REPORT OF THE
SPECIAL RECLAMATION FUND
ADVISORY COUNCIL

March 23, 2017

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EXECUTIVE SUMMARY

The Special Reclamation Fund Advisory Council (the "Council") was established by the Legislature in 2001 in order to ensure the effective, efficient and financially stable operation of the Special Reclamation Fund (the Fund). (W.Va. Code § 22-1-17). According to W.Va. Code § 22-1-17 the Council shall consist of eight members, including the Secretary of the West Virginia Department of Environmental Protection (DEP) or his or her designee, the Treasurer of the State of West Virginia or his or her designee, the Director of the National Mine Land Reclamation Center at West Virginia university and five members to be appointed by the governor with the advice and consent of the Senate.

The Fund is designated by the Legislature for the reclamation and rehabilitation of lands subject to permitted surface mining operations and abandoned after 1977, where the bond posted is insufficient to cover the cost of reclamation. The Fund is presently funded by a tax of 27.9 cents per ton of clean coal mined in West Virginia. From this revenue, funds based on a tax rate of 15 cents per ton are being paid into the Special Reclamation Water Trust Fund (SRWTF), while coal tax revenues based on 12.9 cents per ton are being paid into the Fund. According to W.Va. Code § 22-3-11**, "**Beginning with the tax period commencing on July 1, 2009, and every two years thereafter, the special reclamation tax shall be reviewed by the Legislature to determine whether the tax should be continued: *Provided*, That the tax may not be reduced until the Fund and SRWTF have sufficient moneys to meet the reclamation responsibilities of the state established in this section."

The SRWTF was created "for the purpose of assuring a reliable source of capital to construct, operate, and maintain water treatment systems on forfeited sites." (W.Va. Code § 22-3-11).

The Secretary of the DEP is required to conduct formal actuarial studies every two years and conduct informal reviews annually on the Fund and SRWTF. The Council is also required to make a report to the Legislature every year on the financial condition of the Fund. (W.Va. Code § 22-1-17). The report is to include: "A recommendation as to whether or not any adjustments to the special reclamation tax should be made considering the cost, timeliness and adequacy of bond forfeiture reclamation, including water treatment [and] a discussion of the council's required study issues."

In accordance with the statutory requirements, the Council submits the following:

1. **Recommendation**: The Council recommends that the present 12.9 cent per ton tax dedicated to the Fund remain in force and that the tax dedicated to the SRWTF remain at 15 cents per ton. Additional recommendations by the Council can be found in the body of this report on page 36.
2. **Study issues**: Pursuant to W.Va. Code §22-1-17, the Council is also required to "Identify and define problems associated with the special reclamation fund." The Council conducted multiple studies during 2016; one to evaluate the current and future conditions of the coal markets which ultimately impacts the revenue of the Funds and another to expand water treatment efforts to a watershed basis in order to enhance water quality on a watershed basis rather than site-by-site.
   Studies conducted during the 2015 report period include:
   1. 2016 Consensus Coal Production Forecast for West Virginia.
   2. Watershed Scale Approaches to AMD Remediation: Martin Creek and Sandy Creek.

Findings of these studies are outlined in the body of the report.

Membership Status of the Special Reclamation Fund Advisory Council

Currently Mike Sheehan serves as the member representing the Cabinet Secretary of the DEP. Carolyn Atkinson serves as the member representing the Treasurer of the State of West Virginia. Dr. Paul Ziemkiewicz serves as the member representing the Director of the National Mine Land Reclamation Center at West Virginia University. Christine Risch, Marshall University, Center for Business and Economic Research, serves as the Actuary/Economist member. Bill Raney serves as the member representing the interests of the coal industry. John Morgan serves as the member representing the interest of environmental protection organizations. Ronald Pauley serves as the member representing the interests of coal miners. The SRFAC member representing the interests of the general public is currently vacant. The DEP shall make every attempt to work with the Governor to have this vacancy filled in the upcoming year.

BACKGROUND ON THE SPECIAL RECLAMATION FUND

Article 1, Chapter 22 of the Code of West Virginia was amended by the West Virginia Legislature in 2001, creating an eight-member Special Reclamation Fund Advisory Council (the “Council”) with the responsibility of ensuring the effective, efficient and financially stable operation of the Special Reclamation Fund. The legislation establishing the Council also increased the tax on clean coal mined in West Virginia, from three to seven cents per ton (the “Continuing Tax”), and levied an additional seven cents per ton (the “Temporary Tax”), to be deposited into the Fund. The revenues of the Fund were designated to pay for reclamation on post-1977 bond-forfeited sites.

The 2001 legislation provided for the Temporary Tax to be in effect for thirty-nine months. As a result of a 2005 actuarial report finding that the expiration of the Temporary Tax would result in nearly immediate insolvency of the Fund, the Temporary Tax was extended by the Legislature in 2005, for an additional eighteen months. A 2007 actuarial study commissioned by the Council found that the failure to extend the Temporary Tax again would result in insolvency of the Fund. Accordingly, in 2008 the Legislature, through SB 751, created the SRWTF and enacted a temporary, twelve-month tax of 7.4 cents which was to be allocated between the Fund and a SRWTF. Twelve and nine-tenths cents was dedicated to the Fund and 1.5 cents was deposited into the SRWTF. An updated actuarial study in 2008 concluded that terminating the temporary tax would result in insolvency within a few years. In response, in the 2009 legislative session, the Legislature amended W.Va. Code § 22-3-11 to remove the expiration date for the Temporary Tax and provided instead for biennial review of the Tax by the Legislature. (Acts of the Legislature 2009, chapter 216).

Based upon projections under the 2011 Actuarial Valuation performed by Pinnacle Actuarial Resources, Inc. the Fund was found to be sufficiently funded under the existing 12.9 cent tax. However, the Council was concerned that as the SRWTF began making payments for water capital and ongoing water treatment in Fiscal Year 2019, as projected, the

SRWTF would fall into a deficit position in the second year of operation-2020." (2011 Actuarial Valuation, page 3). Declining coal production projected by the 2011 Consensus Coal Production Forecast and the significant increase in water treatment costs resulting from court rulings in two cases are contributing factors in the projected insolvency of the SRWTF. Accordingly, in 2012 the Legislature increased the special reclamation tax to 27.9 cents per ton, 15 cents of which was to be deposited into the SRWTF.

Based upon projections under the 2013 Actuarial Valuation performed by Pinnacle Actuarial Resources, Inc. the Fund was projected to be over 100 percent funded using a 20-year cash flow basis and 95.7 percent funded using a 35-year cash flow basis. The SRWTF was (and is today) accumulating 15 cents per ton coal tax revenue and interest and was projected by the 2013 Actuarial Valuation to be 150.4 percent funded using a 20-year cash flow basis and 89.9 percent funded using a 35-year cash flow basis.

Based on the 2015 Actuarial Study, the Fund is projected to fall to a low of $51.5 million in 2018. This is due to paying for all reclamation cost for both land and water as well as operation and maintenance cost associated with water treatment. The Fund then slowly recovers to $187.5 million by the end of the twenty-year study period, at which point an $8.2 million liability is projected to remain. The SRWTF is expected to accumulate approximately $120 million by 2018 before it begins to support water reclamation costs in 2019 *(However, it should be noted that as of December31, 2016 the balance in the SRWTF has only reached $80 million).* Afterwards, the SRWTF continues to show gains until it reaches $289.8 million by the end of the twenty-year study period and a $110.5 million liability is projected to remain. Both funds combined are projected to total approximately $477.3 million at the end of the twenty-year study period and a total liability of $118.7 million will remain.

The previous figures represent the actuary's central estimate. However, since the coal tonnage fees represent the bulk of the revenues to the Funds the study also looked at two adverse scenarios in which the coal tonnage fee collections were 10% and 25% below anticipated coal tonnage fee collections every year. The study then used statistical techniques to determine the potential for deviation of actual numbers from the central estimate and calculated confidence levels for 75th, 90th, and 95th percentiles of loss. As can be seen in the following table a surplus remained for the Funds under each of these scenarios.

Table 1

Ending Fund Balance Year-End 2035

	Loss Scenario			
Revenue Scenario	Central	75th Percentile	90th Percentile	95th Percentile
Central	477,331,353	460,063,494	425,028,127	393,405,869
10% Adverse	400,318,543	383,050,684	348,015,318	316,393,060
25% Adverse	306,732,063	289,464,204	254,428,838	222,806,579

FINANCES OF THE SPECIAL RECLAMATION FUND & THE SRWTF

This section of the Report to the Legislature outlines the financial status of the Fund for calendar year 2016 and provides comments regarding the future financial position of the Fund. The three key factors that have the most effect on the adequacy of the Fund are the coal production levels in West Virginia, the risk of future forfeitures, and the cost of reclaiming existing and future bond-forfeited sites.

The DEP acknowledges that future forfeitures and any water management costs associated with them could affect funding needs of the Fund and the SRWTF. DEP is currently working to compile water management and treatment costs on active (still permitted) and revoked sites in order to better inform the actuaries and policy makers in prediction of future water management and treatment costs associated with revoked sites. Additionally, the SRFAC is continuously looking for ways to improve upon the ability to project future forfeitures, which, as is outlined later in this report, will be a focal point of the Council through 2017.

The Office of Surface Mining Reclamation and Enforcement (OSMRE) supports DEP's efforts to improve the active mine pollutional inventory to ensure the accuracy of future forfeiture cost projections.

To summarize the data and analysis that follow, it should be noted that the Fund will cover all costs for both land reclamation and water treatment through June 2018. Then starting in July 2018, the SRWTF was to begin covering the cost for water treatment—both water capital costs and ongoing water treatment costs. The DEP plans to review the fiscal status of each fund to determine the most appropriate spending strategy that will protect the solvency of each fund into the future.

As of December 31, 2016 the Fund has accumulated assets of $72 million while the SRWTF has accumulated $80 million in assets, a 25% increase over 2015 SRWTF values. Increased revenues for the SRWTF are attributed to the tax increase in 2012 as well as the improved investment strategy which was initiated in 2013 as described below.

In May of 2013, following numerous discussions between DEP personnel and members of the Investment Management Board and the Board of Treasury Investments, the Council was updated on various investment options and made the following recommendations:

The first recommendation was in two parts:

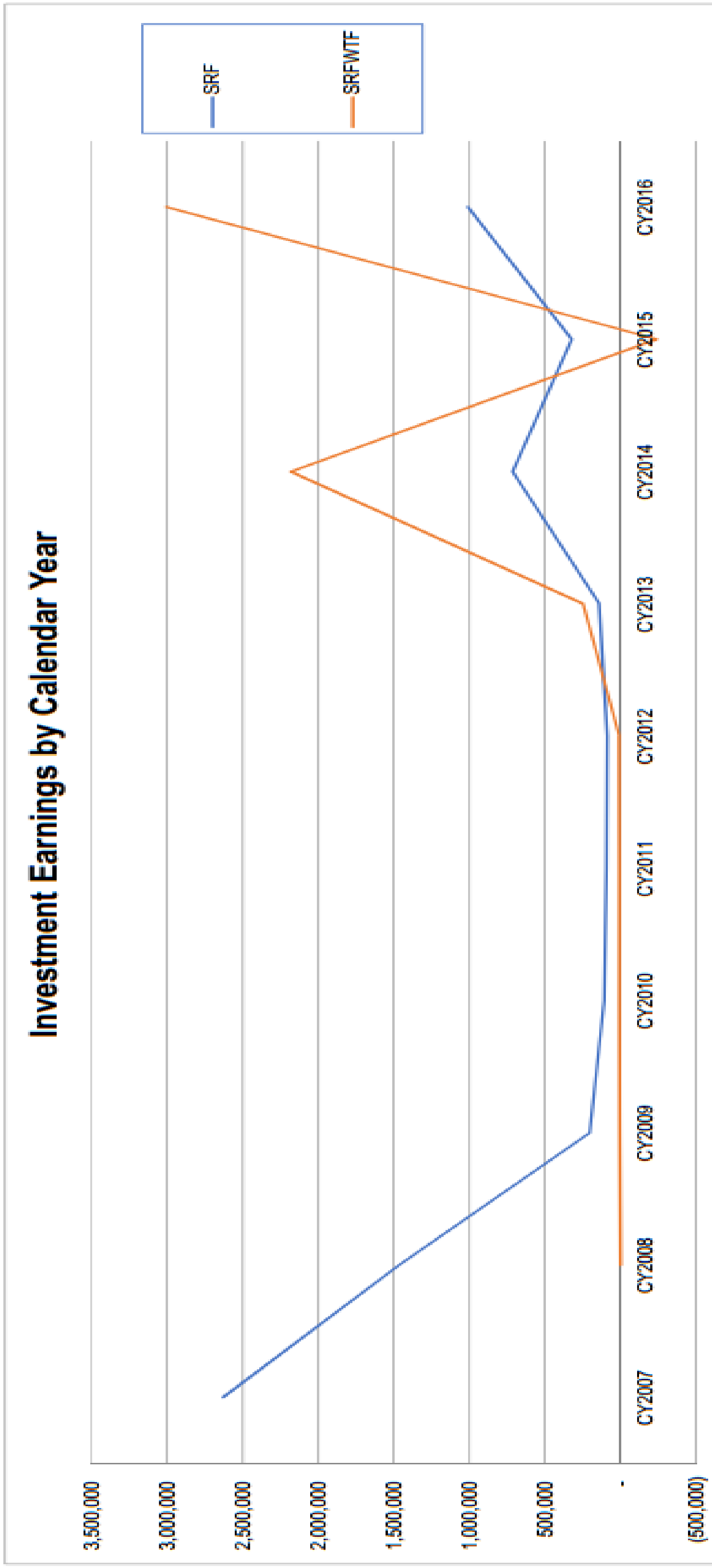
1. That the current balance of the Water Quality (WQ) Trust Fund and all additional revenue of the WQ Trust Fund through Fiscal Year (FY) 2018 be invested in the Investment Management Board (IMB) fixed income pool until FY 2019.
2. That DEP developed plans to maximize the return on investment for future WQ Trust revenue.

The second recommendation was also in two parts:

1. That the current balance of the Special Reclamation (SR) Fund be invested in the West Virginia (WV) short term bond pool with the exception of $5 million, which should remain in the WV money market pool.
2. That DEP develops plans to maximize the return on investment for future SR Fund revenue.

In October of 2013 the balance of $28 million from the SRWTF was transferred to the Investment Management Board Fixed Income Pool.

In June of 2013, with the exception of $5 million, the balance of the Fund was transferred to the WV Short Term Bond Pool. The following chart depicts the investment earnings for the previous six years prior to the new investment strategies and results of the new strategy leading up to the current year.



	CY2007	CY2008	CY2009	CY2010	CY2011	CY2012	CY2013	CY2014	CY2015	CY2016	CY2007 - 2016
SRF	2,631,119.03	1,465,564.25	205,214.88	109,652.38	92,668.76	88,882.52	141,062.46	716,146.49	325,054.72	1,010,964.20	6,786,329.69
SRFWTF		415.39	6,241.45	6,701.73	7,616.86	10,706.26	250,149.78	2,181,986.49	(238,203.32)	3,005,253.10	5,230,867.74

Figure 1

Since 2001, despite a very aggressive reclamation schedule, the Fund has been serving the people of West Virginia well through providing for the reclamation of bond-forfeited sites. At the time of the initial legislation in 2001, there were 392 forfeited permits requiring reclamation, including 122 requiring water treatment. Since passage of that legislation, an additional 211 permits have forfeited as well, bringing the total to 603 permits requiring reclamation. Of those, work has been completed on 486 permits. With regard to water treatment, the Fund is treating water at 144 sites and has an additional 50 sites under review or construction. As of December 31, 2016, the Fund has accumulated cash and investments totaling $72 million, while the SRWTF had accumulated $80 million.

Graphic summaries of the status of the Funds are outlined in the following figures.

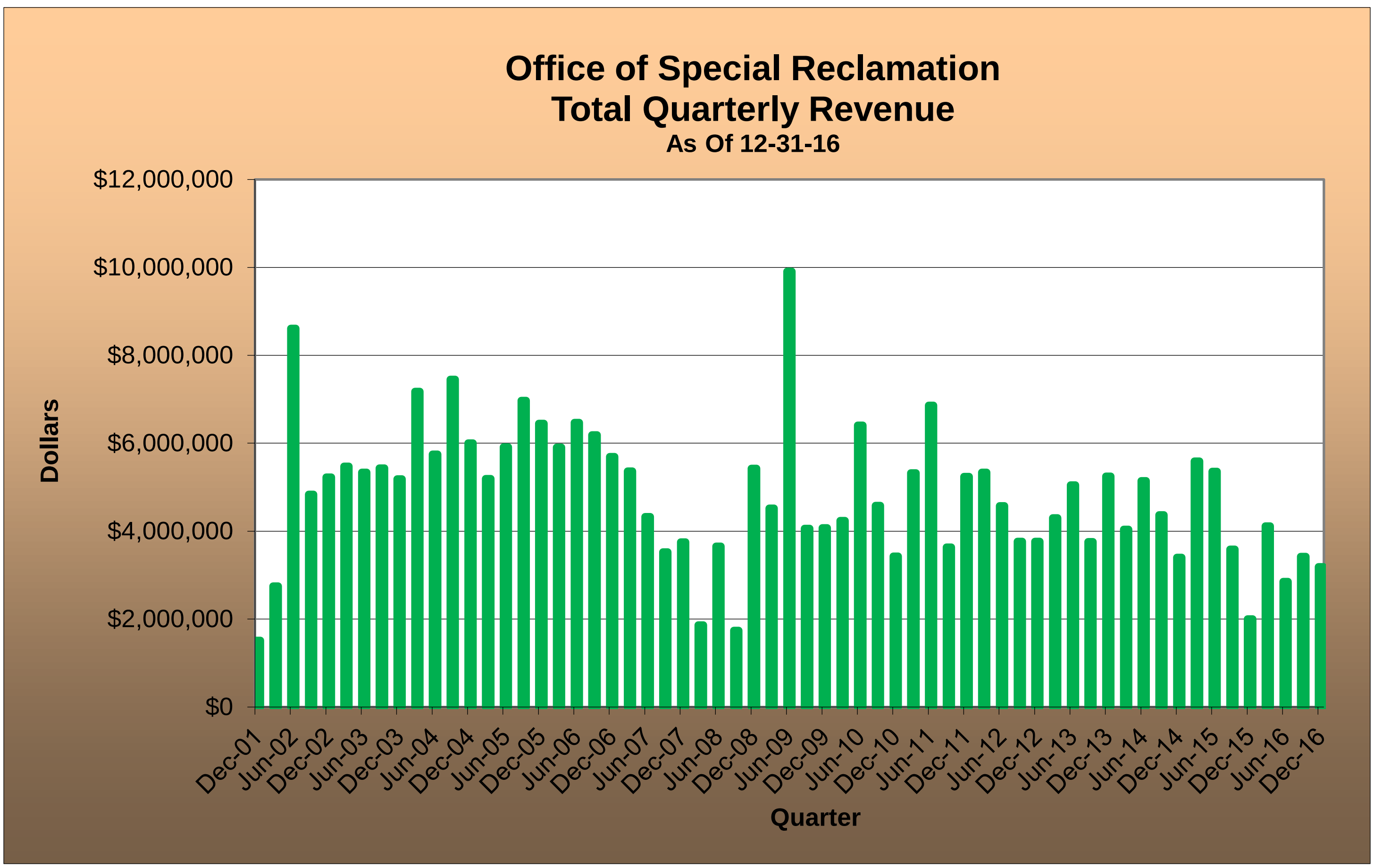


Figure 2

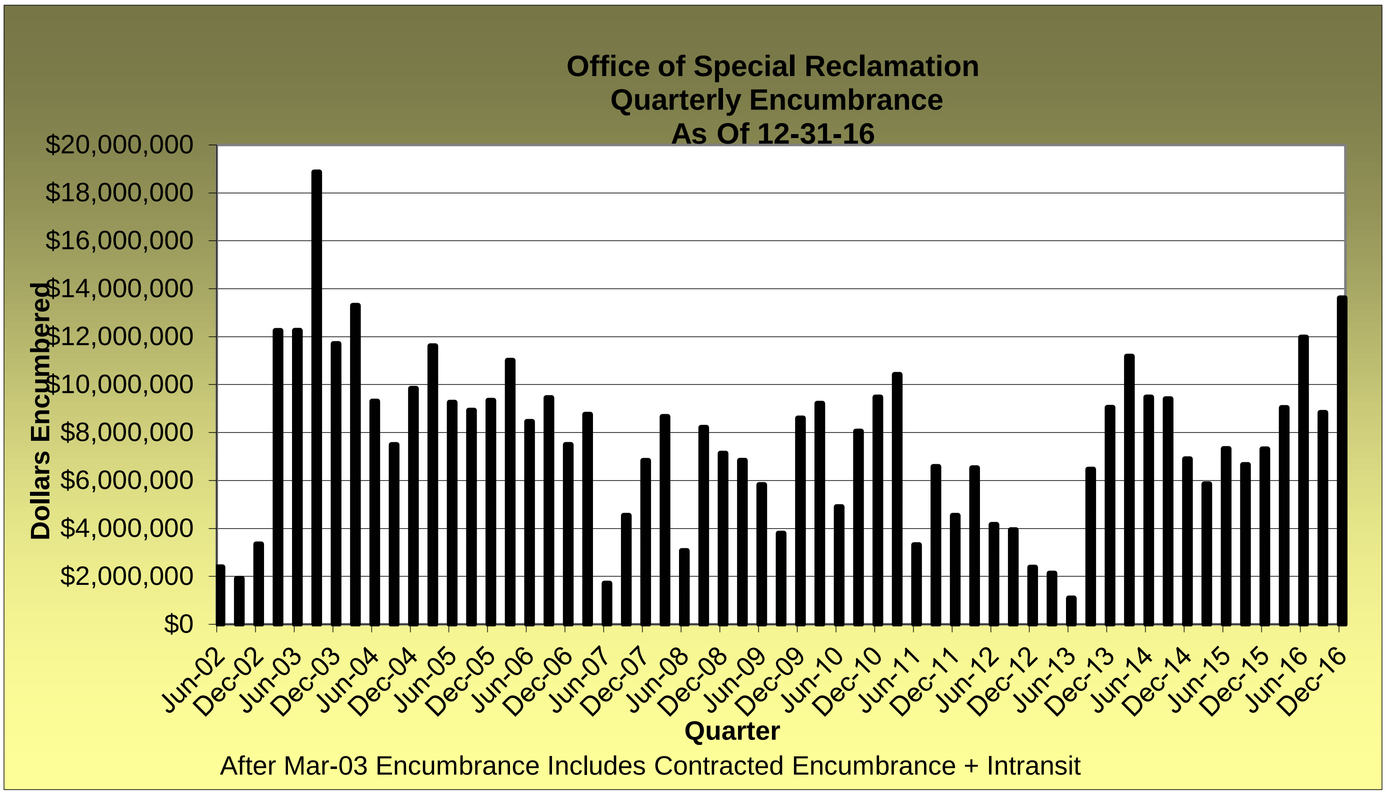

Office of Special Reclamation
Quarterly Encumbrance
As Of 12-31-16
$20,000,000
$18,000,000
$16,000,000
$14,000,000
$12,000,000
$10,000,000
$8,000,000
$6,000,000
$4,000,000
$2,000,000
$0
Dollars Encumbered
Jun-02 Dec-02 Jun-03 Dec-03 Jun-04 Dec-04 Jun-05 Dec-05 Jun-06 Dec-06 Jun-07 Dec-07 Jun-08 Dec-08 Jun-09 Dec-09 Jun-10 Dec-10 Jun-11 Dec-11 Jun-12 Dec-12 Jun-13 Dec-13 Jun-14 Dec-14 Jun-15 Dec-15 Jun-16 Dec-16
Quarter
After Mar-03 Encumbrance Includes Contracted Encumbrance + Intransit

Figure 3

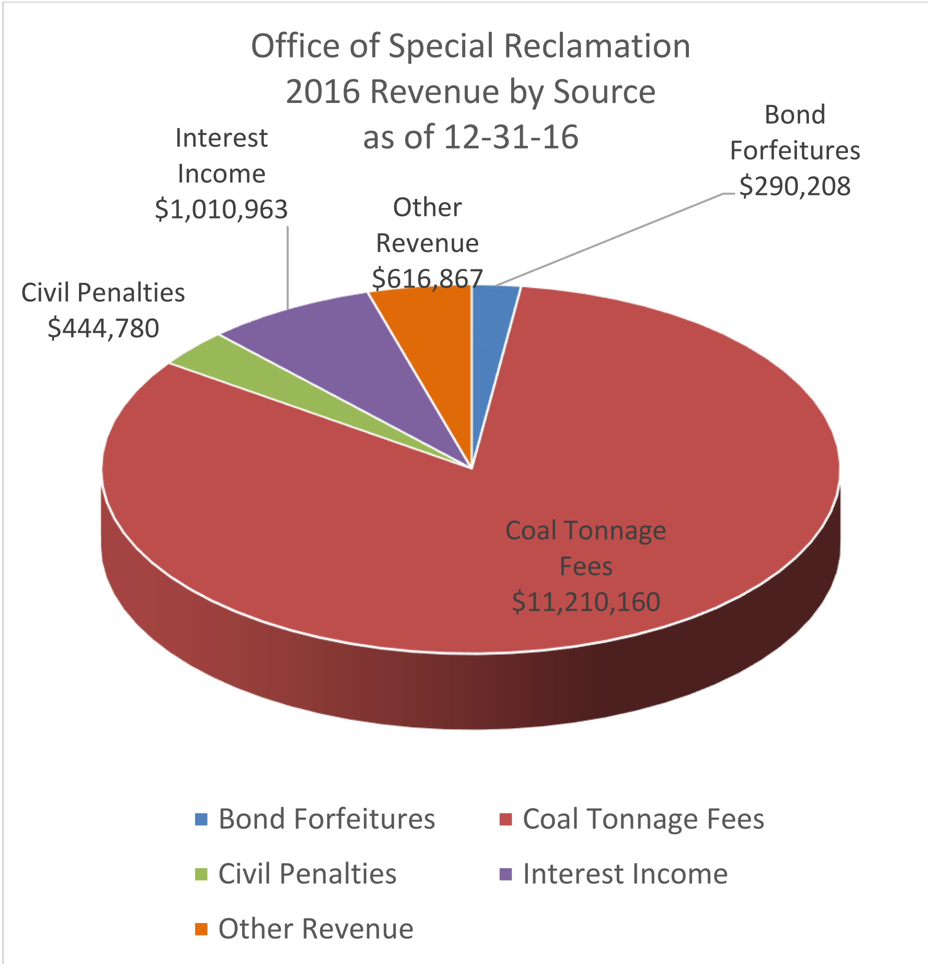


Figure 4

Water Treatment Funding

The current main funding mechanism for bond-forfeited sites is the 27.9 cent tax per ton of clean coal mined. In 2008, the Legislature authorized, but did not separately fund, the SRWTF. In reliance on the SRWTF statutory authorization, beginning in July 2008, coal tax revenues based on a tax rate of 1.5 cents per ton were being paid into the SRWTF. In addition, coal tax revenues based on 12.9 cents per ton were being paid into the Fund. In 2012 the Legislature increased the amount dedicated to the SRWTF to 15 cents per ton, but based on the funded status of the Fund at the time the Fund remained at 12.9 cents per ton. Unless modified in response to future legislation, for budgeting and analysis purposes, the DEP plans to continue paying all costs for both land and water reclamation work out of the Fund through FY 2018. Funding the water reclamation and treatment from the Fund will allow the SRWTF to build up assets, although it is not anticipated to remain solvent without future continuing funding. The current balance in the SRWTF is $80 million as of December 31, 2016. Prior to the end of FY 2018 the DEP will evaluate reclamation progress and the financial status of both Funds to determine future payment plans for reclamation activities moving forward. The Council is continuing to look at alternatives for water treatment funding.

Increased water capital cost and water treatment cost are the result of two identical lawsuits filed against the DEP. In 2011 and 2012 the DEP entered into separate consent decrees with the northern and southern district courts respectively. As will be discussed later in this report, the DEP was required to apply for and obtain NPDES permits for all the sites included in Attachment A of the consent decrees plus an additional 21 sites which were included in an earlier lawsuit, for a total of 192 sites. The DEP estimated that it will cost approximately $35.5 million to bring bond forfeiture sites into compliance with the more stringent water quality based effluent limits. Additionally, DEP estimated that it will cost approximately $6.7 million to operate and maintain these treatment systems on an annual basis.

DEP has fulfilled the requirements of the Consent Decree by obtaining all NPDES permits.

Additional Charges to the Fund Due to NPDES Requirements

Due to NPDES requirements, the DEP has been faced with charging more expenditures to the Fund. These include:

- Realty – Land and/or easement purchases have been necessary to expand existing or new water treatment sites outside permit boundaries. The following are costs associated with expansion of sixteen (16) sites where additional land was needed to ensure compliance with the more stringent water quality based effluent limits (WQBEL):
    - Surveying - $450

- Appraisals - $5,400
- Appraisal reviews - $600
- Cost of Timber - $0 for CY2016
- Recording fees - $44
- Easement purchases - $54,300.00

- Hiring private consulting engineers – To meet the requirements of the consent decree and in an attempt to maintain the land reclamation schedule, the DEP has been compelled to hire private engineering consulting firms to complete designs for projects that have historically been done in-house. As of the date of this report fourteen (14) contracts have been awarded at a total cost of $3,280,413.15 and one (1) additional contract has been prepared for bids. DEP estimates that contractual design increases project cost by 10 to 12%.
- Increased staff – As a result of having to apply for and obtain NPDES permits at all bond forfeiture sites now and into the future, the DEP has found it necessary to incorporate an NPDES permitting section into the Office of Special Reclamation (OSR - The office responsible for reclamation of land and waters for bond forfeited sites). Five new staff members consisting of one (1) program manager and three (3) engineering technicians and one (1) environmental resource specialist have been added to fulfil the NPDES requirements for the DEP. This is an additional charge to the Fund of approximately $194,856/year for salaries alone.
- NPDES permitting fees:
    - Application fees - $1,000/application
    - Modification fees - $500/mod.
    - Annual fees - $1000/permit.
- Water sampling related to permit applications

New DEP Policy Relevant to the Fund

Effective May 21, 2014 the DEP has implemented a new policy establishing a standard procedure the DEP will follow to terminate the State's jurisdiction over bond-forfeited former mining sites (Special Reclamation Sites). With a decision that the Special Reclamation Site has satisfied the applicable performance standards, DEP will terminate jurisdiction over the subject Special Reclamation Site. The new policy limits the vulnerability of the State, and consequently the Fund, by reducing the possibility of lawsuits pertaining to damages unrelated to former mining practices or reclamation practices, i.e. due to recreation, timbering, oil & gas, etc., as well as any changes to environmental laws taking effect after reclamation of the subject Special Reclamation Site. The DEP will retain jurisdiction of Special Reclamation Sites, or portions thereof, that are necessary for the effective treatment of mine discharges emanating from the subject Site.

DMR Actions

In 2016, DEP permittees holding approximately 900 permits were involved with bankruptcy cases and plans in West Virginia. The DEP has and continues to actively monitor each of these bankruptcy proceedings, taking appropriate and aggressive steps as necessary both in the regulatory and bankruptcy forums to ensure that the permit holders transfer the permits to capable and responsible operators or take other steps to reclaim the sites in accordance with the permits. In 2016, DEP has taken an active role in the chapter 11 cases of Alpha, Patriot, and Walter. Those efforts continue in connection with the resolution reached in the Patriot bankruptcy in October 2015. In addition, DEP's efforts have secured substantial financial and other commitments to help ensure full reclamation and water treatment on the affected permitted sites. In particular, DEP negotiated an agreement with Alpha and its secured creditors which provided significant funding to provide for bonding and reclamation at the approximately 500 sites of the Alpha permits. The settlement consisted of the surety bonds Alpha posted to obtain its mining permits remaining fully in place with Alpha, West Virginia's last remaining self-bonded coal company, posting an additional $100 million in penal bonds with respect to its active and inactive mining sites in West Virginia. In addition, Alpha will post $39 million in letters of credit or cash bonds as additional financial assurance to supplement the self-bond guarantee, for the performance of Alpha's reclamation and water treatment obligations at its other remaining sites in West Virginia. In short Alpha has agreed to post penal bonds for, and reclaim and treat water at all its remaining mining sites, including the sites at which it has ceased mining operations. The company and its secured creditors have committed to provide additional funding totaling approximately $209 million to this end. The agreement allows for the continued operation of various mining sites in West Virginia. Profits from the operation of those sites are expected to support reclamation and water treatment efforts. For calendar year 2016 approximately $630,064 has been paid from Special Reclamation Fund accounts for outside legal costs associated with bankruptcy proceedings of coal mining permittees. During 2016, another large coal permittee, Arch Coal (with 169 permits in West Virginia), filed for and emerged from chapter 11 bankruptcy.

Litigation

1. The Fund through FY 2018 and the SRWTF starting in FY 2019 has acquired liability for additional water treatment as a result of lawsuits filed against the DEP, as described below.

Identical complaints were filed in the Northern and Southern District Courts, Civil Actions No. 07-cv-87 (the "Northern District Case") and No. 2:07-0410 (the "Southern District Case"), assigned to Judge Irene Keeley and Judge John T. Copenhaver, Jr., respectively. Both cases were styled *West Virginia Highland Conservancy and West Virginia Rivers Coalition v. Randy C. Huffman, Secretary, West Virginia Department of Environmental Protection.*

The two suits alleged that the West Virginia Department of Environmental Protection (DEP) had violated, and continues to violate, the federal Clean Water Act (the Act) by failing to obtain West Virginia National Pollutant Discharge Elimination System (WV/NPDES) permits when the DEP reclaims and treats water at bond forfeited sites as directed by state law.

The Northern District Case named 18 specific bond forfeited sites and the Southern District Case named 3 sites.

On March 26, 2009, the Northern District Court entered summary judgment in favor of Plaintiffs in the Northern District Case, and granted a permanent injunction. The injunction requires DEP to apply for, process, and issue WV/NPDES permits to itself for the discharge into waters and streams of pollutants from the eighteen bond-forfeited, coal mining sites at issue in the case, whose reclamation the agency is required to manage. DEP appealed this decision to the United States Court of Appeals for the Fourth Circuit ("Fourth Circuit Court of Appeals"). By order dated November 8, 2010, the Fourth Circuit Court of Appeals affirmed the Northern District Court's ruling.

Similarly, a motion for summary judgment in the Southern District Case was granted by Order dated August 24, 2009. The Southern District Court found that the Secretary of the DEP was "in violation of the National Pollutant Discharge Elimination System permitting requirements of the Clean Water Act." The Southern District Court ordered the Secretary to "apply for, and obtain, NPDES permits for all sites at issue in this action," and the parties subsequently submitted a joint stipulation agreeing to the same injunctive relief and timeframes for compliance set forth in the Northern District litigation. The Southern District Court entered final judgment August 31, 2010.

On January 11, 2010, the same Plaintiffs (West Virginia Highlands Conservancy and West Virginia Rivers Coalition) and the Sierra Club submitted a letter giving DEP notice of their intent to sue DEP regarding discharges from 131 additional bond forfeited sites on the same legal basis as the previous suits. Based on the outcome of the previous litigation, DEP engaged in settlement negotiations with the Plaintiffs and reached agreement regarding the permitting of the 21 sites in the previous litigation and the additional 131 sites. In August 2011, the Plaintiffs filed two new suits regarding the additional sites, *West Virginia Rivers Coalition, et al v. Huffman*, Civil Action No. 1:11-cv-118 (N.D. W.Va.), and *West Virginia Rivers Coalition, et al v. Huffman*, Civil Action No. 2:11-cv-524 (S.D. W.Va.), and lodged a proposed Consent Decree with both courts. The Northern District Court entered the Consent Decree on October 12, 2011. The Southern District Court entered the Consent Decree February

10, 2012. A list of all bond forfeited sites at issue in all four suits is attached to the Consent Decree as Attachment A. As required by the Consent Decree on July 2, 2012 DEP submitted a Final Treatment Cost Report to Plaintiffs and SRFAC, in which DEP determined the capital cost and annual operating and maintenance costs for water discharges from each bond forfeiture site to meet applicable water quality based effluent limitations. The DEP estimated that these costs will amount to $35.5 million for one-time capital construction costs and over $6 million in annual operations and maintenance costs.

The Consent Decree resolves all four suits filed by the Plaintiffs regarding bond forfeited sites. The Consent Decree required DEP to obtain WV/NPDES permits for all 21 bond forfeiture sites cited in the initial litigation by September 1, 2011. Thereafter, DEP issued draft WV/NPDES permits for 50 additional sites by the end of each calendar year, beginning in 2012. By December 31, 2015 the Consent Decree required DEP to issue draft WV/NPDES permits for all bond forfeited sites listed in Attachment A of the Consent Decree and for sites that were in existence on the date the Decree was executed. Thereafter, the DEP shall exercise its best judgment on the timing of issuance of draft permits for sites forfeited after the execution of the consent decree.

Note: *The final draft permit was issued December 10, 2015.*

2. A third case presents potential for future litigation, should the legislature not adequately fund the Fund and SRWTF. *West Virginia Highlands Conservancy v. Secretary Salazar, DOI*, Civil Action No. 2:00-1062 (S.D. W.Va.). The West Virginia Highlands Conservancy (WVHC) had filed a motion with the U.S. District Court for the Southern District of West Virginia to reopen the case and schedule further proceedings on the grounds that the recommendations of the Special Reclamation Advisory Council were not being followed with regard to funding the Special Reclamation Fund. Based upon the Legislature's extension of funding through the Continuing and Temporary taxes, the case was placed on the court's inactive docket as of May 2008; however, the court allowed the possibility of a renewed motion if the Legislature does not continue to provide sufficient monies for the Fund to remain solvent.

In March 2011, the WVHC moved once again to have the litigation reopened alleging continuing problems with the Fund. A status conference was held on August 5, and the court ordered the filing of a joint status report. On August 25, 2011, the WVHC and the Defendants filed a joint status report with the court. The WVHC stated that the court should not delay reopening the case until the new actuarial report and Advisory Council recommendations are issued, whereas the Defendants recommended that it was premature for the court to reopen this matter prior to the close of the 2012 legislative session.

On March 30, 2012, a status conference call was conducted by the Court. In light of the enactment of Senate Bill 579 that increased the special reclamation tax from 14.4 cents to 27.9 cents per ton of clean coal mined, the Plaintiff acknowledged that it would move to withdraw its Second Motion to reopen and refile it to address the changed circumstances that have occurred since the filing of its motion to reopen.

On April 2, 2012, the WVHC filed its Motion to withdraw its Second Motion to reopen this case with the Court. On August 5, 2012, the Court issued an Order granting the Plaintiff's Motion to withdraw its Second Motion. In addition, the Court granted the WVHC leave to file an additional motion to explain deficiencies that remain, notwithstanding the recent revenue increase in the Special Reclamation Fund.

This case remains open, so the District Court can address any issue that may arise regarding the State's ABS (alternative bonding system).

3. West Virginia Highlands Conservancy, West Virginia Rivers Coalition, and Sierra Club v. Huffman United States District Court – Northern District of West Virginia (Keeley) and United States District Court, Civil Action No. 1:16-cv-70 – Southern District of West Virginia (Goodwin) and United States District Court, Civil Action No. 2:16-cv-03769.

These are companion cases filed by the same parties against the Department under the citizen suit provisions of the Clean Water Act, alleging that the Office of Special Reclamation is in violation of certain NPDES permit limits on five sites in the Northern

District and two sites in the Southern District. The Southern District case has not proceeded past initial disclosures. With regard to the Northern District case, the parties held both an informal settlement conference and a Court ordered mediation in late December, and the plaintiffs agreed that the agency is doing everything it can to bring the sites at issue into compliance. However, the plaintiffs will not agree to settle the case without the DEP agreeing to pay their attorney fees. The agency has refused to do this on the following premise: the only relief the plaintiffs asked for in their complaint is injunctive relief (i.e. a Court order requiring the DEP to bring itself into compliance with its permits); the agency is already doing everything within its power to get into compliance (and the plaintiffs agree that this is the case); therefore, there is no injunctive relief to grant. If the Court does not (or cannot) award injunctive relief, then it cannot award attorney fees. Because the Office of Special Reclamation has approximately 250 of these permits, the agency wants a determination from the Court with regard to its liability for attorney fees when the plaintiffs did not "substantially prevail" on any matter at issue.

Study Issues

1. 2016 Consensus Coal Production Forecast for West Virginia

The West Virginia Consensus Coal Production Forecast is a combined production forecast comprised of four component forecasts; Energy Information Administration (EIA), Energy Ventures Analysis (EVA), Marshall University Center for Business and Economic Research (CBER), and West Virginia University Bureau for Business and Economic Research (BBER). A consensus approach to forecasting seeks the "wisdom of crowds" in producing an expectation for output from the coal industry. The Consensus Forecast is used to provide the best expectation of tax revenues to be collected for mandatory reclamation activities conducted through the Special Reclamation Fund and the Special Reclamation Water Trust Fund. The West Virginia Consensus Coal Production Forecast is calculated for the years 2016 through 2040.

The report describes recent historical coal production trends for the State of West Virginia including the individual industries that comprise the major segments of demand. Each of the component forecasts used to form the Consensus Forecast is then described, with information about assumptions and resulting projected levels of production for West Virginia. The process used to produce the Consensus is also described, including the weightings applied to each of the component forecasts.

In this year's report the EIA maintains the highest share of the consensus due to historical accuracy of its forecasts. The EIA model projects total coal consumption in the U.S. electric power sector to be lower than in its Annual Energy Outlook 2015 analysis due in part to assumed implementation of the Clean Power Plan (CPP), and to projected natural gas prices that are lower than prior assumptions (EIA AEO2015, Coal Market Module). Central Appalachian coal production is projected to decline faster than in Northern and Southern Appalachia. Northern production is projected to decline by 1.5 percent per year through 2040 while Central Appalachian production is projected to decline by 1.8 percent per year.

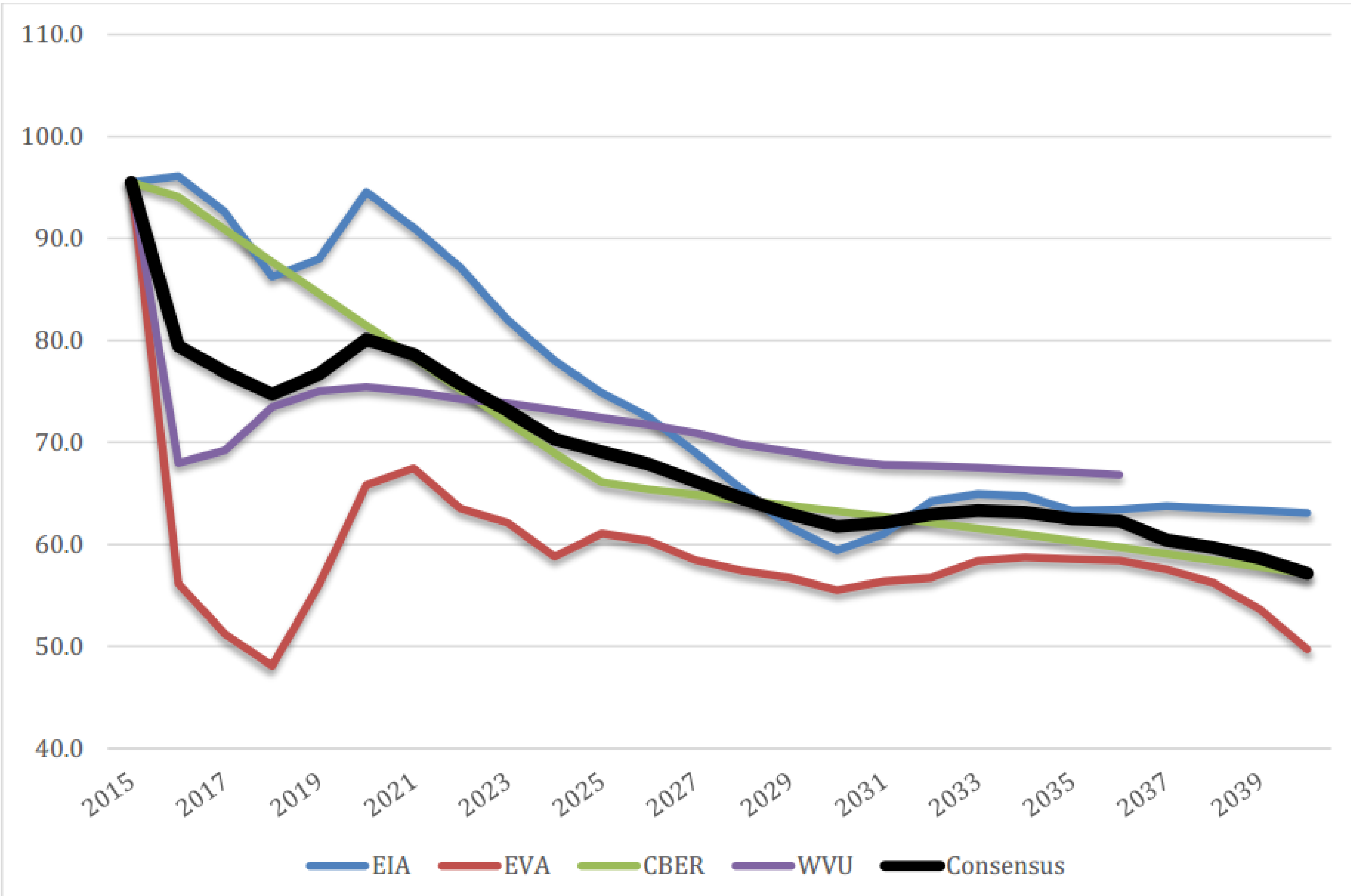
The potential impact of the EPA's CPP rule is included in two of the component forecasts that comprise the West Virginia Consensus Forecast, those from EIA and EVA. The EPA finalized the CPP in 2015, but the Supreme Court stayed the rule in 2016 due to pending litigation (EIA 2016). Because of the stay, some forecasters exclude the CPP from baseline forecasts.

The CBER model is influenced by inclusion of preliminary 2015 coal production and demand data. This added another year of decline to already declining historical trends.

The WVU base case model does not include the potential effects of the Clean Power Plan. This provides one explanation for its higher projected levels of production toward the end of the forecast period.

The component models within the consensus forecast incorporate a wide range of possible levels of West Virginia coal production over the next 25 years. These varying levels of forecasted coal production illustrate the impact of various supply and demand variables and uncertainty over the continuation of recent trends. The consensus reduces uncertainty by combining the forecasts into one aggregate projection where West Virginia coal production declines sharply in 2016, flattens for a few years, and then declines moderately through 2040, see Figure 5. The full report can be found in Appendix B.

Figure 5: Component and Consensus Forecast 2016 (million tons)



2. Watershed Scale Approaches to AMD Remediation: Martin Creek and Sandy Creek

A. Purpose

As was discussed earlier in this report, the DEP is now required to obtain NPDES permits for all water treatment facilities on former mining sites that have had their permits revoked and bonds forfeited. In some instances this will only lead to DEP discharging compliant waters into streams that are significantly impaired by pre-law acid mine drainage (AMD). Therefore, the DEP is pursuing an alternative NPDES permitting structure for bond forfeiture water treatment sites within the Martin Creek and Sandy Creek watersheds that will result in a large-scale benefit by treating in-stream rather than on a site-by-site basis, thereby addressing both pre-law and post-law AMD problems which will ultimately restore the streams biological integrity.

The DEP applied for a variance to water quality standards that would enable the Special Reclamation Program to treat in-stream in lieu of at-source treatment. The variance, which was part of a larger rules bundle, was included in House Bill 117 which passed on June 2, 2016 and went into effect on July 8, 2016. It is currently pending approval by the USEPA. The DEP is working with the USEPA to develop a watershed based NPDES permitting structure from within the framework of the Clean Water Act. DEP treatment sites within the watershed where the variance is applied would be covered by the watershed-based NPDES permit, and the DEP would be required to meet certain in-stream water quality limits at a pre-determined stream location. The reasoning behind this approach is to enable DEP to use its' money more wisely and accomplish more by treating in-stream, thereby addressing pre- and post-law AMD problems at comparable cost to what is currently being spent by treating at-source. In other words, if DEP is spending $200,000 on an annual basis at certain bond forfeiture AMD treatment sites within a particular watershed, that $200,000 could be used to place in-stream dosers at strategic locations within the watershed to restore stream miles on a watershed basis, rather than discharging compliant water into "dead" streams.

The DEP has entered into a contractual agreement with WRI to conduct in-stream treatment studies in two watersheds where a variance will be applied, Martin Creek and Sandy Creek. The purpose of these studies is to provide the DEP with data to guide future management decisions on the placement of dosers to treat these two watersheds on a watershed level. Following is a summary of their findings.

B. Study

The goal of the Clean Water Act (CWA) is to restore and protect the Nation's waters. West Virginia's Special Reclamation Fund (SRF), administered by the Department of Environmental Protection's Office of Special Reclamation, supports the goals of the CWA by treating acid mine drainage (AMD) discharges from post-1977 coal mines that have transferred their surety bonds and water treatment liabilities to the State. Known as bond forfeiture sites, the cost of treating their AMD discharges to CWA standards is high and, unfortunately, the treated water is commonly discharged to streams that are severely impaired due to AMD from pre-1977 abandoned mines.

Table 1 Summary of costs for in-stream vs. at-source dosing. Projected stream mile recovery anticipates completion of AMD projects either underway or planned.

Martin Creek	At-source treatment	In-stream treatment
O&M cost projection (years)	20	20
Annual O&M	$ 218,084	$ 145,533
Total Capital Cost	$ 4,825,824	$ 1,200,000
Total O&M	$ 4,361,684	$ 2,910,664
Total cost	$ 9,187,508	$ 4,110,664
Projected stream mile recovery*	**0**	**3.4**
Sandy Creek		
O&M cost projection (years)	20	20
Annual O&M	$ 189,568	$ 223,708
Total Capital Cost	$ 2,609,587	$ 1,444,032
Total O&M	$ 3,791,369	$ 4,474,166
Total cost	$ 6,400,955	$ 5,918,198
Projected stream mile recovery**	**0**	**10.8**

* With completion of the T&T AMD project
** With addition of a passive treatment unit at Barlow Portal

Thus, the expense of treating bond forfeiture sites is rarely reflected in-stream restoration benefits. This project explored a strategy for using SRF funds for permit compliance while restoring AMD impaired watersheds. It shifts the treatment from individual discharges to the receiving stream while achieving compliance at a point downstream in the watershed rather than at the point where discharge leaves the bond forfeited property. This reduces the number of treatment locations and allows treatment at stream locations with preexisting road access and the potential to restore the maximum number of stream miles. Most significantly, for less cost, it treats all of the acidity in the stream rather than the small fraction that originates at bond forfeiture sites. This study compared the costs and benefits of instream vs. at-source AMD treatment in two watersheds in northern West Virginia: Martin and Sandy Creeks, both in Preston County. Both streams are severely impaired by AMD and both contain a mix of abandoned mines and bond forfeitures and both discharge to major recreational water bodies: the Cheat River and Tygart Lake. The results (Table 1) indicate that instream dosing alone would not achieve adequate stream benefits but, when paired with ongoing or planned restoration projects, would restore 3.4 and 10.8 miles of Muddy Creek and Sandy Creek respectively. Costs for the in-stream options were less than the costs of current at-source treatment projects which restore zero stream miles. Projected 20-year costs for the two options indicate that in-stream dosing on Martin Creek would save $5,076,844 or a 55% cost reduction while in-stream dosing on Sandy Creek would save $482,757 or a cost reduction of 8%. The difference in cost savings is largely due to the smaller number of bond forfeiture sites in the Sandy Creek watershed.

For complete results the full report can be found in Appendix B of this report.

Special Projects

1. Off-Grid Solar Power Installation at Former Buffalo Coal Surface Mine Site Grant County, WV

The former Buffalo Coal surface mining complex is located in a rural section of western Grant County, WV approximately 4 miles from the community of Bismarck, and near Mt. Storm Lake. Buffalo Coal Company held active permits in this area since approximately 1980. Several hundred acres of surface mine land, both reclaimed and un-reclaimed, exist in the area. All surface mining activities in the area have ceased. Mining permits were revoked on Sept. 29, 2006 and associated bonds were forfeited.

AMD exists at several locations across the property. At one location, the location of this proposed project, AMD occurs year-round, with outfall flow rates from a few gallons per minute during dry weather conditions, up to several hundred gallons per minute during heavy precipitation periods. Since mining permits were revoked, AMD treatment is now under the direction and operation of DLR.

DLR performs AMD treatment at this location by adding lime directly to the impacted water via a mechanically operated liming station. This operation currently uses no electricity (no electricity is available to the immediate area), relying on gravity-feeding of lime and manually adjusting rates of lime addition to the outfall. After lime is added, treated water flows through a series of settling ponds, ultimately discharging into Fourmile Creek, then into Stony Creek. In winter months, the facility uses propane for heating purposes to keep the treated AMD from freezing during the lime treatment process. Due to the extreme winter weather that occurs in this area, with heavy snow and snow drifts making access roads impassable at times, combined with the sites remote location and extensive time requirements to reach the site, accessing the location on a regular basis to monitor and adjust lime addition rates is quite challenging, expensive, and at time dangerous, for DLR workers.

Since no electric lines are located in the area, and AMD treatment will be required for the next several years, DLR has been researching the possibility of utilization of an off-grid power supply to upgrade its liming operations. Specifically, DLR wants to upgrade its liming facility to an automated system, being able to adjust liming rates as needed. Installation and use of an automated system will significantly reduce long-term expenses associated with labor, travel and road upkeep.

Due to its location near the existing NedPower Mt. Storm wind farm facility, located approximately 2 miles east of the site, OSR worked in conjunction with the WVDOE to have a wind feasibility study performed. The study included the use of Sonic Detection and Ranging (SODAR) technology to record wind speeds and wind directions to evaluate existing wind speed conditions to determine if utilization of a wind turbine would supply needed power for an automated liming facility. The study concluded that, while suitable wind resources are available, the overall life-cycle cost of an appropriately-sized wind turbine, including turbine installation, anticipated maintenance costs and a turbine life span expectancy of well less than 20 years, a wind-generated power supple wasn't a favorable option as an off-grid power supply to meet long-term continuous power requirements for this project.

The DLR also researched solar power electrical generating systems. As part of this work, the site was visited by an experienced and licensed solar panel professional installer to get ideas and conceptual designs on how a solar panel array might be a suitable alternative to meet long-term power needs. The site has ample "sky-view" space available (locations available for a solar panel array which would not be shadowed by any surrounding features that would limit electric generation potential). Space is also available at the liming facility for locating batteries for power storage along with ancillary system control equipment. The simplicity of operation and minimal expected maintenance cost of solar panels, combined with a long-life operation of at least 25 years (25-year guarantee is the current industry standard for solar panels), makes this off-grid power generation alternative the most favorable for this project.

DLR has installed a solar panel array with battery storage for power that can be used as needed for automation of the liming facility. In the event insufficient power is available via the solar panels, due to prolonged days without sunlight and/or extensive snow on the panels, a propane generator will be utilized, with automated on/off components, for backup power. Since a propane tank is already located on-site (propane used for heating purposes), utilizing a propane generator is the most economical choice for backup power.

DLR will be partnering with multiple entities to educate various groups and agencies that may be considering solar powered electrical generation. Eastern Community and Technical College, located in nearby Moorefield, WV, is interested in using this project as an "in-the-field" training location for their renewable energy technician program.

The DLR is also currently working closely with the West Virginia Brownfields Assistance Centers, located at Marshall University and West Virginia University, on utilization of this site for educational opportunities pertaining to AMD treatment and the use of renewable energy. As surface mine sites are considered "brownfields" by definition, both Centers work with multiple groups and entities across the State on reutilization of former surface mine properties for new use, including renewable energy opportunities.

Finally, the DLR will partner with the West Virginia Division of Energy to showcase this project as a unique example of utilizing renewable energy in off-grid applications. The DEP will assist in creation of an educational and research project brochure for use jointly by the West Virginia Division of Energy, DLR and associated entities.

2. Geomorphic Landform Design as a Reclamation Option for the Royal Scot Coal Refuse Site, Greenbrier County, WV

The Office of Special Reclamation (OSR), Division of Land Restoration within the West Virginia Department of Environmental Protection (WVDEP) partnered with West Virginia University (WVU) and the US Department of Interior Office of Surface Mining, Reclamation, and Enforcement to identify best available technology options for reclamation of the Royal Scot refuse site located in Greenbrier County, WV. Implementing the new technology, Geomorphic Landform Design (GLD), has the potential to improve off-site water quality.

The overall goal of the project is to design, construct, and monitor an engineered reclamation that includes an engineered cap system with ground contouring to minimize precipitation infiltration and direct surface runoff using four engineered stream channels. The design replicates a mature natural landform that is in equilibrium with erosive forces and minimizes slope mass wasting and maintenance costs. The landform cap system uses a blend of 60% Compacted Coarse Coal Refuse to 40% short paper fiber (MGro™) as a growth medium.

In 2016, the completed objectives included the final design for the 45-acre Royal Scot site and a construction cost estimate with comparisons to the baseline design. The reclamation cost is estimated at $2,809,587 with overhead and profit. Project benefits are aimed at reducing long-term operation and maintenance costs through reduced environmental impact obtained from improved water quality; improved flood control; and reduced land reclamation and water liabilities to the State’s Special Reclamation Fund.

Plans for 2017 include advancing with a field site investigation and construction, validate the WVU laboratory material property test values for the coarse coal refuse, and to obtain construction parameters such as field compaction limits. A field mixing and grass growth study is planned at the site to evaluate the 60% refuse to 40% MGro blend. If proven successful, the technique can be part of a cost-effective solution to improve water quality at active and future refuse facilities, abandoned mine lands, bond forfeiture sites, and closed coal refuse impoundments within the Appalachian region.

For a more descriptive explanation of this project please refer to Appendix C

3. Golden Delicious Apple Orchard Project

The Central Appalachia Empowerment Zone (CAEZ) has an MOU with the WV National Guard (WVNG) and will also be partnering with West Virginia State University, West Virginia Department of Agriculture, and the Office of Coalfield Community Development, to reintroduce the Golden Delicious Apple Tree to its county of origin. With available land, water, labor and financial resources the Golden Delicious Apple presents a viable option to position Clay County as a player in national agriculture and tourism markets for West Virginia.

The reintroduction/ planting of the Golden Delicious Apple Trees as well as the apple industry in general in central West Virginia will create employment for a variety of positions such as marketing, picking, processing, etc. The overall goal of this project is to re-establish the Golden Delicious Apple tree in its county of origin and to bring enough apple trees in general to Central West Virginia to entice food processors and manufacturers to the region. For example, the Mott' s Facility in Aspers, Pennsylvania employees nearly 550 employees and consumes 10% of Pennsylvania's apple production or 40 million pounds. To produce that many apples, 50,000 trees are needed.

The Greendale Coal Apple Orchard Project, located in Clay County, is part of the initiative of the CAEZ to diversify the economy of Central West Virginia. The WVNG approached the OSR looking for abandoned mine sites, preferably in Clay County, to use as a test orchard. OSR reviewed numerous permit files and reclamation plans with the WVNG and Greendale Coal, S-73-83 was selected as the test site. Through joint discussions between the WVNG, DEP, and the landowner, the WVNG was able to lease approximately ten (10) acres of land from within the forfeited surface mine site. The WVNG cleared and prepared the 10 acres for planting. Afterwards, one thousand five hundred (1,500) saplings were planted by the WVNG and inmates from the Department of Corrections. The OSR purchased one thousand three hundred (1,300) bags of top soil which was placed in each hole prior to planting the saplings. This was to increase the survivability rate of the saplings, giving them more opportunity take root. Another enticing feature of the Greendale site is that OSR will be constructing an acid mine drainage (AMD) treatment facility on the site. The WVNG plans to experiment with irrigation on the site, using both raw, untreated AMD, and treated water. To suit the needs of the experiment OSR will incorporate access points for irrigation purposes throughout the treatment system, which could lead to potential cost benefits to the OSR considering the fact that for each 3,000 trees planted 18 gallons of water is consumed each day.

Central West Virginia's economy has been devastated by the downturn in the local coal industry. Much like the rest of the Appalachian coalfields, central West Virginia's economy was highly dependent on the extraction industries of coal and timber. With both industries struggling, it is more critical now more than ever that the area create a new industry that will help offset the highs and lows of its current economic base. It is also important that this new endeavor compliment a growing area of the economy in the region, tourism.

Central West Virginia is in need of a new economic engine to diversify its economy, add value to post mined property, and complement its tourist based economy. The apple industry is a growing industry that has natural ties to West Virginia. It impacts all aspects of an economy, from family owned farms to multimillion dollar investment by multinational companies. This initiative is already under way with a 3,000-tree orchard to be planted in 2016 and workshops being held about this opportunity. A large injection of apple trees to create the feedstock for food processing is necessary to establish the industry within central West Virginia.

Additional information on the Golden Delicious Apple Projects can be found in Appendix C or by contacting Jeff Wood at jeffrey.a.wood54.nfg@mail.mil.

NEW DEVELOPMENTS

1. Department of Environmental Protection's Exemption from the Review and Approval Requirements of the Division of Purchasing.

Senate Bill 474 amended §5A-3-3 of the Code of West Virginia, 1931, exempting the DEP's construction or reclamation contracts from the review and approval requirements of the Division of Purchasing. All construction or reclamation contracts will now be processed within the Purchasing Division of the DEP. This should allow for a better turn-around time on these types of projects as the DEP will have the advantage of focusing solely on DEP projects.

2. Master Service Agreement with the West Virginia Land Stewardship Corporation

The OSR has always been faced with a very demanding reclamation schedule for both land and water. Recent court rulings have required OSR to go back and reevaluate and/or redesign existing water treatment systems to meet more stringent water quality based effluent limits. This has delayed progress in becoming current with all reclamation activities. In an attempt to avoid hiring additional engineers, leaving OSR with long-term financial obligations (salaries) for a short-term problem, OSR began obtaining the services of consulting engineers, as was discussed earlier in this report. However, dealing with multiple consultants on multiple reclamation projects proved to be very time consuming for OSR engineers. To avoid consuming the time of OSR's engineers OSR sought assistance from the West Virginia Land Stewardship Corporation (WVLSC)

The WVLSC was created by state legislation in 2013 to lessen the burdens of government when government identifies a need for WVLSC to assist with land stewardship, safeguarding sites, and protecting the environment. The WVLSC is a collaborative effort among the public, private, and nonprofit sectors to provide West Virginia and its citizens a statewide, nonpartisan land stewardship, community and economic development non-profit corporation.

On February 1, 2016, the WVDEP granted funding to the WVLSC for the purpose of implementing Special Reclamation Program Assistance Pilot Project (Project # VLSP-15-01) for the LaRosa Fuels site. The pilot project has been successful in demonstrating the WVLSC capacity to develop an Architectural/Engineering (A/E) Expression of Interest (EOI) documents, conduct legal advertisement, convene an EOI Evaluation Team for the review and ranking of qualified A/E firms, and the final selection of the A/E firm. The WVLSC successfully executed a Master Services Agreement (MSA) with the A/E firm to conduct the project site tour and subsequently submit a Proposed Scope of Work for OSR review and comment. The OSR approved Scope of Work was executed with a Work Order on October 26, 2016. At the request of OSR, WVLSC seeks to further enhance the capacity of OSR professional staff on land reclamation and water treatment design and construction activities for an additional six reclamation projects consisting of 10 sites by performing the same Project Tasks required in the LaRosa Fuels Pilot Project. The WVLSC and OSR have agreed that efficiency can be enhanced by modifying the EOI process to allow for an open-ended assignment of projects to multiple qualified A/E firms selected for qualification in water treatment and for land reclamation.

3. Partnership with Southwestern Energy Production Company, LLC

Southwestern Energy Production Company, LLC (SWN) is the third largest producer of natural gas in the lower 48. They are an independent energy company primarily engaged in natural gas and crude oil exploration, development and production. In late 2014 and early 2015, SWN acquired approximately 425,098 net acres in West Virginia and southwestern Pennsylvania targeting natural gas, natural gas liquids and crude oil in the Marcellus, Utica and Upper Devonian Shales.

In 2012, SWN launched their ECH2O, Energy Conserving Water, program to support their commitment to be neutral regarding their use of fresh water in their operations by 2016. Simply put, their commitment means that for each gallon of fresh water they use in their operations, they will replenish or offset an equivalent amount through conservation and innovation. They are committed to demonstrating it is possible to offset the volume of water used to become net neutral. Taking the lead is part of their Value+ approach. By working proactively, they plan to take a balanced approach to developing energy for our country and achieve their goal. SWN believes reaching for this goal is not only the right thing to do, but it will deliver extra value both economically and for the environment. Over the next three years, SWN will focus on four key areas: **Conservation, Reduction, Protection and Innovation.**

Conservation – SWN has made water sourcing and conservation a priority and even have an on-staff team of specialists continually reviewing current practices with the goal of creating better solutions. They work with state agencies, municipalities, non-governmental organizations and other industries to enhance water quality and develop conservation projects that effect local watersheds. SWN will create partnerships with other industries to improve water availability through mutually beneficial projects.

Reduction - SWN will reduce fresh water demand by decreasing the total volume of water needed, or replace fresh water with alternatives, such as recycled fluids or non-potable water sources. In 2012, their water reduction efforts in the Fayetteville Shale led to 100% recycling of flow back fluid and reduction in total water use of 12% on average across all wells completed compared to 2011.

Protection - SWN will protect water resources, minimizing their impact on natural resources and watersheds where they work. Working with the Nature Conservancy, SWN has developed Stream Smart to provide industry leading practices ensuring effective sedimentation and erosion control.

Innovation - SWN pursues innovative technologies that will provide new means for water treatment or new ways of replacing water. They take a leadership role in pursuit of new drilling and completions technologies directed at reduction in water use.

SWN has been working with West Virginia Department of Environmental Protection, Division of Land Restoration's Office of Special Reclamation on a potential project to collect and convey AMD sources in the Muddy Creek watershed to the T&T Treatment Plant currently under construction. As was discussed earlier in this report, the Muddy Creek watershed is a major contributor of AMD pollution to the Cheat River. Although SWN is not a contributor to the AMD they do operate in the general area, utilize water in their operations and are concerned about water quality. The goal of this potential Partnership Project between SWN, OSR and AML is to restore water quality in Muddy Creek to a condition that will support aquatic life and further improve water quality in the Cheat River. In total, the Project is anticipated to collect and transport an average of 1200 gallons per minute (gpm) to the T&T Treatment Plant for processing and discharge.

SWN has sent DEP a conditional letter of commitment in support of the Project. Subject to the conditions established in the letter, SWN is prepared to provide, as a contribution to the governmental agency owning the Project, funds necessary to construct the Project up to $2,500,000 and for the related operation and maintenance of the pipelines conveying the waters under the Project up to $375,000 per year for up to 5 years from 2017 through 2021.

2017 SRFAC Study Issues

- Actuarial analysis of the SRF and SRWTF.
- Consensus Coal Production Forecast
- Continue Review of DMR database:

The SRFAC is continuously looking for ways to improve the ability to project future forfeitures. The DMR database of open permits is the primary source of information used for the biennial actuarial analysis of the SRF and SRWTF. The analysis relies heavily on information obtained from forfeited permits and applied to current permits to project future forfeitures.

The SRF would like to explore options to increase the linkages of data from past forfeitures to open permits, to improve the predictive power of historical data. Some pieces of data that may be available in the permit databases that have not been previously utilized include:

- length of time a permit had a particular status
- number of times a permit changed status
- groupings with other permits (proximity or use)
- annual coal production associated with a permit or group of permits

The SRFAC recognizes that not all these pieces of data are available, even in open permits, and may no longer be available for permits that forfeited many years ago, but would like to explore the ability to enhance the information available that can help quantify risk. The database will need to be cleaned and augmented prior to the appointment of the actuary.

Special Reclamation Fund Advisory Council Recommendations to the Legislature

Based upon conclusions drawn from information included in this report, the Council makes the following recommendations to the Legislature:

The Council recommends that the present 12.9 cent per ton tax dedicated to the Fund remain in force and that the tax dedicated to the SRWTF remain at 15 cents per ton. The Council further recommends that the State Legislature form a panel to examine the elements of our State code that result in uncontrolled liabilities, how other states deal with such issues and finally to propose a State legislative initiative to rationalize water quality regulation to meet the conditions of the Federal Clean Water Act while adding rationality and certainty to the process.

The Council recommends that the Legislature continue to examine the implications of the recent court rulings and subsequent lawsuit settlements on the Special Reclamation Fund, Abandoned Mine Lands, and voluntary efforts by citizen-led watershed groups to address historic mining-reclamation related liabilities. The Council further recommends that the Legislature examine the mine reclamation and bonding programs of other states and as implemented in Tennessee by the federal Office of Surface Mining in order to determine if the statute and regulations creating the Fund and SRWTF in West Virginia have inappropriately structured SMCRA to assume long-term CWA liabilities. The Council further recommends the Legislature examine the separate and distinct authorities of the Clean Water Act (CWA) in assessing the eligibility of future forfeitures for transfer of liabilities to the SRWTF. The Council is concerned about default transfer of water treatment liability to the SRWTF when opportunities exist to pursue responsible parties under the CWA per the requirements of an NPDES (CWA Section 402) permit.

The Council would like to recognize the DEP for their conscientious management of the Fund and the SRWTF and their efforts in minimizing the impacts of bankruptcies to the Funds.

Special Reclamation Fund Advisory Council
Annual Report to the Legislature
March 10, 2017

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Wright, Dianna D

From: John Morgan <John.Morgan@respec.com>
Sent: Monday, March 20, 2017 2:30 PM
To: Wright, Dianna D
Subject: Re: Annual Report Signature Page

Dianna,
Just trying to catch up and my apologies for the delay in getting back to you.
I have no problem in approving Mike to sign in my behalf. Thanks for thinking of it.

John S L Morgan

Appendices for 2016 SRF Advisory Council Annual Report (All Appendices as of 12-31-16)

A. DEP Graphs:

Land and Water Permits Scheduled by Quarter and Projects Completed
Land Permits To Be Contracted
Land Liabilities To Be Contracted
Permits Forfeited Since 6-30-01
Reclamation Projects Started Since 6-30-01
Contract Dollars Encumbered
Cash Balance
Total Revenue
Revenue Collected by Source: Bonds, Civil Penalties, Tax

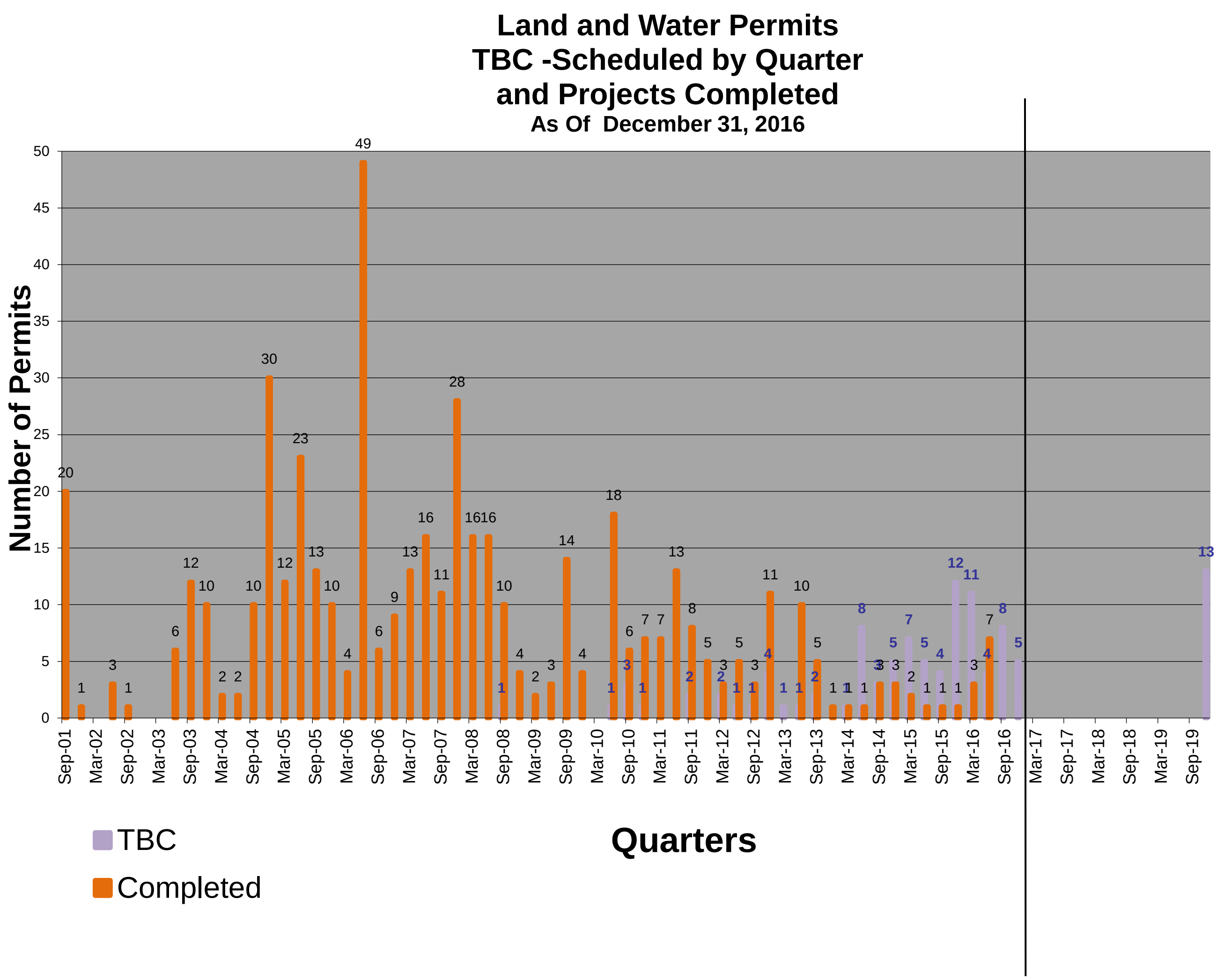
B. Reports Commissioned by the Council

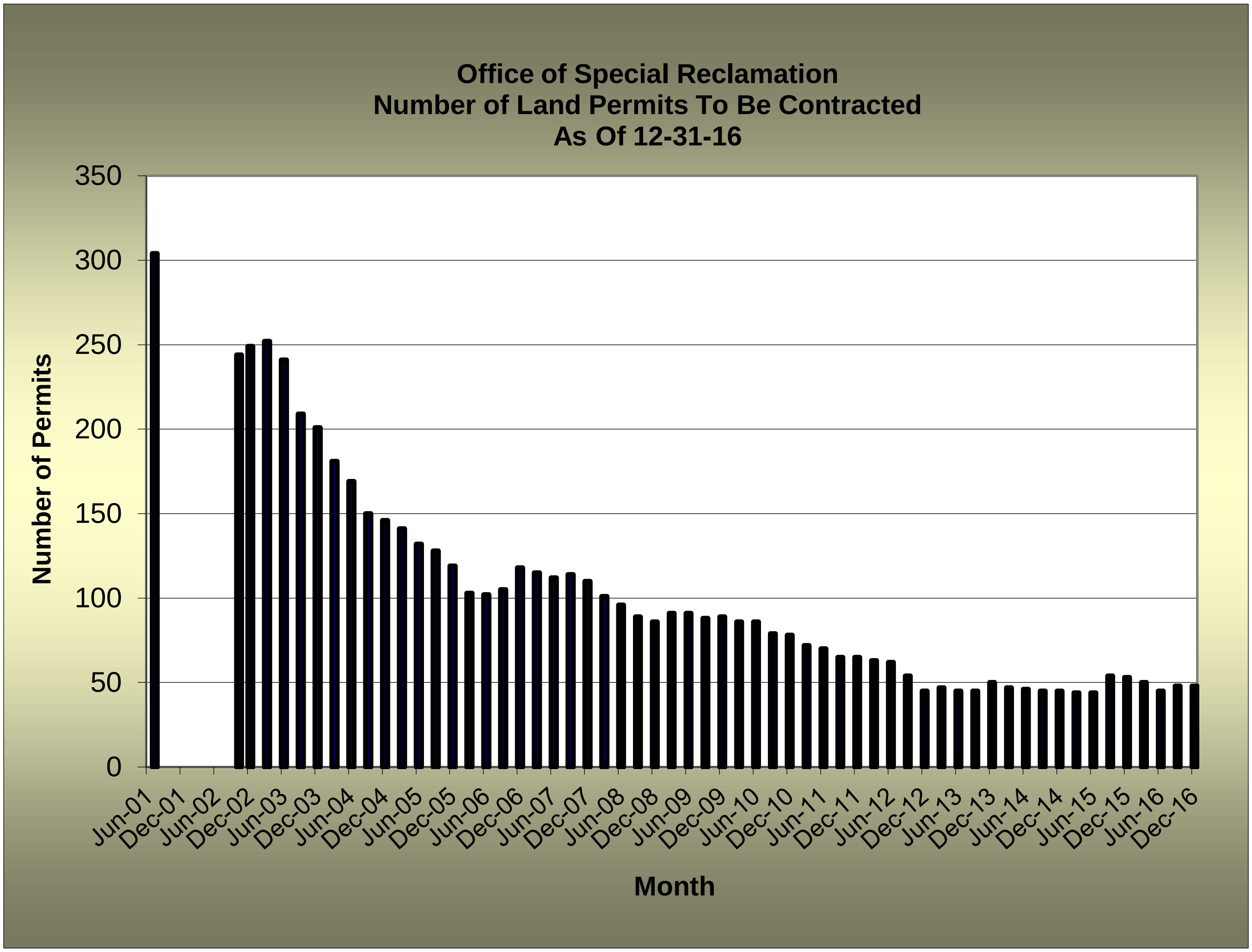
- **a.** 2016 Consensus Coal Production Forecast for West Virginia
- **b.** Watershed Scale Approaches to AMD Remediation: Martin Creek and Sandy Creek
    - i. Wv342 4dec15.pptx - Martin Creek AMD Treatment Project

C. Special Projects

- **a.** Geomorphic Landform Design as a reclamation option for the Royal Scot coal refuse site, Greenbrier County, WV
- **b.** *A Golden Apple Opportunity* - An Initiative of the Central Appalachia Empowerment Zone of West Virginia To Diversify the Economy of Central West Virginia.

Appendix A


Land and Water Permits
TBC -Scheduled by Quarter
and Projects Completed
As Of December 31, 2016
Number of Permits
Quarters
TBC
Completed


Office of Special Reclamation
Number of Land Permits To Be Contracted
As Of 12-31-16
Number of Permits
350
300
250
200
150
100
50
0
Jun-01
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
Jun-04
Dec-04
Jun-05
Dec-05
Jun-06
Dec-06
Jun-07
Dec-07
Jun-08
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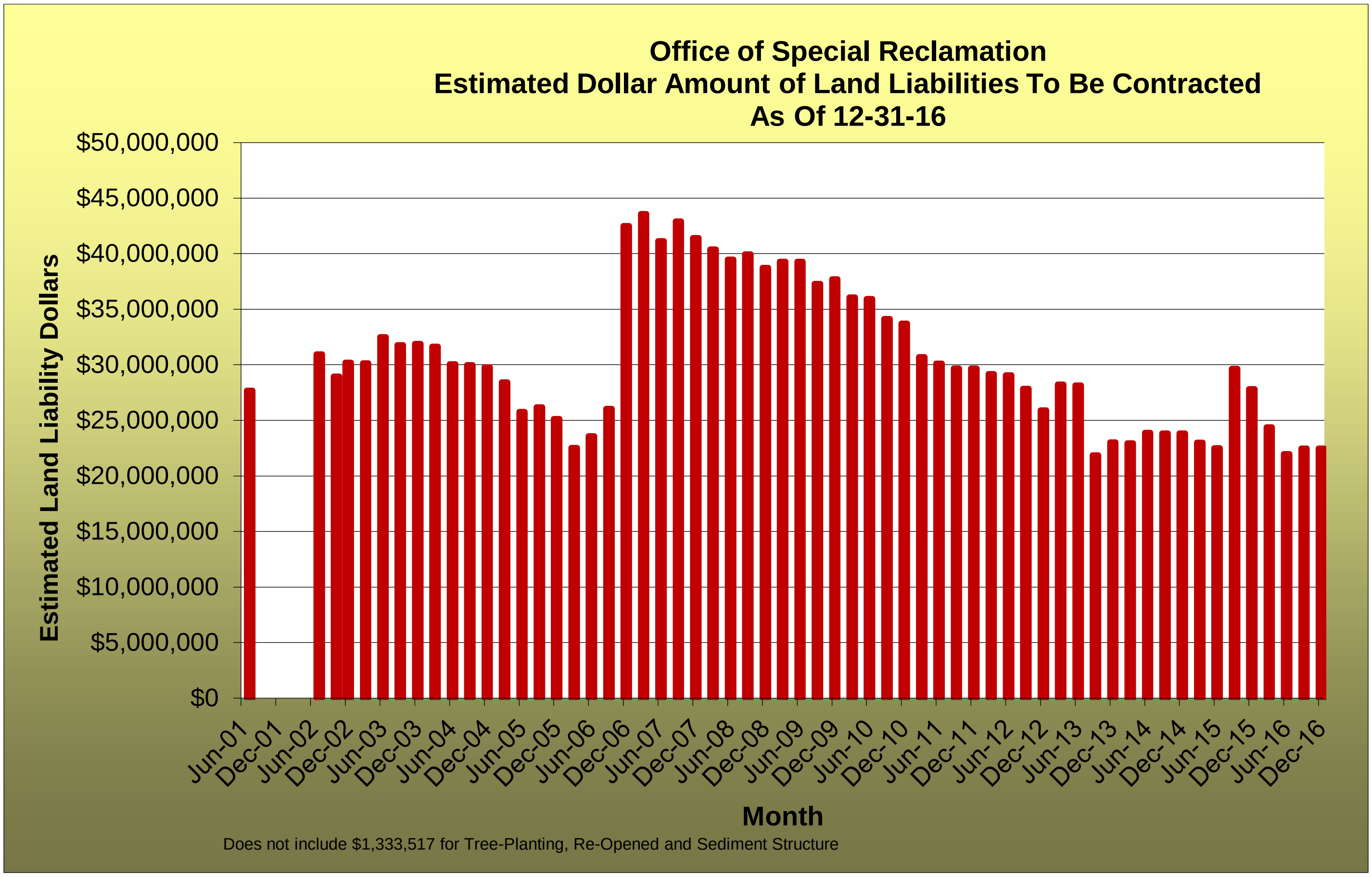
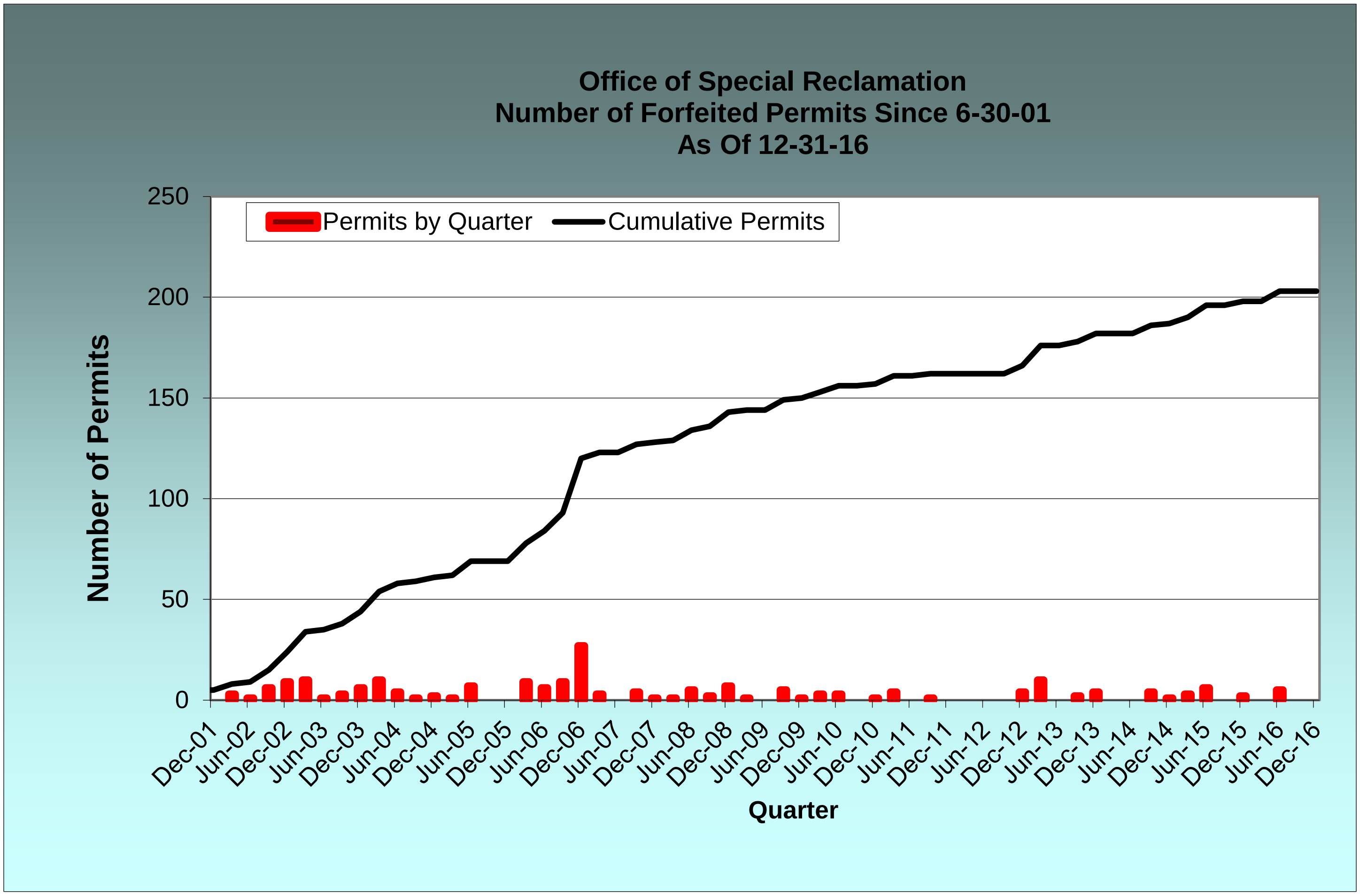
Jun-16
Dec-16
Month


Office of Special Reclamation
Estimated Dollar Amount of Land Liabilities To Be Contracted
As Of 12-31-16
Estimated Land Liability Dollars
$50,000,000
$45,000,000
$40,000,000
$35,000,000
$30,000,000
$25,000,000
$20,000,000
$15,000,000
$10,000,000
$5,000,000
$0
Jun-01 Dec-01 Jun-02 Dec-02 Jun-03 Dec-03 Jun-04 Dec-04 Jun-05 Dec-05 Jun-06 Dec-06 Jun-07 Dec-07 Jun-08 Dec-08 Jun-09 Dec-09 Jun-10 Dec-10 Jun-11 Dec-11 Jun-12 Dec-12 Jun-13 Dec-13 Jun-14 Dec-14 Jun-15 Dec-15 Jun-16 Dec-16
Month
Does not include $1,333,517 for Tree-Planting, Re-Opened and Sediment Structure


Office of Special Reclamation
Number of Forfeited Permits Since 6-30-01
As Of 12-31-16
Permits by Quarter
Cumulative Permits
Number of Permits
250
200
150
100
50
0
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
Jun-04
Dec-04
Jun-05
Dec-05
Jun-06
Dec-06
Jun-07
Dec-07
Jun-08
Dec-08
Jun-09
Dec-09
Jun-10
Dec-10
Jun-11
Dec-11
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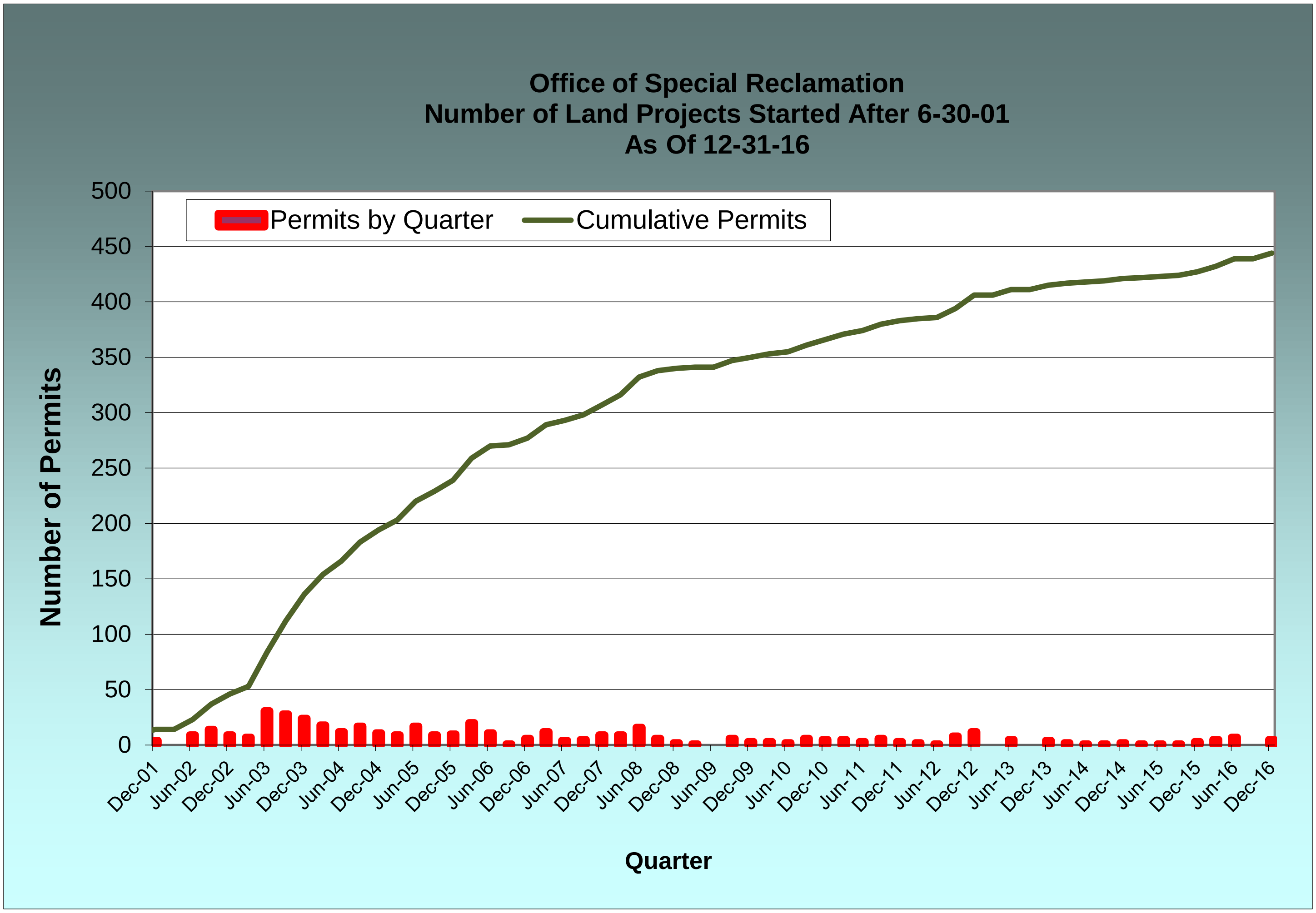
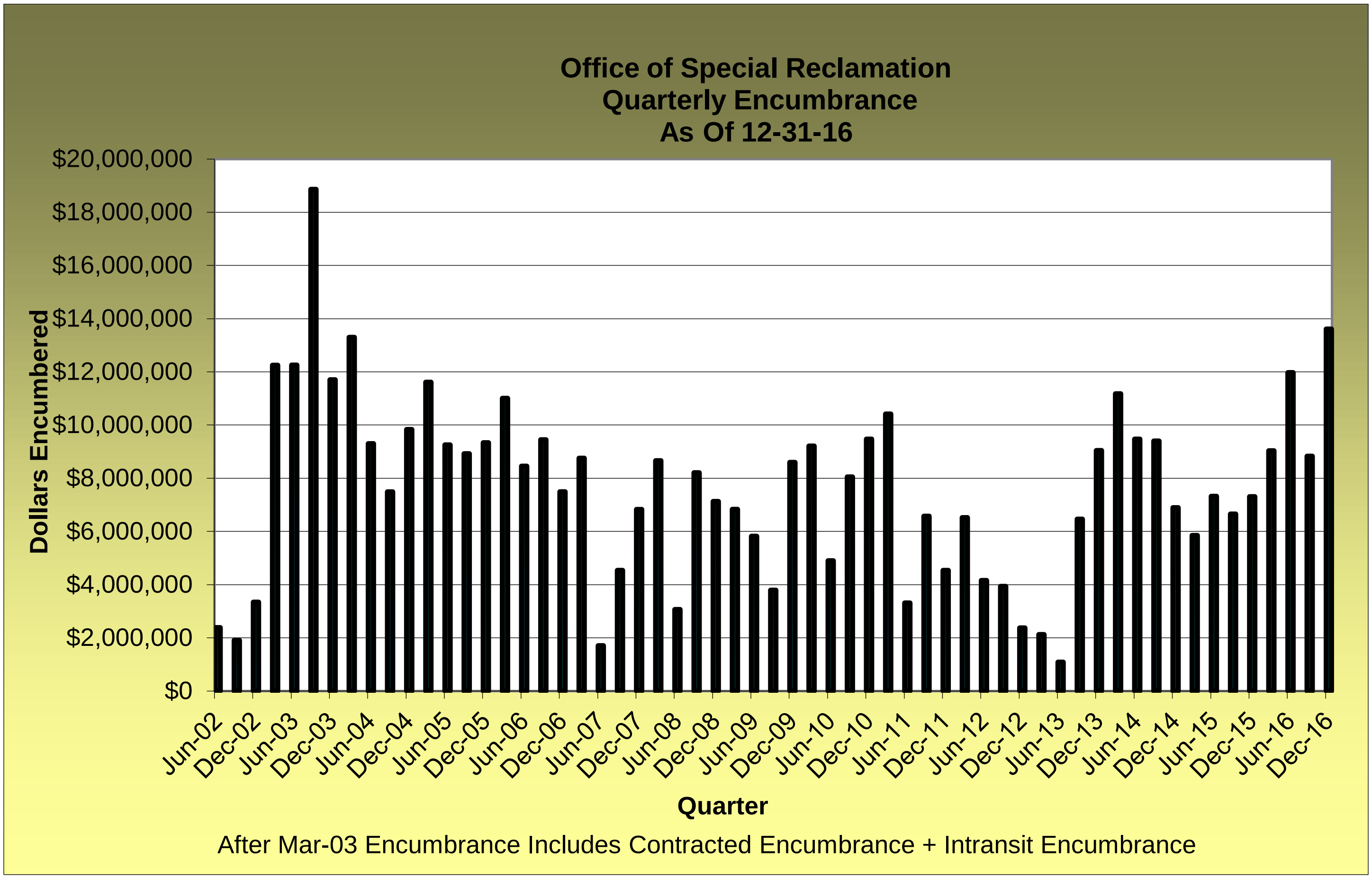
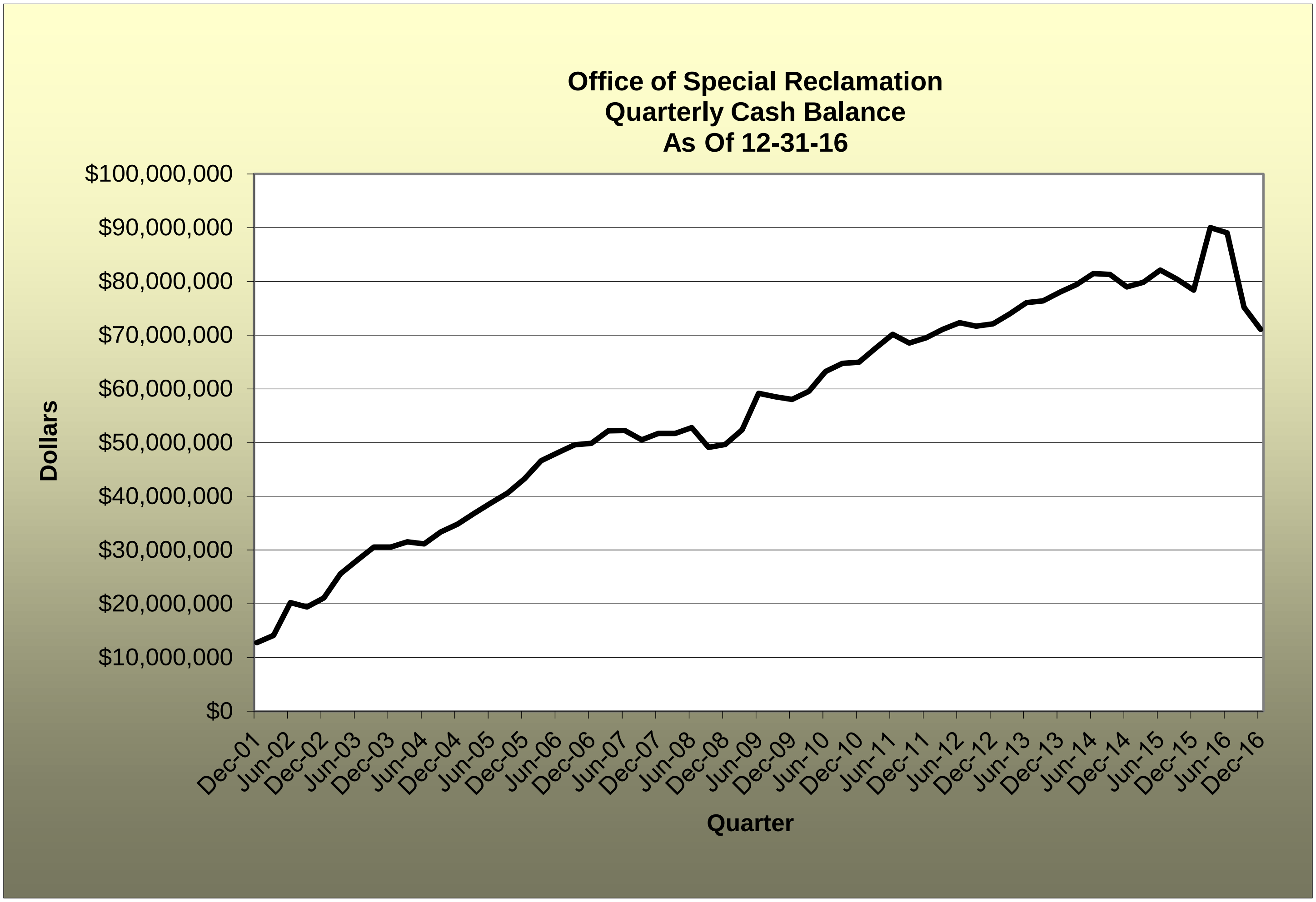
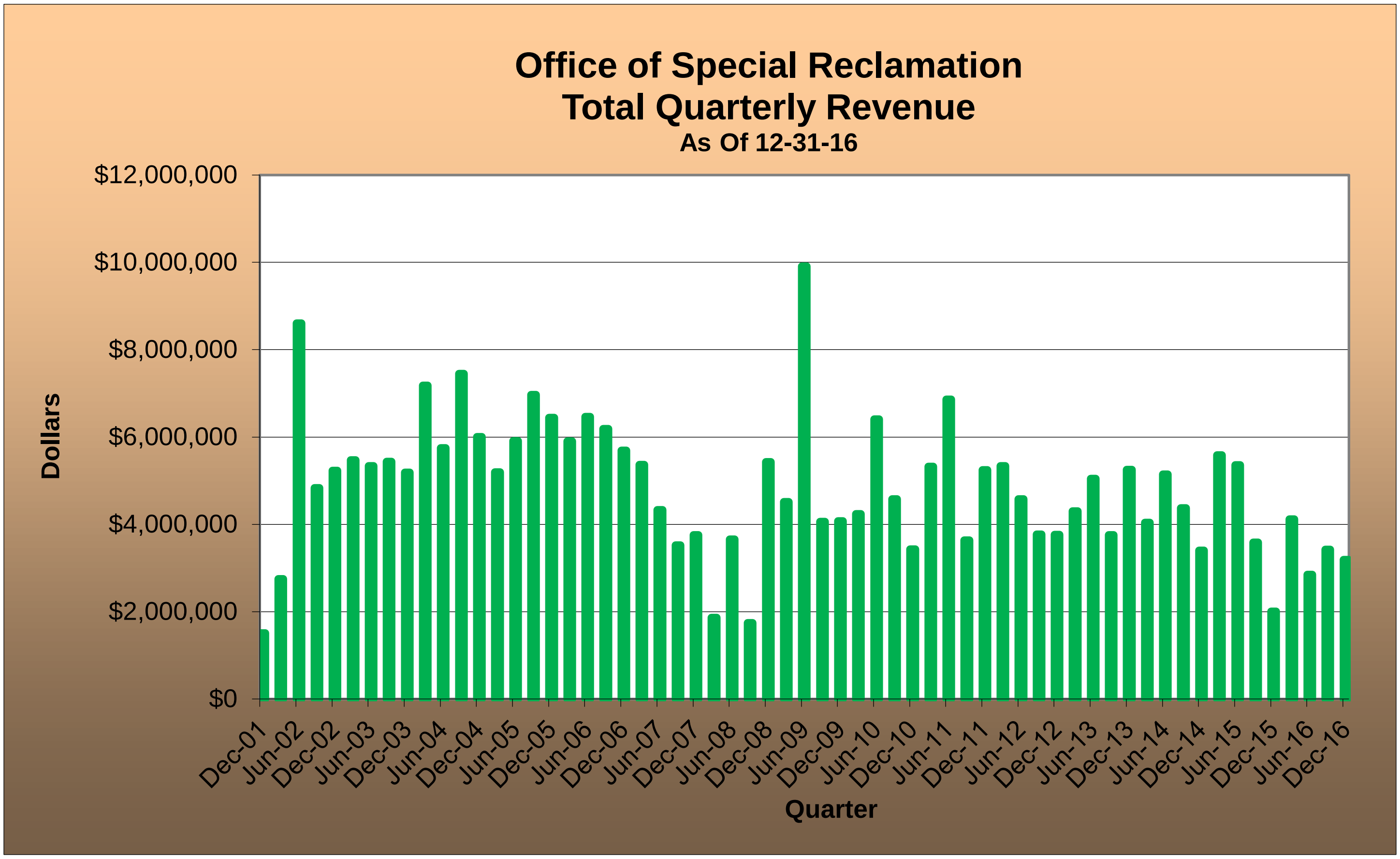
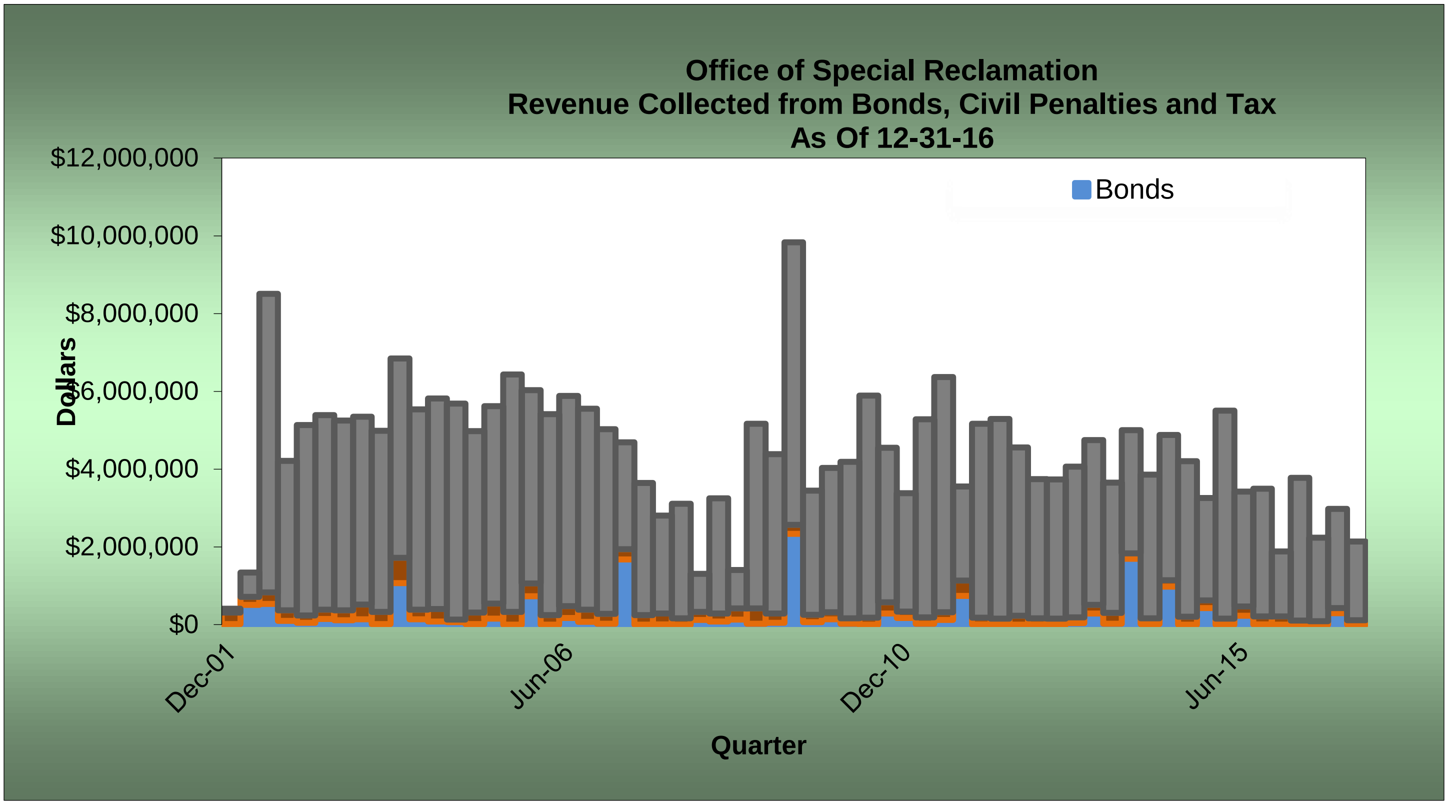
Dec-12
Jun-13
Dec-13
Jun-14
Dec-14
Jun-15
Dec-15
Jun-16
Dec-16
Quarter


Office of Special Reclamation
Number of Land Projects Started After 6-30-01
As Of 12-31-16
Permits by Quarter
Cumulative Permits
Number of Permits
0
50
100
150
200
250
300
350
400
450
500
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
Jun-04
Dec-04
Jun-05
Dec-05
Jun-06
Dec-06
Jun-07
Dec-07
Jun-08
Dec-08
Jun-09
Dec-09
Jun-10
Dec-10
Jun-11
Dec-11
Jun-12
Dec-12
Jun-13
Dec-13
Jun-14
Dec-14
Jun-15
Dec-15
Jun-16
Dec-16
Quarter


Office of Special Reclamation
Quarterly Encumbrance
As Of 12-31-16
Dollars Encumbered
$20,000,000
$18,000,000
$16,000,000
$14,000,000
$12,000,000
$10,000,000
$8,000,000
$6,000,000
$4,000,000
$2,000,000
$0
Jun-02
Dec-02
Jun-03
Dec-03
Jun-04
Dec-04
Jun-05
Dec-05
Jun-06
Dec-06
Jun-07
Dec-07
Jun-08
Dec-08
Jun-09
Dec-09
Jun-10
Dec-10
Jun-11
Dec-11
Jun-12
Dec-12
Jun-13
Dec-13
Jun-14
Dec-14
Jun-15
Dec-15
Jun-16
Dec-16
Quarter
After Mar-03 Encumbrance Includes Contracted Encumbrance + Intransit Encumbrance


Office of Special Reclamation
Quarterly Cash Balance
As Of 12-31-16
$100,000,000
$90,000,000
$80,000,000
$70,000,000
$60,000,000
$50,000,000
$40,000,000
$30,000,000
$20,000,000
$10,000,000
$0
Dollars
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
Jun-04
Dec-04
Jun-05
Dec-05
Jun-06
Dec-06
Jun-07
Dec-07
Jun-08
Dec-08
Jun-09
Dec-09
Jun-10
Dec-10
Jun-11
Dec-11
Jun-12
Dec-12
Jun-13
Dec-13
Jun-14
Dec-14
Jun-15
Dec-15
Jun-16
Dec-16
Quarter


Office of Special Reclamation
Total Quarterly Revenue
As Of 12-31-16
Dollars
$12,000,000
$10,000,000
$8,000,000
$6,000,000
$4,000,000
$2,000,000
$0
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
Jun-04
Dec-04
Jun-05
Dec-05
Jun-06
Dec-06
Jun-07
Dec-07
Jun-08
Dec-08
Jun-09
Dec-09
Jun-10
Dec-10
Jun-11
Dec-11
Jun-12
Dec-12
Jun-13
Dec-13
Jun-14
Dec-14
Jun-15
Dec-15
Jun-16
Dec-16
Quarter


Office of Special Reclamation
Revenue Collected from Bonds, Civil Penalties and Tax
As Of 12-31-16
$12,000,000
$10,000,000
$8,000,000
$6,000,000
$4,000,000
$2,000,000
$0
Dollars
Bonds
Dec-01
Jun-06
Dec-10
Jun-15
Quarter

Appendix B

Consensus Coal Production Forecast for West Virginia: 2016

Prepared for:

Special Reclamation Fund Advisory Council,

West Virginia Department of Environmental Protection

Date:

September 2016

CBER
Center for Business and Economic Research

Consensus Coal Production Forecast for West Virginia: 2016

Authors:

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Huntington, West Virginia 25701

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Executive Summary

The 2016 West Virginia Consensus Coal Production Forecast is an annual projection developed to anticipate the volume of tax revenues likely to be received for mandatory reclamation activities undertaken by the Special Reclamation Fund and the Special Reclamation Water Trust Fund. The Consensus calculates projected West Virginia coal production for the years 2016 through 2040.

The consensus forecast projects West Virginia coal production to decline to about 80 million tons in 2016, remain flat for a few years, and then decline to 57 million tons by 2040. Examination of recent trends in demand for West Virginia coal show declines since 2012 led by reduced exports. Since 2012, demand by the power generation industry has been flat, while demand by the commercial and industrial sectors has slowly declined.

The 2016 forecast figures are lower than the 2015 Consensus, in part due to inclusion of possible effects of the EPA's Clean Power Plan rule for regulating carbon dioxide emissions from power plants. The potential effects of the rule are included in two of the component forecasts, while two forecasts do not explicitly include the rule.

The four component forecasts that comprise the consensus are from the U.S. Energy Information Administration (EIA), Energy Ventures Analysis (EVA), Marshall University's Center for Business & Economic Research (CBER) and West Virginia University's Bureau for Business & Economic Research (BBER). The EIA and EVA models explicitly include potential effects of the Clean Power Plan, whereas the CBER and BBER models do not. The EIA maintains the highest share of the consensus due to the relatively high historical accuracy of its forecasts.

Expectations are for most of the projected near-term decline in demand for West Virginia coal to come from the power generation industry. This is due both to persistent low prices for natural gas used for competing generation and to pending retirements of coal-fired generating capacity in the region at plants that are customers of West Virginia coal. Natural gas prices are expected to rise throughout the forecast time period and mitigate some of the potential decline. However, when combined with plant closure and the potential impacts of the Clean Power Plan, the net effect is for demand to continue to fall.

Consensus Coal Production Forecast for West Virginia: 2016

Introduction

The West Virginia Consensus Coal Production Forecast is a combined production forecast comprised of four component forecasts. A consensus approach to forecasting seeks the "wisdom of crowds" in producing an expectation for output from the coal industry (Armstrong 2001). The Consensus Forecast is used to provide the best expectation of tax revenues to be collected for mandatory reclamation activities conducted through the Special Reclamation Fund and the Special Reclamation Water Trust Fund.

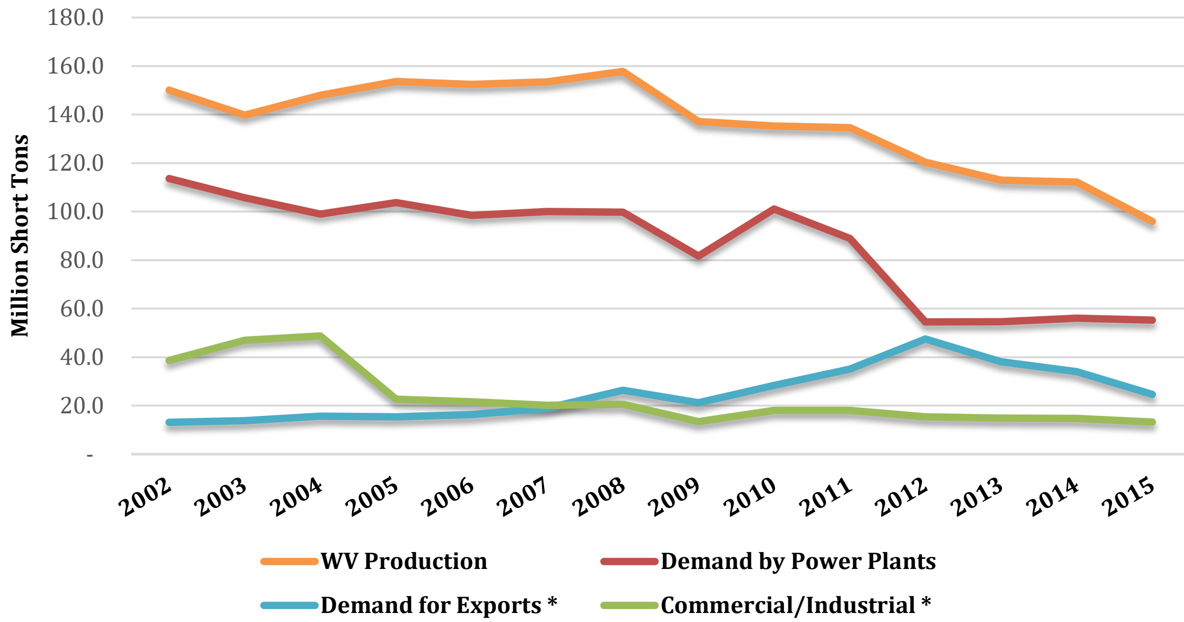
This report describes recent historical coal production trends for the State of West Virginia including the individual industries that comprise the major segments of demand. Each of the component forecasts used to form the Consensus Forecast is then described, with information about assumptions and resulting projected levels of production for West Virginia. The process used to produce the Consensus is also described, including the weightings applied to each of the component forecasts. The West Virginia Consensus Coal Production Forecast is calculated for the years 2016 through 2040.

Overview

West Virginia coal production for 2015 was around 95.5 million tons (EIA 2016),[1] a decline of about 14 percent from the 111.9 million tons produced in 2014. This decline reflects various trends and events within the coal industry's primary markets: power generation, exports and industrial demand as well as expectations regarding environmentalc policy. Figure 1 shows recent demand trends with preliminary and estimated sector-level data for 2015.

[1] 95.5 million tons is the Energy Information Administration's revised 2015 production value based on the final 2015 value published by MSHA (clean coal production reported on MSHA Form 7000-2). The West Virginia Office of Miner's Health, Safety and Training reports 2015 production of 102.9 million tons, but this is not exclusively clean coal which is the final production volume.

Figure 1: Historical West Virginia Coal Production and Components of Demand



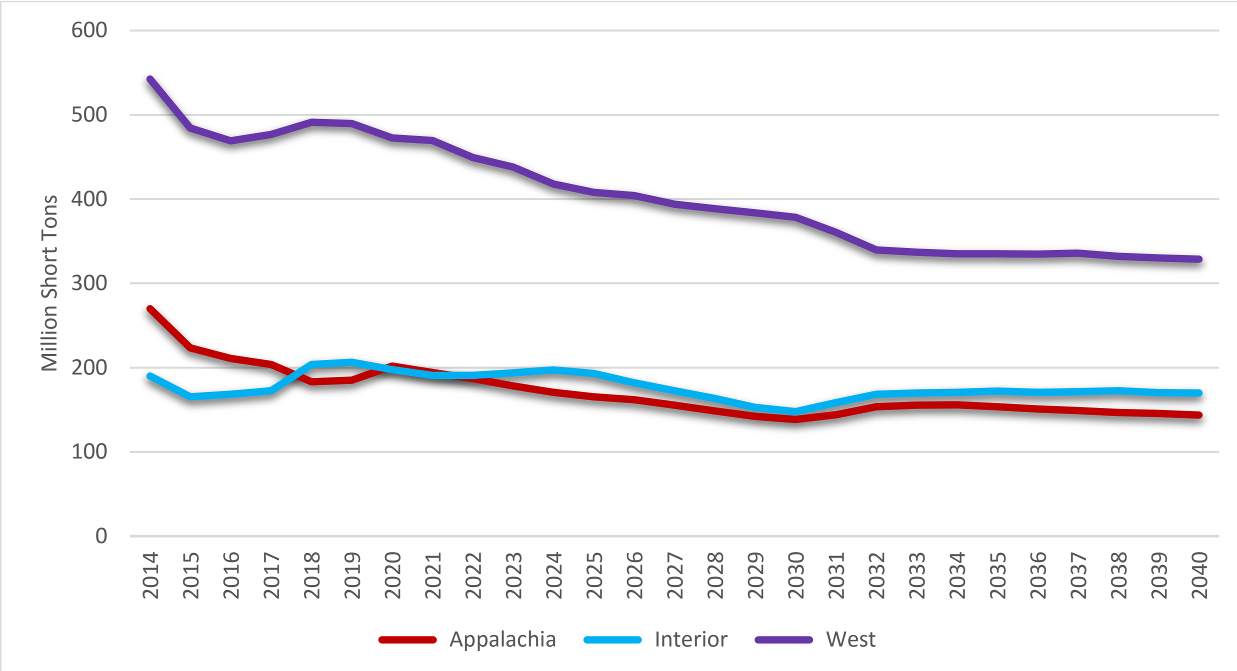
Source: (EIA 2016). Asterisked (*) 2015 volumes estimated by MU CBER. Other 2015 figures are preliminary by EIA.

Future demand for West Virginia coal depends on several variables. These include the price(s) paid by gas-fired electrical generators for natural gas in the region, the lifespan and generation levels of the coal-fired power plants that will continue to burn coal from the State, exchange rates and the rate of economic growth of countries that import West Virginia coal, and the nature of compliance with environmental regulations.

The Energy Information Administration's (EIA) Annual Energy Outlook (AEO) 2016 base case model forecasts Appalachian coal production to decline steadily through 2040, with some stability in the 2017 to 2021 and 2028 to 2032 time periods. As shown in Figure 2, stable Interior[2] coal production is projected to surpass declining Appalachian production after 2017.

[2] Arkansas, Illinois, Indiana, Iowa, Kansas, Western Kentucky, Louisiana, Mississippi, Missouri, Oklahoma, and Texas.

Figure 2: EIA Forecasted Coal Production, by Region



Source: (EIA 2016)

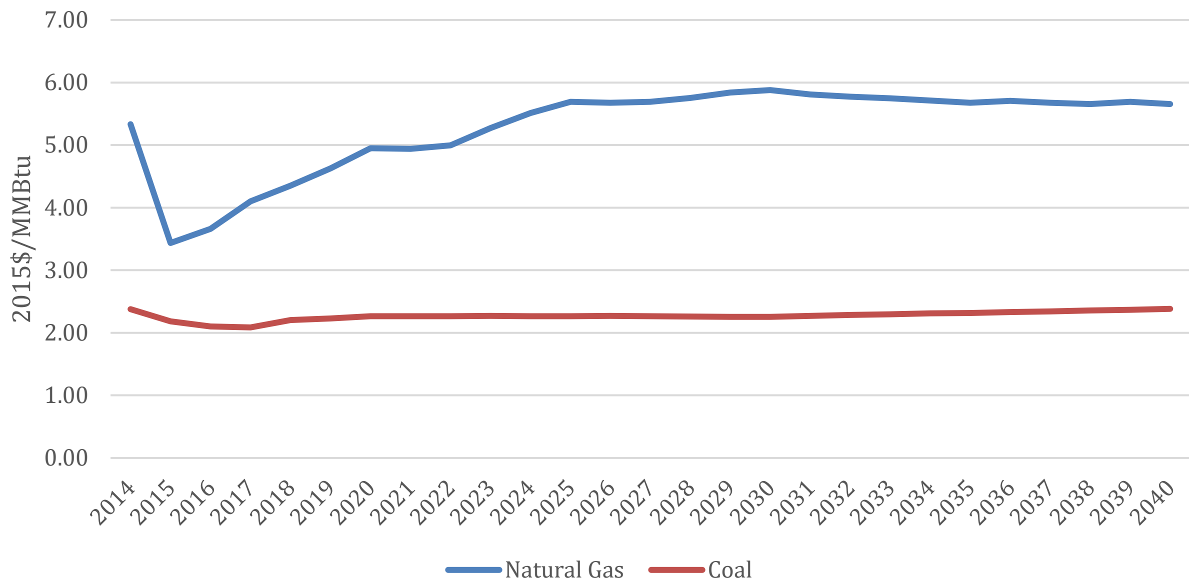
The Electricity Sector

Preliminary power plant fuel receipts data for 2015 published by the EIA indicate that demand for West Virginia-produced coal by the electricity sector fell slightly in 2015, to about 55.3 million tons, compared to about 56.1 million tons in 2014 (EIA 2016). Demand for West Virginia coal by the power generation industry declined by only 1.4 percent between 2014 and 2015 while total electric power industry coal consumption fell by nearly 13 percent (EIA 2016). A large contributor to coal demand is the price of natural gas, which fell in 2015, with the average U.S. price for the electric power sector declining to $3.35/mcf from $5.20/mcf in 2014 (EIA 2016).

Natural Gas Prices

Similar to many forecasts, in its AEO 2016 Reference Case analysis the EIA continues to project gas prices delivered to the power generation sector to increase at a faster rate than coal prices (see Figure 3). Rising natural gas prices are expected to moderate declining coal demand. However, abundant gas production from the Marcellus play continues to result in particularly low gas prices in that area one in which West Virginia coal competes. In 2015, Marcellus-area prices continued to trade at a discount to the Henry Hub price, the national benchmark for natural gas. Recent prices for Zone 4 Marcellus gas, a hub in northeast Pennsylvania, and Dominion South, a hub in southwest Pennsylvania illustrate this differential. Through June of 2016, prices at these hubs have been in the range of 50 to 75% of the Henry Hub price.[3]

Figure 3: Forecasted Natural Gas & Coal Prices to Electricity Sector[4]



Source: (EIA 2016)

Coal-Fired Power Plant Retirements

Since 2015, no additional units at coal-fired power plants in West Virginia have closed. However, other coal-fired plants in the region that consume West Virginia coal have announced plans to retire. These include new plans, such as those to close units at Sammis in Ohio (The Plain Dealer 2016), as well as other previously announced closures such as the Asheville plant in North Carolina (The Charlotte Observer 2016) and the Yorktown plant Virginia (The Daily Press 2016).

Environmental Regulation

The potential impact of the EPA's Clean Power Plan (CPP) rule is included in two of the component forecasts that comprise the West Virginia Consensus Forecast, those from EIA and Energy Ventures Analysis (EVA). The EPA finalized the CPP in 2015, but the Supreme Court stayed the rule in 2016 due to pending litigation (EIA 2016). Because of the stay, some forecasters exclude the CPP from baseline forecasts.

---

[3] EIA, *Natural Gas Weekly Update*, January through June of 2016.

[4]Natural gas prices were converted from 2015$/Mcf to 2015$/MMBtu using a factor of 0.9756.

EIA's base case forecast does include the impact of the Clean Power Plan. Due in part to this rule, EIA projects declines in consumption of coal for power generation at a rate of 1.6 percent per year through 2040.

The Industrial Sector

As shown previously in Figure 1 demand for West Virginia coal by the industrial sector (coke plants and self-generating manufacturers, including coal-fired combined heat and power plants) continues a slow and steady decline driven by a decline in demand for metallurgical coal. EIA's national-level projections forecast a decline in industrial demand for coking coal through 2040, at an annualized rate of 1.2 percent, and an increase in other industrial demand at a rate of 0.6 percent per year (EIA 2016).

U.S. imports of steel products have declined since mid-2015. According to data published by the U.S. Department of Commerce International Trade Administration (ITA) imports of steel mill products in the first half of 2016 were about 31% lower than for the first half of 2015 (ITA 2016). The effect of this decline on demand for steel produced in the U.S. is uncertain.

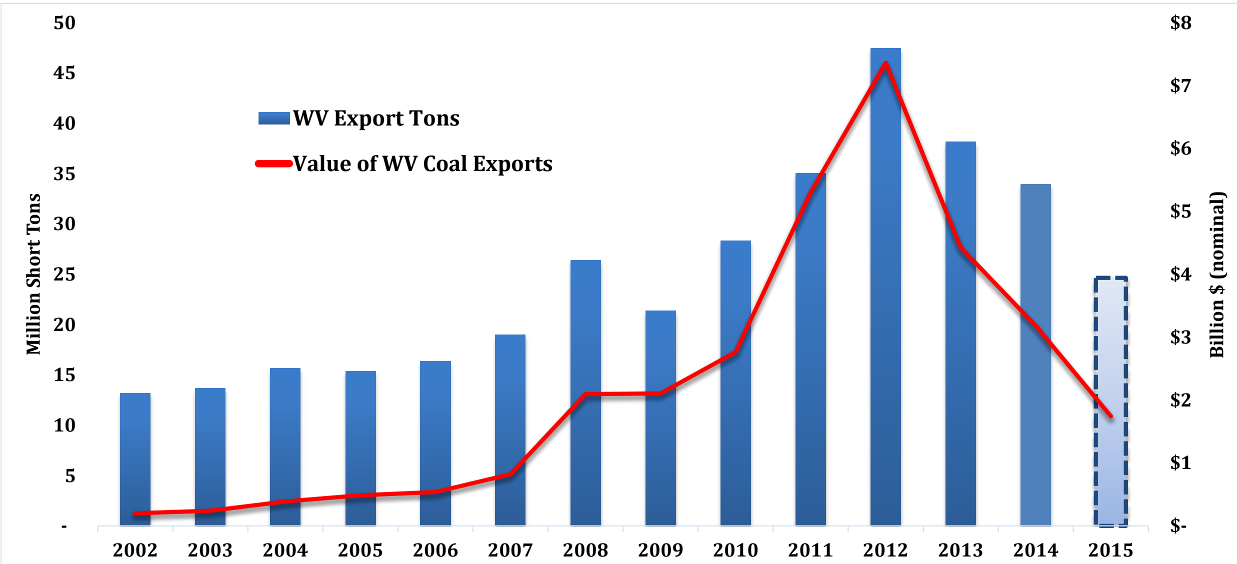
Exports

The nation's coal exports fell again in 2015, to 74 million short tons, down from about 97 million short tons in 2014.[5] The EIA AEO 2016 Reference Case projects total U.S. coal exports to remain below 2015 levels until 2031 (EIA 2016).

The value of coal exports from West Virginia fell to $1.7 billion in 2015, from $3.2 billion in 2014. In spite of another year of declining coal exports, both in value and tonnage, the state maintained exports to many countries in Europe, South America, Africa and Asia. The top five importing countries by value were the Netherlands, Ukraine, Brazil, France and Canada (ITA 2016). Figure 4 shows the value of West Virginia-based coal exports and associated tonnage from 2002 to 2015.

[5] 2015 data for coal export tonnage by U.S. state of origin has not yet been released. CBER estimates West Virginia's exports based on historical shares of total exports and the value of coal exports from the state.

Figure 4: Value and Tonnage of West Virginia Coal Exports, 2002 to 2015



Source: (EIA 2016) (ITA 2016); 2015 Export tonnage estimated by CBER.

Component Forecasts

Energy Information Administration (EIA)

Publication: Annual Energy Outlook 2016

Date: July 2016

Forecast Horizon: 2016-2040

Region(s): Northern Appalachia, Central Appalachia

The EIA provides a forecast of coal production by region in its Annual Energy Outlook, projecting through 2040 (EIA 2016). This projection is generated using the National Energy Modeling System (NEMS). NEMS uses a market-based approach that balances energy supply and demand while considering regulations and industry standards.

The EIA's regional forecasts are adjusted to adapt these figures to forecast West Virginia coal production. The Northern Appalachia region includes Pennsylvania, Maryland, Ohio, and Northern West Virginia while Central Appalachia includes Virginia, Eastern Kentucky, Northern Tennessee, and Southern West Virginia. To forecast West Virginia coal production through 2040, the annual growth rate for Northern Appalachia is applied to 2015 production figures for Northern West Virginia and the annual growth rate for Central Appalachia is applied to Southern West Virginia figures.[6] Only the EIA Reference Case figures are used.[7]

Key Assumptions:

Macroeconomic Issues: Real GDP growth averages 2.2% per year from 2015 to 2040.

Coal Prices: U.S. real minemouth prices are expected to decline slightly in the near-term and return to current levels by 2022. EIA expects Northern Appalachian coal prices to be relatively flat through 2025 and to increase thereafter, from $58.70 in 2015 to $68.80 by 2040. Central Appalachian prices are projected to decline and return to current levels by 2025 and then to increase slightly through 2040, from $67.90 in 2015 to $70.90 in 2040.

---

[6] For more information on the adaptation of the EIA's forecasts, see Appendix A.

[7] The EIA presents several situations in the Annual Energy Outlook 2016: a Reference Case, Alternative Clean Power Plan (CPP) cases, High and Low Economic Growth Cases, High and Low World Oil Price Cases, High and Low Oil and Gas Resource Cases, High and Low Technology Efficiency Innovation Cases and others. The Reference Case was selected for the Consensus Forecast as a continuation of current trends, assuming known technology and technological/demographic trends.

Natural Gas Prices: Henry Hub[8] spot prices for natural gas averaged $3.33 per million Btu in 2014 and $2.62 per million Btu in 2015.[9] Prices are expected to be about $2.58 in 2016 and rise thereafter at an annual rate of 2.5 percent, resulting in an average expected price of $4.86 per million Btu in 2040.

Electricity: U.S. use of coal for production of electricity is expected to decline by 1.6% annually from 2015 to 2040. Coal-fired generating capacity is expected to decrease at a rate of two percent per year through the 2040. By comparison, combined-cycle (natural gas) capacity is projected to increase by 1.8 percent per year and renewable capacity by 3.3 percent per year.

Industrial/Commercial: The industrial sector is expected to have a slight increase in coal consumption by 2025 compared to 2015 levels. A decline in consumption is projected in metallurgical coal use (27 percent lower in 2040 than 2015). Other industrial use is projected to increase by about 17 percent from 2015 levels. The commercial sector is expected to maintain flat coal consumption throughout the forecast period.

Exports: National coal exports are expected to decline in the near-term and return to 2015 levels around 2030.

Environmental: The AEO2016 Reference case assumes that the CPP will proceed as currently promulgated, and that all states will implement it by using a mass-based standard that caps emissions from both existing and new power plants, with allowance revenues rebated to ratepayers (EIA 2016).

[8] The Henry Hub in Louisiana is the delivery point for the natural gas futures contract on the New York Mercantile Exchange.
[9] Henry Hub spot prices are listed in real dollars in 2015. Nominal prices from previous years are inflation-adjusted to the equivalent dollar value in the year 2015.

Results:

Table 1: EIA Annual Energy Outlook 2016 Adapted to West Virginia Production[10]

West Virginia Coal Production (million tons)				
Historical		**Preliminary**	**Forecast**	
2013	**2014**	**2015**	**2016**	**2017**
112.8	111.9	95.5	96.1	92.6
		Forecast		
2018	**2019**	**2020**	**2021**	**2022**
86.2	88.0	94.6	91.1	87.2
		Forecast		
2023	**2024**	**2025**	**2026**	**2027**
82.0	78.0	74.9	72.5	69.0
		Forecast		
2028	**2029**	**2030**	**2031**	**2032**
65.3	61.7	59.4	61.0	64.2
		Forecast		
2033	**2034**	**2035**	**2036**	**2037**
64.9	64.7	63.3	63.4	63.8
		Forecast		
2038	**2039**	**2040**		
63.5	63.3	63.1		

[10] The preliminary total coal production number for 2015 (used here and in the following charts/figures) is reported as weekly and monthly data by the EIA and is based on mine-level data reported to the Mine Safety and Health Administration (MSHA).

Energy Ventures Analysis (EVA)

Publication: EVA Long-Term Forecast

Date: July 2016

Forecast Horizon: 2015-2040

Region(s): Northern Appalachia, Central Appalachia, West Virginia

EVA utilizes the AURORAxmp dispatch model that calculates electricity generation by fuel type by developing the least cost dispatch solution to meet power demand. All existing and planned generation capacity is included, and the model can add or retire capacity as needed.

Key Assumptions:[11]

Macroeconomic Issues: GDP growth is expected to average 2.0 % per year through 2040.

Coal Prices: Coal prices for both Northern and Central Appalachia are expected to recover from the very low prices in 2015 although the recovery will take a number of years. By 2040, prices from both regions are expected to be in the $52-54 per ton range in real 2015 dollars and $82-85 per ton range in nominal dollars.

Natural Gas Prices: Gas prices are expected to steadily increase through 2040 resulting in a price of $6.30 per MMBtu (2015$) in 2040.

Electricity: Growth in electricity demand is expected to average 0.6% per year through 2040. Demand for Appalachian coal by the electricity sector is projected to fall 30% between 2014 and 2040. With the retrofit of technologies, coal supply has become fungible meaning demand can switch between coal supply regions (e.g., Northern Appalachia and Illinois Basin) based upon the relative competitiveness of each. Future demand, which is based upon an equilibrium analysis, may shift between supply regions.

Industrial/Commercial: Non-coke industrial demand for Appalachian coal is projected to fall by about 22% between 2014 and 2040. Demand for metallurgical coal from Northern and Central (primarily) Appalachia during this same period is projected to fall by about 27%.

Exports: Steam coal exports from Northern and Central (primarily) Appalachia peaked in 2012 and are projected to decline by about 70% between 2014 and 2040. The decline

[11] Key assumptions for the EVA Long-Term Forecast were provided via email.

reflects the relative lack of competitiveness of Central Appalachia coals in the global market. Steam coal exports overall could increase if one or more announced export terminals are built in the Pacific Northwest allowing competitive delivery of Powder River Basin coals into the Pacific market. Met coal exports from Northern and Central (primarily) Appalachia peaked in 2011 and are projected to decline by about 20% between 2014 and 2040. Compared to 2014, total Appalachian coal exports are projected to decline by 30% by 2040.

Environmental: The Cross-State Air Pollution Rule (CSAPR) went into effect January 1, 2015; Phase II goes into effect January 1, 2017. The Mercury and Air Toxics Standards (MATS) went into effect April 2015 with a liberal one-year extension. Section 316(b) of the Clean Water Act goes into effect with 2019 compliance for minor intake modifications and 2022 compliance for these requiring cooling towers. A final rule related to power plant wastewater discharges was announced in September 2015. Upgrades to waste water treatment plants are assumed by 2022. Coal Combustion Residuals (CCR) goes into effect by 2020. Conversion to dry ash handling is assumed by 2022 and use of lined landfills for subsequent ash disposal. National Ambient Air Quality Standards (NAAQS) revisions will include fine particulate and ozone standards. SCR's will be required on all units for NOx. Regional haze compliance using Best Available Retrofit Technology will go into effect in 2020 excepting any announced settlements. Greenhouse Gas New Source Performance Standard is assumed to limit ability to add new coal-fired generation absent partial carbon capture and sequestration or co-firing with gas. Due to the Supreme Court stay of the Clean Power Plan, EVA's base case analysis assumes no Federal program is in place to reduce CO2 emissions on existing plants. However, this forecast is based on projected coal demand under a mass compliance approach to the rule with and without national trading. Regional CO2 programs (i.e., RGGI and AB32) are assumed to continue.

Results:

Table 2: EVA Long-Term West Virginia Coal Production Forecast 2016

West Virginia Coal Production (million tons)				
Historical		Preliminary	Forecast	
2013	**2014**	**2015**	**2016**	**2017**
112.8	111.9	95.5	56.2	51.2
Forecast				
2018	**2019**	**2020**	**2021**	**2022**
48.1	56.1	65.8	67.5	63.5
Forecast				
2023	**2024**	**2025**	**2026**	**2027**
62.1	58.8	61.1	60.3	58.5
Forecast				
2028	**2029**	**2030**	**2031**	**2032**
57.4	56.7	55.5	56.4	56.7
Forecast				
2033	**2034**	**2035**	**2036**	**2037**
58.4	58.7	58.6	58.4	57.5
Forecast				
2038	**2039**	**2040**		
56.2	53.6	49.7		

Marshall University Center for Business and Economic Research (CBER)

Publication: CBER West Virginia Coal Production Forecast 2016

Date: July 2016

Forecast Horizon: 2016-2040

Region(s): West Virginia

The CBER forecast of West Virginia total coal production is an econometric model based on quarterly coal production from 1984 through the third quarter of 2015[12]. The forecast model treats 2009 through 2015 as a structural change in the coal market.[13] Data for the model are from EIA's monthly coal fuel receipts contained in Schedule 2 of Form EIA-923.[14] To create the initial short-term forecast, quarterly changes in total coal production were modeled with a vector autoregression (VAR) approach that explicitly accounted for the forecasted demand for West Virginia-sourced coal in regional power generation.[15] For years beyond 2025, the CBER forecast utilizes an autoregressive approach, which estimates future changes in total coal production based on historical patterns.

Key Assumptions:

Macroeconomic Issues: Moderate average annual GDP growth rates of about 2 to 2.5% per year, consistent with other macroeconomic forecasts. The CBER forecast uses a consensus approach to forecasting coal production in both the short-run and long-run scenarios, combining a base model (status quo) and a structural break model including a dummy variable for the years 2009 through 2015. (See Appendix B for additional details in this consensus approach.)

Natural Gas Prices: Annual natural gas price increases of 2.5% are projected between 2015 and 2025 in the case with the 2009-2015 dummy variable.

Electricity: Demand for West Virginia coal by the electricity sector in the Eastern region is expected to decline by 3.0% annually between 2015 and 2025.[16]

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[12] Final data for all model variables was not available past the third quarter of 2015 at the time of publication.
[13] Dummy variables were included in the model to identify 2009-2015, which moderated the decline in forecasted values, that otherwise result when weighting 2009-2015 equally to the preceding years. See Hansen (2001) for a discussion of structural change as relating to U.S. Labor market trends. http://www.ssc.wisc.edu/~bhansen/papers/jep_01.pdf
[14] Form EIA-923 is available at http://www.eia.gov/electricity/data/eia923/.
[15] For more detail on the power generation demand model, see Appendix B.
[16] 3.0% is an average annual rate.

Exports: Exports are not explicitly modeled in the long-term forecast. However, in the mid to long-term moderate recovery in export markets for West Virginia coal is expected to mitigate some of the decline in demand from the regional power generation sector.

Environmental: Expectations regarding the Clean Power Plan and other environmental legislation affect the demand for West Virginia coal. While environmental policy is not an explicit factor in the CBER forecast, changes in behavior due to the expected impacts of legislation on the economy are present in the historical production data utilized in the model.

Results:

Table 3: CBER Long-term West Virginia Coal Production Forecast 2016

West Virginia Coal Production (million tons)				
Historical		**Preliminary**	**Forecast**	
2013	**2014**	**2015**	**2016**	**2017**
112.8	111.9	95.5	94.1	90.8
		Forecast		
2018	**2019**	**2020**	**2021**	**2022**
87.7	84.6	81.5	78.3	75.2
		Forecast		
2023	**2024**	**2025**	**2026**	**2027**
72.1	68.9	66.1	65.4	64.9
		Forecast		
2028	**2029**	**2030**	**2031**	**2032**
64.3	63.8	63.3	62.7	62.1
		Forecast		
2033	**2034**	**2035**	**2036**	**2037**
61.5	60.9	60.3	59.7	59.1
		Forecast		
2038	**2039**	**2040**		
58.4	57.8	57.1		

West Virginia University Bureau for Business and Economic Research (BBER)

Publication: WVU BBER Coal Production Forecast 2016

Date: July 2016

Forecast Horizon: 2016-2036

Region: Northern West Virginia and Southern West Virginia

The WVU BBER Coal Production Forecast is an econometric model based upon changes in factors that affect the demand and price for coal sourced from mines in Northern and Southern West Virginia between 1985 through 2014. Historical data on coal prices, production and other energy-related data are obtained from a variety of Energy Information Administration reports. Forecasts for the model's US-specific explanatory variables were taken from the IHS Economics May 2016 forecast and the 2016 Annual Energy Outlook preliminary report from the EIA. Region-specific explanatory variables e.g. exports, were projected by the BBER based upon historical relationships with their corresponding national data series.

Key Assumptions:[17]

Macroeconomic Issues: Expected annual real GDP growth is 2.3% through the forecast horizon.

Coal Prices: Inflation-adjusted coal prices are expected to increase, reaching $64 per short ton (in 2009 dollars) in Northern West Virginia and $62 per short ton in Southern West Virginia— averaged for metallurgical and thermal coal. The U.S. average price is expected to rise to $38 by 2036.

Natural Gas Prices: Real natural gas prices (2009 dollars) paid by utilities are expected to increase at an average annual rate of 2.3% per year between 2016 and 2036, reaching an inflation-adjusted amount of just over $4 by 2036.

Electricity: Total U.S. electricity generation is expected to increase 0.7% per year between 2016 and 2036. Coal and natural gas are expected to account for nearly identical shares (approximately 30%) of overall electricity generation. No new coal-fired power plants are expected to be constructed during the outlook period.

Industrial/Commercial: Total commercial/industrial demand for West Virginia coal is expected to decline 1% per year over the forecast horizon. Most of this decline will be

[17] Key assumptions for the WVU BBER Coal Production Forecast 2016 were provided via email.

driven by non-coke coal industrial/commercial use due to energy efficiency gains and natural gas conversion.

Exports: The baseline forecast assumes 2012 was an all-time peak for West Virginia coal export activity and both metallurgical and steam coal exports from the state will remain below these levels throughout the outlook period. Total exports are expected to increase 42% cumulatively between 2016 and 2036. Southern West Virginia will continue to account for the majority of state coal exports.

Environmental: Only laws that are in place and not currently subject to legal challenges are considered. Retirements of coal-fired generation not compliant with the MATS rule will continue through 2017. The Clean Power Plan and New Source Performance Standards rules are not considered, but given their relevance to future West Virginia coal production, they are addressed in an alternative scenario.

Results:

Table 4: WVU BBER West Virginia Coal Production Forecast 2016

West Virginia Coal Production (million tons)				
Historical		**Preliminary**	**Forecast**	
2013	**2014**	**2015**	**2016**	**2017**
112.8	111.9	95.5	68.0	69.2
		Forecast		
2018	**2019**	**2020**	**2021**	**2022**
73.5	75.0	75.4	75.0	74.3
		Forecast		
2023	**2024**	**2025**	**2026**	**2027**
73.8	73.2	72.4	71.7	70.9
		Forecast		
2028	**2029**	**2030**	**2031**	**2032**
69.8	69.1	68.3	67.8	67.7
		Forecast		
2033	**2034**	**2035**	**2036**	
67.5	67.3	67.1	66.8	

Consensus Forecast

The four long-term forecasts produced by EIA, EVA, CBER, and WVU are combined to create the Consensus Forecast for West Virginia Coal Production.[18] A weighted average is used to combine the four projections as follows (Armstrong 2001):

$$WV\ Coal\ Production_t = w_{EIA} * EIA\ Production_t + w_{EVA} * EVA\ Production_t + w_{CBER} * CBER\ Production_t + w_{WVU} * WVU\ Production_t$$

The weight (w_i) assigned to each forecast is based on the accuracy of past forecasts by that organization. All available forecasts for 2013 through present were evaluated for accuracy. For example, EIA's 2015 Annual Energy Outlook was assessed by considering the accuracy of its 2013, 2014, and 2015 projections.

Predictions for the first years of the time horizon were considered because accuracy is typically highest at the beginning of the forecast. Long-term accuracy was not considered in this weighting method due to the large potential for unpredictable macroeconomic conditions to affect annual error.

The error (e_i) of a forecast was determined using the following formula.

$$e_{i,t} = \frac{Forecast\ Production_{i,t} - Actual\ Production_t}{Actual\ Production_t}$$

The absolute value of the errors was averaged for each forecasting organization to remove the effects of under-estimation and over-estimation canceling each other.

Table 5: Average Absolute Errors

	Average Error
EIA	7.42%
EVA	9.32%
CBER	8.81%
WVU	8.13%

[18] For more information on the creation of consensus forecasts, see http://www.forecastingprinciples.com/paperpdf/Combining.pdf.

The weight given to each organization in the consensus was calculated as follows (Armstrong 2001):

$$w_i = \frac{\frac{1}{e_i}}{\sum_i \frac{1}{e_i}}$$

The Consensus Forecast needed to predict West Virginia coal production through 2040. Since one of the component forecasts (WVU BBER) terminated in 2036, two separate weighting rubrics were used in the consensus calculation. Using the following weights, the Consensus Forecast is calculated.

Table 6: Consensus Weights for 2016-2036

	Weight
EIA	0.28
EVA	0.22
CBER	0.24
WVU	0.26

Table 7: Consensus Weights for 2037-2040

	Weight
EIA	0.38
EVA	0.30
CBER	0.32

The results are shown below in table and figure format. The Consensus Forecast for West Virginia Coal Production shows production levels decreasing through 2018 and then temporarily rebounding through 2020. After 2020, production levels show a steady decreasing trend through 2030. West Virginia coal production levels remain stable from 2030 to 2036 before falling to 57 million tons in 2040.

Table 8: Consensus Forecast for West Virginia Coal Production 2016

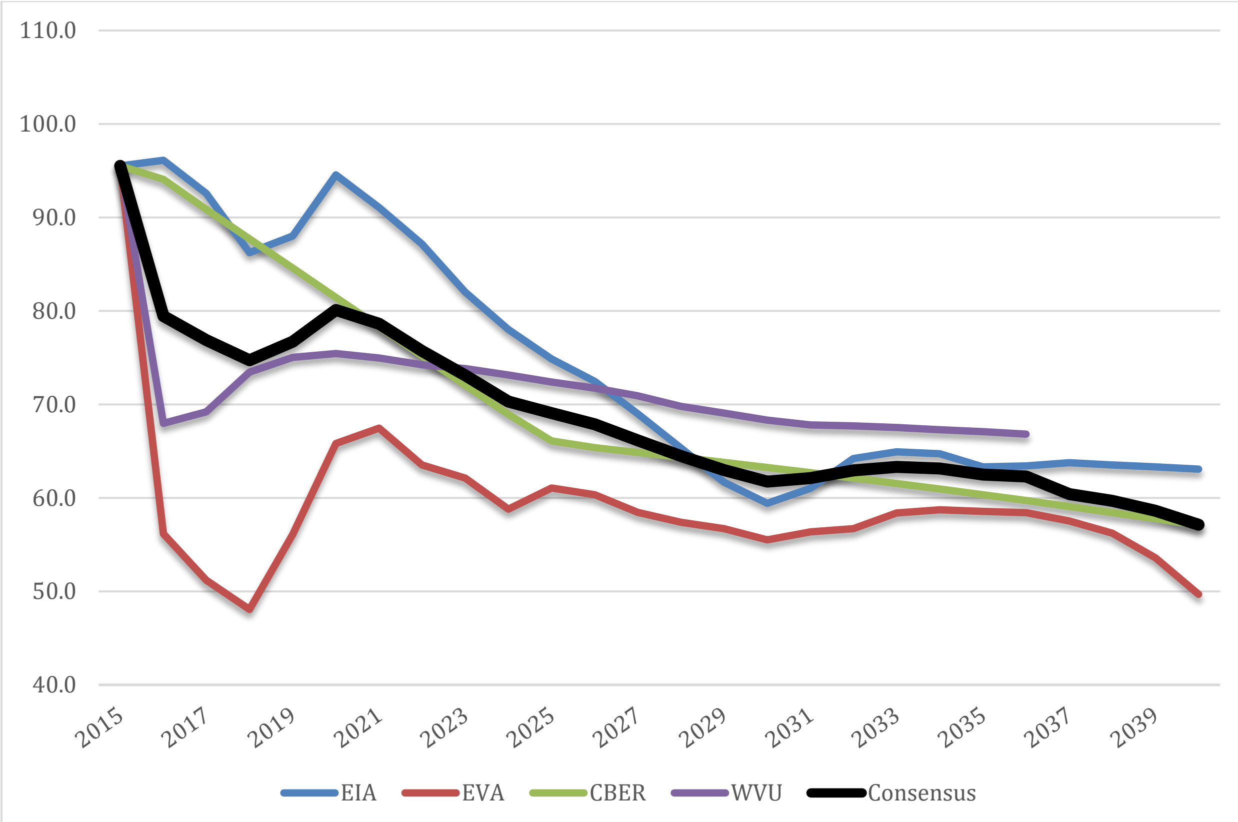
West Virginia Coal Production (million tons)				
Historical		Preliminary	Forecast	
2013	**2014**	**2015**	**2016**	**2017**
112.8	111.9	95.5	79.5	76.9
		Forecast		
2018	**2019**	**2020**	**2021**	**2022**
74.7	76.7	80.1	78.6	75.7
		Forecast		
2023	**2024**	**2025**	**2026**	**2027**
73.1	70.3	69.1	67.9	66.2
		Forecast		
2028	**2029**	**2030**	**2031**	**2032**
64.5	63	61.7	62.1	62.9
		Forecast		
2033	**2034**	**2035**	**2036**	**2037**
63.3	63.1	62.5	62.3	60.4
		Forecast		
2038	**2039**	**2040**		
59.7	58.6	57.1		

Table 9: Comparison of Component Forecasts and 2013-2016 Consensus Forecasts

West Virginia Coal Production (million tons)									
Year	2016 Forecasting Group				2016 Consensus	2015 Consensus	2014 Consensus	2013 Consensus	Actual Tonnage
	EIA	EVA	CBER	WVU					
2013								117.4	112.8
2014							112.4	117.8	111.9
2015						107.2	106.9	113.9	95.5[19]
2016	96.1	56.2	94.1	68.0	79.5	103.4	101.4	112.2	
2017	92.6	51.2	90.8	69.2	76.9	101.7	103.0	113.5	
2018	86.2	48.1	87.7	73.5	74.7	102.7	103.3	108.7	
2019	88.0	56.1	84.6	75.0	76.7	104.8	102.4	105.6	
2020	94.6	65.8	81.5	75.4	80.1	104.9	101.5	105.4	
2021	91.1	67.5	78.3	75.0	78.6	104.4	100.9	104.8	
2022	87.2	63.5	75.2	74.3	75.7	103.4	100.7	106.6	
2023	82.0	62.1	72.1	73.8	73.1	102.8	100.0	107.6	
2024	78.0	58.8	68.9	73.2	70.3	102.8	99.9	107.2	
2025	74.9	61.1	66.1	72.4	69.1	102.4	99.2	106.3	
2026	72.5	60.3	65.4	71.7	67.9	102.2	98.2	106.3	
2027	69.0	58.5	64.9	70.9	66.2	101.7	98.1	106.1	
2028	65.3	57.4	64.3	69.8	64.5	101.2	97.1	105.4	
2029	61.7	56.7	63.8	69.1	63.0	100.9	97.1	105.0	
2030	59.4	55.5	63.3	68.3	61.7	100.9	96.5	104.4	
2031	61.0	56.4	62.7	67.8	62.1	100.5	96.3	103.5	
2032	64.2	56.7	62.1	67.7	62.9	100.9	95.1	101.9	
2033	64.9	58.4	61.5	67.5	63.3	99.8	94.2	99.6	
2034	64.7	58.7	60.9	67.3	63.1	98.3	93.7	99.0	
2035	63.3	58.6	60.3	67.1	62.5	97.3	91.6	97.3	
2036	63.4	58.4	59.7	66.8	62.3				
2037	63.8	57.5	59.1		60.4				
2038	63.5	56.2	58.4		59.7				
2039	63.3	53.6	57.8		58.6				
2040	63.1	49.7	57.1		57.1				

[19] Preliminary production estimate for 2015 from EIA based on data from the U.S. Mine Safety and Health Administration and railroad car loadings from the Association of American Railroads.

Figure 5: Component and Consensus Forecasts 2016 (million tons)



Summary

The 2016 West Virginia Consensus Coal Forecast figures are lower than the 2015 Consensus. A primary reason for this is inclusion of possible effects of the EPA's Clean Power Plan rule for regulating carbon dioxide emissions from power plants.

The component models within the consensus forecast incorporate a wide range of possible levels of West Virginia coal production over the next 25 years. These varying levels of forecasted coal production illustrate the impact of various supply and demand variables and uncertainty over the continuation of recent trends. The consensus reduces uncertainty by combining the forecasts into one aggregate projection where West Virginia coal production declines sharply in 2016, flattens for a few years, and then declines moderately through 2040.

The EIA maintains the highest share of the consensus due to historical accuracy of its forecasts. The EIA model projects total coal consumption in the U.S. electric power sector to be lower than in its AEO2015 analysis due in part to assumed implementation of the Clean

Power Plan, and to projected natural gas prices that are lower than prior assumptions.[20] Central Appalachian coal production is projected to decline faster than in Northern and Southern Appalachia. Northern production is projected to decline by 1.5 percent per year through 2040 while Central Appalachian production is projected to decline by 1.8 percent per year.

The CBER model is influenced by inclusion of preliminary 2015 coal production and demand data. This added another year of decline to already declining historical trends.

The WVU base case model does not include the potential effects of the Clean Power Plan. This provides one explanation for its higher projected levels of production toward the end of the forecast period.

[20] EIA AEO2015, Coal Market Module.

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Appendix A: EIA Forecasts for Northern and Southern West Virginia

The EIA forecasts coal production by region in its Annual Energy Outlook. Appalachia is split into three regions: Northern, Central, and Southern. For the purposes of this study, only the Northern and Central Appalachian regions are applicable. The Northern Appalachia region includes Pennsylvania, Maryland, Ohio, and Northern West Virginia while Central Appalachia includes Virginia, Eastern Kentucky, Northern Tennessee, and Southern West Virginia. Forecasts for these regions are adapted to Northern and Southern West Virginia production. EIA's forecasted annual growth rates for Northern and Central Appalachia are shown first.

Table 10: Growth Rates for Coal Production in Northern and Central Appalachia (EIA)

	2015	**2016**	**2017**	**2018**	**2019**
Northern Appalachia	-8.7%	6.8%	-3.2%	-21.6%	-2.4%
Central Appalachia	-39.3%	-5.4%	-4.2%	9.9%	5.7%
	2020	**2021**	**2022**	**2023**	**2024**
Northern Appalachia	15.5%	-5.4%	-4.3%	-2.4%	-4.5%
Central Appalachia	1.4%	-2.3%	-4.2%	-8.8%	-5.1%
	2025	**2026**	**2027**	**2028**	**2029**
Northern Appalachia	-2.7%	-1.2%	-4.2%	-4.6%	-4.3%
Central Appalachia	-5.3%	-5.1%	-5.3%	-6.0%	-6.8%
	2030	**2031**	**2032**	**2033**	**2034**
Northern Appalachia	-2.9%	7.2%	11.3%	-0.2%	0.1%
Central Appalachia	-4.4%	-2.0%	-1.5%	2.9%	-0.8%
	2035	**2036**	**2037**	**2038**	**2039**
Northern Appalachia	-0.4%	-1.5%	-0.7%	-1.0%	-1.5%
Central Appalachia	-4.4%	2.4%	2.1%	0.3%	1.2%
	2040				
Northern Appalachia	-2.6%				
Central Appalachia	2.3%				

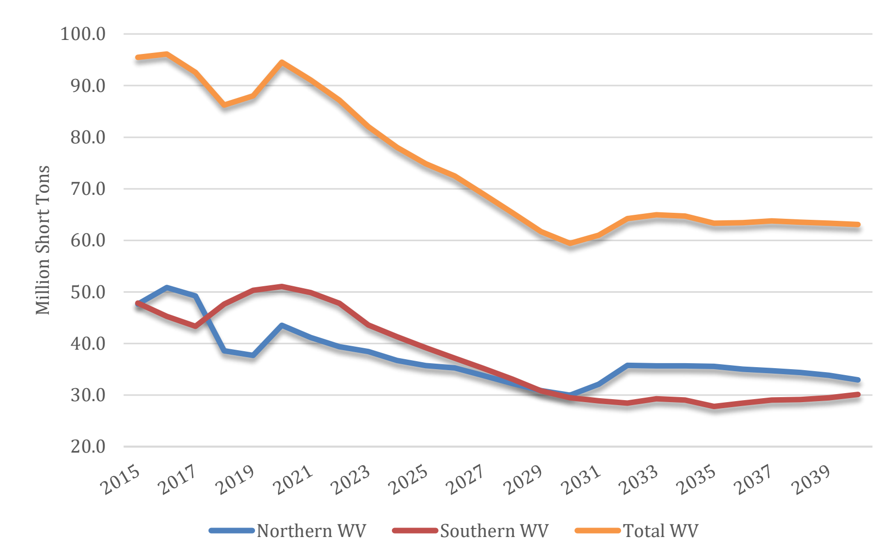
These regional growth rates are applied to preliminary 2015 production data for Northern and Southern West Virginia coal to achieve the 2016 State forecast shown in Table 11.[21] Growth rates for Northern Appalachia are used to project Northern West Virginia coal production, and rates for Central Appalachia are applied to Southern West Virginia. Total forecasted West Virginia coal production is the sum of calculated forecasts for Northern and Southern West Virginia.

[21] 2015 production data is the preliminary data published by EIA.

Table 11: West Virginia Coal Production by Region (EIA)

	2015	**2016**	**2017**	**2018**	**2019**
Northern WV	47.6	50.9	49.2	38.6	37.7
Southern WV	47.8	45.3	43.3	47.6	50.3
Total WV	**95.5**	**96.1**	**92.6**	**86.2**	**88.0**
	2020	**2021**	**2022**	**2023**	**2024**
Northern WV	43.5	41.2	39.4	38.4	36.7
Southern WV	51.0	49.9	47.8	43.6	41.3
Total WV	**94.6**	**91.1**	**87.2**	**82.0**	**78.0**
	2025	**2026**	**2027**	**2028**	**2029**
Northern WV	35.7	35.3	33.8	32.2	30.8
Southern WV	39.2	37.2	35.2	33.1	30.8
Total WV	**74.9**	**72.5**	**69.0**	**65.3**	**61.7**
	2030	**2031**	**2032**	**2033**	**2034**
Northern WV	30.0	32.1	35.7	35.7	35.7
Southern WV	29.5	28.9	28.5	29.3	29.0
Total WV	**59.4**	**61.0**	**64.2**	**64.9**	**64.7**
	2035	**2036**	**2037**	**2038**	**2039**
Northern WV	35.5	35.0	34.7	34.4	33.9
Southern WV	27.8	28.4	29.0	29.1	29.5
Total WV	**63.3**	**63.4**	**63.8**	**63.5**	**63.3**
	2040				
Northern WV	33.0				
Southern WV	30.1				
Total WV	**63.1**				

Figure 6: West Virginia Coal Production by Region (EIA)



Appendix B: Power Generation Demand Forecast

As in previous forecasts, to better understand the dynamics influencing total coal production for West Virginia, CBER analyzed data on West Virginia Coal consumed by power plants in the eastern region of the United States. The data for the analysis are from EIA's monthly fuel receipts data (EIA 2016), which have been aggregated into total quarterly fuel receipts of coal sourced from West Virginia for the period 2002-2015 (3rd quarter). Additional factors considered for the analysis include real natural gas prices and electricity demand (as indicated by average heating and cooling degree-days in the region).

To construct the power generation demand forecast, CBER first projected electricity demand in the region, using coal-fired power plant capacity as a proxy. A key assumption is that capacity required to serve estimated electricity demand is irrespective of fuel type and thus indicative of electricity demand generally. Using a vector autoregression model (VAR), CBER jointly forecasted the quarterly change in total fuel receipts for West Virginia-sourced coal and real natural gas prices, conditional on modest growth in electricity demand.

The 2016 CBER West Virginia Coal Production Forecast is a consensus of a base model and a structural break model. In the base model, the above described variables are considered with all years weighted the same. The second model treats the substantial decline in production observed in 2009-2015 as a structural break in the coal market.[22] The CBER forecast gives both the base model and structural break model an even weight in the final forecast calculation. This consensus approach is also applied to the long-run CBER forecast.

[22] Dummy variables were included in the model to identify the years 2009-2015, which moderated the decline in forecasted values that otherwise result when weighting 2009-2015 equally to the preceding years.

Watershed Scale Approaches to AMD Remediation: Martin Creek and Sandy Creek WV 342

Final Report

Prepared for: West Virginia Department of Environmental Protection
Office of Special Reclamation

Submitted: February 14, 2017

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Executive Summary

The goal of the Clean Water Act (CWA) is to restore and protect the Nation's waters. West Virginia's Special Reclamation Fund (SRF), administered by the Department of Environmental Protection's Office of Special Reclamation, supports the goals of the CWA by treating acid mine drainage (AMD) discharges from post-1977 coal mines that have transferred their surety bonds and water treatment liabilities to the State. Known as bond forfeiture sites, the cost of treating their AMD discharges to CWA standards is high and, unfortunately, the treated water is commonly discharged to streams that are severely impaired due to AMD from pre-1977 abandoned mines. Thus the expense of treating bond forfeiture sites is rarely reflected in-stream restoration benefits. This project explored a strategy for using SRF funds for permit compliance while restoring AMD impaired watersheds. It shifts the treatment from individual discharges to the receiving stream while achieving compliance at a point downstream in the watershed rather than at the point where discharge leaves the bond forfeited property.

This reduces the number of treatment locations and allows treatment at stream locations with pre-existing road access and the potential to restore the maximum number of stream miles. Most significantly, for less cost, it treats all of the acidity in the stream rather than the small fraction that originates at bond forfeiture sites.

This study compared the costs and benefits of in-stream vs. at-source AMD treatment in two watersheds in northern West Virginia: Martin and Sandy Creeks, both in Preston County. Both streams are severely impaired by AMD and both contain a mix of abandoned mines and bond forfeitures and both discharge to major recreational water bodies: the Cheat River and Tygart Lake. The results (Table 1) indicate that in-stream dosing alone would not achieve adequate stream benefits but, when paired with ongoing or planned restoration projects, would restore 3.4 and 10.8 miles of Muddy Creek and Sandy Creek respectively. Costs for the in-stream options were less than the costs of current at-source treatment projects which restore zero stream miles.

Table 1 Summary of costs for in-stream vs. at-source dosing. Projected stream mile recovery anticipates completion of AMD projects either underway or planned.

Martin Creek	At-source treatment	In-stream treatment
O&M cost projection (years)	20	20
Annual O&M	$ 218,084	$ 145,533
Total Capital Cost	$ 4,825,824	$ 1,200,000
Total O&M	$ 4,361,684	$ 2,910,664
Total cost	$ 9,187,508	$ 4,110,664
Projected stream mile recovery*	**0**	**3.4**
Sandy Creek		
O&M cost projection (years)	20	20
Annual O&M	$ 189,568	$ 223,708
Total Capital Cost	$ 2,609,587	$ 1,444,032
Total O&M	$ 3,791,369	$ 4,474,166
Total cost	$ 6,400,955	$ 5,918,198
Projected stream mile recovery**	**0**	**10.8**

* With completion of the T&T AMD project
** With addition of a passive treatment unit at Barlow Portal

Projected 20-year costs for the two options indicate that in-stream dosing on Martin Creek would save $5,076,844 or a 55% cost reduction while in-stream dosing on Sandy Creek would save $482,757 or a cost reduction of 8%. The difference in cost savings is largely due to the smaller number of bond forfeiture sites in the Sandy Creek watershed.

Introduction

Acid mine drainage (AMD) is the most important source of stream impairment in West Virginia. Most of it comes from pre-law, abandoned coal mines. Post-1977 bond forfeiture coal mines are also an important but secondary source of AMD. Previous studies have demonstrated significant cost savings and projected increased environmental benefit by applying in-stream lime dosers at strategic locations within the stream system rather than using lime dosers to treat individual sources (Ziemkiewicz 2006). In the fall of 2015 the West Virginia Department of Environmental Protection (WVDEP) Office of Special Reclamation (OSR) commissioned the West Virginia University Water Research Institute (WVWRI) to determine the advantages of in-stream vs. at-source AMD treatment in two watersheds in northern West Virginia: Martin Creek and Sandy Creek. Martin Creek is the most important source of AMD entering the Cheat River upstream of the Cheat Canyon, an important white water tourism location while Sandy Creek discharges to Tygart Reservoir, also an important recreational water body.

The performance of the watershed-scale approach to AMD remediation via in-stream dosing was evaluated dosing the streams over a one year period, monitoring water quality in response to treatment and comparing results to restoration targets.

Sampling locations for restoration targets were at Martin Upstream Fickey (MUF) for the Martin subwatershed study and at both the Left Fork Little Sandy Mouth (LFLSM) and Maple Run Mouth (MRM) for the Sandy Creek subwatershed. Results from weekly sampling indicate in-stream treatment was successful in achieving restoration targets in the Martin Creek subwatershed. Despite fluctuations in doser operations, continuous monitoring of pH at the compliance point at MUF indicated that pH was maintained within the restoration target with the exception of a pH spike above 9.0 that lasted for 30 minutes, this event coincided with lime doser charging at an upstream site. In the Sandy Creek subwatershed, LFLSM restoration targets were within range for pH and dissolved aluminum (Al) during the study period, while total iron (Fe) exceeded the restoration target of 14 mg/L for 9 out of the 37 samples. At compliance point MRM, weekly sampling results for pH, dissolved Al and dissolved Fe were within restoration target range during the entire study period.

Background

Martin Creek:

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

Sandy Creek:

Sandy Creek is a subwatershed in the lower section of the Tygart Valley River basin. The Sandy Creek subwatershed drains over 90.3 square miles and flows into Tygart Lake (WVDEP 2003a). As per the 1982

Tygart Valley River Subbasin Abandoned Mine Drainage Assessment, Sandy Creek was identified as contributing 49.5% of the total acid load to the Tygart between Philippi, WV and the mouth at Fairmont, WV. Water quality data collected during the assessment found 9,325 lbs/day of acid being discharged into Tygart Reservoir from Sandy Creek (WVDEP 1987).

West Virginia Department of Environmental Protection (WVDEP) identified multiple AML sites that discharge AMD into Left Fork Little Sandy Creek, Left Fork Sandy Creek, and Maple Run. Additionally, several BFS within the watershed fall under WVDEP's Office of Special Reclamation (OSR).

The 2002 303(d) list identified impairment by iron, aluminum (total) and manganese (WVDEP 2003b) in the Sandy Creek watershed. Total maximum daily loads (TMDL) limits were developed in 2001. In 2003, the state water quality standard for aluminum changed from total to dissolved aluminum. In its 2004 list, WVDEP only maintained aluminum listings if dissolved aluminum data were available and those data indicated impairment (WVDEP 2004). Five of the six streams previously listed for total aluminum were delisted and the 2004 list only included Little Sandy Creek as impaired by dissolved aluminum.

Project Design

The project was organized around three tasks for both Martin and Sandy Creeks:

Task 1: Dosing Trials

- Site Access – granted through WVDEP.
- Site Preparation and Doser Installation – completed through sub-awards with contractors.
- Doser Operation and Maintenance – Visual assessments performed weekly during sampling events by WVWRI personnel. Martin Creek dosers were checked daily by Aquafix; Sandy Creek dosers were checked daily by WVDEP and Save the Tygart Watershed Association (Aquafix was notified when maintenance was needed).
- Lime – Contracted through Aquafix.

Task 2: Water Quality Sampling

- Grab samples were collected at eleven sites weekly since 27 October 2015 through 20 December 2016 in the Martin Creek watershed with the exception of two weeks in April (12^{th} and 19^{th}).
- Grab samples were collected at eleven sites weekly between 17 February and 6 April 2016 and 7 June through 21 December 2016 in the Sandy Creek watershed.
- Field parameters included: temperature (°C), dissolved oxygen (ppm), specific conductance (µS/cm), and total dissolved solids (mg/L) and turbidity via transparency tube.
- Grab sample were analyzed to determine: pH, alkalinity, acidity, conductivity, sulfates, and total suspended solids along with total and dissolved metals (iron, magnesium, aluminum, calcium, and manganese).
- Flow measurements were determined in-stream when conditions permitted and were calculated when in-stream measurements were not possible.

Task 3: Sludge Monitoring

- Visual assessments via transparency tube, photographs, and lab measured total suspended solids (TSS) estimated turbidity in the receiving streams.

Monthly reports were provided to WVDEP during the course of the study.

Project Goal

The goal of this project was to evaluate, with minimal infrastructural cost, the performance of in-stream dosing. This involved moving temporary dosers to key locations in the test watersheds and providing temporary power arrangements. It was recognized that power and lime feed interruptions would occur but still permit evaluation of the treatment strategy. Outcomes included not only evaluation of the in-stream treatment strategy but also identification of optimal doser locations. Given positive results, permanent dosers using line power and slurry feed would be installed at the identified locations.

Results

Martin Creek

Task 1: Doser operations: Martin Creek

AML discharges in the upstream end of Fickey Run were responsible for the majority of iron loading to Martin Creek. Dosing trials in November 2015 through January 2016 caused dissolved iron to precipitate resulting in significant iron hydroxide moving through Martin Creek and into Muddy Creek, particularly during high flow conditions. As a result it was decided to terminate dosing at the upper Fickey Run location and move the compliance point from the mouth of Martin Creek to the point immediately upstream if its junction with Fickey Run. Restoration targets remained pH 3.2 to 9.0; dissolved Al 15 mg/L; and total iron 10 mg/L. The Fickey (F1) doser was taken off line on 29 December 2015 and was moved to the Left Fork Little Sandy site on 12 Feb 16 for project WV 347. However, water quality monitoring on Fickey Run continued.

Solar power supply was inadequate to maintain reliable doser operation during winter months. As a result, batteries were manually recharged by the site contractor, Aquafix Inc. In addition, the in-stream pH probe and feedback to lime feed control was not reliable. As a result lime feed was reset to manual control. Generators were installed to recharge batteries at the G1 and M1 dosers. A permanent power supply was installed via WVDEP at G1 to alleviate power interruption.

A two-stage auger system was installed at doser G1 on 19 May 16. On 27 July 16, the G1 doser was switched to the permanent power supply. In an effort to assess Martin Creek chemistry with one doser, M1 was turned off on 10 August until 24 August 16 and then permanently beginning 26 August 16. Doser and sampling locations are shown in Figure 1.

M1 was taken offline on 10 Aug 16 to 24 Aug 16 then again on 26 Aug 16 for the remainder of the project period, leaving G1 as the sole doser on the Martin Creek watershed.

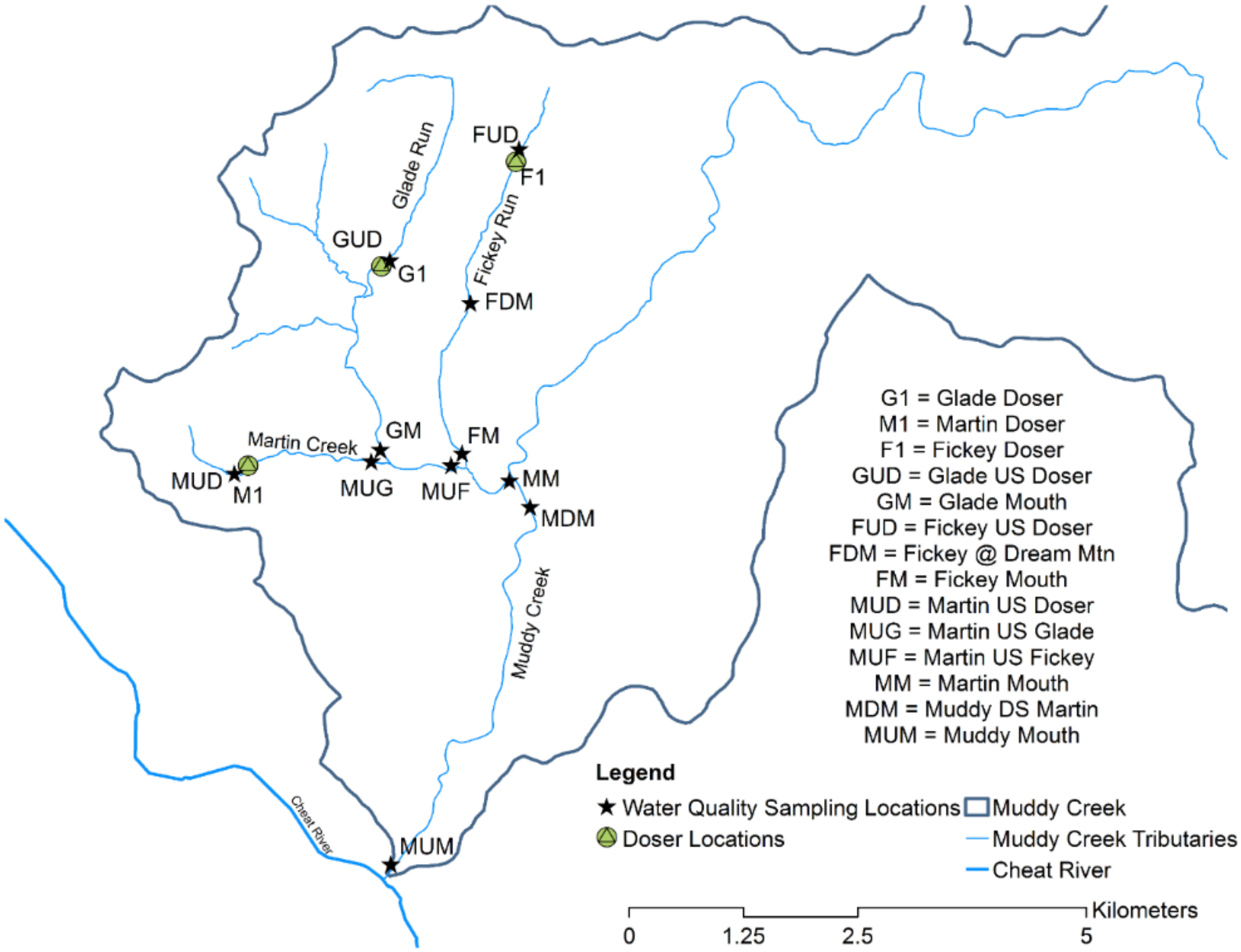

Figure 1. Martin Creek doser and water quality sampling stations.

Task 2: Water Quality Monitoring

Acid and Metal Loading under Varying Conditions

Martin Creek was sampled weekly at eleven sites between 27 October 2015 through 20 December 2016 with the exception of two weeks in April (12th and 19th). Stream flows varied widely in these headwater streams both seasonally and in response to storms. At various times both, one, or zero dosers were engaged as part of the test and in response to power and feed interruptions

Restoration Target Performance

The following discussion addresses system performance with regard to the three restoration targets: pH (3.2 to 9.0), dissolved aluminum (15 mg/L) and total iron (10 mg/L) as determined at Martin Creek upstream of Fickey Run (MUF).

Despite periodic inconsistencies in doser operations, the pH, Al dissolved and Fe total targets have been met at MUF since initiation of dosing in early November 2015. It is important to note that at-source dosers in upper Martin Creek were turned off on 11 Feb and turned back on in March (shaded area in Figure 2).

Also, M1 was taken offline on 10 Aug 16 to 24 Aug 16 then again on 26 Aug 16 for the remainder of the project period, leaving G1 as the solitary doser on the Martin Creek watershed. During this time, restoration targets were met for pH, Al d and Fe t (Figure 2).

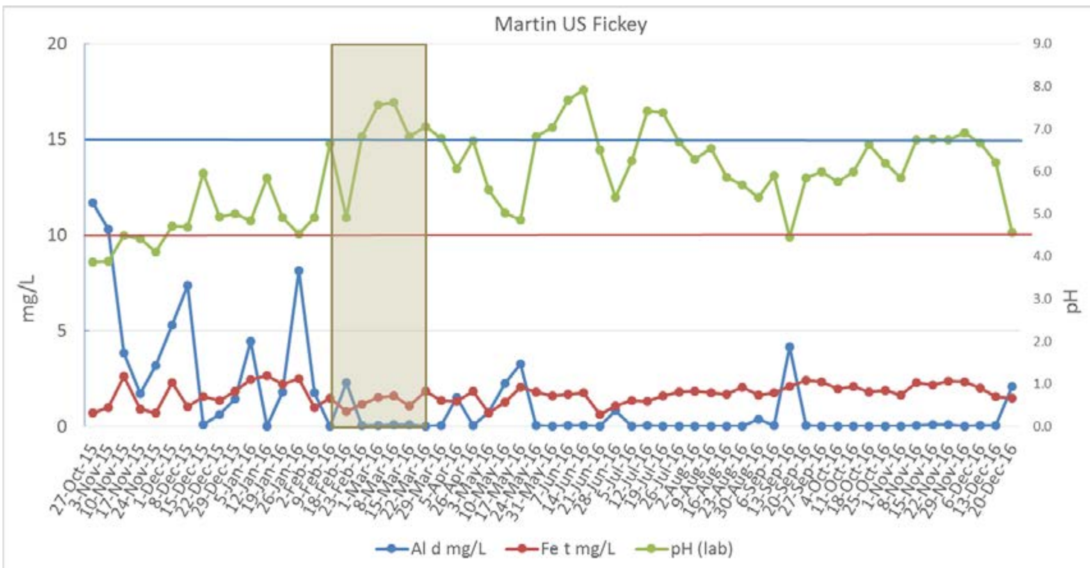

Figure 2. Restoration target performance measured at the compliance point (MUF). The blue horizontal line represents the dissolved aluminum (Al d) restoration target and the red horizontal line represents the total iron (Fe t) restoration target. The shaded area indicates the dates when the Martin Creek at-source dosers were turned off.

A pH probe (sonde) was placed in-stream at MUF on 8 January 2016. It recorded pH at 15 minute intervals. With the exception of two recordings of 9.41 pH and 9.55 pH on 16 June 2016 (caused by upstream activity of filling M1 doser), values stayed within the restoration target of 3.2 to 9 pH (shaded area in Figure 3). Fluctuations in pH at MUF were responsive to in-stream dosing operations.

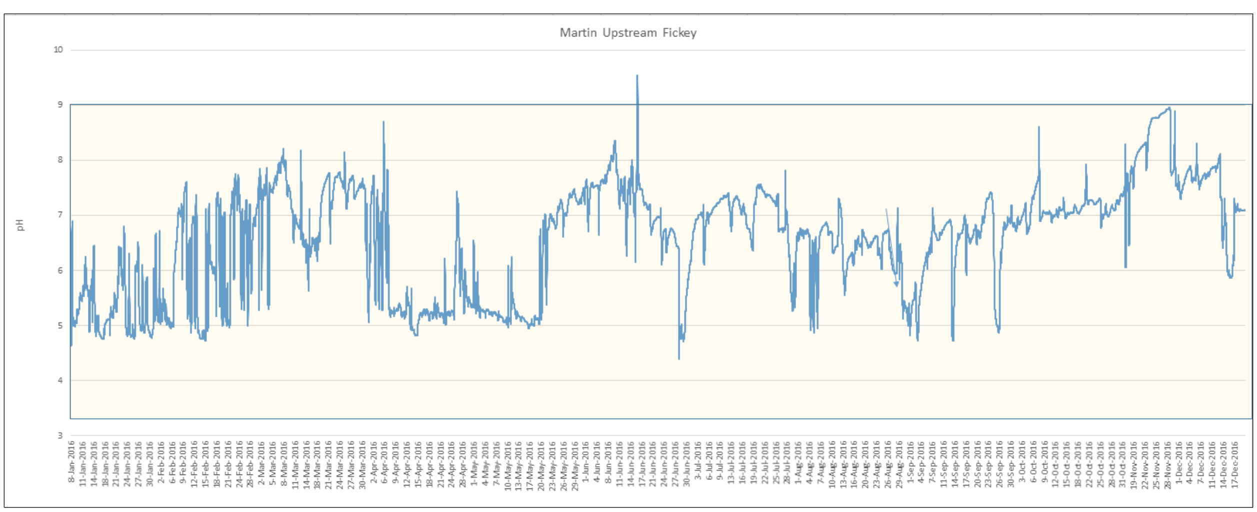

Figure 3. pH values at MUF site from in-stream sonde between 8 January 2016 and 20 December 2017; yellow shading shows restoration target range of 3.2 to 9 pH.

An example of consistent steady pH near neutral is seen during 28 September to 16 November in Figure 4.

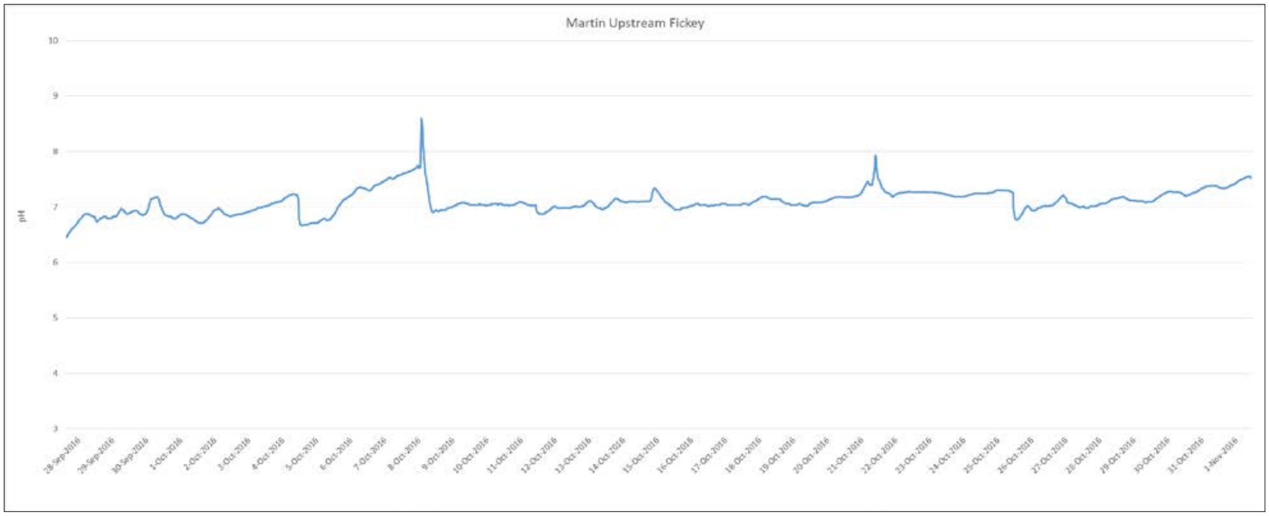

Figure 4. pH values at MUF site from in-stream sonde between 28 September 2016 to 16 November 2016. Note only G1 was operational during this time period.

Task 3: Sludge Monitoring

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

No correlation was found between TSS and flow (Q) at the MUF sampling site (Figure 5). While field observations suggested that higher TSS was associated with increased flow, the results suggests that precipitated metal flocs comprising the TSS were likely mobilized by sudden changes in flow rather than absolute flow volumes. Thus, the effect would be a pulse rather than sustained, elevated TSS after rainfall or runoff events.

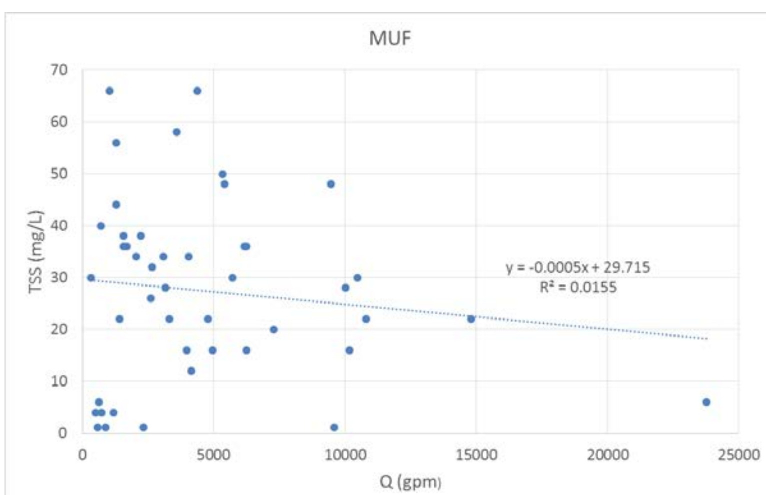

Figure 5. Total suspended solids (TSS) and flow (Q) at the compliance point (MUF).

Martin Creek upstream Fickey Run (MUF)

Figure 6 and Figure 7 depict average and high flow conditions at MUF compliance point while doser was operational.

Figure 6. MUF site during average flow conditions on 15 November 16. Only G1 doser operational.

Figure 7. MUF site during high flow conditions on 2 February 16. Both G1 and M1 dosers operational.

Sandy Creek

Task 1: Doser operations: Sandy Creek

Lime dosing was initiated on the Left Fork Little Sandy on 10 Feb 16; Maple Run dosing was initiated on 17 Feb 16. The solar panels attached to the dosers were unable to supply their power requirements with sufficient reliability. To supplement the solar power supply, generators were purchased by WVDEP and installed at both doser sites. WVDEP provided training and oversight for Save the Tygart Watershed Association to assist in running the generators on a daily basis to provide power to the dosers if needed (note: solar was not installed at the Maple site until March). Overall issues with the dosers in July included generator failure and lime feed interruptions. Sampling and doser locations are shown in Figure 8. Sandy Creek water sampling locations, stars indicate doser sites (yellow = Maple; blue = LFLS).

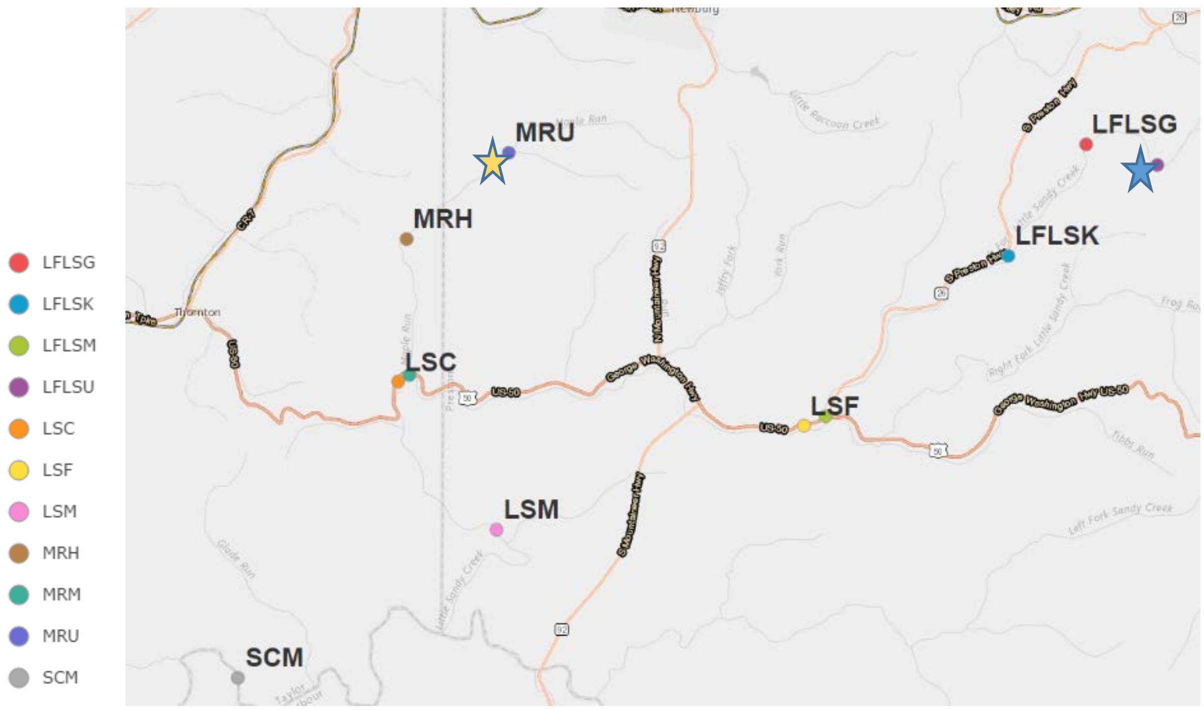

Figure 8. Sandy Creek water sampling locations, stars indicate doser sites (yellow = Maple; blue = LFLS).

Task 2: Water Quality Sampling

Acid and Metal Loading in Varying Conditions

Sandy Creek sites were sampled weekly between 17 February and 21 December 2016. Variations in-stream flow were noted to better gauge its effect on treatment efficiency. Factors such as low, average, or high flow events and varying doser activity during these flow events at both LFLS doser and Maple doser were represented over the one year sampling interval. Restoration targets were based on pH and iron and aluminum concentrations.

Restoration Target

There were two restoration target compliance standards in the Little Sandy watershed: pH (3.3 to 9.0), dissolved aluminum (12 mg/L) and total iron (2 mg/L) as determined at Maple Run mouth (MRM) and pH

(2.5 – 9.0), dissolved aluminum (33 mg/L) and total iron (14 mg/L) at the Left Fork Little Sandy Mouth (LFLSM).

At LFLSM restoration targets were met for pH and dissolved aluminum. Total iron, however, exceeded the limits 24% of the time (Figure 9). These exceedances occurred even when the dosers were operational indicating an overload of iron in the system from several headwater sources. It is likely that additional at-source treatment will be needed to eliminate sufficient iron to achieve compliance.

Concentrations of dissolved Al, total Fe, TSS and pH are shown in Figure 9. Note data prior to 17 February 2016 for total Fe and pH was provided by OSR, no data was available for dissolved Al.

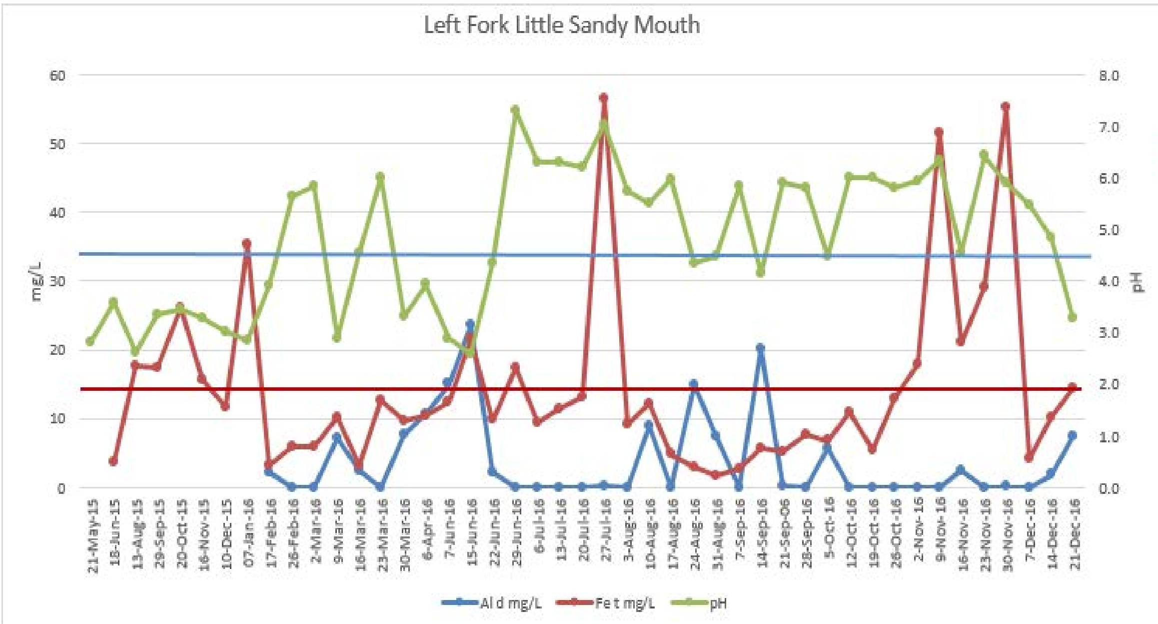

Figure 9. Left: dissolved Al and total Fe at LFLSM; right: total suspended solids (TSS) and pH.

On Maple Run, on the other hand, restoration targets were met when the dosers were operational (Figure 10).

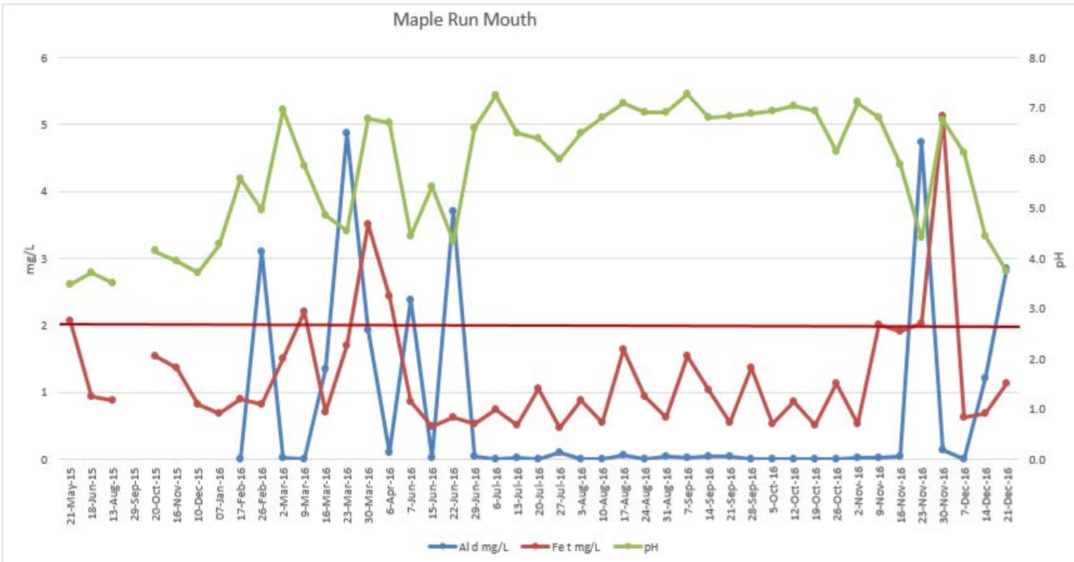

Figure 10. Left: dissolved Al and total Fe at MRM; right pH.

Task 3: Sludge Monitoring: Sandy Creek

Field measured turbidity (via a transparency tube) and laboratory measured total suspended solids (TSS) provided a measurement of suspended metal flocs at sampling stations. Photos were taken at sites to show aesthetic changes to the Sandy Creek watershed in response to dosing during varying flows and seasonal conditions.

No correlations were found between TSS and flow (Q) at either LFLSM or MRM sites (Figure 11 and Figure 12).

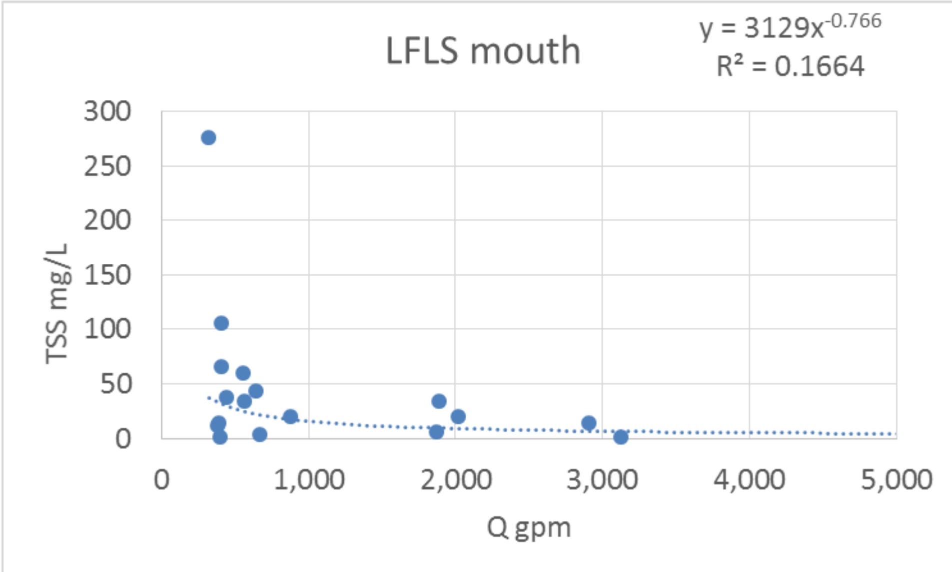

Figure 11. TSS and Q at LFLSM compliance point.

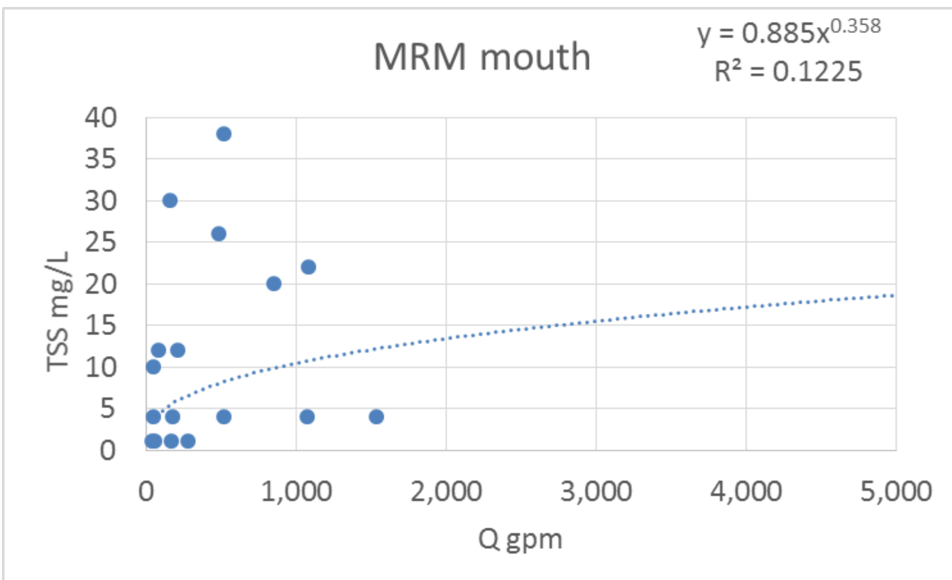

Figure 12. TSS and Q at MRM compliance point.

Left Fork of Little Sandy Mouth (LFLSM)

Figure 13 and Figure 14 depict low and high flow conditions at LFLSM compliance point while doser was operational.

Figure 13. LFLSM site during low flow conditions on 19 October 16. Doser operational.

Figure 14. LFLSM site during high flow conditions on 26 February 16. Doser operational.

Maple Run Mouth (MRM)

Figure 15 and Figure 16 depict low and high flow conditions at MRM compliance point while doser was operational.

Figure 15. MRM site during low flow conditions on 7 Sept 16. Doser operational.

Figure 16. MRM site during high flow conditions on 2 March 16. Doser operational.

Conclusion/Recommendations

In-stream dosing success relies on consistent dosing. Variabilities caused by solar power were resolved with permanent power supply at G1 and LFLS.

Martin Creek

For the Martin Creek study, G1 was sufficient in maintaining compliance at MUF during fall 2016 after M1 was turned off, restoration targets were within range even during high flow conditions on 20 December 2016 sampling event (12,620 gpm at MUF).

Sandy Creek

While MRM restoration target was maintained through the study, LFLS exceeded target levels about 27% of the time. Several untreated AML discharges contributed much of the iron to LFLS downstream of the in-stream doser. Installation of a passive treatment at the largest of these (the Barlow Portal) would improve the probability of success of in-stream dosing on the LFLS.

Cost Evaluation (At-Source vs. In-Stream)

This study compared the costs and benefits of in-stream vs. at-source AMD treatment in two watersheds in northern West Virginia: Martin and Sandy Creeks, both in Preston County. Both streams are severely impaired by AMD and both contain a mix of abandoned mines and bond forfeitures and both discharge to major recreational water bodies: the Cheat River and Tygart Lake. The results are summarized in (Table 2). They indicate that in-stream dosing alone would not achieve adequate stream benefits but, when paired with ongoing or planned restoration projects, would restore 3.4 and 10.8 miles of Muddy Creek and Sandy Creek respectively. Costs for the in-stream options were less than the costs of current at-source treatment projects which restore zero stream miles. Detailed cost evaluation is provided in Table 3 and Table 4.

Projected 20-year costs for the two options indicate that in-stream dosing on Martin Creek would save $5,076,844 or a 55% cost reduction while in-stream dosing on Sandy Creek would save $482,757 or a cost reduction of 8%. The difference in cost savings is largely due to the smaller number of bond forfeiture sites in the Sandy Creek watershed.

Table 2. Summary of costs and benefits associated with the two alternative AMD treatment strategies evaluated during this study.

Martin Creek	At-source treatment	In-stream treatment
O&M cost projection (years)	20	20
Annual O&M	$ 218,084	$ 145,533
Total Capital Cost	$ 4,825,824	$ 1,200,000
Total O&M	$ 4,361,684	$ 2,910,664
Total cost	$ 9,187,508	$ 4,110,664
Projected stream mile recovery*	**0**	**3.4**
Sandy Creek		
O&M cost projection (years)	20	20
Annual O&M	$ 189,568	$ 223,708
Total Capital Cost	$ 2,609,587	$ 1,444,032
Total O&M	$ 3,791,369	$ 4,474,166
Total cost	$ 6,400,955	$ 5,918,198
Projected stream mile recovery**	**0**	**10.8**

* With completion of the T&T AMD project

** With addition of a passive treatment unit at Barlow Portal

Table 3. Evaluation of costs associated with at-source vs. in-stream (watershed scale) AMD treatment.

At-Source AMD Treatment

Martin Creek Permit Name	Permit No.	construction completed	no. of trt sites	current O&M	estimated O&M*	Capital cost**
Rockville Mining	65-78	4-Apr-06	3	$ 49,755		$ 1,268,508
Rockville Mining	S-65-82	1-Dec-05	3	$ 51,162		$ 1,792,032
T&T Fuels	U-125-83	20-Oct-03	1	$ 17,286		$ 197,205
Lobo Capital	UO-204	NA	1		$ 47,631	$ 448,895
Rockville Mining	S-91-85	NA	1		$ 48,309	$ 909,935
Crane Coal	S-27-83	13-May-05	1	$ 3,941		$ 209,250
			10	$ 122,144	$ 95,940	$ 4,825,824

O&M cost projection (years)	20
Annual O&M	$ 218,084
Total Capital Cost	$ 4,825,824
Total O&M	$ 4,361,684
Total cost	**$ 9,187,508**

Watershed scale AMD Treatment

Martin Creek Permit Name	Permit No.	construction completed	no. of trt sites	estimated O&M*	Capital cost**
Glade Run	NA		1	$ 93,594	$ 850,000
Martin Creek	NA		1	$ 51,939	$ 350,000
			2	$ 145,533	$ 1,200,000

O&M cost projection (years)	20
Annual O&M	$ 145,533
Total Capital Cost	$ 1,200,000
Total O&M	$ 2,910,664
Total cost	**$ 4,110,664**

* O&M includes		** Capital	
	Lime		Doser
	Manpower		Installation
	Sludge handling		Sludge handling system
	Sludge disposal		
	Maintenance		

Table 4. Evaluation of costs associated with at-source vs. in-stream (watershed scale) AMD treatment.

At-Source AMD Treatment

Sandy Creek Permit Name	Permit No.	construction completed	no. of trt sites	current O&M	estimated O&M*	Capital cost**
Maurice Jennings	61-83	NA	1		$ 10,671	$ 339,993
Maurice Jennings	53-78	NA			$ 37,295	$ 812,288
Mangus Coal	S-1036-91	NA	1		$ 54,102	$ 754,750
Amanda Nicole	S-1018-88		1	$ 87,500		$ 702,557
			3	$ 87,500	$ 102,068	$ 2,609,587

O&M cost projection (years)	20
Annual O&M	$ 189,568
Total Capital Cost	$ 2,609,587
Total O&M	$ 3,791,369
Total cost	**$ 6,400,955**

Watershed scale AMD Treatment

Sandy Creek Permit Name	Permit No.	construction completed	no. of trt sites	estimated O&M*	Capital cost**
Left Fk. Little Sandy	NA		1	$ 145,254	$ 850,000
Maple Run	NA		1	$ 62,555	$ 350,000
Barlow passive				$ 15,900	$ 244,032
			2	$ 223,708	$ 1,444,032

O&M cost projection (years)	20
Annual O&M	$ 223,708
Total Capital Cost	$ 1,444,032
Total O&M	$ 4,474,166
Total cost	**$ 5,918,198**

* O&M includes	Lime	** Capital cost includes	Doser
	Manpower		Installation
	Maintenance		
	Power		

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Appendix A, Martin Creek

Other Monitoring Points

Figure 17 to Figure 19 summarize dissolved aluminum, total iron, pH and TSS results for the remaining sampling stations.

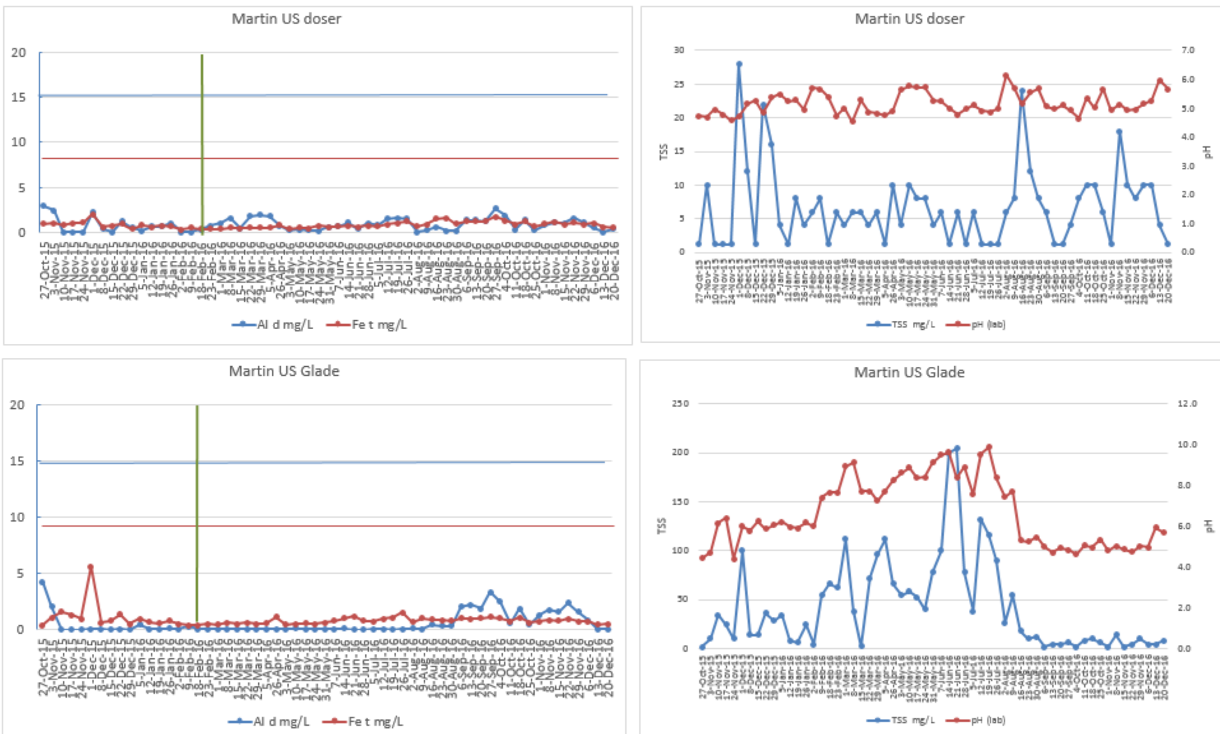


Figure 17. Left, restoration target performance measured at the Martin Creek sampling points. The blue horizontal line represents the dissolved aluminum restoration target and the red horizontal line represents the total iron restoration target. The vertical, green line indicates the date when the Martin Creek at-source dosers were turned off. Right, pH and flow measurements.

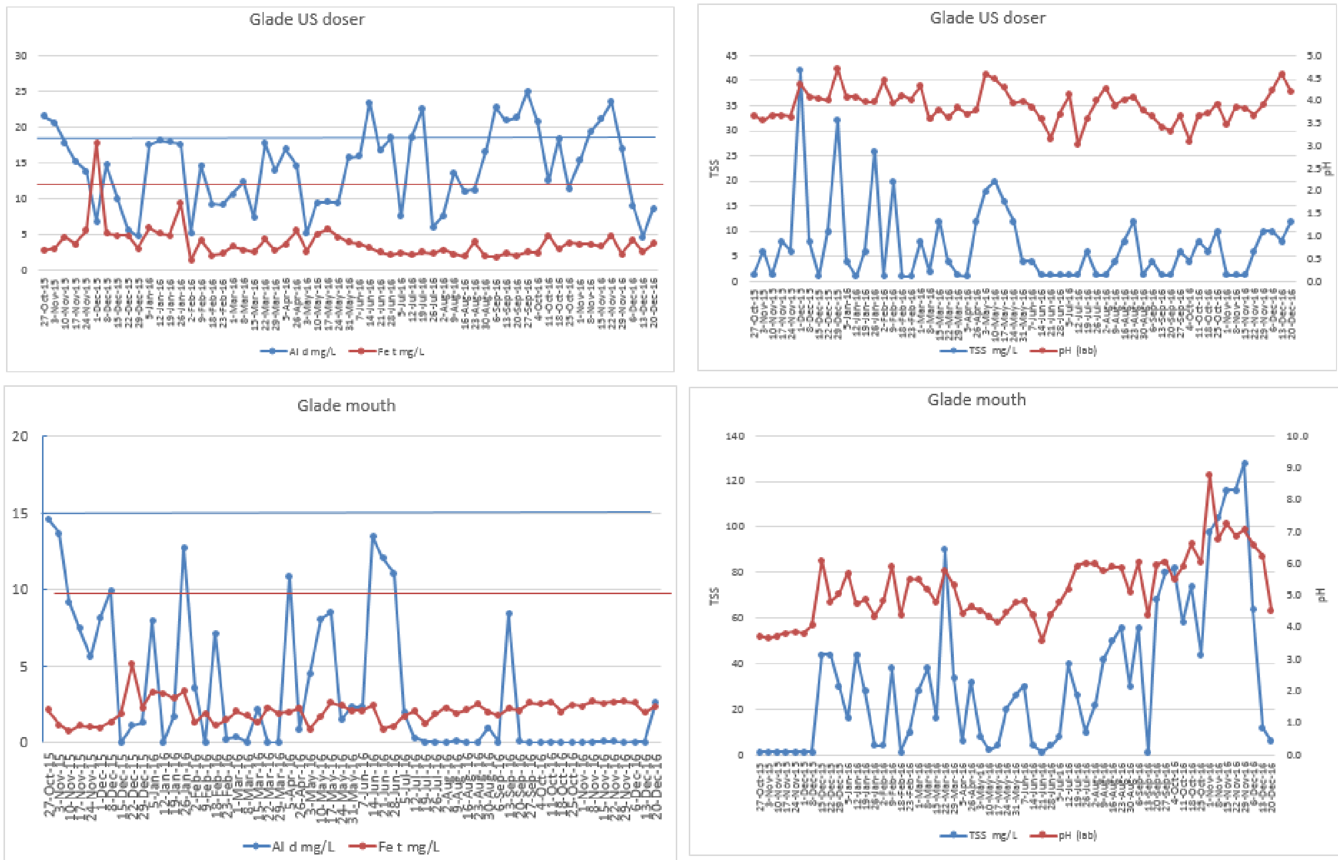


Figure 18. Left, restoration target performance measured at the Glade Run sampling points. The blue horizontal line represents the dissolved aluminum restoration target and the red horizontal line represents the total iron restoration target. Right, pH and flow measurements.

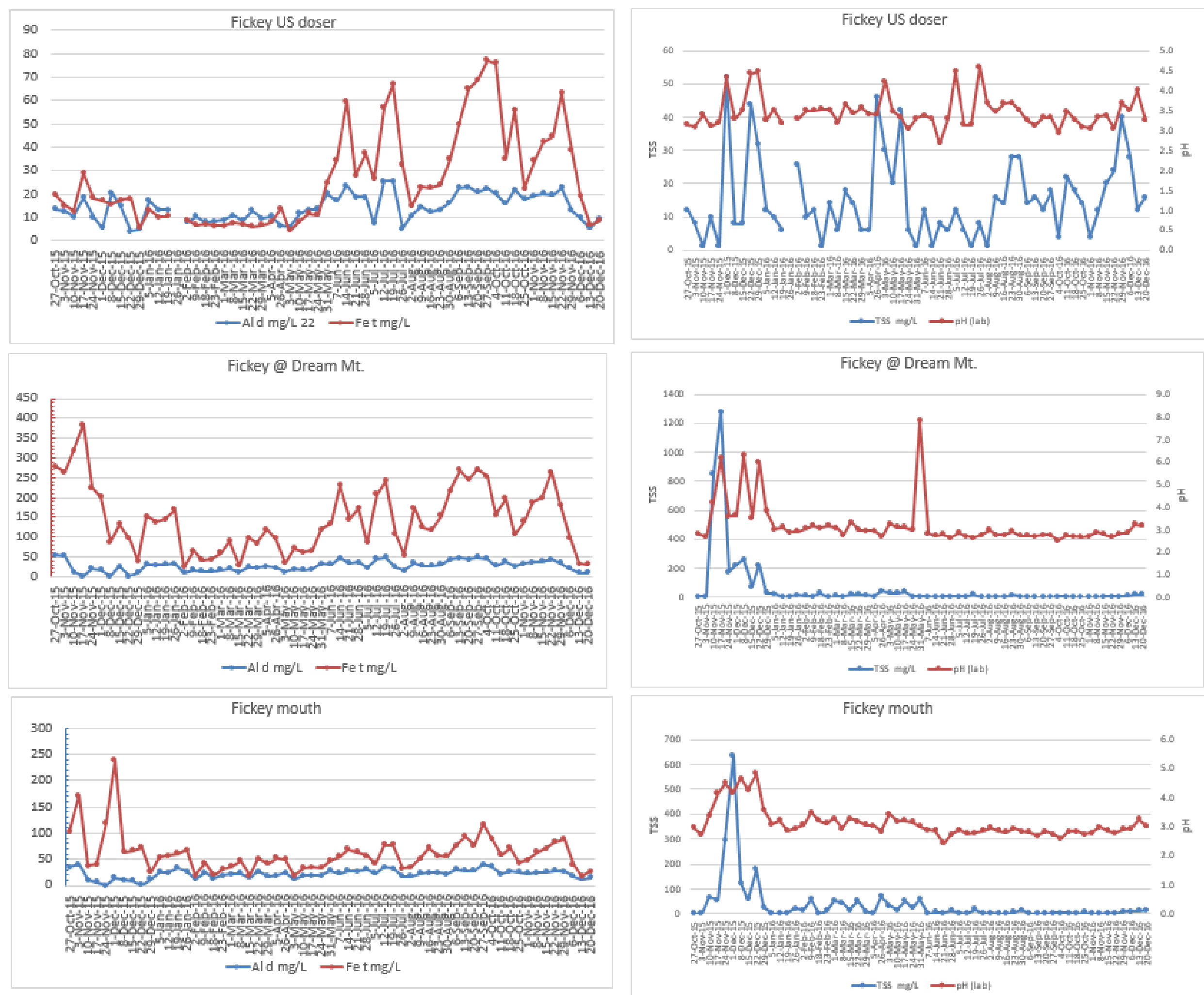


Figure 19. Left, restoration target performance measured at the Fickey Run sampling points. The blue horizontal line represents the dissolved aluminum restoration target and the red horizontal line represents the total iron restoration target. Right, pH and flow measurements.

Appendix B, Sandy Creek

Sandy Creek, other monitoring sites

The following discussion addresses system performance with regard to the three restoration targets: pH (3.3 to 9.0), dissolved aluminum (12 mg/L) and total iron (2 mg/L) as determined at Maple Run mouth (MRM) and pH (2.5 – 9.0), dissolved aluminum (33 mg/L) and total iron (14 mg/L) at the Left Fork Little Sandy Mouth (LFLSM). Concentrations of dissolved Al, total Fe, TSS and pH are shown in to Figure 20 to Figure 24 for all sites monitored.

Compliance Points (LFLS and MRM)

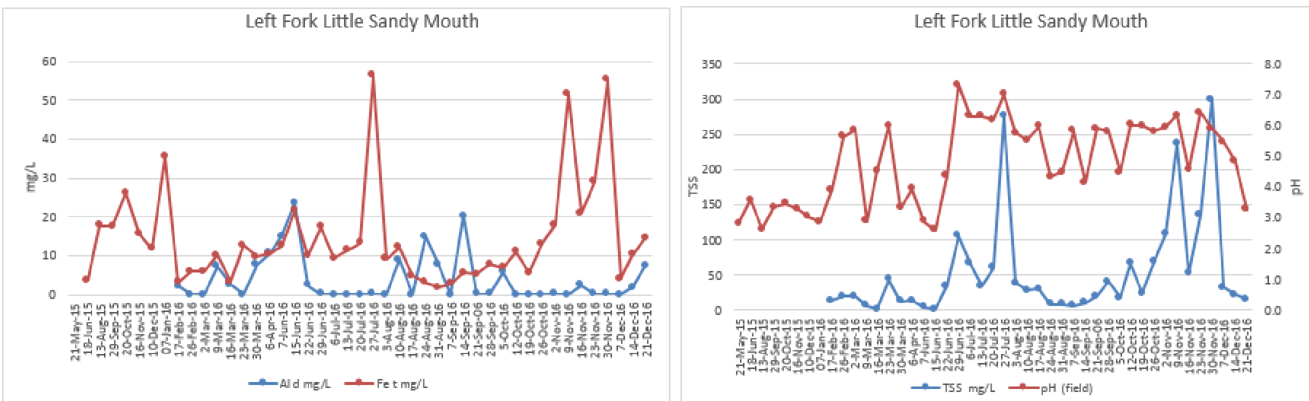


Figure 20. Left: dissolved Al and total Fe at LFLSM; right: total suspended solids (TSS) and pH.

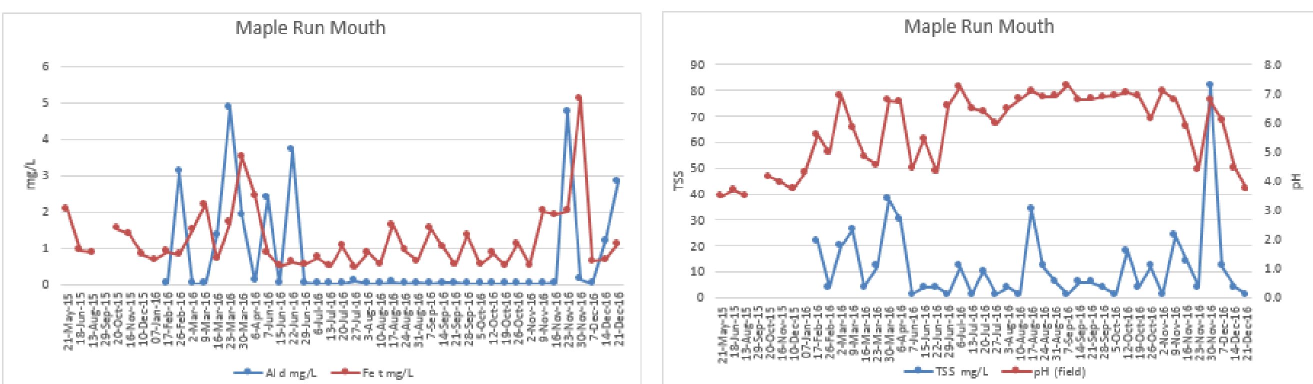


Figure 21. Left: dissolved Al and total Fe at MRM; right: TSS and pH.

Other Monitoring Points

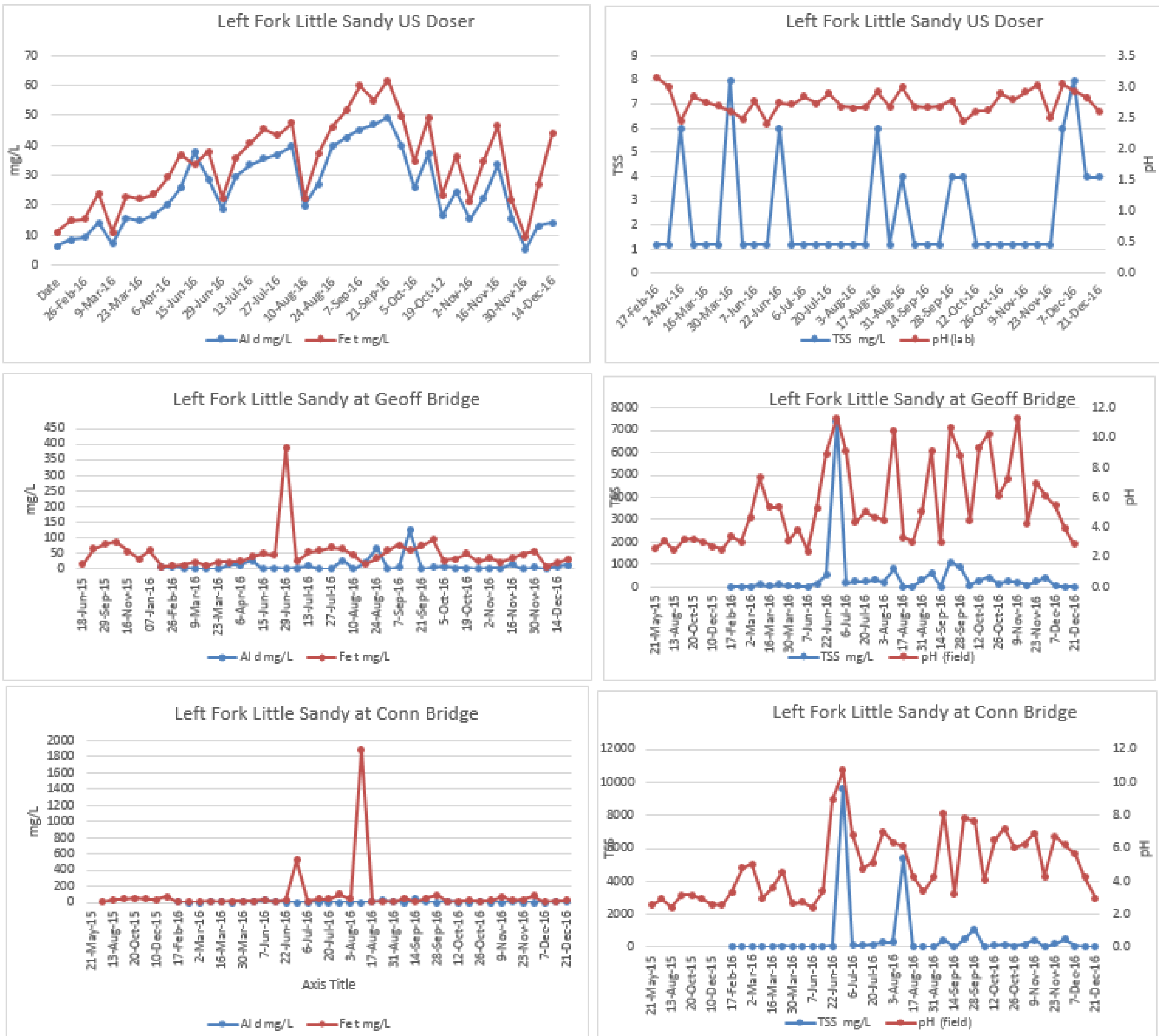


Figure 22. Left, dissolved Al and total Fe at Left Fork Little Sandy sampling points. Right, TSS and pH.

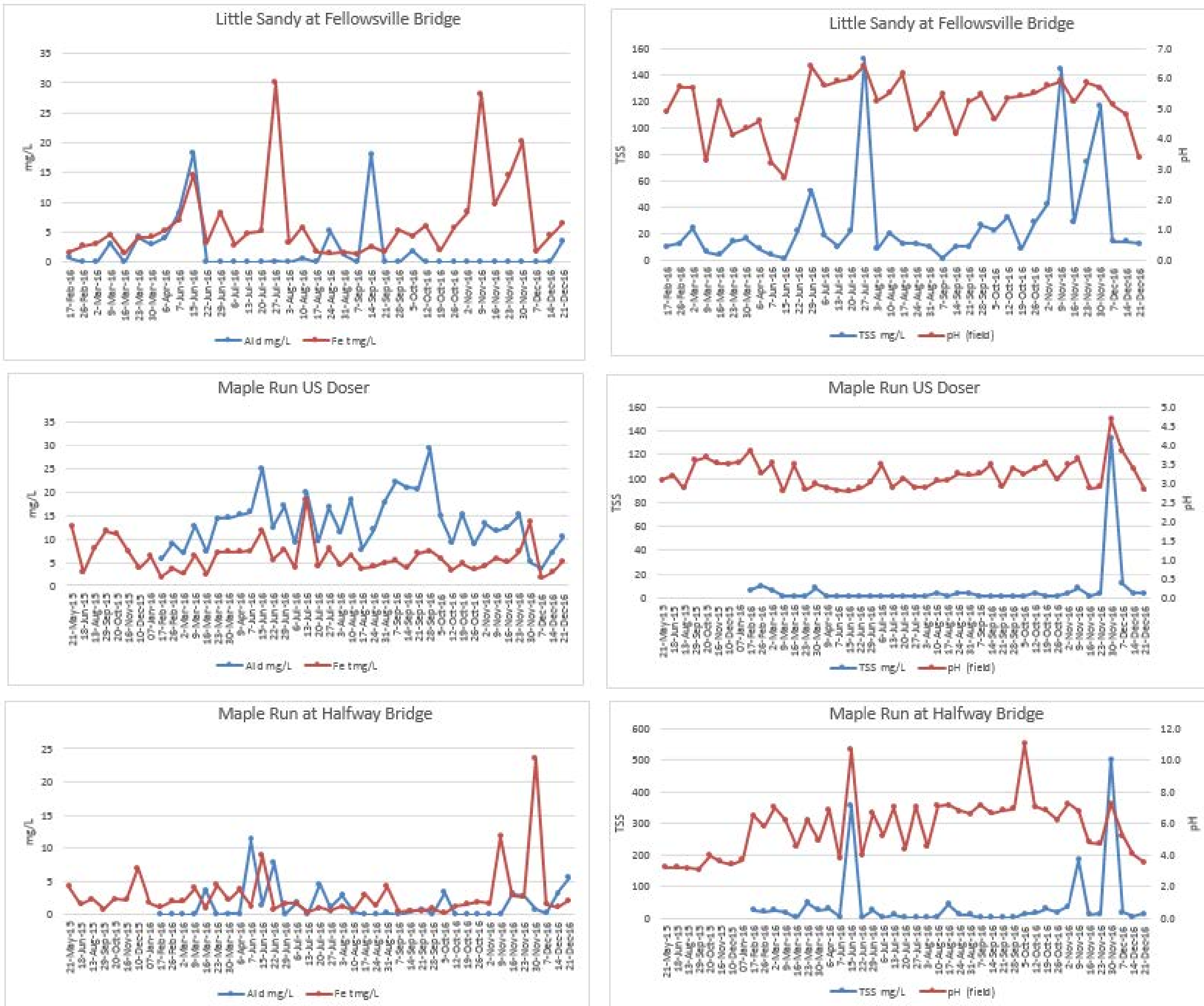


Figure 23. Left, dissolved Al and total Fe at Little Sandy and Maple Run sampling points. Right, TSS and pH..

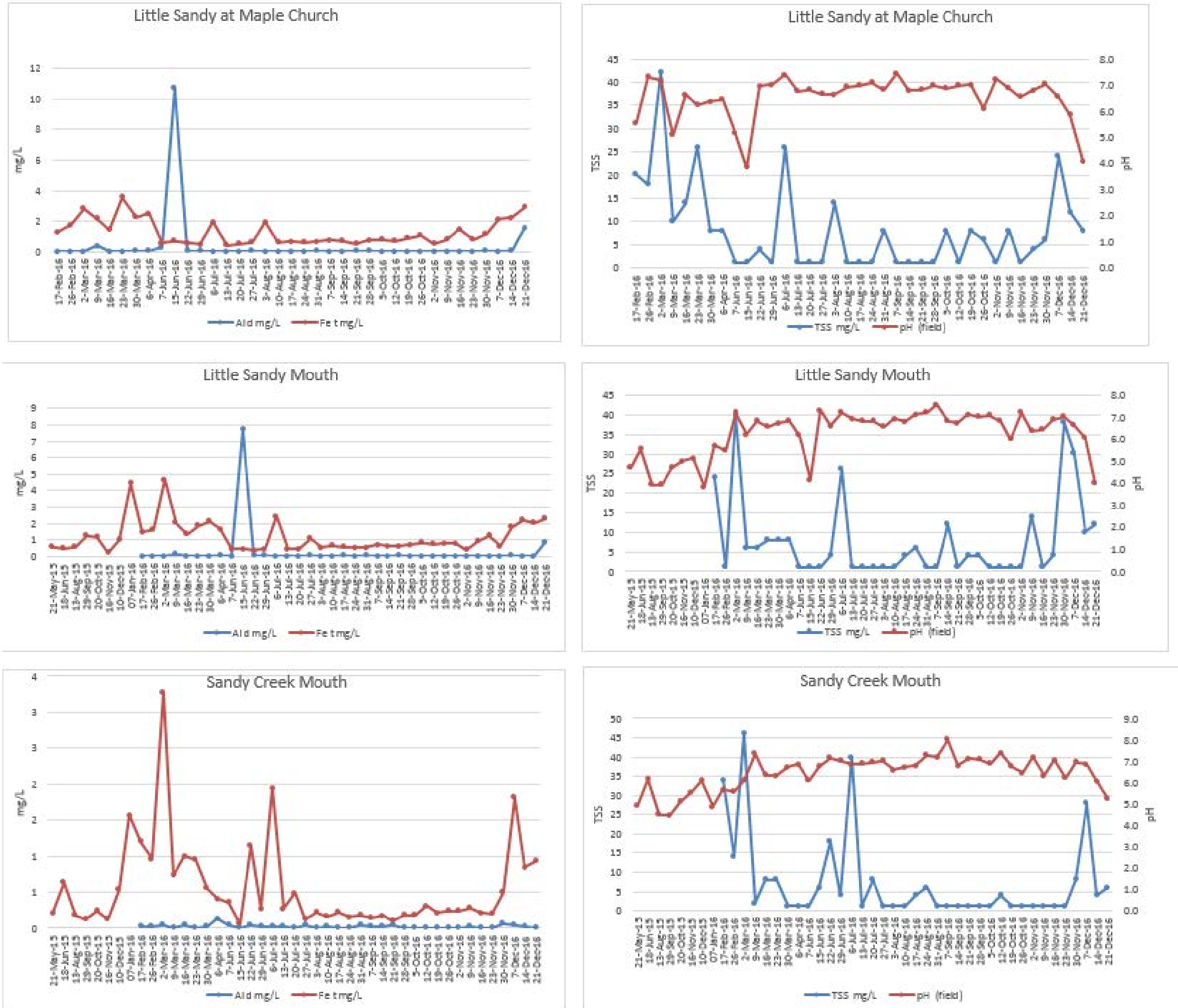


Figure 24. Left, dissolved Al and total Fe at Little Sandy and Sandy Creek mouth sampling points. Right, TSS and pH.

Appendix C

1. Geomorphic Landform Design as a reclamation option for the Royal Scot coal refuse site, Greenbrier County, WV

Prepared by: John Quaranta and Leslie Hopkinson
West Virginia University Department of Civil and Environmental Engineering

BACKGROUND & OPPORTUNITY

The Office of Special Reclamation (OSR), Division of Land Restoration within the West Virginia Department of Environmental Protection (WVDEP) partnered with West Virginia University (WVU) and the US Department of Interior Office of Surface Mining, Reclamation, and Enforcement to identify best available technology options for reclamation of the Royal Scot refuse site located in Greenbrier County, WV. Implementing the new technology, Geomorphic Landform Design (GLD), has the potential to improve off-site water quality. Challenges to site reclamation include steep topography and high infiltration to the refuse pile driving the production of acid-mine drainage.

The overall goal of the Geomorphic Landform Design reclamation project is to design, construct, and monitor an engineered landform. The GLD included an engineered cap system with ground contouring to minimize precipitation infiltration and direct surface runoff using four engineered stream channels. The design will replicate a mature natural landform that is in equilibrium with erosive forces and minimizes slope mass wasting.

In 2016, the project objectives were to design a geomorphic landform for the 45 acre Royal Scot site (Figure 1), then compare and contrast construction cost estimates with the existing water treatment operation and maintenance costs. Project benefits are aimed at reducing long-term operation and maintenance costs through reduced environmental impact; improved water quality; improved flood control; and reduced land reclamation and water liabilities to the State's Special Reclamation Fund.

RESEARCH OBJECTIVES, ACCLOMPLISHMENTS, & OUTCOMES IN 2016

In short, the project objective was to complete a GLD for the Royal Scot field site. To do this, alternative cap and cover systems were developed, tested, and analyzed for placement on the Royal Scot geomorphic reclamation plan. Then computer models were used to evaluate the performance of the cover system on both geomorphic and conventional slopes.

A multi-layered cap and cover system was designed and the components were tested in WVU Civil Engineering geotechnical laboratory. Three materials were evaluated for the cap and cover system which included the existing site coarse coal refuse (CCR), a short paper fiber produced by WestRock's Covington paper mill (marketed as MGro™), and a combination of site and MGro^{TM} materials in a 60% CCR/ 40% MGro™ volumetric blend. The final cover system design selected consists of two layers as shown in Figure 2.

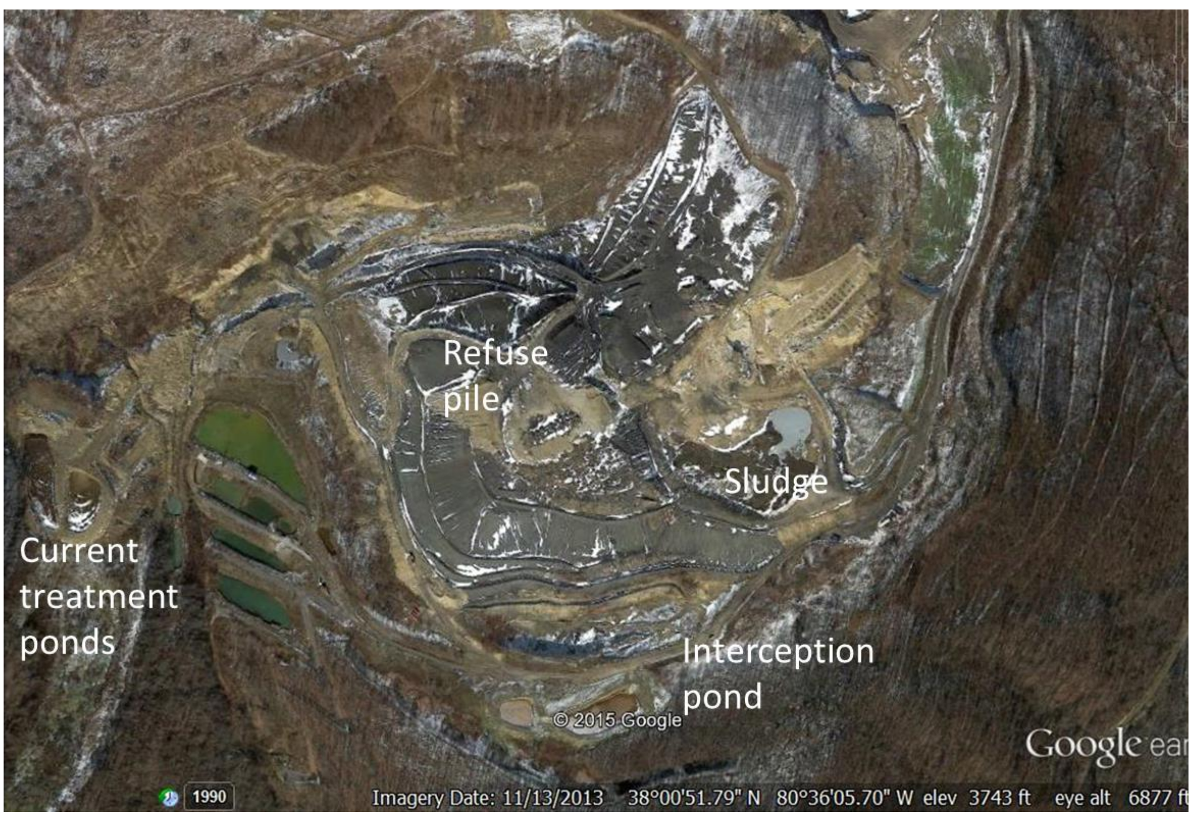


Figure 1. Coarse coal refuse pile

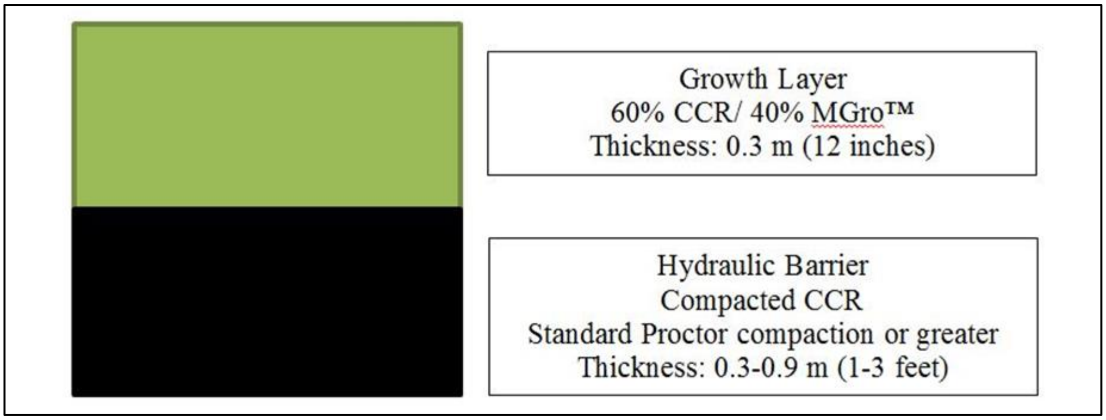


Figure 2: Cap and Cover System

The cap and cover system is to be applied to the entire 45 acre affected area of the reclamation site. The function of this two-layer system is to decrease infiltration and facilitate growth of vegetation using the MGro™ as an agricultural amendment. The top layer of the system is a growth layer composed of the 60% coal refuse/ 40% MGro™ paper fiber and is to be installed at minimum depth for plant growth, to a set to 12 inches. The bottom layer is a hydraulic barrier constructed from compacted coarse coal refuse and the thickness set to between 1-2 feet.

Design of the site slope contours was performed using several computer softwares. Carlson Natural Regrade with GeoFluv™ was used to create a geomorphic reclamation design as shown in Figure 3. This design is radially draining with four geomorphic watersheds (i.e. GLD A, B, C and D, Figure 3) and incorporates conventional bench slope cut profiles in the steepest terrain. The geomorphic watersheds are connected by benched slopes with slopes ranging from 2.5:1 to 2:1. The landform will be covered with 1 ft of MGro™ combined with the refuse at a ratio of 60% refuse to 40% MGro™. All slopes met the design criteria of 2:1 or less. Within the geomorphic landforms, the steep slopes are located in the headwater area of the watersheds, similar to what would be found in natural topography (Figure 4).

Numerical computer modeling for the slopes was completed in the SoilVision Systems ™ modeling suite (SVOffice), a program based on the Finite Element Method (FEM). The program allowed for construction of conceptual slopes whose geometry, properties, and other features could be easily altered for analysis. The SVSlope® and SVFlux ™ modules of SVOffice were used to complete the slope stability factor of safety and seepage modeling. The modeling included assessing precipitation storm events for both a 4-year average and a 100-year design storm.

In summary, the initial outcomes of the project in 2016 first accomplished a GLD analysis with a complete design replete with plan and profile drawings and specifications. Landforming was used to alter the hydrology to reduce the infiltration into the pile. Both the topography and channels incorporated in the design will quickly move stormflow off of the site. Performance of the geomorphic slopes is anticipated to be better than the conventional design.

The geomorphic slope maintains a higher geotechnical factor of safety for both the average and 100-year design storm boundary conditions. Both the GLD and conventional benched slopes meet or exceed the 1.5 minimum factor required by the West Virginia DEP for the project.

Some final performance indicators are presented below:

1. Apply geomorphic landforming principles: Four geomorphic areas were established, and the watersheds drain radially.

2. Reduced stormwater infiltration: Engineered cap systems were applied to minimize infiltration by 44% to 56%. Radially draining the site quickly into armored channels minimizes the contact time with the refuse.

3. Segregate stormwater and groundwater flows: The radially draining hydraulic network captures 87% of rainfall and sends the runoff to a sediment pond.

4. Establish sustainable vegetative cover reducing mass wasting: The MGro™ soil amendment is included to promote vegetation growth.

5. Minimize earthmoving quantities: The design surface alone is achieved by excavating 267,731 yd^3 of material and placing 295,840 yd^3 of material. The quantity difference (28,109 yd^3) is explained with the inclusion of the MGro™ soil amendment (Figure 5).

6. Minimize import material: Onsite material is used throughout the site. The coal refuse was combined with an amendment, MGro^{TM}, to create the growth zone. Sandstone is available for the channel liner and channel filter material.

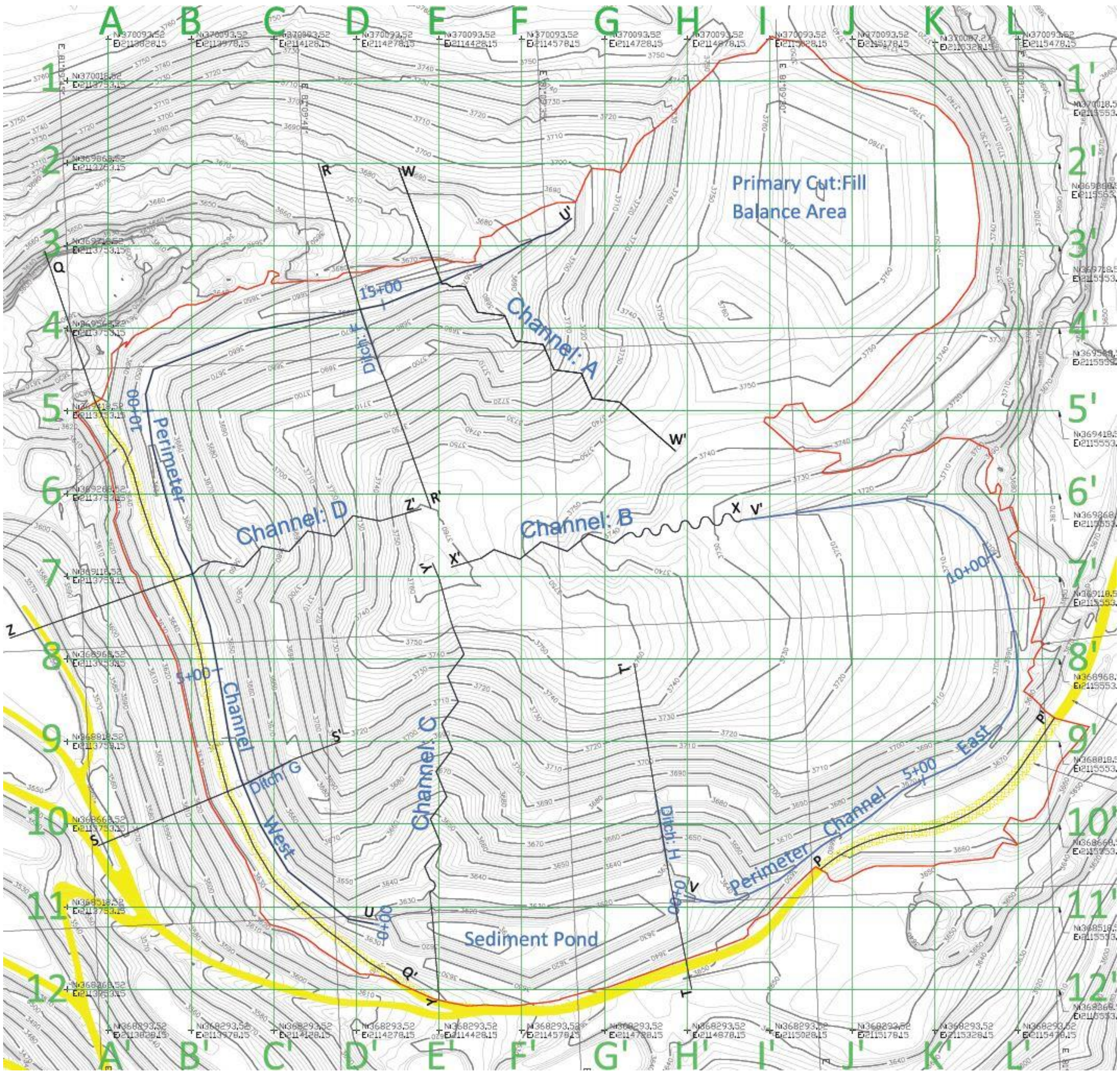


Figure 3. Final Royal Scot GLD design (2-ft contour interval).

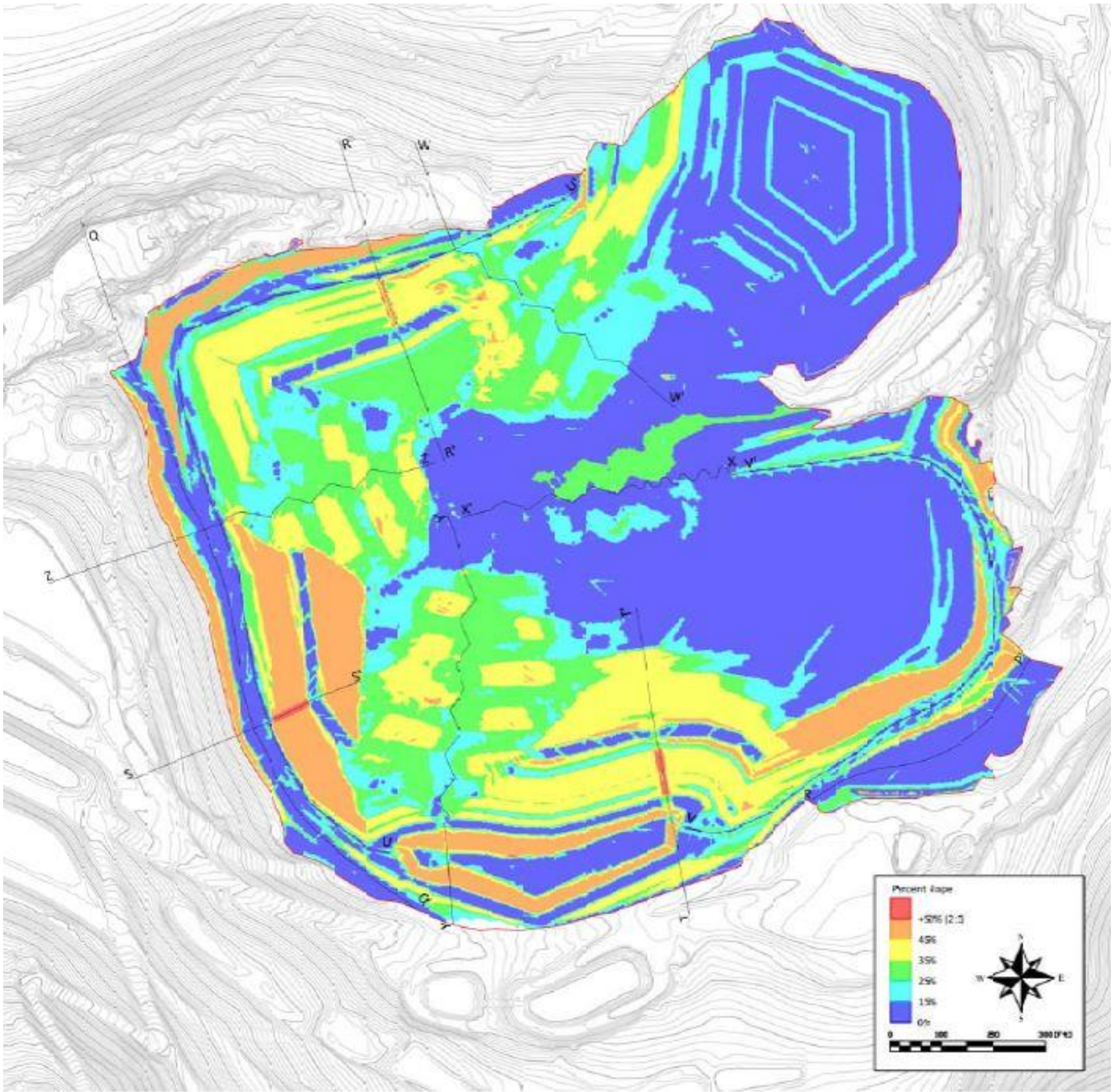


Figure 4. GLD Slope profile distribution (dark blue represents 0% – 15%; cyan represents 15%-25%; green represents 25%-35%; yellow represents 35%-45%; orange represents 45%-50%; red represents 50% and above).

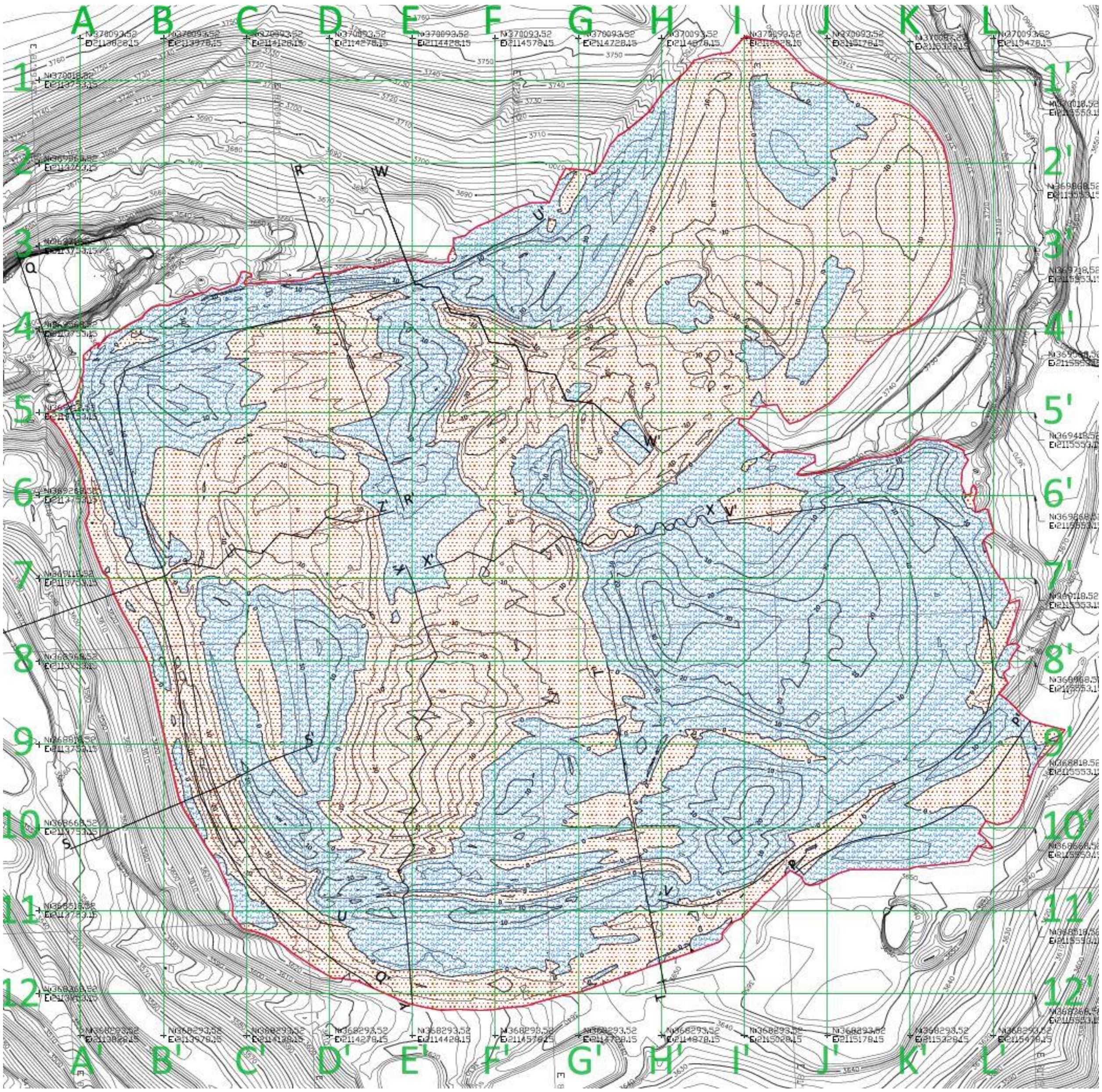


Figure 10. Zones of cut and fill (red areas indicate cut; clue areas indicate fill).

COST ANALYSIS

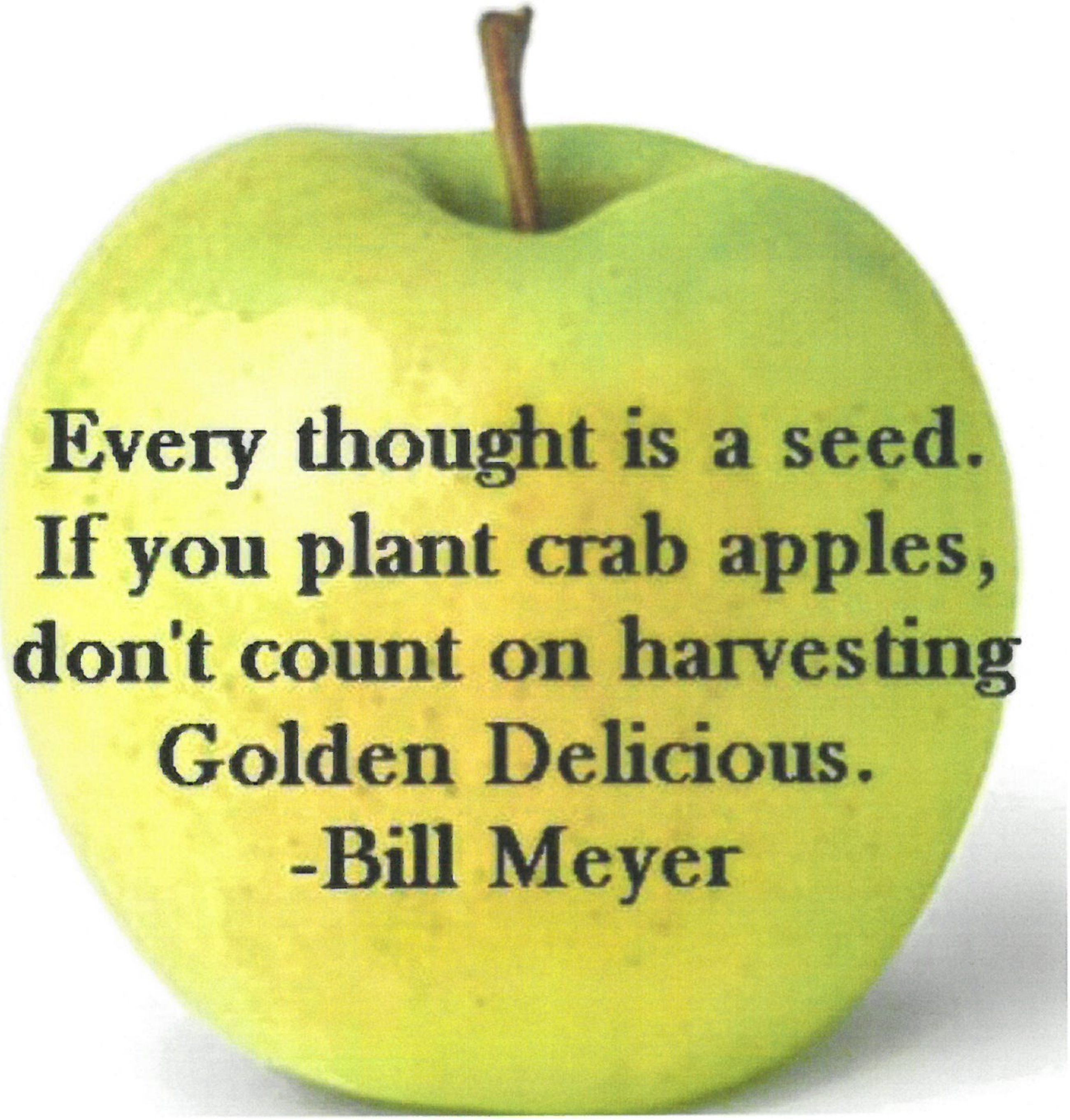
A preliminary cost analysis was compiled for the GLD reclamation option and is presented in tabular format in Table A. This estimate is based on the use of a 60% CCR/40% MGro^{TM} blended cover over a compacted layer. The reclamation cost is estimated at **$2,341,322** without overhead and profit. Assuming a **20%** overhead and profit figure the estimate increases to **$2,809,587.**

Table A: Royal Scot GLD Reclamation Cost Analysis

Item #	Description	Quantity	Unit	Unit Price	Total
01 50 00	**Temporary Facilities and Controls**				
01 52 00	**Construction Facilities**				**0.00**
01 52 13	Field Offices and Sheds (rent per month)	1.00	M	1,838.00	1,838.00
01 52 19	Sanitary Facilities	3.00	EA	672.50	2,017.50
01 54 36	**Equipment Mobilization**				
01 54 36.50	Equipment Mobilization	1.00	EA	10,000.00	10,000.00
01 55 00	**Vehicular Access and Parking**				**0.00**
01 55 13	Temporary Access Roads	406.15	C.Y	6.48	2,633.17
01 57 00	**Temporary Controls**				**0.00**
01 57 26	Site Watering for Dust Control	682585.20	SY	0.05	34,129.26
	Material Transportation				**0.00**
	Mgro Short Paper Fiber Hauling				**0.00**
	Mgro Short Paper Fiber Hauling	29166.00	CY	6.79	198,037.14
31 20 00	**Earth Moving**				**0.00**
31 22 00	**Grading**				**0.00**
31 22 13.20	Rough Grading	227528.40	SY	0.47	106,938.35
31 23 00	**Excavation and Fill**				**0.00**
31 23 16.42	Excavating Bulk Bank Measure	337638.50	CY	1.66	559,129.36
31 23 16.13	Trenching	8731.00	CY	4.36	38,067.16
31 23 23.20	Hauling	337638.50	CY	0.14	48,343.69
31 23 23.14	Backfill	325005.80	CY	1.60	520,009.28
31 23 23.23	Compaction	230125.44	CY	0.38	87,447.67
	Mixing Mgro/CCR in field	72915.00	CY	1.49	108,461.06
31 30 00	**Earthwork Methods**				**0.00**
31 37 00	**RipRap**				**0.00**
31 37 13	Machined RipRap	10466.25	CY	55.00	575,643.75
32 92 00	**Turf and Grasses**				**0.00**
32 92 19.13	Mechanical Seeding, 215 lb./acre	227528.40	SY	0.07	16,745.82
	Blend plowing	455056.80	SY	0.07	31,853.98
01 31 00	**Project Management and Coordination**				
01 31 13	**Project Coordination**				
01 31 13.80	Overhead and Profit	1	%	20.00	468,264.54
				∑ bare cost	**2,341,322.68**
				FINAL COST	**2,809,587.22**

PLANS FOR 2017

Plans for 2017 include advancing with a field site investigation to validate the WVU laboratory material property test values for the coarse coal refuse and to obtain construction parameters such as field compaction limits. A field mixing and grass growth study is planned at the site to evaluate the 60% refuse to 40% MGro blend. If proven successful, the technique can be part of a cost-effective solution to improve water quality at active and future refuse facilities, abandoned mine lands, bond forfeiture sites, and closed coal refuse impoundments within the Appalachian region.


Every thought is a seed.
If you plant crab apples,
don't count on harvesting
Golden Delicious.
-Bill Meyer

A Golden Apple Opportunity

An Initiative of the Central Appalachia Empowerment Zone of West Virginia
To Diversify the Economy of Central West Virginia

Summary

The Central Appalachia Empowerment Zone of West Virginia (CAEZ) has an MOU with the WV National Guard and will also be partnering with West Virginia State University, West Virginia Department of Agriculture, Office of Coalfield Community Development, to reintroduce the Golden Delicious Apple Tree to its county of origin. With available land, water, labor and financial resources the Golden Delicious Apple presents a viable option to position Clay County as a player in national agriculture and tourism markets for West Virginia.

The reintroduction/planting of the Golden Delicious Apple Trees as well as the apple industry in general in central West Virginia will create employment for a variety of positions such as marketing, picking, processing, etc

Introduction and Background

Clay County is the home of the Golden Delicious Apple. Clay County has a population of over 9,000 people with a median household income of $22,120 with 24% of the population below the poverty line. Clay is part of the Charleston MSA of 305,000 people. The town of Clay is the county seat and is located less than fifteen minutes from Interstate 79 (I 79). Central West Virginia's economy has been devastated by the downturn into the local coal industry. Much like the rest of the Appalachian coalfields, central West Virginia's economy was highly dependent on the extraction industries of coal and timber. With both industries struggling, it is more critical now more than ever that the area create a new industry that will help offset the highs and lows of its current economic base. It is also important that this new endeavor compliment a growing area of the economy in the region, tourism.

The Golden Delicious Apple is perhaps the most widely known variety of apple in the US. The very popular apple has the potential to be utilized in aiding the economic situation in Clay County and areas along I 79. The apple was first discovered on a family farm owned by the Mullins family. The family sold the rights to the apple and land surrounding the original tree in 1914 to Stark Brothers Nurseries. Stark Brothers have recently purchased the company from corporate holders. The apple continues on and is cultivated internationally with a large following. With available land, water, labor, and financial resources the golden delicious apple along with the apple industry in general presents a viable option to position central West Virginia as a player in national agriculture and tourism markets for West Virginia.

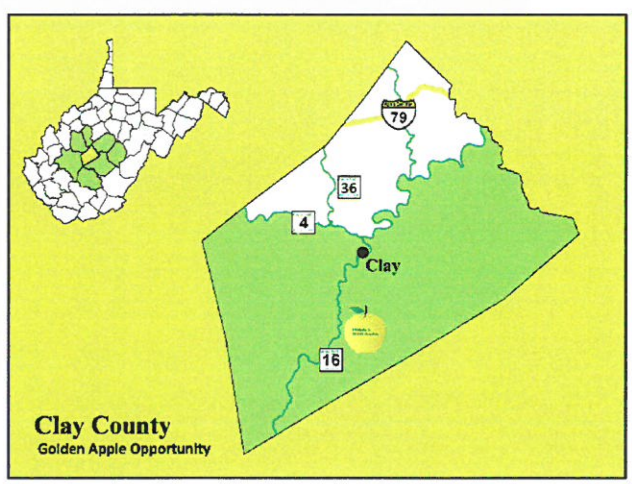
Creating this industry in central West Virginia could not be at a better time. According to the USDA, apple consumption is at a 20 year high. Adding a fruit based industry to the overall economy of central West Virginia has multiple benefits:

- Creating enough capacity will assist in recruiting food product manufacturing to West Virginia, a target industry of the West Virginia Department of Commerce
- Apple orchards vary in size, allowing investment levels to range from people planting trees in their yard to family orchards to commercial growers of over 1,000 acres
- At $200 per ton or $4 per bushel, the going prices of production apples, a 5 acre orchard can bring in revenue of $60,000 per year
- A Cornell University study shows that 1 acre of an apple orchard consumes net 20 tons of CO_2 per year
- Orchards that market as pick your own can bring in between $15-$30 per bushel and add to the tourism economy of West Virginia

Goal for Overall Initiative

The overall goal of this project is to re-establish the Golden Delicious Apple tree to in its county of origin and to bring enough apple trees in general to Central West Virginia to entice food processors and manufacturers to the region. For example, the Mott's Facility in Aspers, Pennsylvania employees nearly 550 employees and consumes 10% of Pennsylvania's apple production or 40 million pounds. To produce that many apple, 50,000 trees are needed. We plan to build/recruit the production capabilities of apples in Central Appalachia by:

- Phase I - Plant Initial 3,000 trees in Clay County
- Phase II - Raise funds to place at least 50,000 trees into the region. This goal is specific to draw outside investment for food processing
- Phase III - Begin programs to assist West Virginians to create orchards in the region to reach a million trees, making West Virginia the largest apple produces on the east coast



Objectives for Phase I

1. Develop a successful orchard on a surface mine site on property controlled by Central Appalachia Empowerment Zone in Clay County, WV
2. Study and understand how the utilization of runoff water in conjunction with apple trees improves the environment
3. Utilize green technology (hydroelectricity) from water utilized by the orchard which also assists in the better use of water from the mine site
4. Once established, use these sites as learning and demonstration sites so that more surface mine sites can be established with orchards in the future.

Project Site Locations:

The Clay County location has site characteristics that are favorable for tree growth except for compaction. To address the site preparation for soil compaction, property is available on one site known near the town of Independence, WV.

Project/Initiative Lead – The Central Appalachian Empowerment Zone

The Central Appalachia Empowerment Zone of WV is the lead economic development organization in Clay County. The CAEZ has been assisting businesses for the past 20 years through real estate development, business retention efforts, facilitating state and federal business loans, offering business education training, bring new investment into the county, and receiving local, state and federal grants for our five county service area.

Directed by a board of committed community-minded, volunteer individuals, the leadership is citizen elected for two to three year terms. We have a county commissioner that sits on our board from each of our five counties. Full time professional staff includes an Executive Director, Office Manager and Small Business Coach. In addition to internal staff, the CAEZ has a memorandum of agreement with the West Virginia National Guard to utilize their staff for agriculture and tourism based projects. The board represents a broad base of local leaders from business and industry, education and government.

The CAEZ collaborates extensively with community groups, nonprofits, and government agencies and has managed state, local and federal grants.

All potential partners will be expected to provide resources as well as ideas, experience, and help drive the project forward utilizing their established networks. Partners will have varied roles throughout the project and will be relied on for their expertise. Initial ownership of the project will be within the Central Appalachia Empowerment Zone with the opportunity of it being spun out into its own entity after it has matured and is sustainable.

Current partners on this initiative are:

The West Virginia National Guard - The WVNG is providing personnel to assist in the management of this project as well as assisting in the physical development of the orchards

WV Division of Energy/Office of Coalfield Community Development– Providing funding for the irrigation system which utilized hydroelectricity

The West Virginia Department of Agriculture – Providing funding under the specialty crop grant program for fencing and to plant trees on public property throughout the county as well as subject matter expertise

West Virginia State University Extension – Providing agriculture subject matter expertise and assistance in educational opportunities during this initiative

Appalachian Regional Commission – Providing funding for the initial tree planting on the mine site

Marshal University Brownfield Assistance Center – Acting as a liaison to the West Virginia Division of Energy to assist in evaluation of the property being utilized

Timeline for Phase I and Overall Initiative

December 2015 (and ongoing) CAEZ workshops on starting agri-businesses

December 2015 –Begin process of building a business plan template for initial project

April 2016 – First Planting & Trees planted on public property throughout the region

October 2016 – Second Planting, installation of irrigation system

2016-2019 – Monitoring and research and development activities of phase I orchard

2019 – Creation/Recruitment of for profit entity to take control of orchard

2019 – Assistance in establishing the creation or recruitment of companies who will utilize the apples produced as feedstock for food based manufacturing (cider or apple sauce as an example)

Current Funding For Phase I

Appalachian Regional Commission/WV Division of Energy (To be used for trees.)	$35,000.00
WV Division of Energy (For irrigation system)	$30,000.00
WVDA (For fencing and trees)	$8,900.00
Total	$ 73,900.00

Funding For Phase II

Purchase of apples	$500,000
Infrastructure	$500,000
Total	$1,000,000

Conclusion

Central West Virginia is in need of a new economic engine to diversify its economy, add value to post mined property, and complement its tourist based economy. The apple industry is a growing industry that has natural ties to West Virginia. It impacts all aspects of an economy, to family own farms to multimillion dollar investment by multinational companies. This initiative is already under way with a 3,000 tree orchard to be planted in 2016 and workshops being held about this opportunity. A large injection of apple trees to create the feedstock for food processing is necessary to establish the industry within central West Virginia.

Additoinal Data -

Apple Estimates Phase I Site 1

Acres	20	
Trees	3,000	
Bushels	60,000	
Pounds	2,400,000	
Water Gallons Daily	54,000	
Price Per Bushel	$4.00	
Total		$240,000.00

Apple Estimates Phase II Site II

Acres	333	
Trees	50,000	
Bushels	1,000,000	
Pounds	40,000,001	
Water Gallons	900,000	
Price Per Bushel	$4.00	
Total		$4,000,000.08

Apple Estimates Phase III Concept
1,000,000 trees

Acres	6,667	
Trees	1,000,000	
Bushels	20,000,000	
Pounds	800,000,000	
Water Gallons	18,000,000	
Price Per bushel	$4.00	
Total		$80,000,000.00

Apple Estimates Phase III
Concept One Commercial growers
500,000 trees

Acres	3,333	
Trees	500,000	
Bushels	10,000,000	
Pounds	400,000,000	
Water Gallons	9,000,000	
Price Per Bushel	4	
Total		$40,000,000.00

Apple Estimates Phase III
Concept 2 Using Five Acre Farms
500,000 trees

Total 5 Acres Farms	667	
trees	500,000	
bushels	10,000,000	
Pounds	400,000,000	
water gallons	9,000,000	
Price Per bushel	$4.00	
Total		$40,000,000.00

Apple Estimates Phase III
Concept Two Using Five Acre Farms
500,000 trees

Acres	5	
Trees	750	
Bushels	15,000	
Pounds	600,000	
Water Gallons	13,500	
Price Per Bushel	$4.00	
Total		$60,000.00