

**The Effects of Subsidence Resulting from  
Underground Bituminous Coal Mining on Surface  
Structures and Features and on Water Resources,  
2003 to 2008**

**Bituminous Mine Subsidence and Land Conservation Act  
ACT 54 Amendments  
Five-Year Report  
August 2003 to August 2008**

**Research Conducted by the University of Pittsburgh for the Pennsylvania  
Department of Environmental Protection**

**Authors**

**Anthony Iannacchione<sup>1</sup>,  
Stephen J. Tonsor<sup>1</sup>,  
Megan Witkowski<sup>2</sup>,  
Jessica Benner<sup>2</sup>,  
Alison Hale<sup>2</sup>,  
and Martine Shendge<sup>2</sup>**

<sup>1</sup> – Associate Professor

<sup>2</sup> – Graduate Student

**Participating University Personnel:**

Swanson School of Engineering

*Department of Civil and Environmental Engineering*

Anthony Iannacchione, Associate Professor and Principal Investigator

Megan Witkowski, Graduate Student and Team Leader

Amy Patil, Graduate Student

Nicole Iannacchione, Graduate Student

Mohamed Koubaa, Undergraduate Student

School of Arts and Sciences

*Department of Geology and Planetary Science*

William Harbert, Associate Professor

Jessica Benner, Graduate Student and Team Leader

Martine Shendge, Graduate Student

Aron Schmid, Graduate Student

*Department of Biological Sciences*

Stephen J. Tonsor IV, Associate Professor

Alison Hale, Graduate Student and Team Leader

Jacob Phillips, Undergraduate Student

Matthew Simon, Undergraduate Student

Chris Fisher, Undergraduate Student

Caitlin Weber, Undergraduate Student

## CONTENTS

|  |        |
|--|--------|
| TITLE PAGE .....   | i      |
| CONTENTS .....   | iii    |
| ACKNOWLEDGMENTS .....  | v      |
| ACRONYMS AND ABBREVIATIONS .....   | vii    |
| EXECUTIVE SUMMARY .....  | EX_1   |
| SECTION I: Introduction.....   | I_1    |
| SECTION II: Data Collection and Methods of Analysis .....  | II_1   |
| SECTION III: Underground Bituminous Coal Mining During the 3 <sup>rd</sup> Assessment Period. ....   | III_1  |
| SECTION IV: A Summary of the PA DEP Observations on the Effects of Undermining Interstate 79 during the 3 <sup>rd</sup> Assessment Period.....   | IV_1   |
| SECTION V: Effects of Mining on Structures .....   | V_1    |
| SECTION VI: Effects of Mining on Water Supplies.....   | VI_1   |
| SECTION VII: Effects of Mining on Land.....  | VII_1  |
| SECTION VIII: Effects of Mining on Stream.....   | VIII_1 |
| SECTION IX: Effects of Mining on Wetlands – Recent Progress .....  | IX_1   |
| SECTION X: Discussion, Summary, Conclusions .....  | X_1    |
| REFERENCES .....   | R_1    |
| APPENDIX A: Mining Activity during the 3 <sup>rd</sup> Assessment Period .....   | A_1    |
| APPENDIX B1: Summary of Reported Effects from Active and Closed Mines during the 3 <sup>rd</sup> Assessment Period .....   | B_1    |
| APPENDIX B2: Summary of Reported Effects occurring in the 2 <sup>nd</sup> Assessment Period at Active Mines and their Resolution Status at the end of the 3 <sup>rd</sup> Assessment Period..... | B_3    |
| APPENDIX C: Maps from the University GIS Database Depicting Mining Extent, Overburden, and Surface Features .....  | C_1    |
| APPENDIX D1: <i>Bailey Mine</i> -- Information on Streams Undermined by Longwall Mines during the 3 <sup>rd</sup> Assessment Period and Surveyed by the University of Pittsburgh .....           | D_1    |
| APPENDIX D2: <i>Blacksville No.2</i> -- Information on Streams Undermined by Longwall Mines during the 3 <sup>rd</sup> Assessment Period and Surveyed by the University of Pittsburgh .....      | D_23   |
| APPENDIX D3: <i>Cumberland Mine</i> -- Information on Streams Undermined by Longwall Mines during the 3 <sup>rd</sup> Assessment Period and Surveyed by the University of Pittsburgh .....       | D_30   |
| APPENDIX D4: <i>Emerald Mine</i> -- Information on Streams Undermined by Longwall Mines during the 3 <sup>rd</sup> Assessment Period and Surveyed by the University of Pittsburgh .....          | D_39   |
| APPENDIX D5: <i>Enlow Fork Mine</i> -- Information on Streams Undermined by Longwall Mines during the 3 <sup>rd</sup> Assessment Period and Surveyed by the University of Pittsburgh .....       | D_43   |

APPENDIX E1: Stream Investigation Reports for the 3<sup>rd</sup> Assessment Period..... E\_1  
APPENDIX E2: Stream Re-Surveyed from the 2<sup>nd</sup> Assessment Period with Mitigation Work  
and Flow Status Observations (made by the University)..... E\_4  
APPENDIX F1: Summary of Re-Survey of Problem Streams from the 2<sup>nd</sup> Assessment Period  
..... F\_1  
APPENDIX F2: Summary of Survey of Stream with Reported Effects from the 3<sup>rd</sup>  
Assessment Period ..... F\_3  
APPENDIX G1: Undermined Wetland during the 3<sup>rd</sup> Assessment Period Sorted by Mine G\_1  
APPENDIX G2: Wetland Inventory for Enlow Eork Mine, Panels F12 to F18 Permit Revision  
..... G\_4  
APPENDIX G3: Wetland Inventory for the Cumberland Mine, Collected in 2004..... G\_7  
PLATE 1: Study Area for the 3<sup>rd</sup> Assessment Period of ACT 54.....

## ACKNOWLEDGEMENT

The authors have many individuals and groups to thank. In the beginning, the principle investigators of the 2<sup>nd</sup> assessment report, Dr(s) *Donald Conte* and *Larry Moses*, met with the University on several occasions to discuss lessons learned from their experience. Their guidance, insight, and recommendation all proved invaluable.

During the data collection phase of this project several organizations deserve our recognition. The University staff made trips to four coal companies to collect files and maps. The companies not only fulfilled these requests but, in many cases, also supplied AutoCAD or ArcGIS files containing precise mining outlines and locations of structures, water supplies, and land features important to the study. In addition, the Western Pennsylvania Conservancy provided their Aquatic Community Classification data base in a GIS format. In particular, the University would like to thank:

- *Jonathan Pachter, Mark Stanley, and Joshua Silvis* of Consol Energy;
- *Terry Dayton, Michelle Anderson, and Brad Miller* of Alpha Resources;
- *Jim Public, Rob Bottegai, and Peter Merritts* of AmFire Mining (Now part of Alpha Resources);
- *Dennis Foster, Joseph Zelanko, and J. Clifford Forrest* of Rosebud Mining; and
- *Jeff Wagner, Western Pennsylvania Conservancy.*

Both Consol Energy and Alpha Resources provided a field trip for University students to examine impacts from underground coal mining and associated mitigation efforts (see report cover for pictures of the field trip participants).

The University would also like to thank employees of Commonwealth of Pennsylvania for their support of this project. In particular --

### Department of Environmental Protection's District Mining Operations

- *William Plassio*, District Mining Manager, and *Michael Terretti*, Director of the District Mining Operations, PA DEP, for allowing their staff to assist the University in data collection;
- *Gregory Prentice*, Compliance Manager, *Joel Koricich*, Engineering Supervisor, *Joseph Leone*, Chief of the Bituminous Mining Permits Section, and *James Welsh*, Technical Services Manager, all of the California District Mining Operations for their help in collecting, interpreting, and reviewing the data contained within office files.

### Department of Environmental Protection's Bureau of Mining & Reclamation

- *Harold Miller* (retired), Chief, *Gregory Shuler*, Geologist, and *Michele Hamlin*, Geologist, Underground Mining Section, Division of Permits, for contract monitoring and assistance in data collection and analysis as well as technical review of this report. A special note of thanks is extended to *Harold Miller* for his years of service and level of dedication in regards to the ACT 54 reviews.

### Department of Transportation

- *Roy Painter*, District Geotechnical Engineer, Engineering District 12, for supplying pictures and data collected by PennDOT during the undermining of Interstate 79.

The authors would like to thank the following individuals at the University of Pittsburgh. Without their support, this report could not have been completed:

- *Dr. Radisav Vidic*, Department Chair of Civil and Environmental Engineering, *Rama Bazaz*, Associate Director of Engineering Administration, and *Sonia Suhy*, Administrative Assistant, for helping us through all of the contractual and budgetary processes;
- *Mohamed Koubaa*, *Amy Patil*, and *Nicole Iannacchione*, Undergraduate and Graduate Students at the Swanson School of Engineering, for helping with complying information, digitizing maps, and analyzing data. *Nicole Iannacchione* also prepared the report cover.
- *William Harbert*, Associate Professor in the Department of Geology and Planetary Science, and *Aron Schmid*, Graduate Student, for assisting with ArcGIS programming and utilization.
- *Jacob Phillips*, *Matthew Simon*, *Chris Fisher*, and *Caitlin Weber*, Undergraduate Students in the Department of Biological Sciences, for their efforts in conducting stream investigations and laboratory analysis of taxa found within these streams.

Lastly, the authors would like to recognize William E. Martin of Indiana Tech for his outstanding and tireless efforts in editing this report.

## ACRONYMS and ABBREVIATIONS

|                 |  |
|-----------------|--|
| %EPT            | Percent of all taxa that are Ephemeroptera, Plecoptera and Trichoptera |
| ACCD            | Aquatic Community Classification Database                              |
| Act 418         | Surface Mining Conservation and Reclamation Act                        |
| ACT 54          | BMSLCA as amended 1994   |
| ArcGIS          | GIS software by ESRI   |
| ARMPS           | Analysis of Retreat Mining Pillar Stability                            |
| BMR             | Bureau of Mining and Reclamation                                       |
| BMSLCA          | Bituminous Mine Subsidence and Land Conservation Act                   |
| BUMIS           | Bituminous Underground Mining Information System                       |
| CAD             | Computer Aided Drawing   |
| CDMO            | California District Mining Office                                      |
| Clean Water Act | Federal Water Pollution Control Amendments of 1972 (P.L. 92-500)       |
| Commonwealth    | Commonwealth of Pennsylvania   |
| CUP California  | University of Pennsylvania   |
| DCNR            | Department of Conservation and Natural Resources                       |
| DEM             | Digital Elevation Model  |
| EIA             | Federal Energy Information Administration                              |
| EHB             | Environmental Hearing Board  |
| ERRI            | Environmental Resources Research Institute                             |
| ESRI            | Environmental Systems Research Institute                               |
| FC+PR Richness  | Filterer-Collector + Predator Taxa Richness                            |
| FGDC Federal    | Geographic Data Committee  |
| ft              | feet   |
| Geo-TIF         | Geo-Tagged Image Format  |
| GIS             | Geographic Information System  |
| GPS             | Global Positioning System  |
| I79             | Interstate 79  |
| JPEG            | Joint Photographic Experts Group                                       |
| m               | meter  |
| MOU             | Memorandum of Understanding  |
| NAD 1983        |  |
| NAD 1927        |  |
| NGO             | Non-Government Organizations   |
| NHD             | National Hydrography Dataset   |
| NIOSH           | National Institute for Occupational Safety and Health                  |
| NWI             | National Wetland Inventory   |
| O&M             | Operation and Maintenance  |
| PA              | Pennsylvania   |
| PA DCNR PA      | Pennsylvania Department of Conservation and Natural Resources          |
| PA DEP          | Pennsylvania Department of Environmental Protection                    |
| PACC            | Pennsylvania Aquatic Community Classification                          |
| PaGWIS          | Pennsylvania Groundwater Information System                            |
| PASDA           | Pennsylvania Spatial Data Access                                       |
| pct             | percent  |
| PEM             | wetlands showing emergent vegetation                                   |

The Effects of Subsidence Resulting from Underground Bituminous Coal Mining on Surface Structures and Features and on Water Resources, 2003 to 2008 – University of Pittsburgh

---

|            |  |
|------------|--|
| PennDOT    | Pennsylvania Department of Transportation  |
| PFO        | forested wetlands  |
| PSS        | wetlands showing scrub/shrub   |
| PSU        | Pennsylvania State University  |
| PUB        | wetlands showing less than 30-pct vegetative cover and unconsolidated bottom                   |
| R5UBH      | riverine with unclassified perennial vegetation, unconsolidated bottom and permanently flooded |
| RMSE       | Root Mean Squared Error  |
| RPZ        | Rebuttable Presumption Zone  |
| SA         | Subsidence Act   |
| SMCRA      | Surface Mining Control and Reclamation Act of 1977   |
| TBS        | Total Biological Score   |
| TGD-001    | Technical Guidance Document 363-0300-001   |
| TGD-655    | Technical Guidance Document 563-2000-655   |
| TIF        | Tagged-Image Format  |
| UGISdb     | University of Pittsburgh Geographic Information System Database                                |
| University | University of Pittsburgh   |
| US         | United States  |
| USGS       | US Geological Survey   |
| UTM        | Universal Transverse Mercator  |
| WL         | Water Loss   |
| WPC        | Western Pennsylvania Conservancy   |
| WRDS       | Water Resources Data System  |



### Reverse Look-up

GIS software by ESRI (ArcGIS)  
Analysis of Retreat Mining Pillar Stability (ARMPS)  
Aquatic Community Classification Database (ACCD)  
Bituminous Mine Subsidence and Land Conservation Act (BMSLCA)  
Bituminous Underground Mining Information System (BUMIS)  
BMSLCA as amended 1994 (ACT 54)  
Bureau of Mining and Reclamation (BMR)  
California District Mining Office (CDMO)  
California University of Pennsylvania (CUP)  
Commonwealth of Pennsylvania (Commonwealth)  
Computer Aided Drawing (CAD)  
Department of Conservation and Natural Resources (DCNR)  
Digital Elevation Model (DEM)  
Environmental Hearing Board (EHB)  
Environmental Resources Research Institute (ERRI)  
Environmental Systems Research Institute (ESRI)  
Federal Energy Information Administration (EIA)  
Federal Geographic Data Committee (FGDC)  
Federal Water Pollution Control Amendments of 1972 (P.L. 92-500) (Clean Water Act)  
feet (ft)  
Filterer-Collector + Predator Taxa Richness (FC+PR Richness)  
forested wetlands (PFO),  
Geographic Information System (GIS)  
Geo-Tagged Image Format (Geo-TIF)  
Global Positioning System (GPS)  
Interstate 79 (I79)  
Joint Photographic Experts Group (JPEG)  
Memorandum of Understanding (MOU)  
meter (m)  
NAD 1983 or NAD 1927  
National Hydrography Dataset (NHD)  
National Institute for Occupational Safety and Health (NIOSH)  
National Wetland Inventory (NWI)  
Non-Government Organizations (NGO)  
Operation and Maintenance (O&M)  
PA DEP Bureau of Mining and Reclamation Technical Guidance Document (TGD-655)  
PA Department of Conservation and Natural Resources (PA DCNR)  
PA Department of Transportation (PennDOT)  
PA Groundwater Information System (PaGWIS)  
Pennsylvania (PA)  
Pennsylvania Aquatic Community Classification (PACC)  
Pennsylvania Department of Environmental Protection (PA DEP)  
Pennsylvania Spatial Data Access (PASDA)  
Pennsylvania State University (PSU)  
percent (pct)

Percent of all taxa that are Ephemeroptera, Plecoptera and Trichoptera (% EPT)  
Rebuttable Presumption Zone (RPZ)  
riverine with unclassified perennial vegetation, unconsolidated bottom and permanently flooded (R5UBH)  
Root Mean Squared Error (RMSE)  
Subsidence Act (SA)  
Surface Mining Conservation and Reclamation Act (Act 418)  
Surface Mining Control and Reclamation Act of 1977 (SMCRA)  
Tagged-Image Format (TIF)  
Technical Guidance Document 363-0300-001 (TGD-001)  
Technical Guidance Document 563-2000-655 (TGD-655)  
Total Biological Score (TBS)  
United States (US)  
Universal Transverse Mercator (UTM)  
University GIS Database (UGISdb)  
University of Pittsburgh (University)  
US Geological Survey (USGS)  
Water Loss (WL)  
Water Resources Data System (WRDS)  
Western PA Conservancy (WPC)  
wetlands showing emergent vegetation (PEM)  
wetlands showing less than 30-pct vegetative cover and unconsolidated bottom (PUB)  
wetlands showing scrub/shrub (PSS)