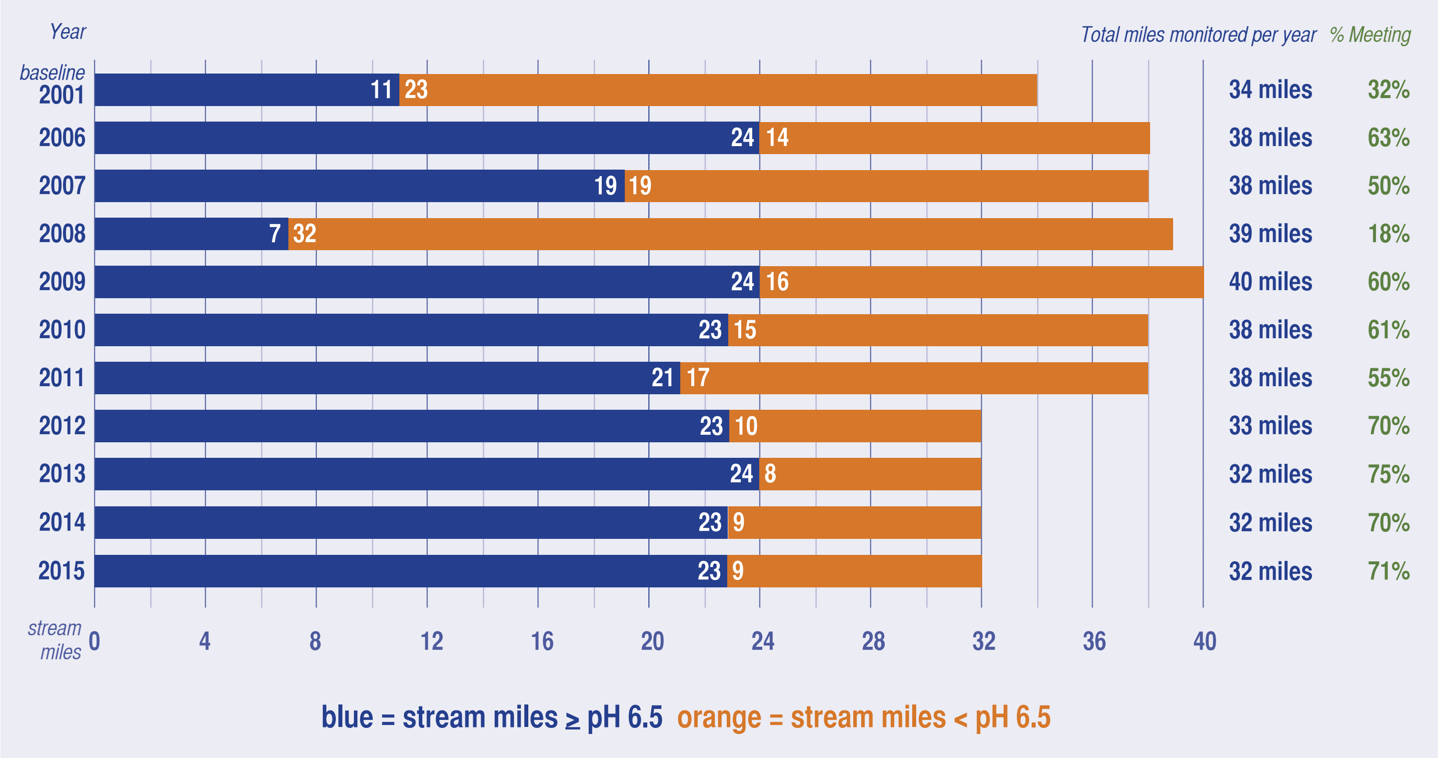


In Monday Creek pH values have improved throughout the watershed from baseline conditions (2001) to 2015. In 2015, stream miles meeting pH target of 6.5 is approximately 23 miles of the 32 miles monitored (72%).

Chemical Water Quality

There are approximately 32 stream miles monitored each year along the mainstem of Monday Creek, 38 miles when major tributary Snow Fork is included. The restoration target for pH is 6.5. In 2007, 19 stream miles of the 38 monitored met the pH target of 6.5. However in 2008 only 7 miles of the 39 miles monitored met this target. In 2009 and 2010 data shows an increase again with approximately 24 of the 39 miles monitored meeting the pH target. In 2011, the site near Lost Run MC00500 dropped below the pH target with an average pH value of 6.24. From 2012 -2015, stream miles meeting the pH target have remained constant. The mainstem of Snow Fork, downstream of Essex Doser has been discontinued for monitoring. Site SF00940 represents the five miles missing from the total miles monitored in past years 38 down to 33 (Figure 1). Snow Fork (SF00100) fails to meet the pH target of 6.5 and treatment in this basin is unlikely.

Figure 1. Monday Creek pH



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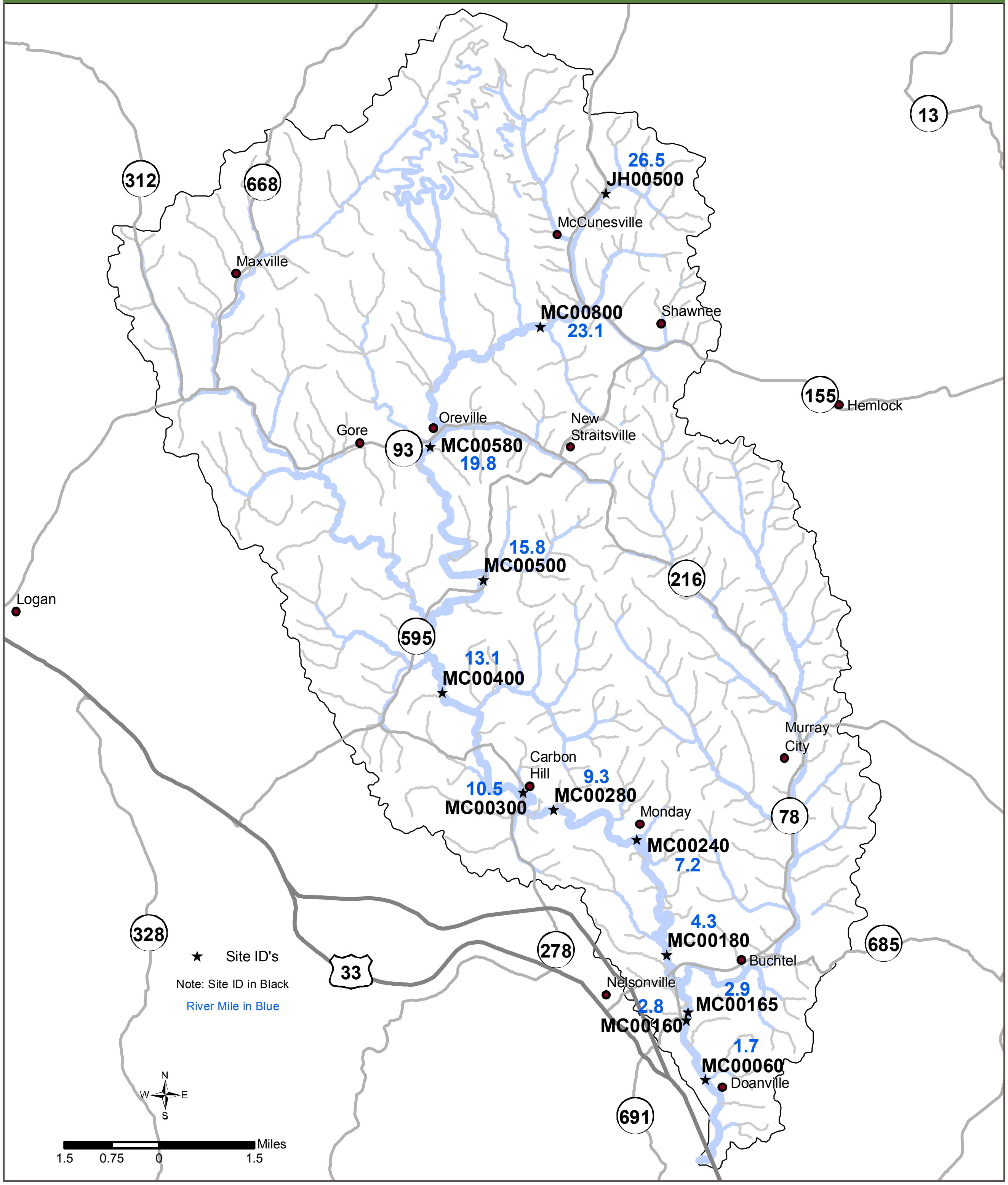
Chemical Water Quality

Monday Creek

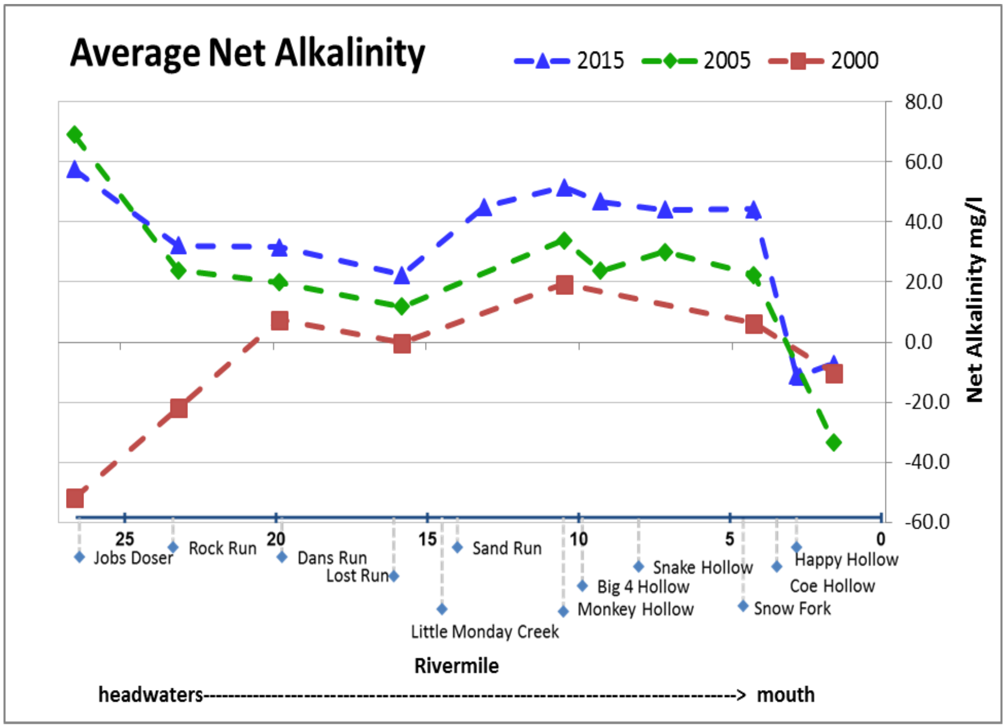


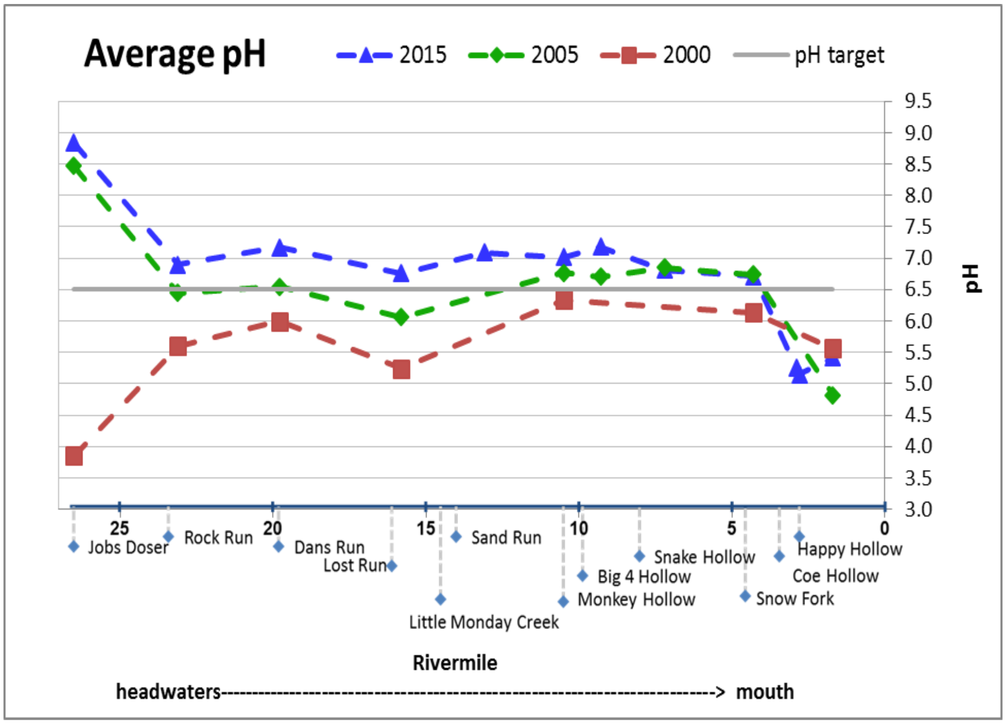
Chemical water quality analysis per stream reach

Chemical water quality changes along the mainstem of Monday Creek are shown in the stream reach graphs below. Chemical long-term monitoring data is utilized to generate line graphs along the stream gradient from headwaters to the mouth. Along the x-axis named tributaries are shown to illustrate sources of water entering the mainstem. A list of long-term monitoring sites utilized to generate the graphs with their river miles are shown below.

Monday Creek Mainstem

Site ID	JH00500	MC00800	MC00580	MC00500	MC00400	MC00300	MC00280	MC00240	MC00180	MC00165	MC00160	MC00060
Rivermile	26.5	23.1	19.8	15.8	13.1	10.5	9.3	7.2	4.3	2.9	2.8	1.7





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Chemical water quality analysis per stream reach

Monday Creek Mainstem

Site ID	JH00500	MC00800	MC00580	MC00500	MC00400	MC00300	MC00280	MC00240	MC00180	MC00165	MC00160	MC00060
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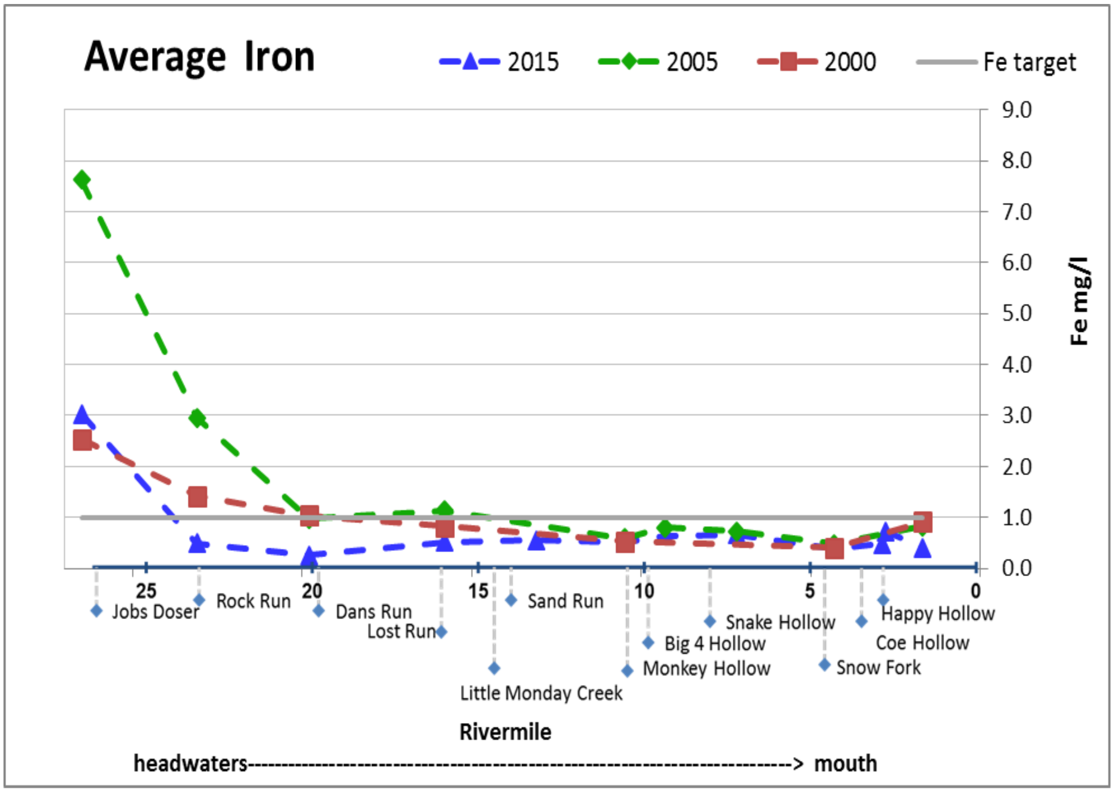
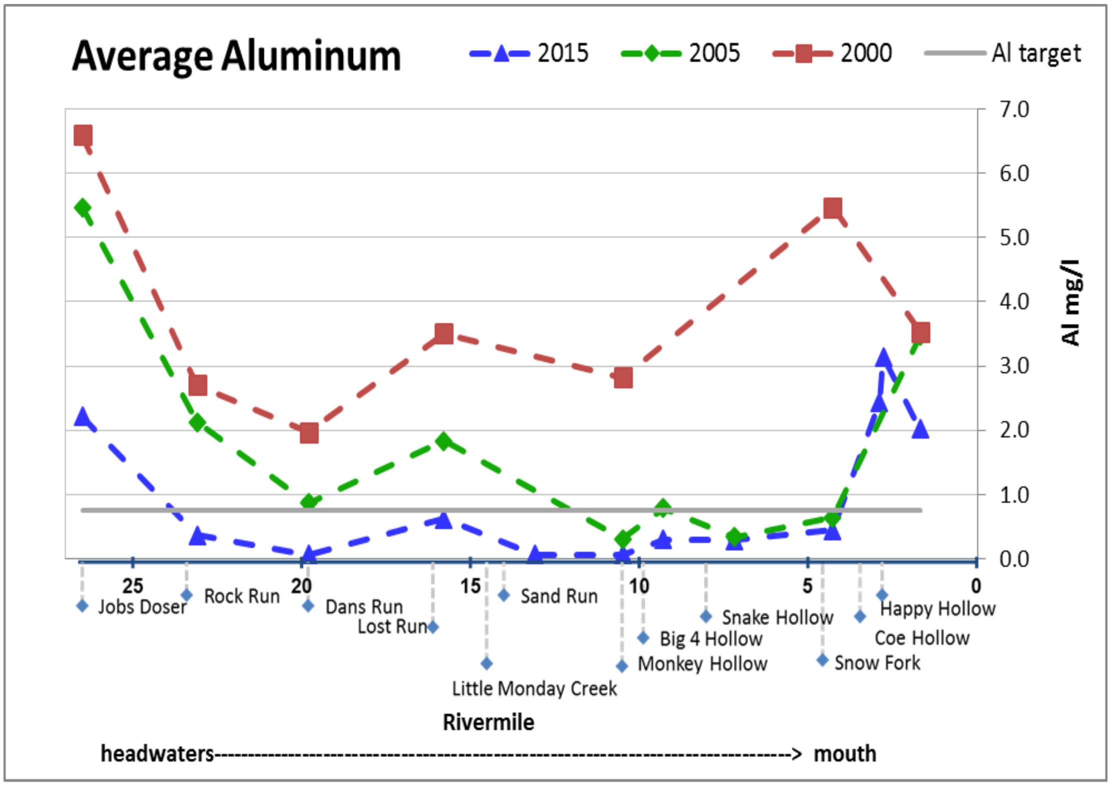
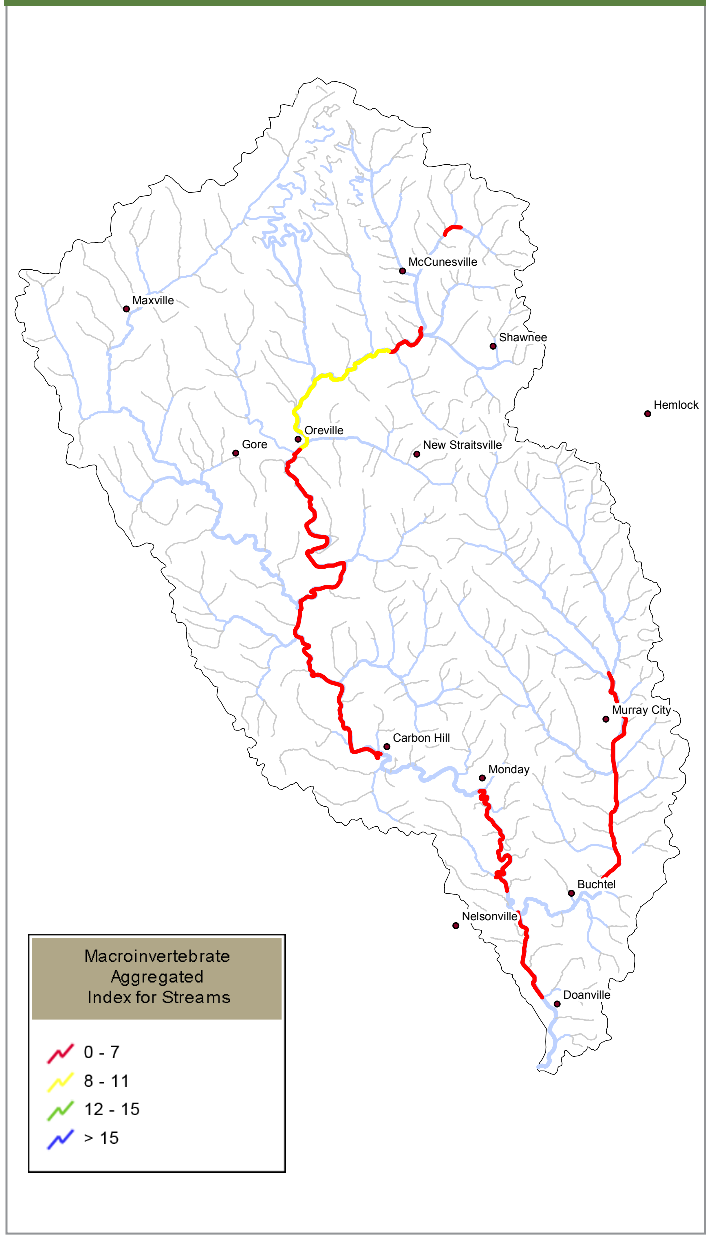


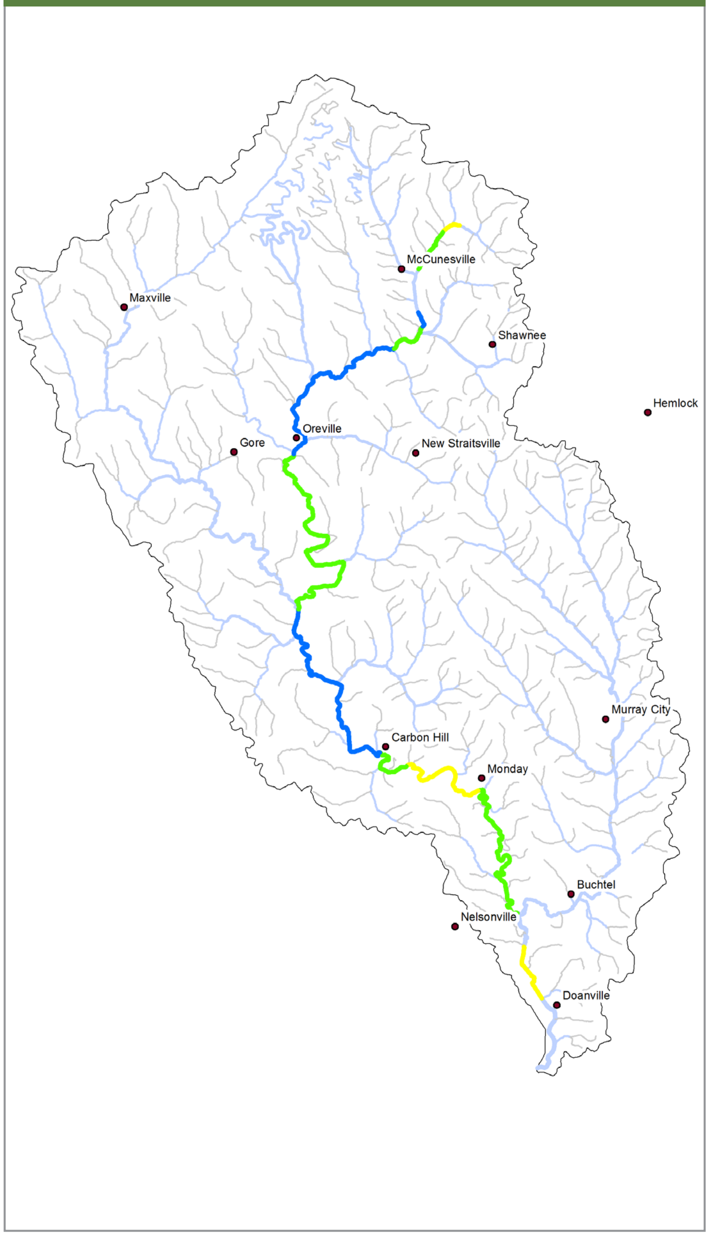


Biological Water Quality

Monday Creek baseline MAIS



Monday Creek 2015 MAIS

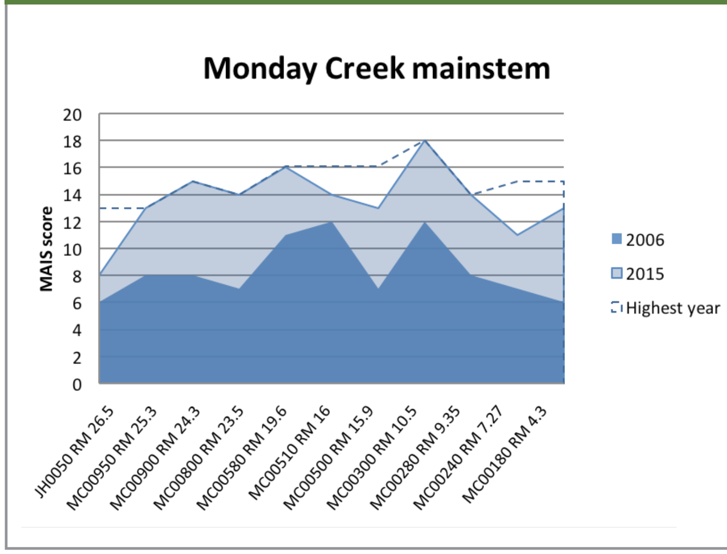


MAIS samples were collected throughout Monday Creek at established annual monitoring stations from 2001 through 2015.

Biological Water Quality

Long-term monitoring of biological quality along the Monday Creek mainstem has shown steady improvements in biological quality over the last ten years and this year saw continued improvement across all sites. In 2014 two sites that had previously been showing improvement declined. After two years of exceeding MAIS score targets and appearing to be well into recovery, RM 15.9, downstream of Lost Run, declined to “9” and RM 9.35, at Carbon Hill downstream of Monkey Hollow dropped from “15” in 2013 to “11” and disrupted what had been a statistically significant trend in biological recovery. In 2015, the biological scores at these two sites were back up to “13” and “14” respectively, indicating that the 2014 low scores were unusual. This year the statistical trend of recovery at both sites was re-established, as was the recovery trend for the final two other long term sites previously categorized as ‘unchanged’. All long term sites are now categorized as ‘improved’ and only two sites this year did not exceed the MAIS target of “12” for biological quality, JH0500 at the site of the doser and MC0240 at Snake Hollow. In addition, there was overall continued improvement as indicated by sustained or new high scores at six of the eleven long term sites: MC0950, MC0900, MC0800, MC0580, MC0510, and MC0300 at Carbon Hill. The latter site earned an outstanding “18” in biological quality, which is unusual for our study watersheds in southeast Ohio.

Figure 2. Area of Degradation

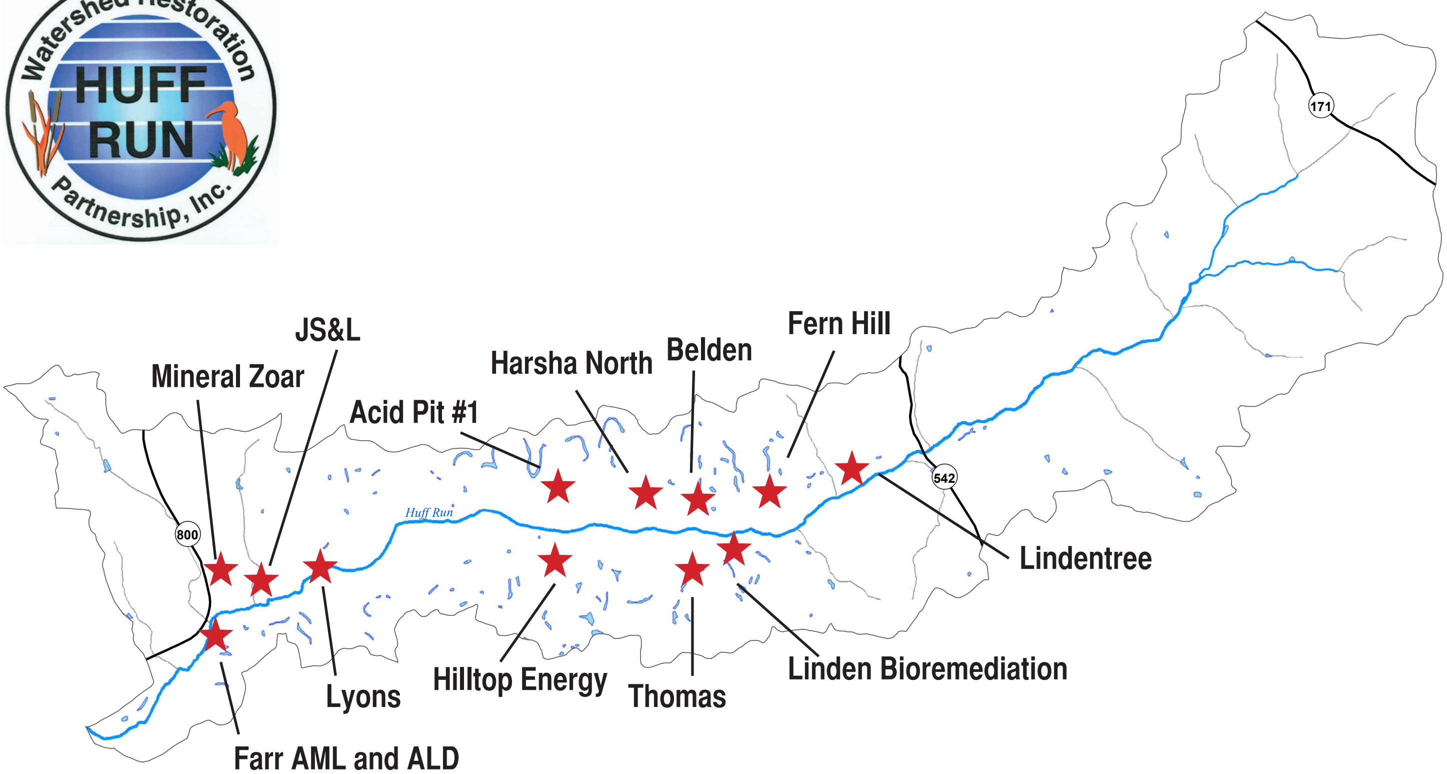


The blue dashed line identifies the highest MAIS score ever a chieved at that site throughout the monitoring time period.

Figure 3. Monday Creek MAIS Regressions

Site ID Rivermile	2001	2002	2003	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Linear trend	R square	P-value	No. of years
JH09020 RM 27.4				8	6	6	4	4	4	4					declined			7
JH00500 RM 26.5	4	6	4	7	6	5	4	7	8	9	11	10	13	8	**improved**	0.60205	0.00833	14
MC00950 RM 25.3				7	8	7	4	9	6	10	10	10	12	13	**improved**	0.62005	0.00684	11
MC00900 RM 24.3				6	8	12	12	11	11	12	12	14	12	15	**improved**	0.58144	0.01032	11
MC00800 RM 23.5	5	3	1	11	7	9	12	7	13	11	13	12	14	14	**improved**	0.61921	0.00691	14
MC00580 RM 19.6	8	9	10	13	11	12	12	13	16	14	16	15	14	16	**improved**	0.64342	0.00524	14
MC00510 RM 16	2	6	6		12	11	10	10	10		14	14	14	14	**improved**	0.55877	0.0129	12
MC00500 RM 15.9					7	8		5			15	16	9	13	**improved**	0.47498	0.02748	7
MC00300 RM 10.5	5	10	13	13	12	14		12	16	16	15	16	16	18	**improved**	0.68552	0.00189	13
MC00280 RM 9.4					8	9	10	9	14	12	10	15	11	14	**improved**	0.49954	0.02229	10
MC00240 RM 7.3				8	7	7	8	10	14	10	8	11	13	11	**improved**	0.39462	0.05177	11
MC00180 RM 4.3	2	6	2	8	6	9	7	4	13	9	9	15	11	13	**improved**	0.46662	0.02946	14

HUFF RUN
WATERSHED REPORT



Reductions

Total acid load reduction 2015 = 1,095 lbs/day

Total metal load reduction 2015 = 25 lbs/day

excluding Mineral Zoar and Farr

Costs

Design $724,181
(excluding Linden Bioremediation and Lyons II)

Construction $4,584,172

Total cost through 2015 = $5,308,353

Timeline of the Huff Run Watershed Project Milestones & AMD Projects

1985
- Study funded by ODNR conducted by Benatec Associates to identify acid problems in Huff Run Watershed

1988
- First abandoned mine land project, Jobes, completed in the watershed

1996
- Huff Run Watershed Restoration Partnership founded

2000
- Huff Run AMDAT completed
- Huff Run Watershed Coordinator funded for six years
- First acid mine drainage restoration project, Farr, completed in watershed

2001
- First draft of Huff Run Watershed Plan completed

2002
- Linden Bioremediation Project constructed

2003
- Acid Pit Restoration Project completed

2004
- Lindentree Restoration Project completed

2005
- Rural Action and Huff Run awarded US EPA Targeted Watershed Grant
- Rural Action adds VISTA volunteer to Huff Run staff
- Second draft of Huff Run Watershed Plan authored, endorsed by the State of Ohio
- Lyons Restoration Project constructed

2006
- Harsha North Restoration project completed

2007

2008
- Belden Restoration Project constructed
- Fern Hill (HR-42) Phase II Project constructed

2009
- Huff Run Watershed Coordinator funded for three years
- Mineral Zoar Project completed
- Rural Action adds AmeriCorps member to Huff Run staff

2010
- Thomas Project, Fern Hill Pond A & Belden Gob pile constructed

2011
- Lyons II constructed

2012
- Hilltop Restoration Project started

2013
- Completed Hilltop Restoration Project
- MWCD Partners in Watershed Management Grant awarded for environmental education and community outreach

2014
- Project development for JS&L AMD Reclamation Project and the Farr Phase II

2015
- Constructed JS&L AMD Restoration Project, funded by ODNR-DMRM and OEPA
- Received $1.7M ODOT Mitigation

Huff Run Projects

Acid mine drainage reclamation projects completed in Huff Run Watershed:

2003 *Farr Project* (FAR01/02) – Surface reclamation, limestone channels, anoxic limestone drains, and passive wetland*
Linden Bioremediation Project (LIN08) – Pyrolusite limestone bioremediation bed

2004 Acid Pit #1 Project (ACP01) – Drain impoundments and surface reclamation

2005 Lyons Project (LYN01) – Steel slag bed, limestone channels, drain impoundments, and surface reclamation

Lindentree Project (LNT01) – Steel slag bed, limestone channels, and fill acid pits

2006 Harsha North Project (HAN05) – Surface reclamation, limestone trenches, and reclaimed gob pile

2008 Fern Hill HR-42 Pits A, B, & C (FRN01) – Surface reclamation, limestone Channels and reclaim 3 acidic pits

Belden and Belden Gob Pile Project (BLD01) – Surface reclamation, steel slag beds, reclaim gob pile, and passive settling ponds

2009 *Mineral Zoar (MZR08) – Reverse alkaline producing systems (RAPS)*

2010 Thomas Project (LIN01/THM06) – Surface reclamation and passive settling ponds

2011 Lyons II maintenance Project (LYN01) – Additional steel slag installed, pipe clean-outs, and added limestone berms to settling pond

2013 Hilltop Energy Project (HRT21/HR37) – Reclaimed gob pile, surface reclamation, limestone channels, and settling pond

2015 JS&L AMD Reclamation (HR25) – Limestone channels, limestone leach bed and precipitation basin.

Italicized indicates projects are not actively monitored for acid and metal load reduction purposes

**Indicates no yearly trend graphs due to lack of pre or post data*

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Yearly acid and metal load reduction trends per project

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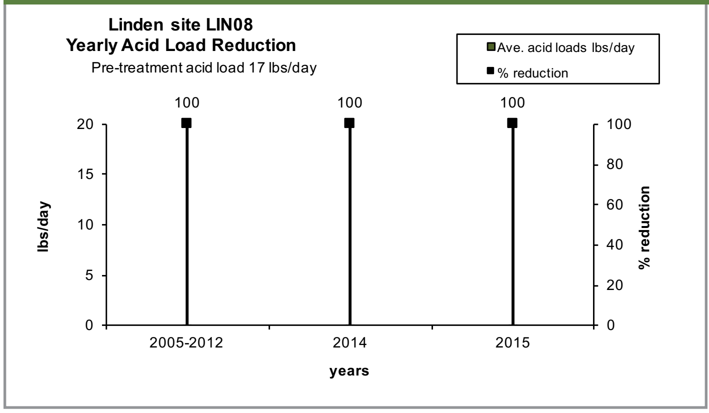
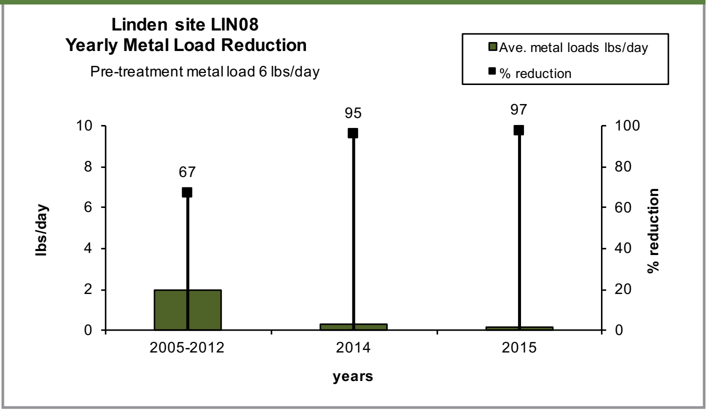
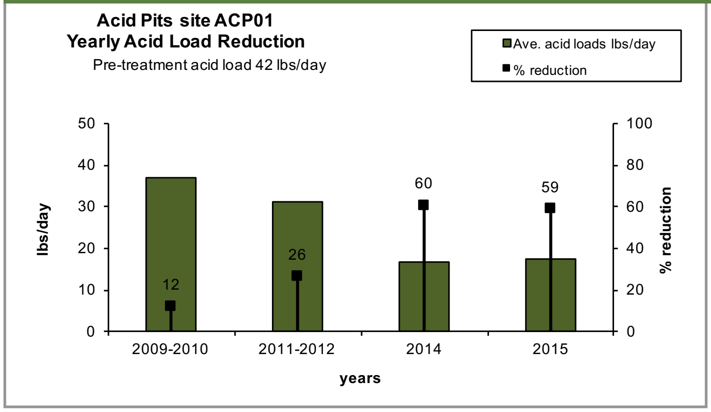
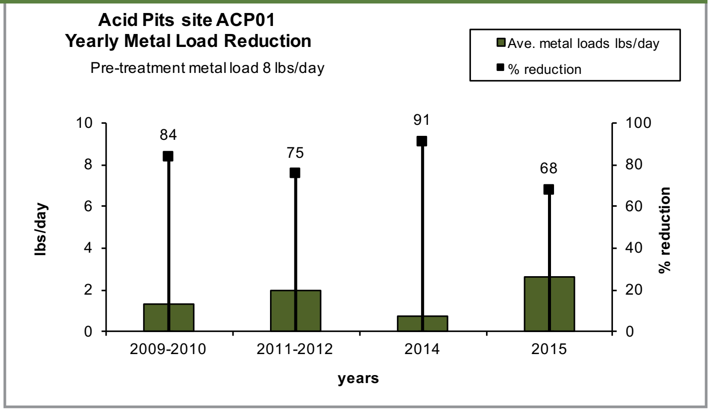
Linden site LIN08



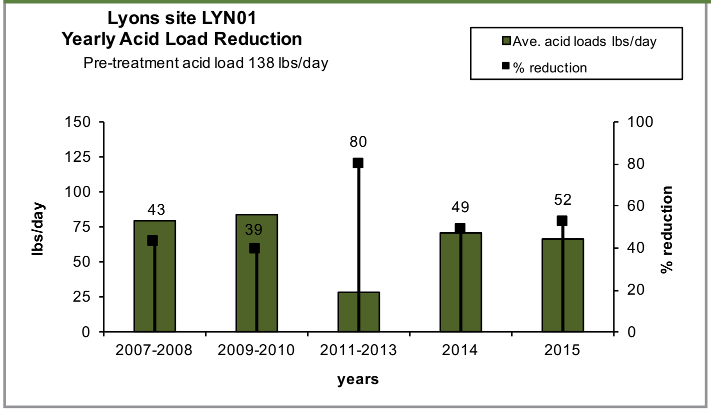


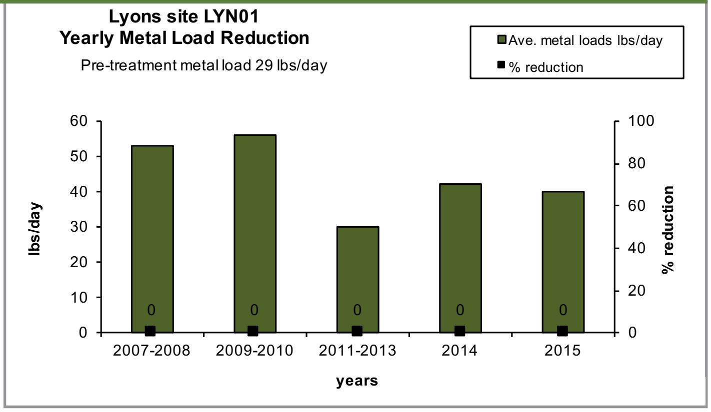
Acid Pits site ACP01





Lyons site LYN01





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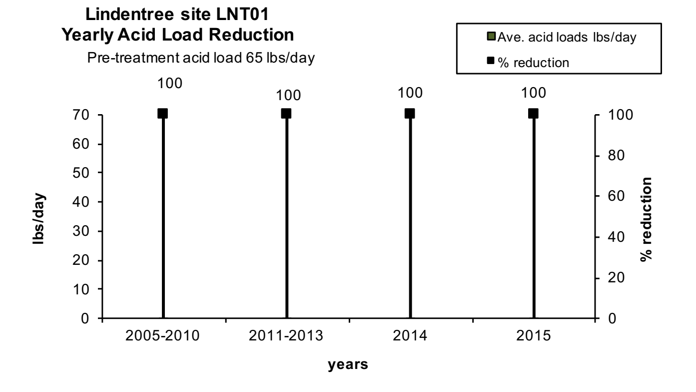
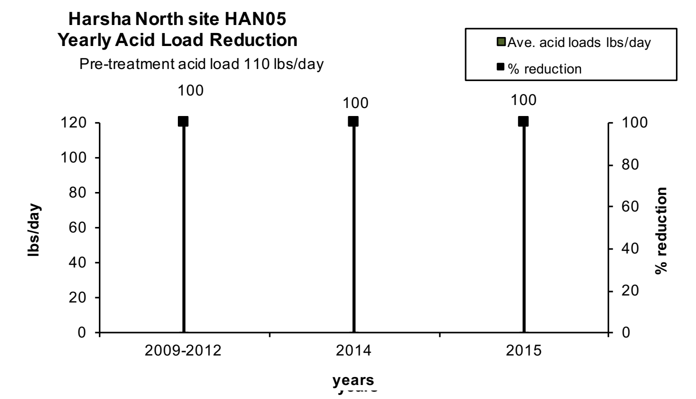
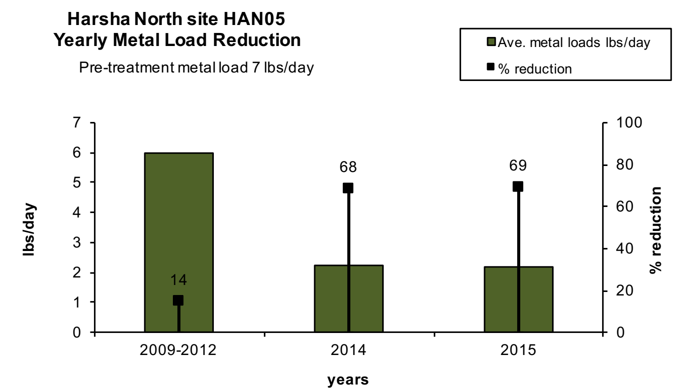
Yearly acid and metal load reduction trends per project

Lindentree site LNT01

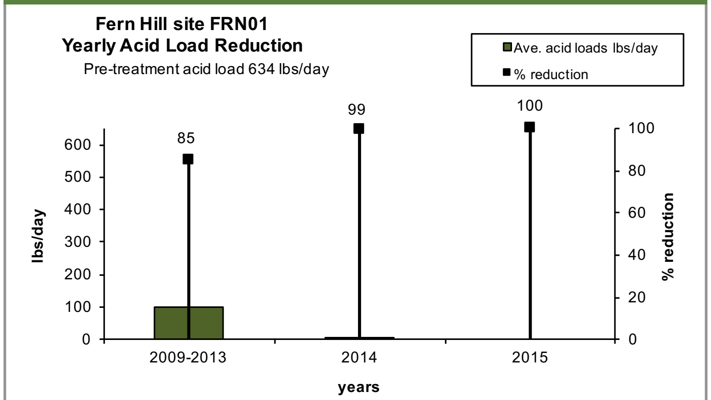


Harsha North site HAN05



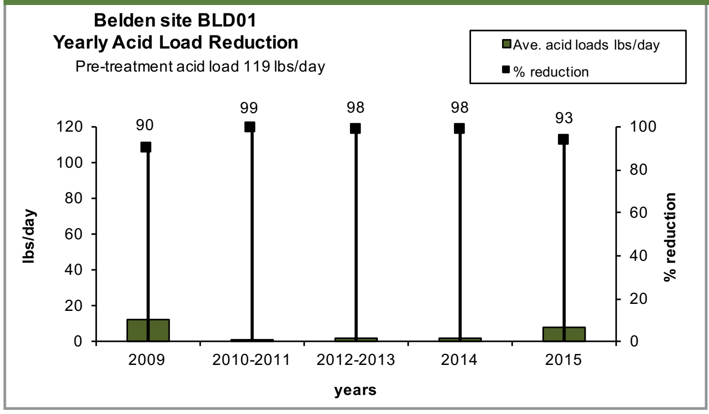


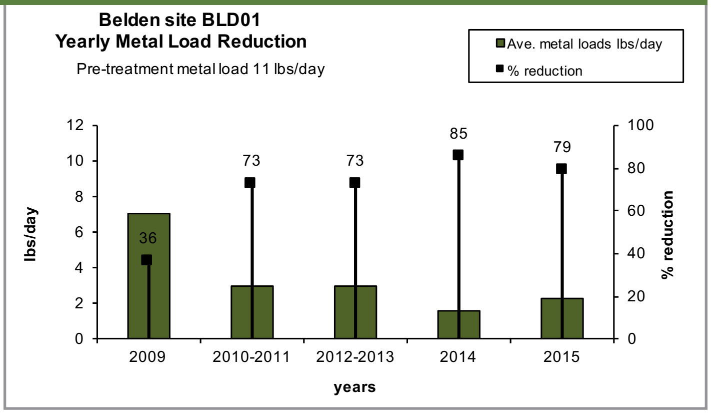
Fern Hill site FRN01



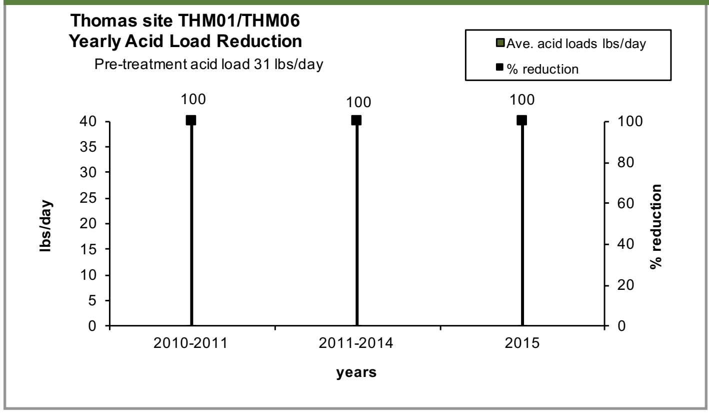
Yearly acid and metal load reduction trends per project

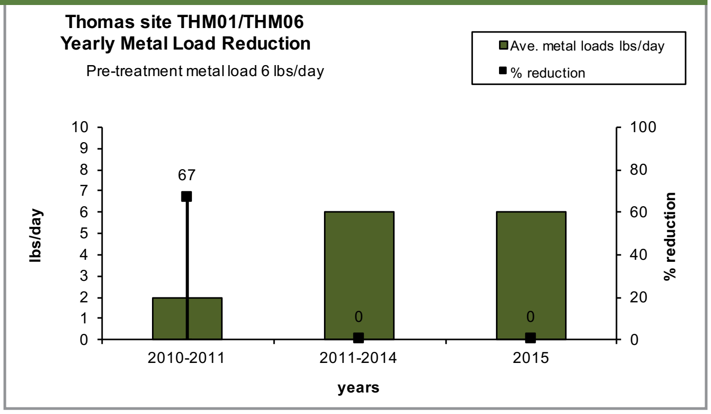
Belden site BLD01



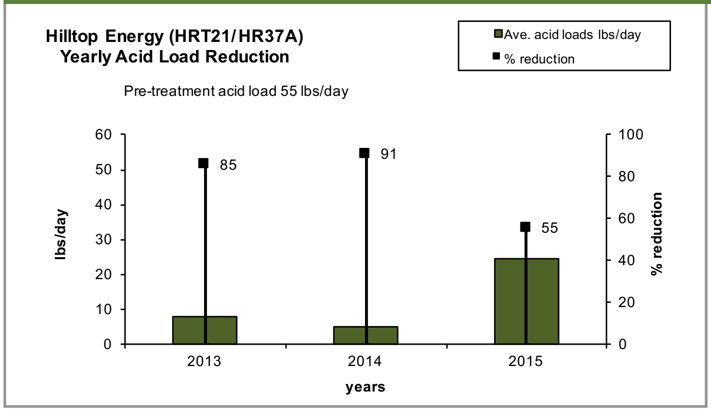


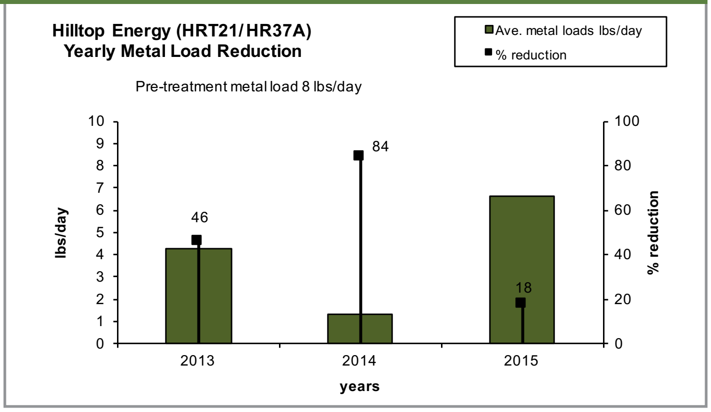
Thomas site THM01/THM06





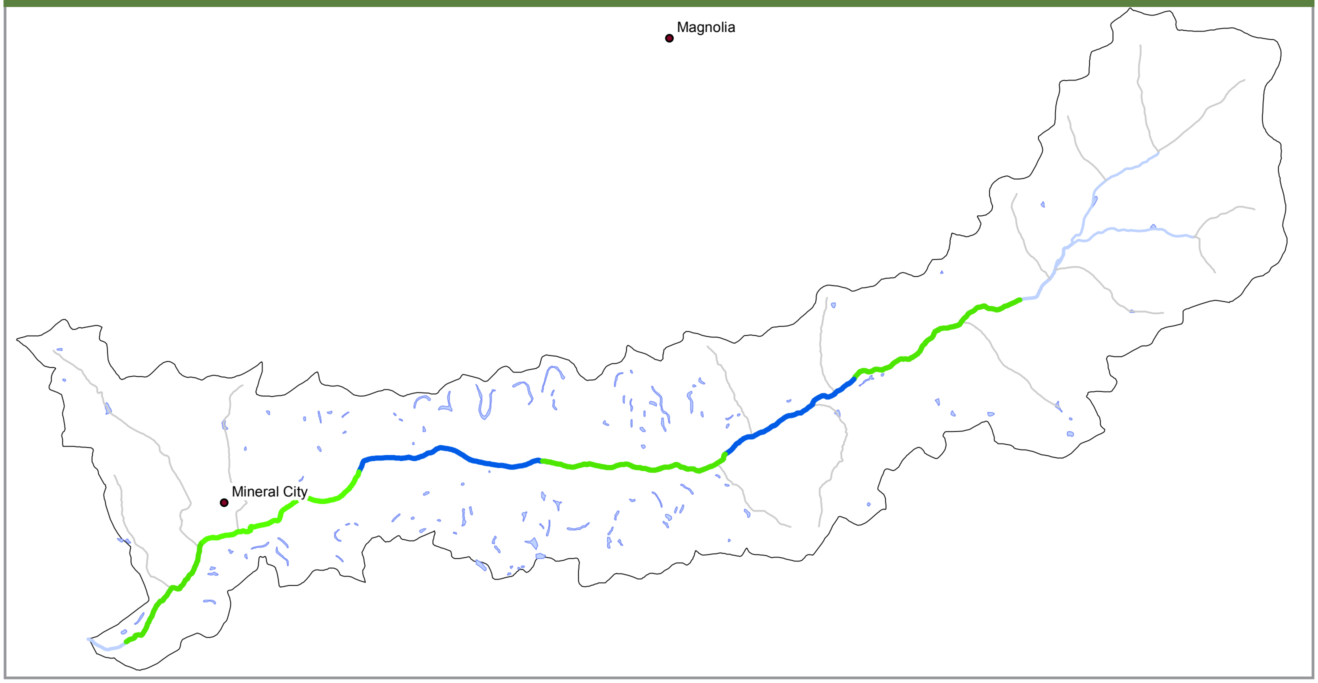
Hilltop Energy (HRT21/HR37A)



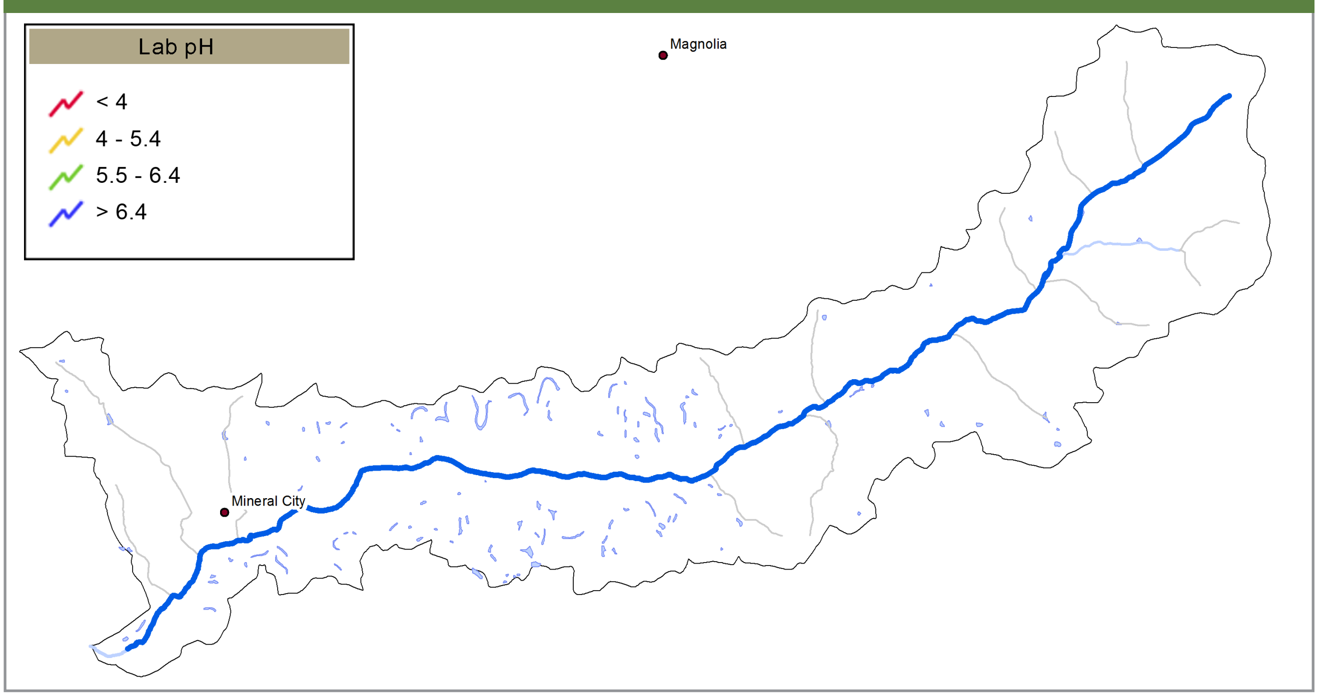


Chemical Water Quality

Huff Run baseline pH



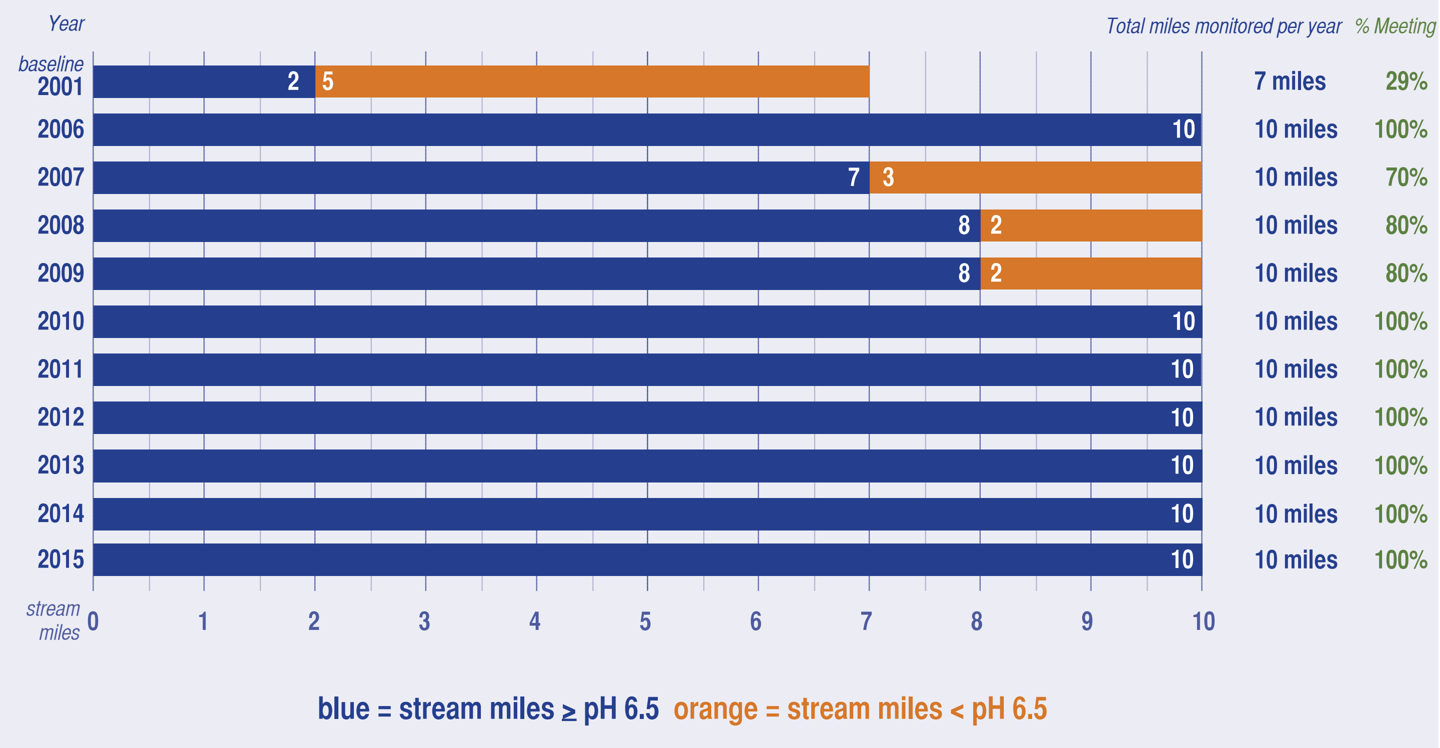
Huff Run 2015 pH



Huff Run pH values have improved from baseline conditions (1985-1998) to 2015. The entire length of Huff Run has met the pH target (6.5) for the last six years.

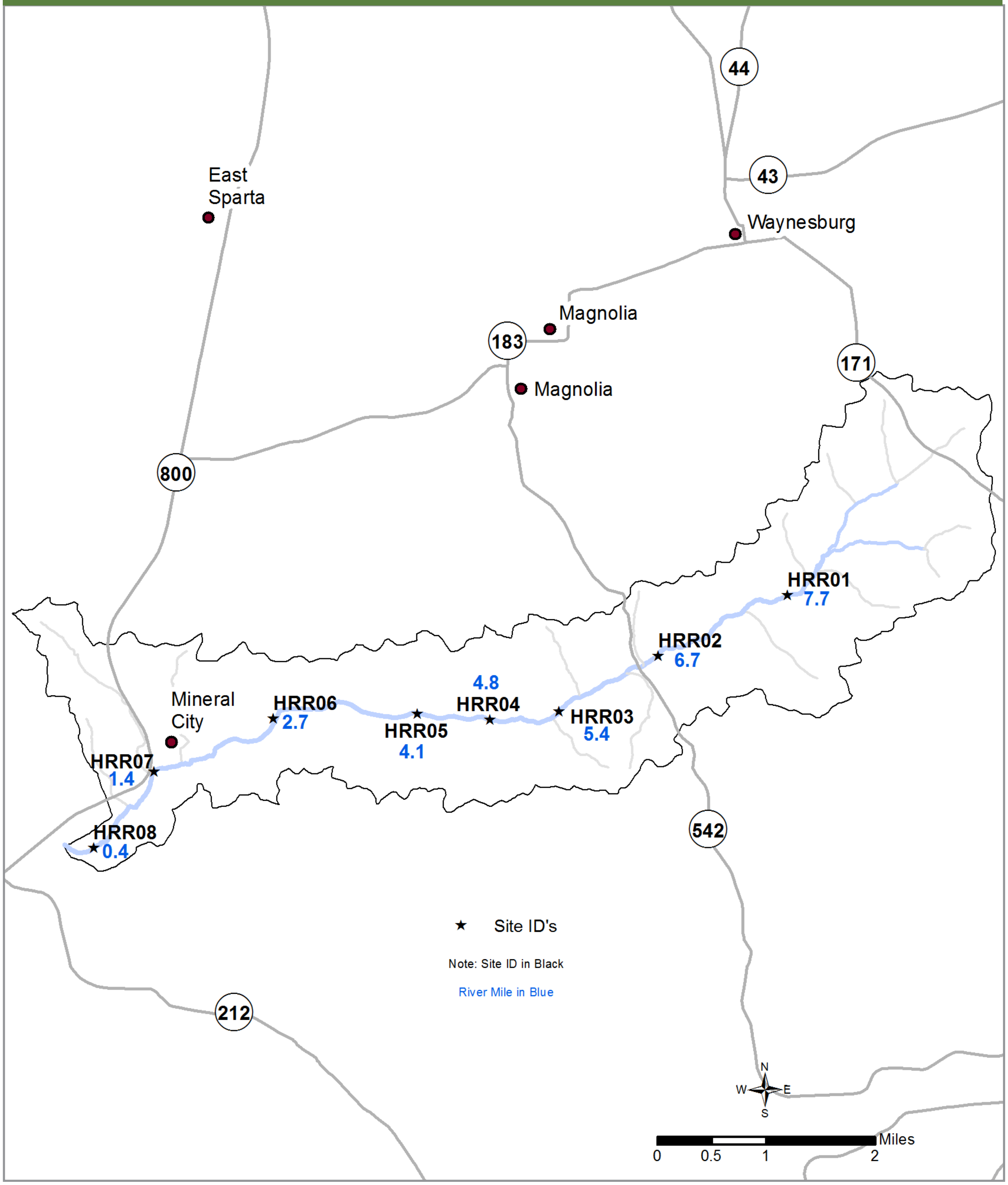
The mainstem of Huff Run is approximately 10 miles in length with monitoring occurring year round. In 2009, 8 miles met the pH target of 6.5 while the two downstream stream reaches (HRR08 and HRR07) fell slightly below the target with an average pH of 6.4. From 2010 to 2015, all 10 miles met the pH target.

Huff Run pH



Chemical water quality analysis per stream reach

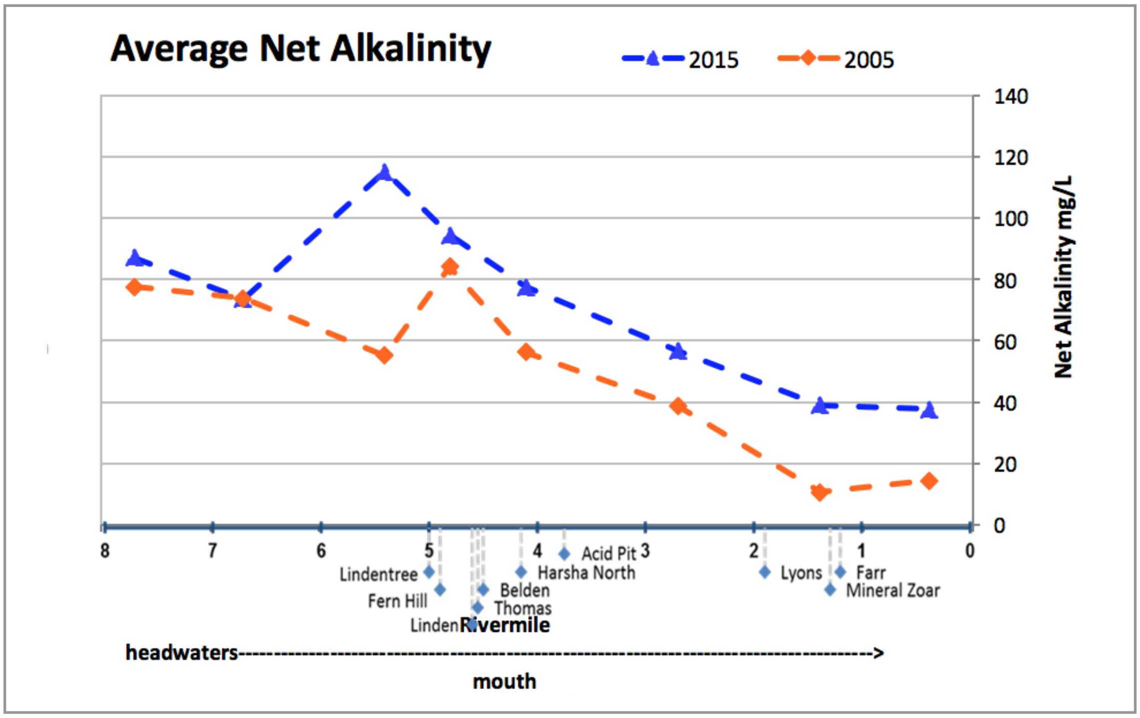
Huff Run

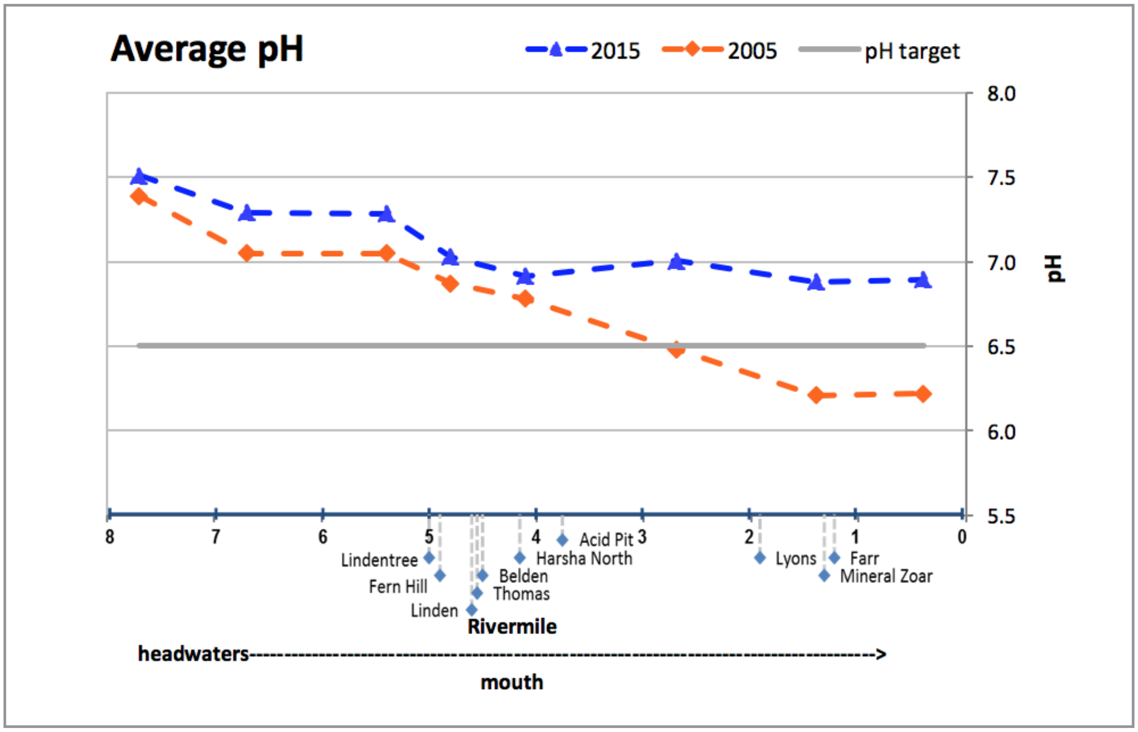


Chemical water quality analysis per stream reach

Chemical water quality changes along the mainstem of Huff Run are shown in the stream reach graphs below. Chemical long-term monitoring data is utilized to generate line graphs along the stream gradient from headwaters to the mouth. Along the x-axis named tributaries are shown to illustrate sources of water entering the mainstem. A list of long-term monitoring sites utilized to generate the graphs with their river miles are shown below.

Huff Run								
Site ID	HRR01	HRR02	HRR03	HRR04	HRR05	HRR06	HRR07	HRR08
Rivermile	7.7	6.7	5.4	4.8	4.1	2.7	1.4	0.4





Chemical water quality analysis per stream reach

Huff Run								
Site ID	HRR01	HRR02	HRR03	HRR04	HRR05	HRR06	HRR07	HRR08
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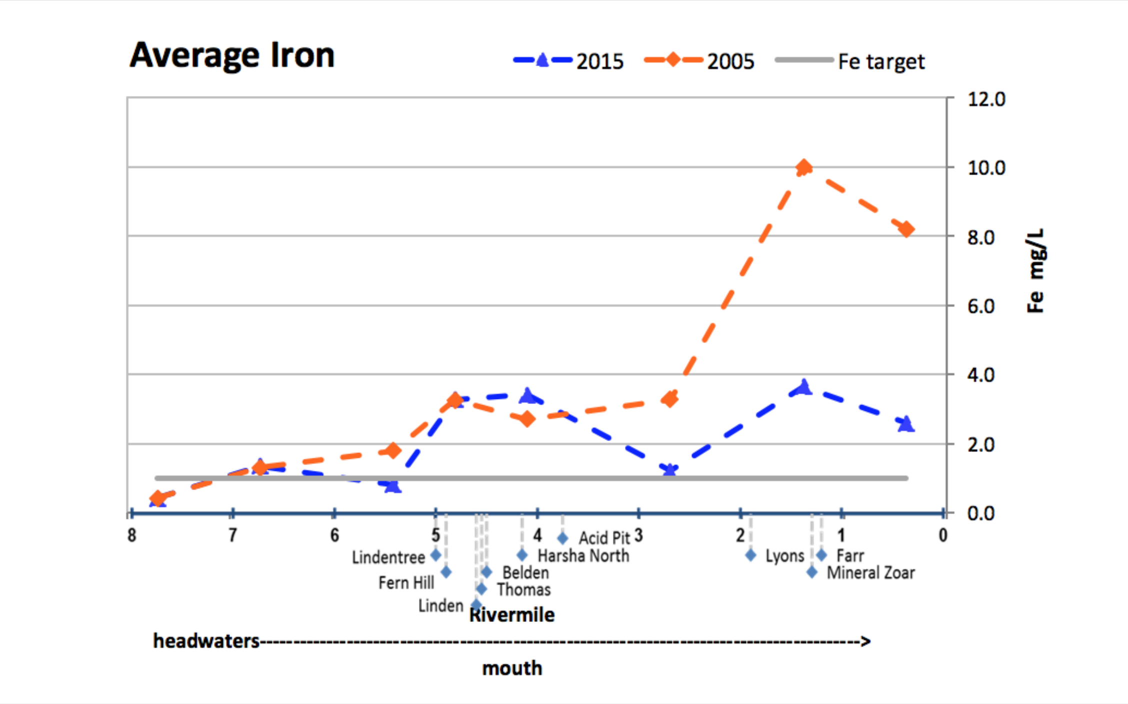
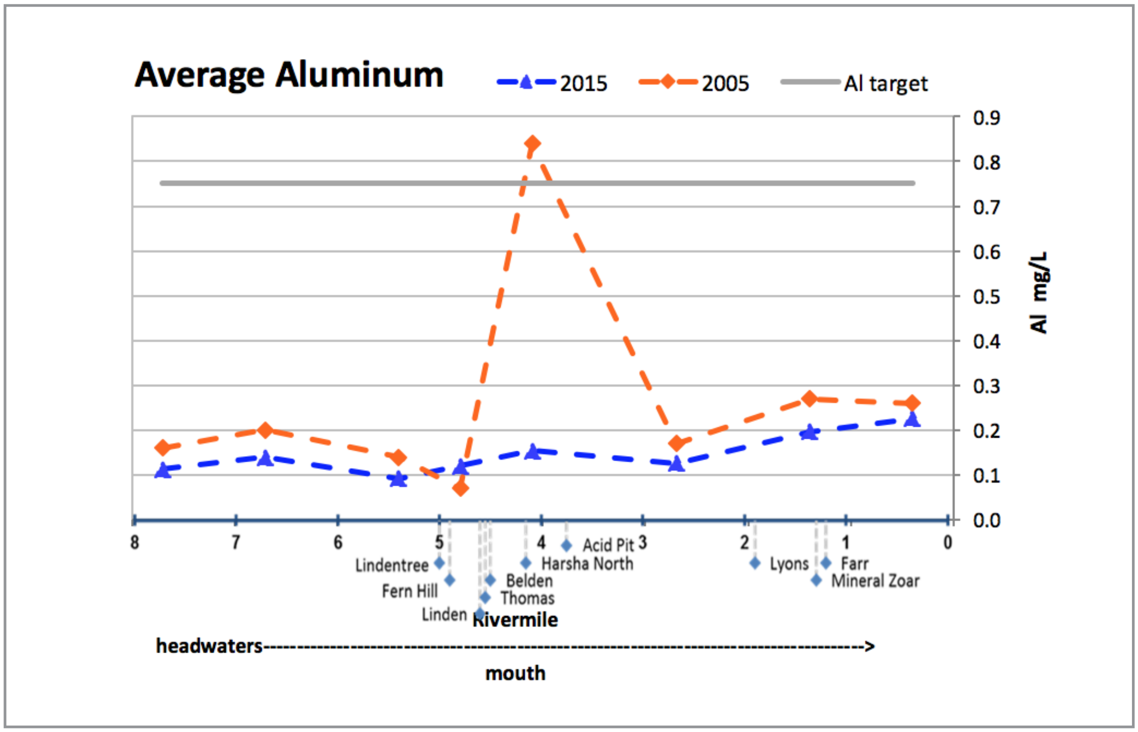
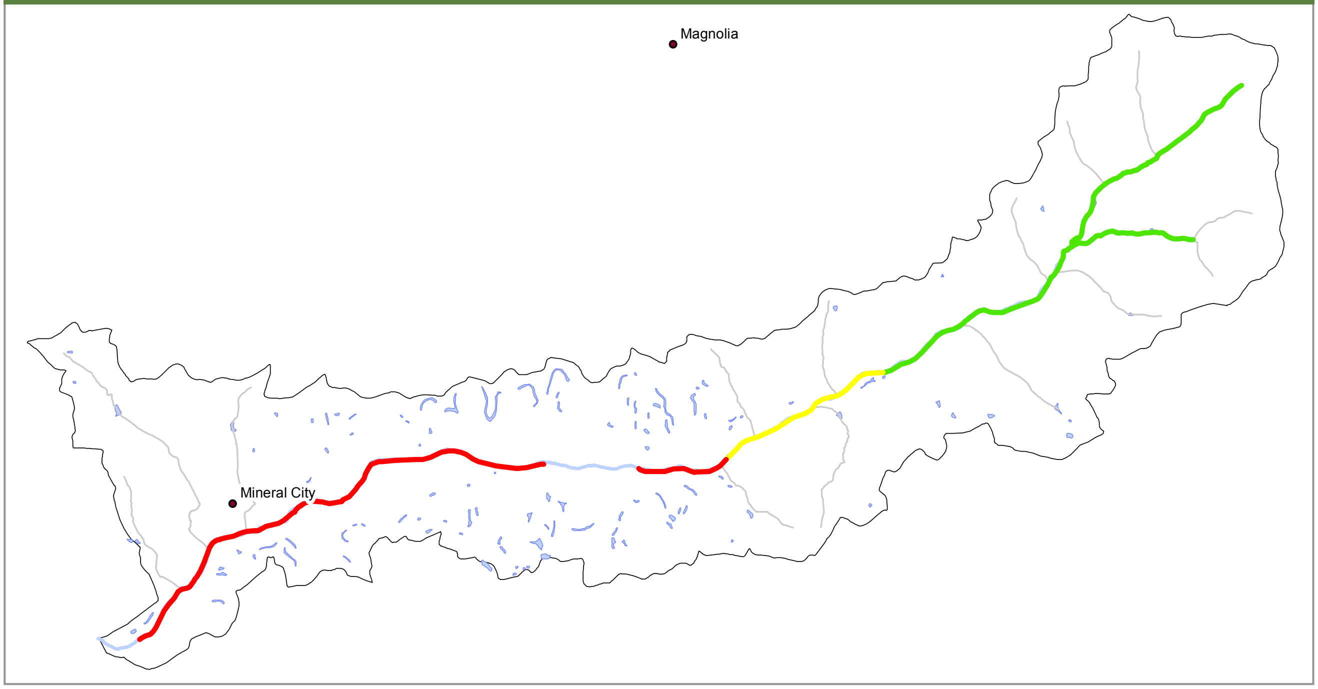


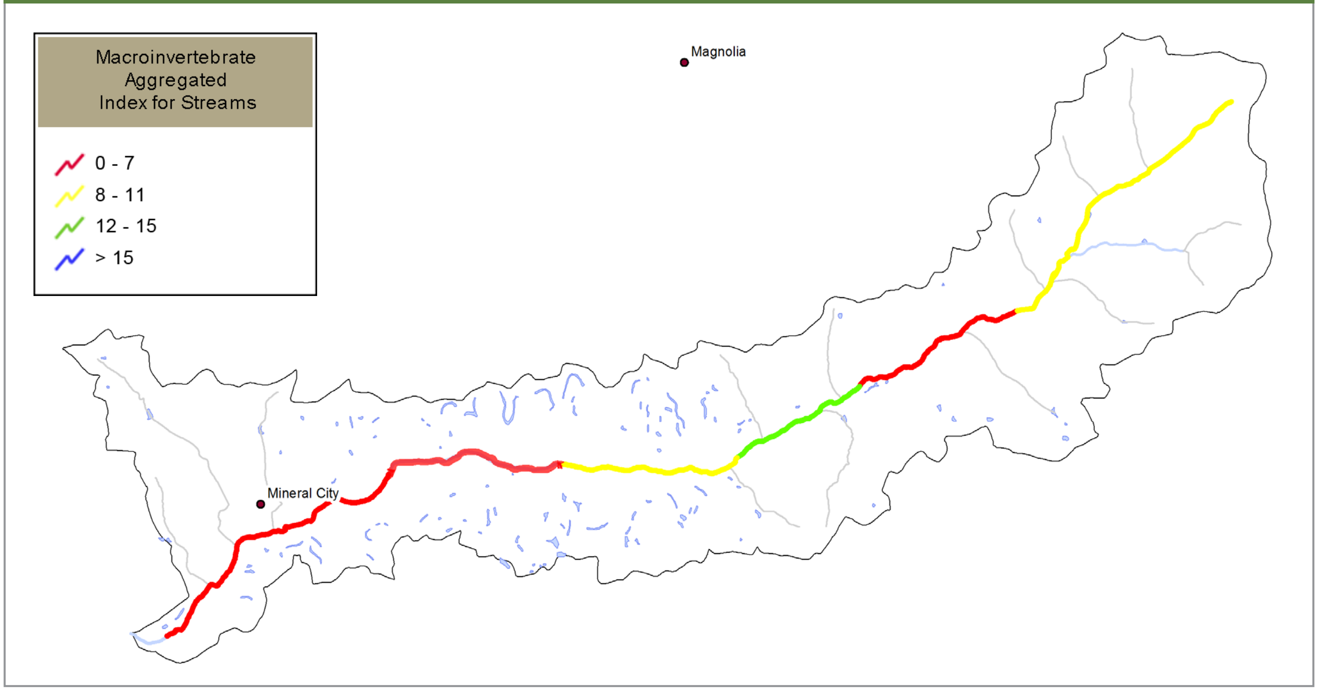


Biological Water Quality

Huff Run baseline MAIS



Huff Run 2015 MAIS



Biological quality in Huff Run decreases from headwaters to the mouth.

Biological Water Quality

Biological quality in Huff Run (based on macroinvertebrate data) improved modestly along the length of the mainstem. In 2014 for the first time since monitoring began in 2005 one of the eight monitoring sites (RM 5.4), improved enough to be categorized as sustained and statistically significant and four sites (RM 7.7, 5.4, 4.8 and 2.7) achieved new high scores that year. In 2015, RM 5.4 became the first site to reach its biological restoration target, earning a MAIS score “13”. RM 2.7 also earned a new high score of “11” and became the second site along the mainstem to show sustained biological recovery. These improvements, however, do not extend further downstream; biological quality at the two lowermost sites continues to be relatively poor. Scores at the upper two sites were also unusually low this year.

Figure 1. Area of Degradation 2006-2015

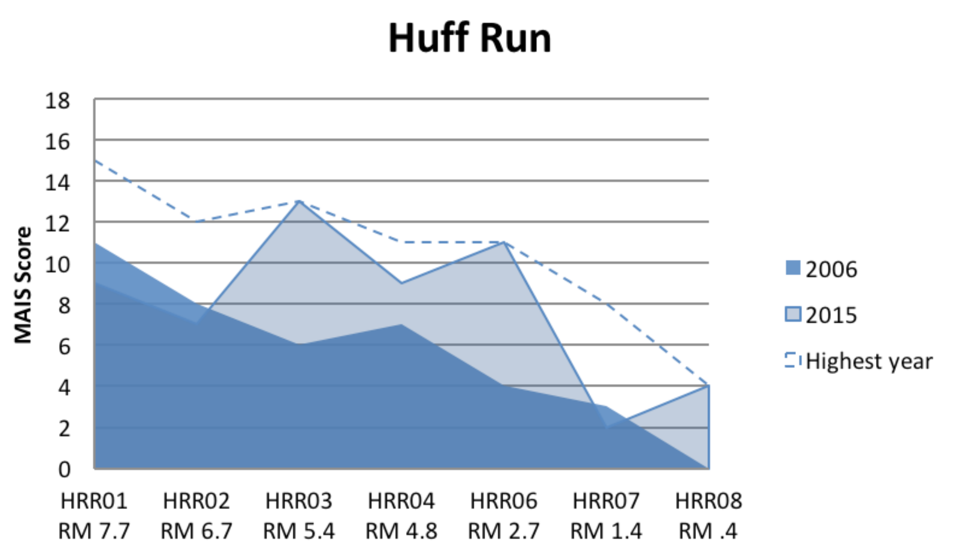


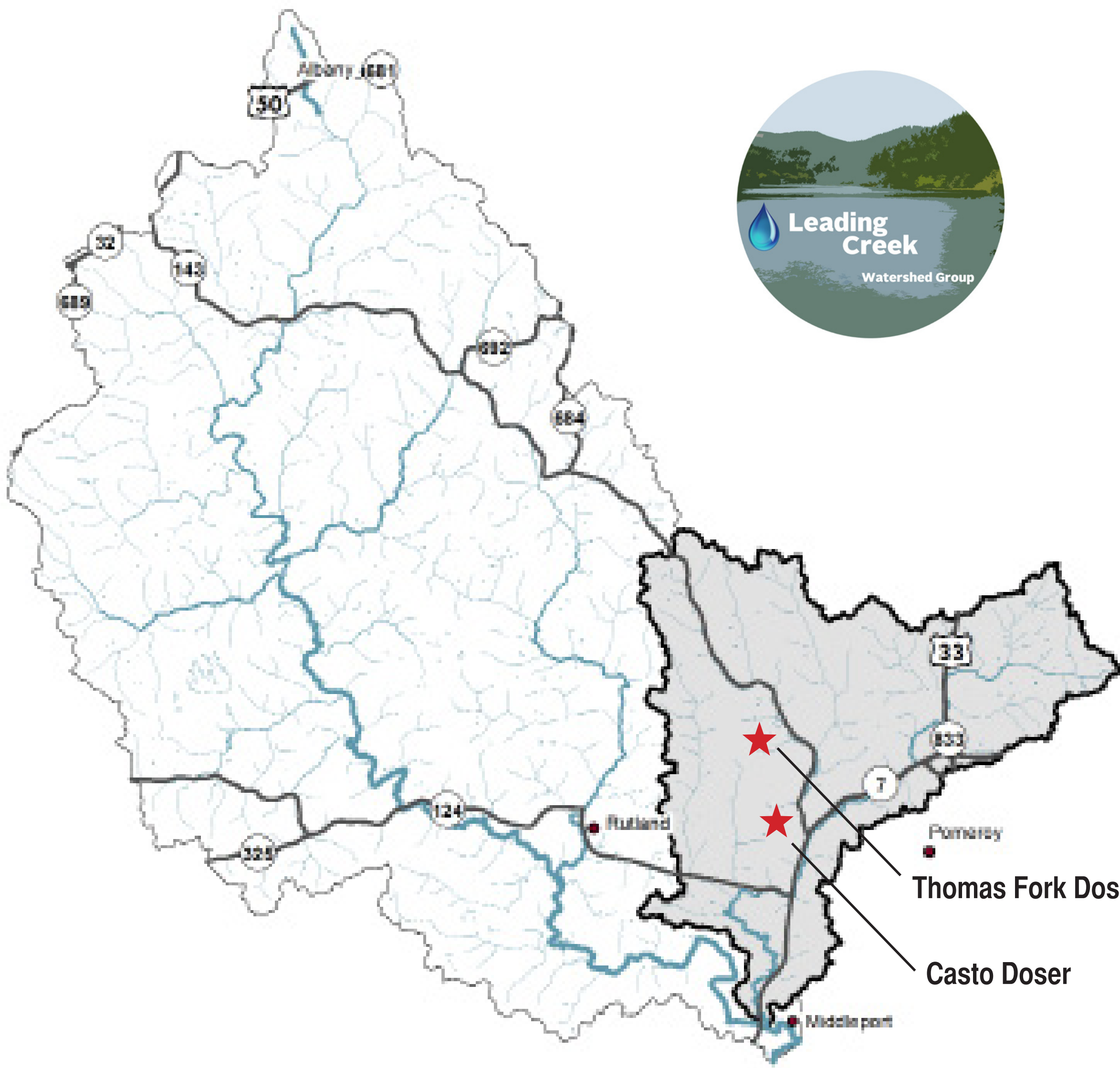
Figure 2. Huff Run MAIS Regressions

	RM	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Linear trends	R square	P-value	No. of years
HRR01	7.7	14	11	12	12	13	9	13	6	10	15	9	no change	0.0972	0.350655	11
HRR02	6.7	12	8	8	8	9	11	11	11	10	9	7	no change	0.016667	0.705201	11
HRR03	5.4	8	6	7	6	8	9	7	9	10	11	13	**improved**	0.677237	0.001862	11
HRR04	4.8	6	7	9	8	9	9	6	7	9	11	9	no change	0.26	0.109078	11
HRR06	2.7	5	4	5	3	4	5	3	4	5.5	7	11	**improved**	0.352671	0.054061	11
HRR07	1.4	2	3	3	2	8	2	2	3	5	7	2	no change	0.063035	0.456462	11
HRR08	0.4	3	0	4	3	4	3	3	3	3	4	4	no change	0.203521	0.163704	11

LEADING CREEK
WATERSHED REPORT

2015 NPS Report - Leading Creek Watershed

Generated by Non-Point Source Monitoring System
www.watersheddata.com



Reductions

Total acid load reduction = 661 lbs/day

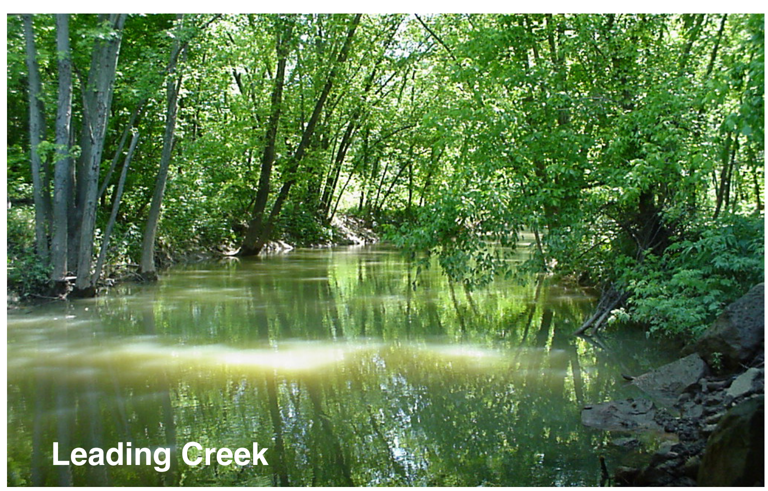
Total metal load reduction = 154 lbs/day

Costs

Design $36,132

Construction $692,349

Total Costs through 2015 = $728,481



Timeline of the Leading Creek Watershed Project Milestones & AMD Projects

1993	• SOCCO mine release into Leading Creek
1994	
1995	• Mother's Day Flood
1996	
1997	
1998	• Leading Creek Improvement Plan by Dr. Cherry completed
1999	• USFWS began working with Meigs SWCD on watershed projects
2000	
2001	• First Leading Creek Stream Sweep conducted
2002	
2003	• Meigs SWCD Conservation Area purchased along Little Leading Creek • Meigs SWCD obtained first watershed coordinator grant
2004	
2005	• Leading Creek Watershed Management Plan completed
2006	• Pauline Atkins Memorial Trail completed • Leading Creek AMDAT Plan completed
2007	
2008	• Leading Creek TDML Report completed
2009	• Leading Creek Water Trail established • First AmeriCorps member dedicated to the Leading Creek Watershed
2010	• Leading 'From the Past' book completed • Leading Creek Volunteer Monitor Program begun
2011	• Freshwater mussels reintroduced
2012	• Thomas Fork Doser Project completed
2013	• Biological observations along Thomas Fork indicate an increase in diversity of fish and macroinvertebrate species since 2010
2014	• Project development for Casto Doser reclamation scheduled for 2015
2015	• Casto Doser began operating October 2015, adding alkalinity to Thomas Fork to supplement low flow conditions

Leading Creek Projects

Acid mine drainage reclamation projects completed in Leading Creek Watershed:

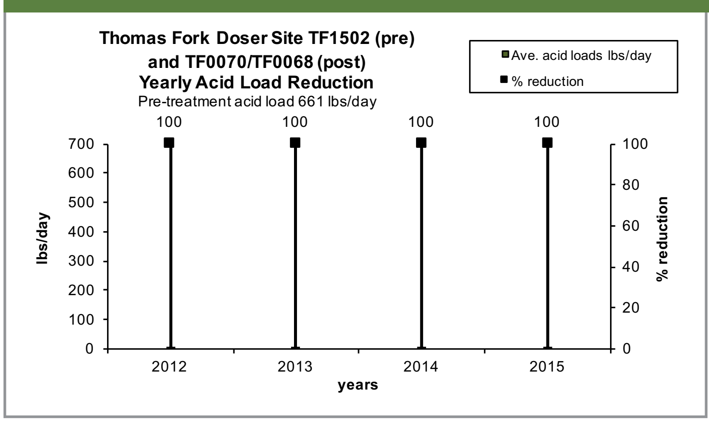
2012 Thomas Fork Doser (TF1502 pre/ TF0070 and TF0068 post) – Active calcium oxide doser

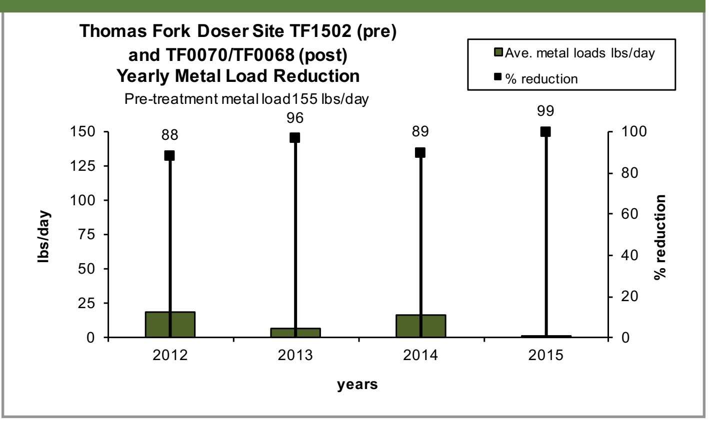
2015 Casto Doser (TF0030) – Active calcium oxide doser

Yearly acid and metal load reduction trends per project

Similar to other environmental best management practices (BMPs), performance of passive acid mine drainage reclamation projects are also expected to decline with time. Active treatment systems are not expected to decline with time but sometimes need to be maintained to perform adequately. Currently, operation and maintenance plans are being designed for each existing system and are planned for future projects. The graphs below show the mean annual acid and metal load reduction using the Stoertz Water Quality Evaluation Method (Kruse et al., 2014) for each year (or group of years) during post-reclamation from the project effluent. From these graphs the rate of decline (and/or improvement) with time of the treatment system is implied. Knowing the rate of decline will aid in the implementation of operation and maintenance plans.

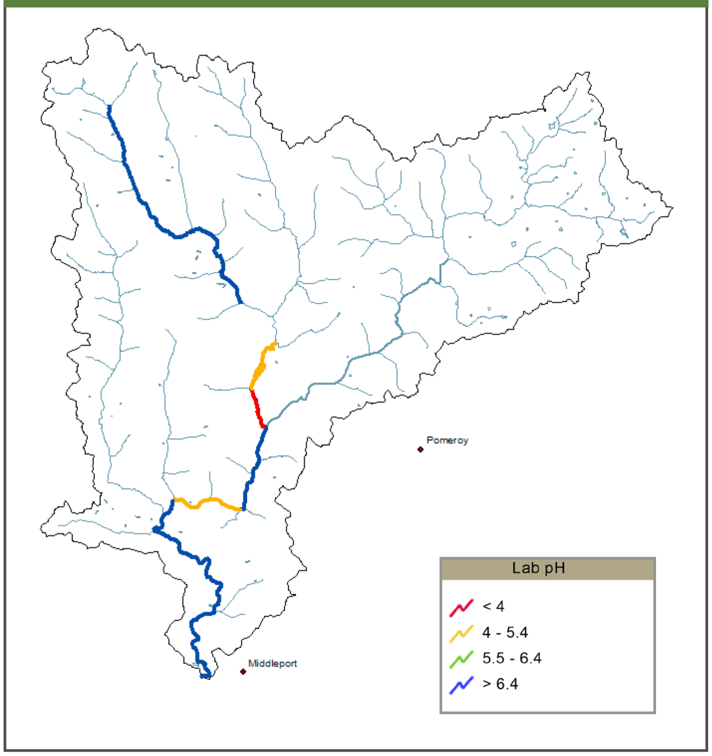
Thomas Fork Doser Site TF1502 and TF0070/TF0068



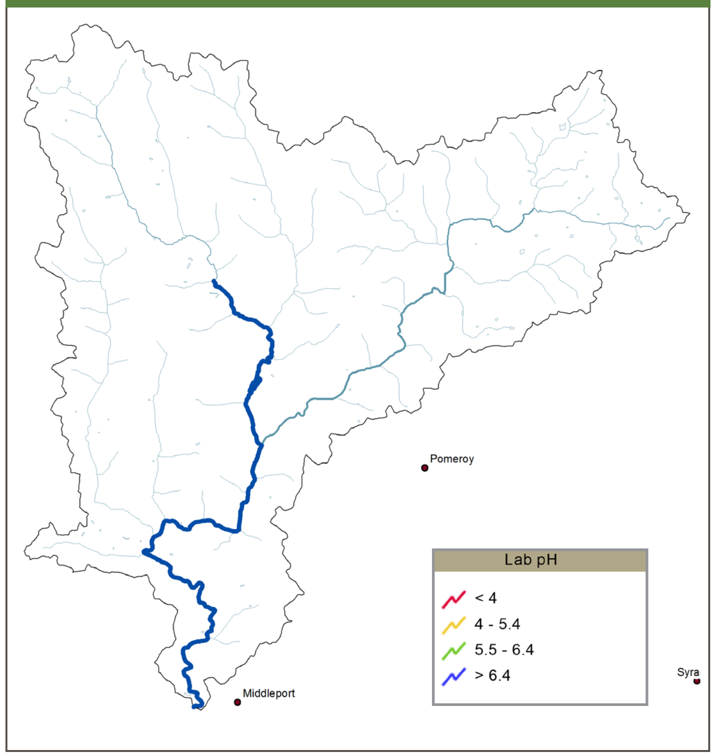


Chemical Water Quality

Thomas Fork baseline (2009) pH

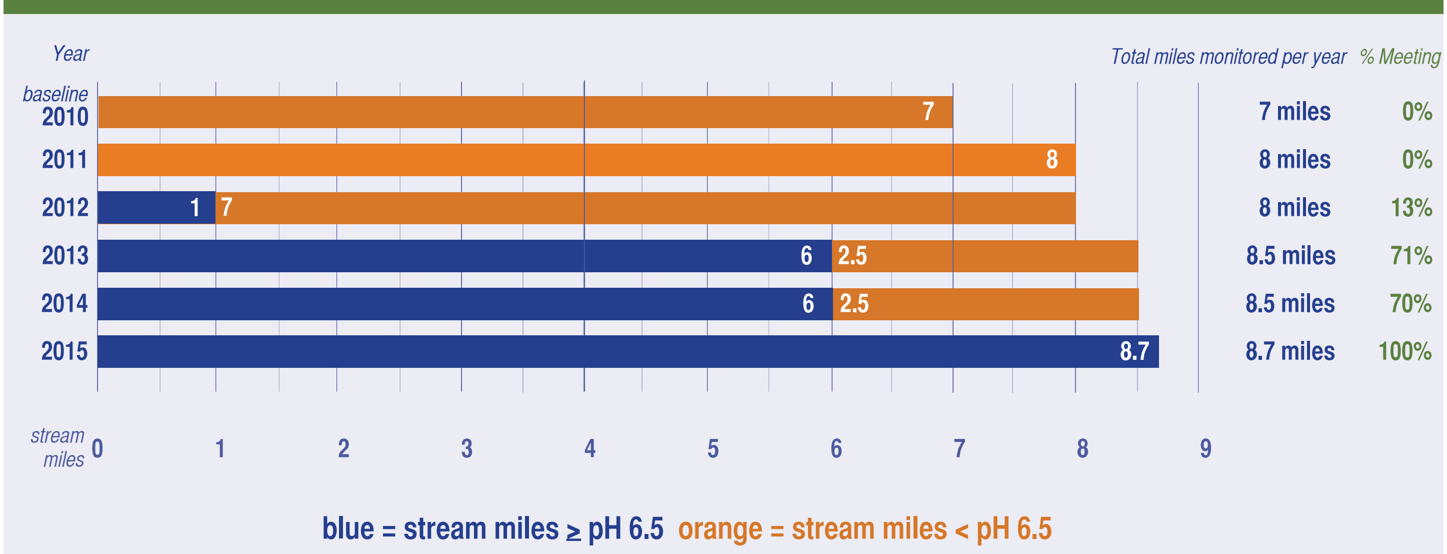


Thomas Fork 2015 pH



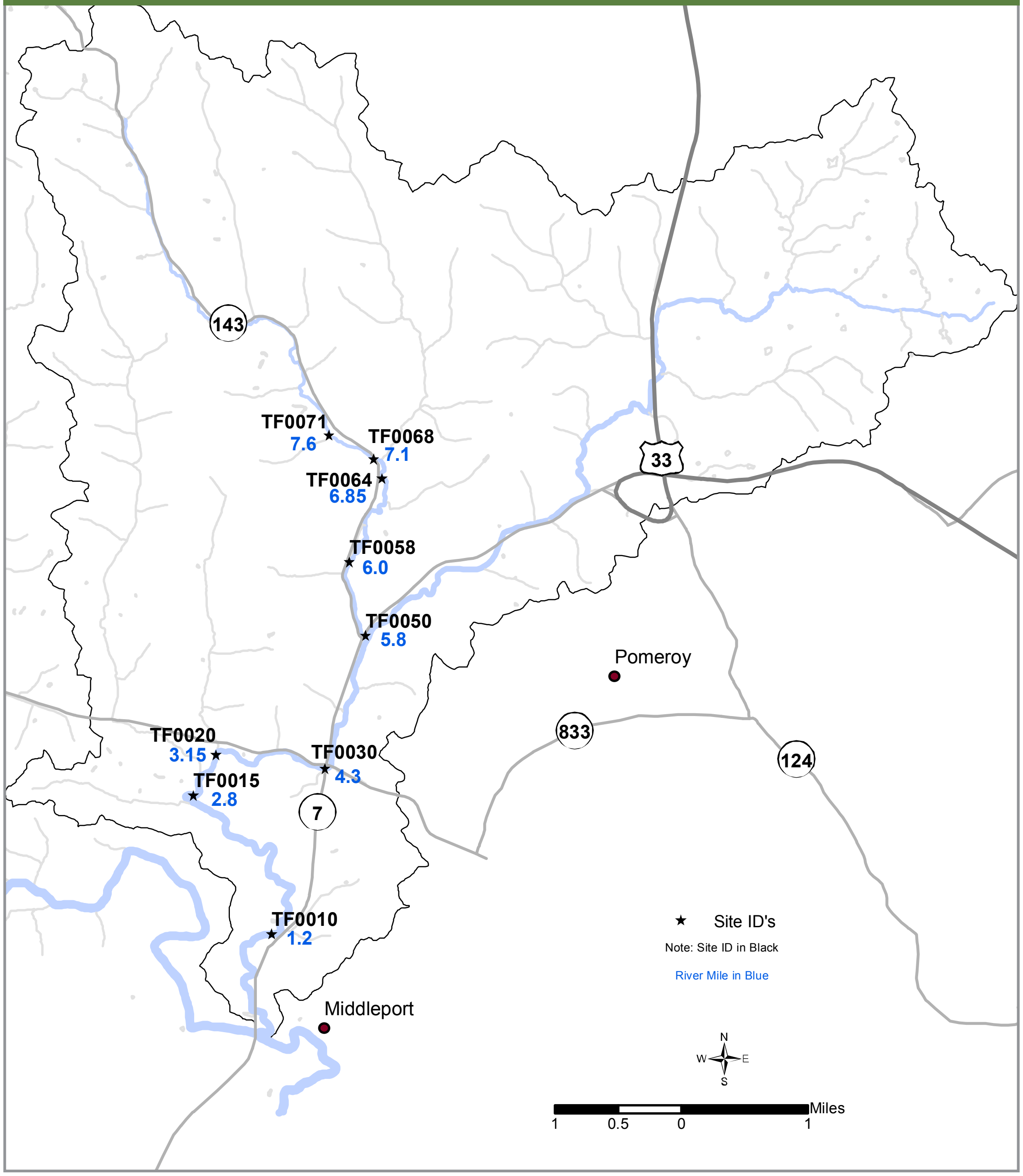
Thomas Fork in 2015, show 8.7 stream miles meeting the pH target of (6.5) of the 8.7 miles monitored (100%). The 2.5 miles of streams that didn't meet the pH target last year are now on average meeting the pH target.

Figure 1. Thomas Fork total stream miles monitored for pH through time



Chemical Water Quality

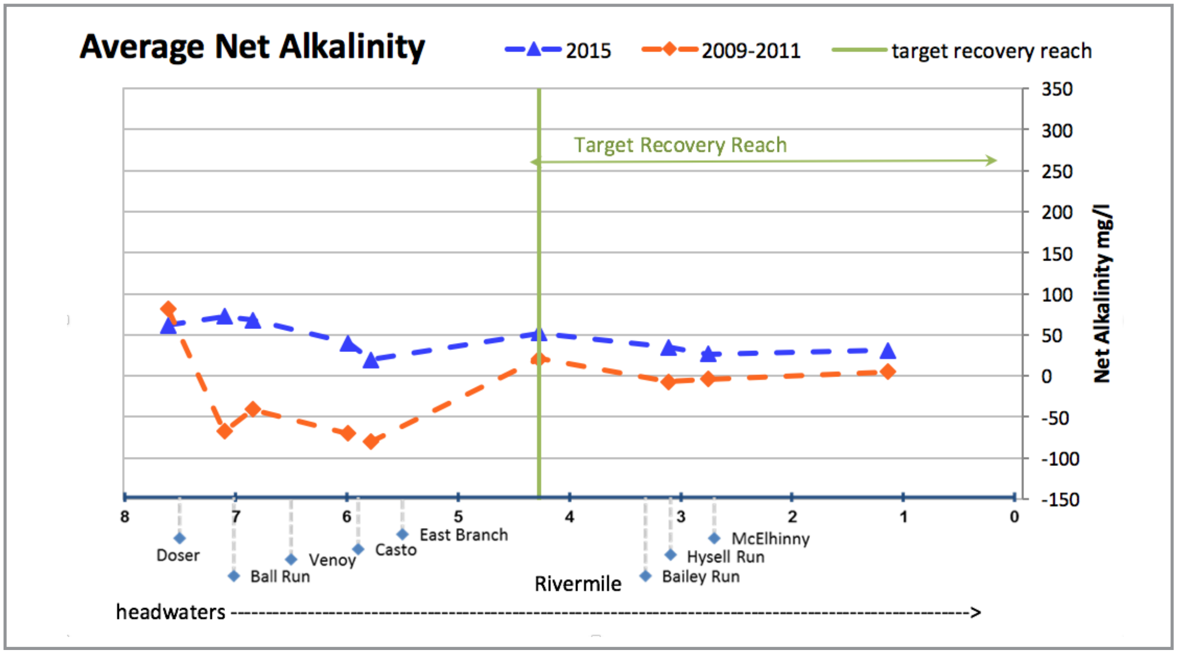
Thomas Fork

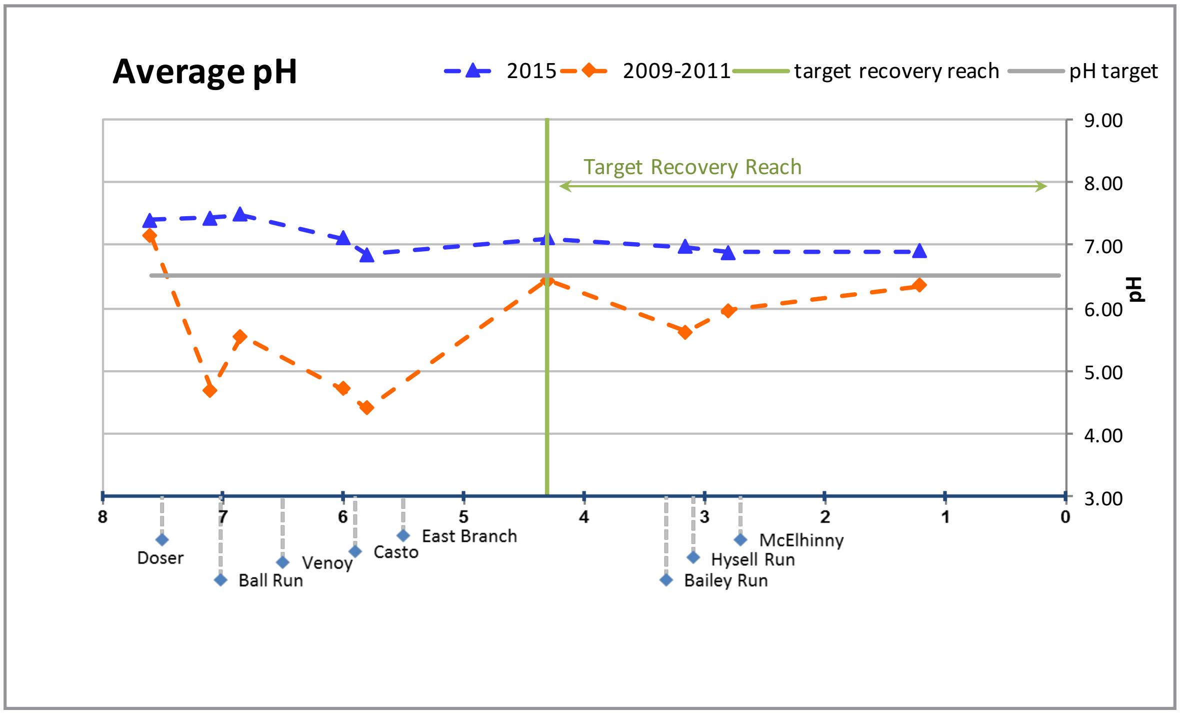


Chemical Water Quality

Chemical water quality changes along the mainstem of Thomas Fork are shown in the stream reach graphs below. Chemical long-term monitoring data is utilized to generate line graphs along the stream gradient from headwaters to the mouth. Along the x-axis named tributaries are shown to illustrate sources of water entering the mainstem. A list of long-term monitoring sites utilized to generate the graphs with their river miles are shown below.

Leading Creek Watershed									
site ID	TF0071	TF0068	TF0064	TF0058	TF0050	TF0030	TF0020	TF0015	TF0010
Rivermile	7.6	7.1	6.85	6	5.8	4.3	3.15	2.8	1.2





Chemical Water Quality

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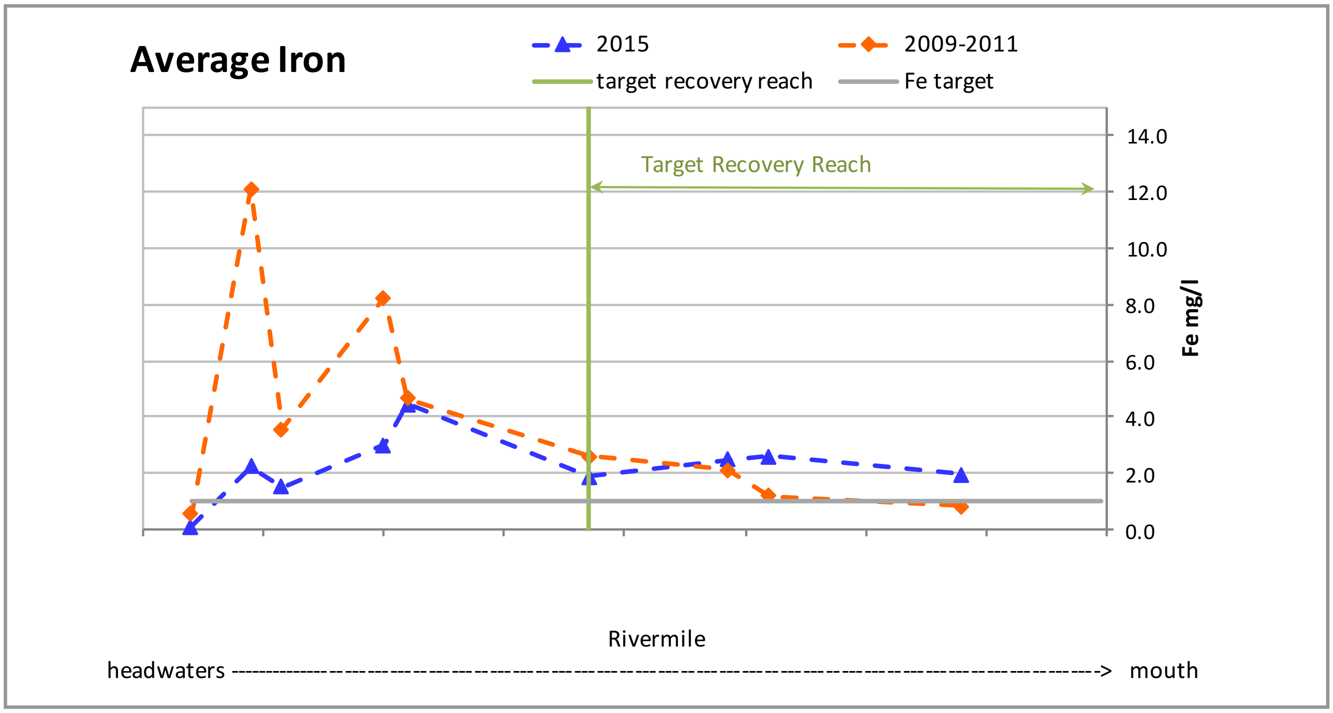
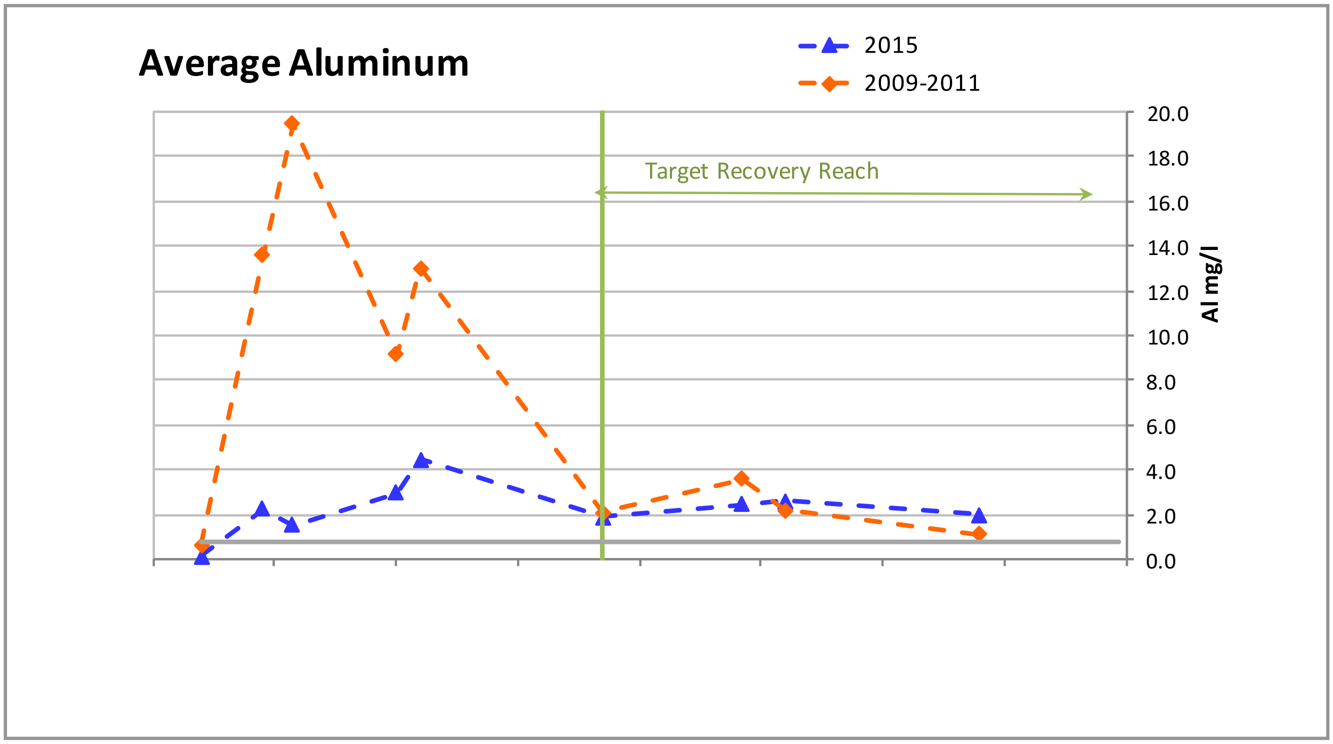
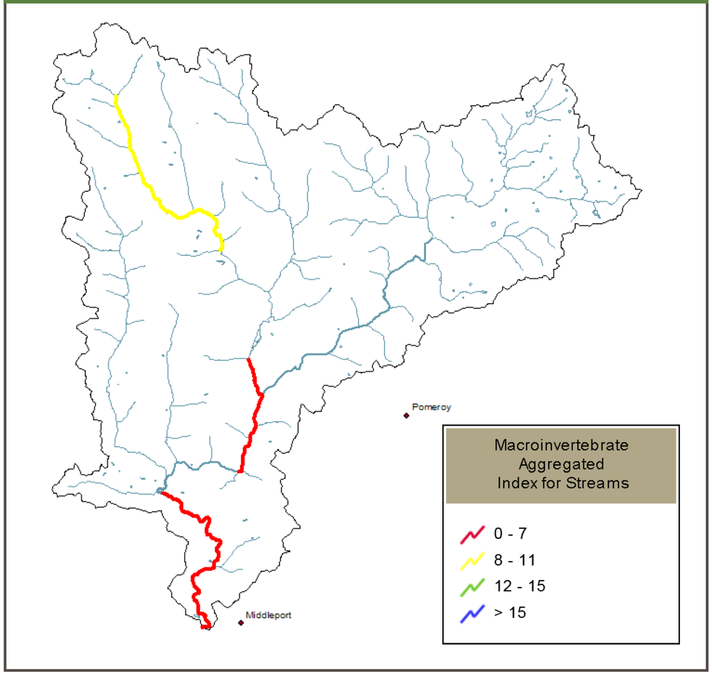


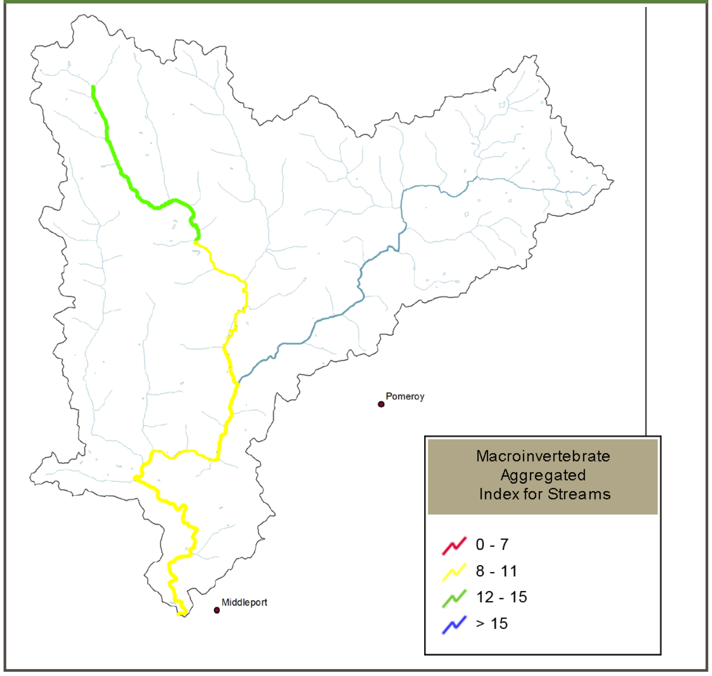


Biological Water Quality

Thomas Fork baseline MAIS



Thomas Fork 2015 MAIS



MAIS samples were collected along Thomas Fork a tributary to Leading Creek. These sites are along the mainstem at established long-term monitoring stations, collected from 2009 through 2015.

Thomas Fork

This year was the seventh year of biological monitoring in Thomas Fork of Leading Creek, and macroinvertebrate scores at most sites were similar to those recorded for the past three years. Overall biological quality has been higher for the past three years than the "5's" scored at most of the sites in 2009, 2011 and 2012. Improvements still have not attained statistical significance yet, but two sites, TF0050 and TF0015 earned new high scores of "10" and "11" this year.

Figure 2. Area of degradation 2009-2015

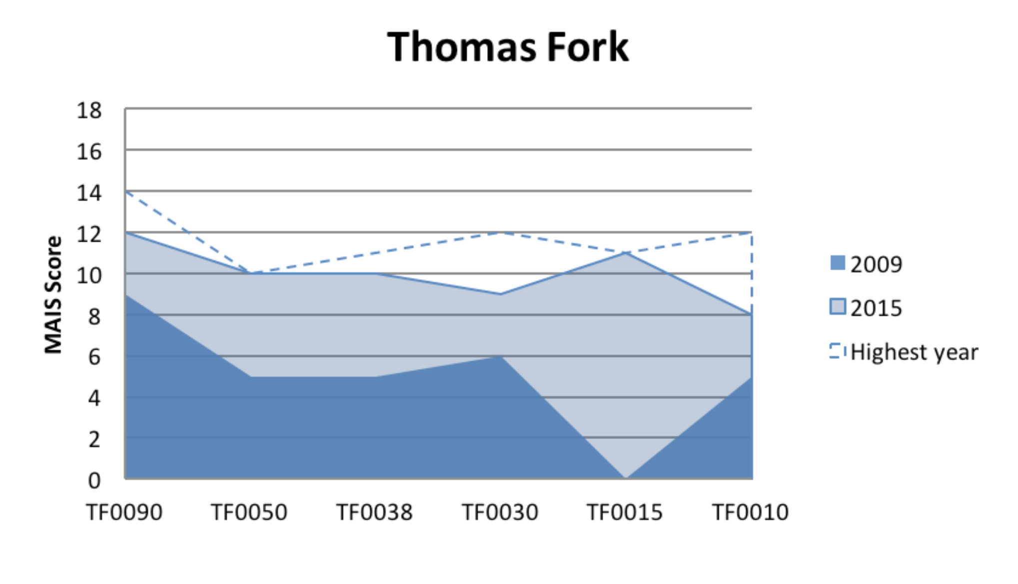


Figure 3. Thomas Fork MAIS Regressions

	2009	2010	2011	2012	2013	2014	2015	Linear trends	R square	P-value	No. of years
TF0090 RM 7.9	9	13	12	11	14	14	12	no change	0.320076	0.185566	7
TF0050 RM 5.5	5	8	3	2	8	6	10	no change	0.182857	0.338563	7
TF0038 RM 5.0	5	11	7	5	10	9	10	no change	0.189922	0.328368	7
TF0030 RM 4.3	6	12	4	5	10	9	9	no change	0.056882	0.606527	7
TF0015 RM 2.56		8	6	5	9	10	11	no change	0.511624	0.110059	6
TF0010 RM 1.2	5	12	5	5	10	9	8	no change	0.048193	0.636232	7

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References

Johnson, Kelly, 2009. Personal Communications, Ohio University Biological Sciences

Kinney, Chad, 2006. A Comparison of Two Methods of Bioassessment in Streams. Master Thesis at Ohio University.

Kinney, Chad, and Ben McCament, 2010. Screening Guidelines for the Identification of Acid Mine Drainage (AMD) Impaired Watersheds and for Acid Mine Drainage Abatement and Treatment (AMDAT) Plan Selection and Prioritization. Ohio Department of Natural Resources – Division of Mineral Resources Management (ODNR-DMRM) Guidance Document

Kruse, Natalie, Mary W. Stoertz, Douglas H. Green, Jennifer R. Bowman, and Dina L. Lopez, 2014. *Acidity Loading Behavior in Coal-Mined Watersheds.* Mine Water and the Environment 33:177-186.

Stoertz, Mary W. and Douglas H. Green, 2004. Mean Annual Acidity Load: A Performance Measure to Evaluate Acid Mine Drainage Remediation. Ohio Department of Natural Resources Conservation and Restoration Innovations 2004 Applied Research Conference at Ohio University

US Geological Survey (USGS), 2001. *Techniques for estimating selected streamflow characteristics of Rural, unregulated streams in Ohio.* Water-resources investigation report 02-4068. Columbus Ohio.

US Geological Survey (USGS) Stream Stats website – flow characteristics
http://water.usgs.gov/osw/streamstats version 2

Appendix: Quality Assurance Quality Control (QAQC)

HUFF RUN

	Collection Period	Samples Collected	Duplicate Samples Collected	Blanks
	1/21/15-12/8/15	66	5	1
Percent of Samples	-	-	7.6%	1.5%

Percent Difference from Lab and Field

	% Difference pH	% Difference Conductivity	Duplicate Samples Collected
Range	0-59.2	0.1-55.0	5
Median	4.7	3.7	7.6%

Percent Difference of Duplicate Samples (5)

	% Difference pH	% Difference Conductivity	% Difference Iron	% Difference Aluminum	% Difference Acidity	% Difference Alkalinity
Range	0.3-1.0	0-3.9	0.5-22.5	0-76.3	0.8-21.1	0-1.0
Median	0.3	0.3	2.3	2.5	5.1	0

Blanks (1)

Percent difference in the blank sample is 1.52%, showing little carryover.

LEADING CREEK

	Collection Period	Samples Collected	Duplicates	Blanks
	5/20/15-12/4/15	27	4	1
Percent of Samples	-	-	14.8%	3.7%

Percent Difference from Lab and Field

Leading Creek	% Difference pH	% Difference Conductivity
Range	0.8-6.9	0.4-67.8
Median	3.5	4.5

Percent Difference of Duplicate Samples (3)

	% Difference pH	% Difference Conductivity	% Difference Iron	% Difference Aluminum	% Difference Acidity	% Difference Alkalinity
Range	0-3.2	0-71	3.7-166	3.9-172	7-102	0.28-46
Median	1.6	35.5	84.9	80	54.5	23.1

Blanks (1)

The one blank sample tested showed little carryover.

MONDAY CREEK

Monday Creek	Collection Period	Samples Collected	Duplicate Samples	Blanks
	3/18/15 – 11/16/15	194	7	3
Percent of Samples	-	-	4%	2%

Percent Difference from Lab and Field

	% Difference pH	% Difference Conductivity
Range	0-17.7	0-161.9
Median	2.1	1.8

Percent Difference of Duplicate Samples (7)

	% Difference pH	% Difference Conductivity	% Difference Iron	% Difference Aluminum	% Difference Acidity	% Difference Alkalinity
Range	0-8.2	0-2.5	0-30.5	0-17.0	1.0-28.6	0-4.2
Median	0.5	0.3	2.7	2.7	4.9	0.3

Blanks (3)

When one of the blank samples showed evidence of carryover, equipment was cleaned using the methods outlined in the QAQC manual.

Appendix: Quality Assurance Quality Control (QAQC)

RACCOON CREEK

Raccoon Creek	Collection Period	Samples Collected	Duplicates	Blanks
	1/27/15 - 12/15/15	318	17	8
Percent of Samples	-	-	6%	3%

Percent Difference from Lab and Field

	% Difference pH	% Difference Conductivity
Range	0-27.7	0-14.4
Median	3.6	1.4

Percent Difference of Duplicate Samples (17)

	% Difference pH	% Difference Conductivity	% Difference Iron	% Difference Aluminum	% Difference Acidity	% Difference Alkalinity
Range	0-2.4	0-4.0	0-3.2	0-10.4	0.5-26.4	0-13.8
Median	0.3	0.4	1.0	0.9	2.6	0.7

Blanks (8)

Based on the data provided in the QAQC report, there appears to be little carryover.