

Appalachian Coal Mining Related Research

National Meeting of the American Society of Mining and Reclamation

June 2015



Current Research Projects

- Biological Response
- Methods Development
- Multipurpose

Potential Future Research Questions

Your Projects, Questions, and Opportunities

Ionoregulation and osmoregulation of major ions by freshwater animals

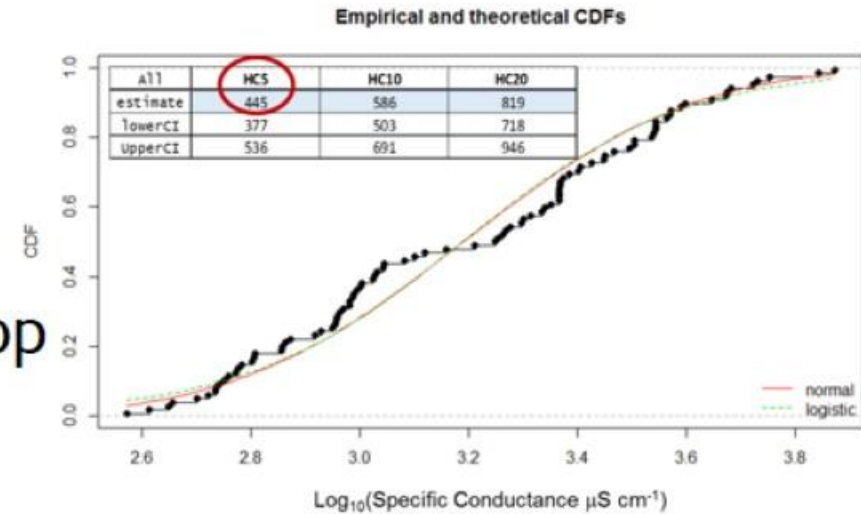
- ▶ Office of Research and Development - Cincinnati
- ▶ Review of the physiology literature on what is known about ionoregulation of Na^+ , K^+ , Ca^{2+} , Mg^{2+} , Cl^- , HCO_3^- , SO_4^{2-} , and $\text{NH}_3/\text{NH}_4^+$ in freshwater fish, insects, crustaceans, and mollusks.
- ▶ Identify the mechanisms behind adverse effects associated with elevated concentrations of these ions in freshwaters.
- ▶ Are the mechanisms the result of osmotic stress or effects associated specifically with individual ions?
- ▶ Draft review for journal submission

Background Macroinvertebrate Drift from Headwater Tributaries

- ▶ EPA Region 3 and Office of Research and Development
- ▶ Field sampling in Kentucky
- ▶ Quantifying monthly 24-hr macroinvertebrate drift from the mouths of forested tributaries
- ▶ Implications for mitigation/restoration success by predicting downstream dispersal potential from clean tributaries
- ▶ Manuscript in preparation

Artificial stream studies of effects of ion mixtures on drift, emergence, and abundance

- ▶ Office of Research and Development - Cincinnati
- ▶ Community-level responses including, periphyton structure, invertebrate drift and adult insect emergence were paired with single-species bench-top and in/ex-situ exposures to mixtures of salts that emulated deep well brines and valley fill effluent.
- ▶ Although background ionic concentration was greater in the mesocosm studies (average ca. 115 $\mu\text{S}/\text{cm}$ in a paired mining mixtures study), EC25 effect levels were consistent with conductivity levels reported in the Field-based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams
- ▶ Manuscript in progress

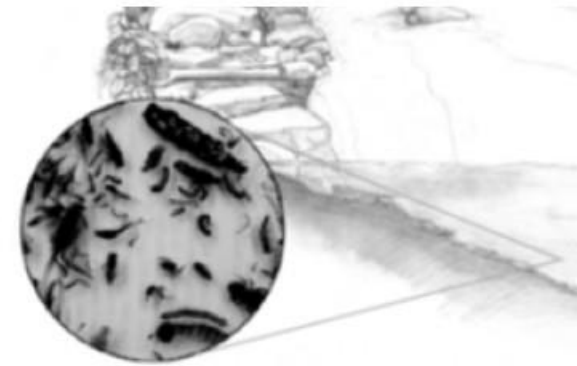


Macroinvertebrate Response to Total Dissolved Solids (TDS) Dosing

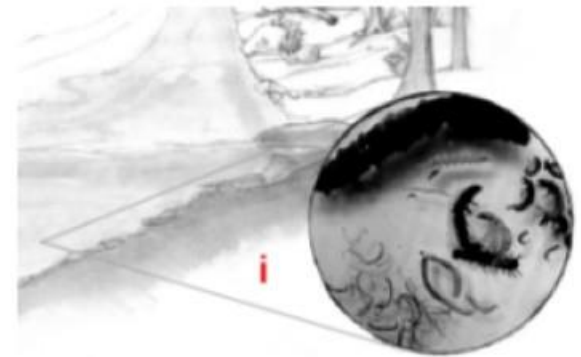
- ▶ EPA Region 3 and Office of Research and Development
- ▶ Field tests in Kentucky
- ▶ Macroinvertebrate drift response to short duration TDS dosing (MgSO_4) at various concentrations
- ▶ Manuscript in progress

Persistence of Ecological Impacts Downstream of Valley Fills

- ▶ Partnership between EPA Region 3 and OSMRE
- ▶ Duration of effects on biological communities downstream of reclaimed valley fills in WV
- ▶ Valley fills ranged in age from 11 to 33 years since reclamation
- ▶ Published in *Environmental Management* (2014)
54:919-933



Sensitive taxa



Tolerant taxa

Effect of MTM on Fish and Benthos: A Decadal Comparison

- ▶ EPA Region 3
- ▶ Data from 2000 vs. 2011 in three WV watersheds that underwent varying changes in mining land use
- ▶ Compare independent responses of fish and macroinvertebrates
- ▶ Data analysis underway; awaiting new assessment methodology from WV



Whole Effluent Toxicity (WET) Study: Laboratory Comparability

- ▶ EPA Region 3
- ▶ *Ceriodaphnia dubia* chronic WET for valley fill effluents
- ▶ Comparing results of split samples between two NELAC certified laboratories
- ▶ Data analysis underway

Modeling the Acute Toxicity of Major Geochemical Ions to *C. Dubia*

- ▶ Office of Research and Development - Duluth
- ▶ *Ceriodaphnia dubia* toxicity tests with binary salt mixtures to understand the interactive toxicity of ion mixtures
- ▶ For *C. dubia*, data suggest generalized toxicity related to total osmolarity (with Ca dependence), with more specific and potent mechanisms for Mg, Ca, and K
- ▶ Toxicity of most tested field-based mixtures driven by osmolarity, some by Mg
- ▶ Manuscripts in progress

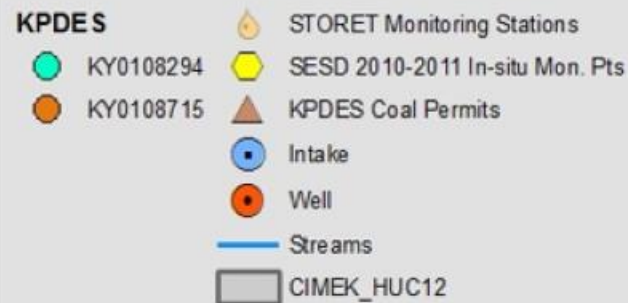
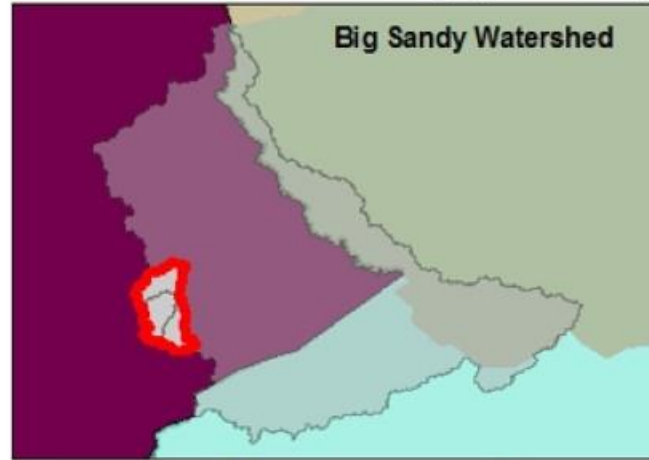
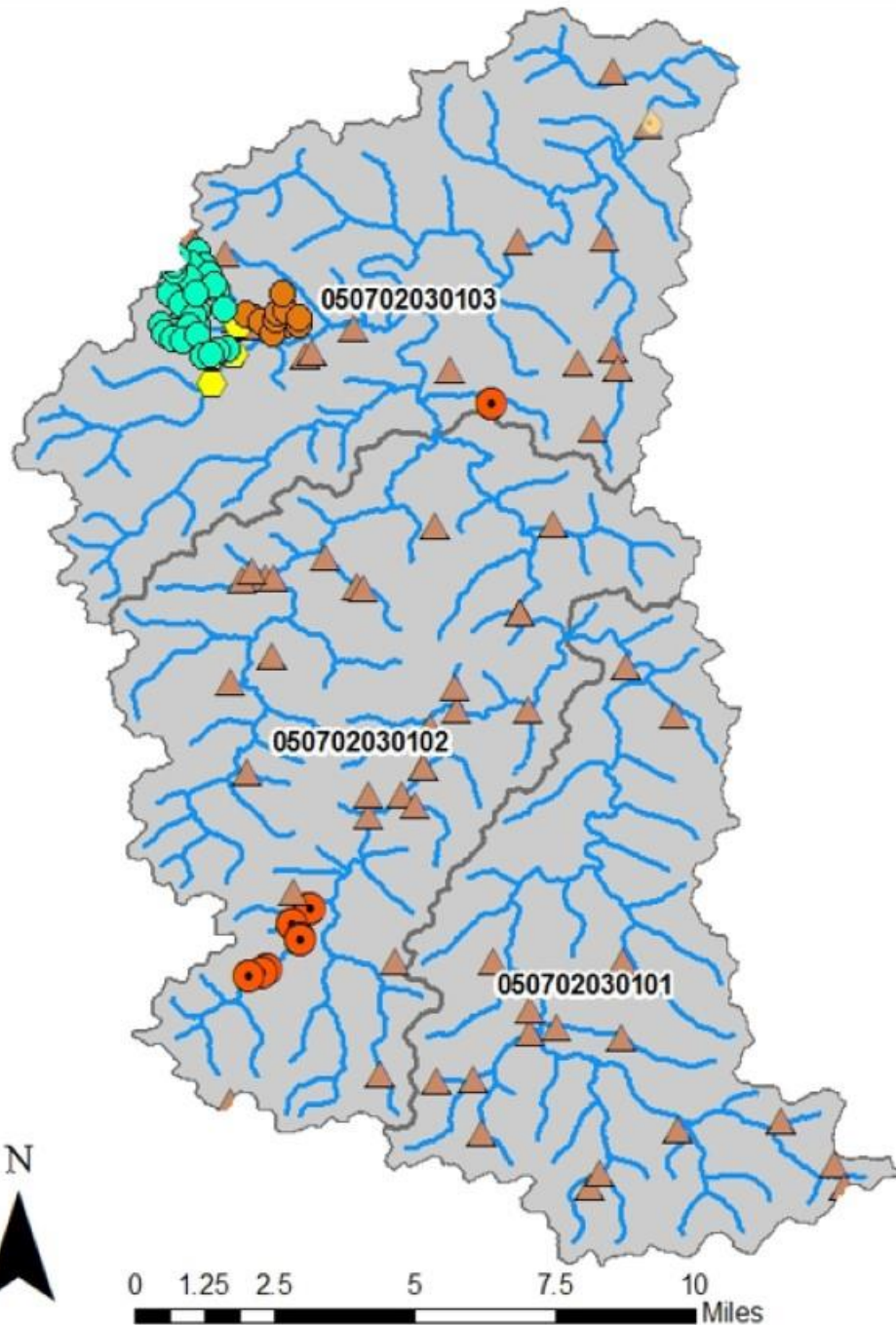
Field-based Method to Develop Ambient Aquatic Life Water Quality Criteria for Conductivity

- ▶ EPA Office of Science and Technology
- ▶ Working to develop a draft recommended method for states
- ▶ Once final, states and authorized tribes located in any region of the country may use the method
- ▶ Would not impose any binding water quality criteria on any state
- ▶ Allow states to develop science-based conductivity criteria that appropriately reflect ecoregional- or state-specific factors such as background conductivity and ionic and aquatic community composition.
- ▶ Independent external peer review completed Winter 2015
- ▶ Anticipating that the draft method will be made available in 2015 for comment before finalization

Cumulative Impacts of Mining in Eastern Kentucky (CIMEK)

- ▶ EPA Region 4 Lead
- ▶ Project Objective: To evaluate the cumulative impacts of coal mining in 3 HUC 12 watersheds in the Big Sandy River Basin (Eastern KY)
- ▶ Initial 402, 404 and NEPA regulatory interests
 - ▶ What is the condition of the watershed?
 - ▶ What is the relationship of the watershed's health and condition to historical and current surface mining?
 - ▶ What parameters best measure cumulative impacts from mining?
- ▶ Primary Data collection in 2013 and 2014
- ▶ Data analysis with the Office of Research and Development is underway

Cumulative Impact of Mining in Eastern Kentucky (CIMEK)



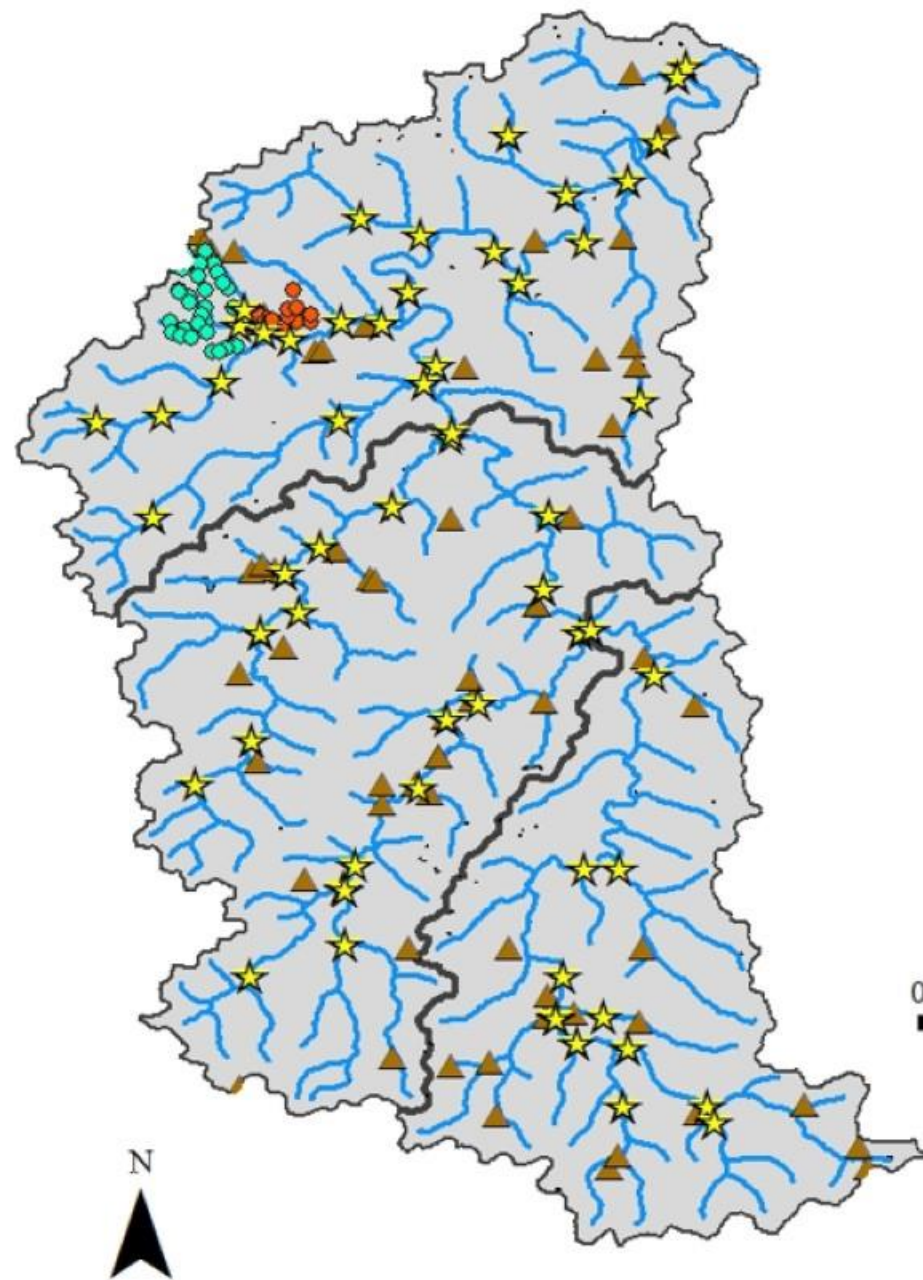
- Water Chemistry**
- Sampling for:
- ▶ Aluminum
 - ▶ Alkalinity
 - ▶ Ammonia
 - ▶ Antimony
 - ▶ Arsenic
 - ▶ Barium
 - ▶ Cadmium
 - ▶ Calcium
 - ▶ Chloride
 - ▶ Chromium
 - ▶ Copper
 - ▶ Hardness
 - ▶ Iron
 - ▶ Lead
 - ▶ Magnesium
 - ▶ Manganese
 - ▶ Mercury (trace level)
 - ▶ Nickel
 - ▶ NO₂ + NO₃
 - ▶ Potassium
 - ▶ Selenium
 - ▶ Silver
 - ▶ Sodium
 - ▶ Sulfate
 - ▶ TDS
 - ▶ Thallium
 - ▶ TKN
 - ▶ TP
 - ▶ TSS
 - ▶ Zinc

- ▶ Continuous (every 15minutes):
 - ▶ Water level
 - ▶ Specific conductivity

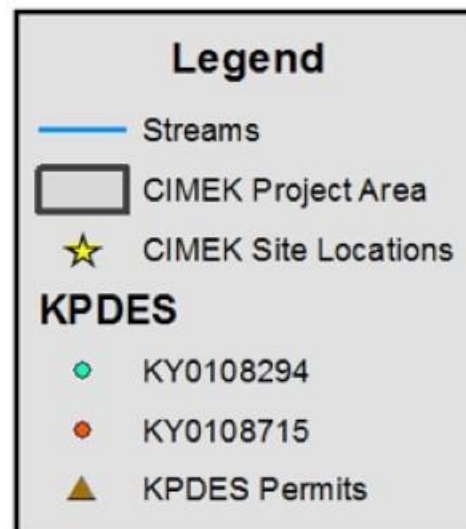
- ▶ Macroinvertebrate Monitoring
 - ▶ Headwaters and Wadeables in 2013 and 2014

- ▶ Fish Tissue in Aug 2013 and 2014
 - ▶ Mercury
 - ▶ Selenium
 - ▶ Thallium

- ▶ Data analysis just beginning
- ▶ Reports expected in 2016



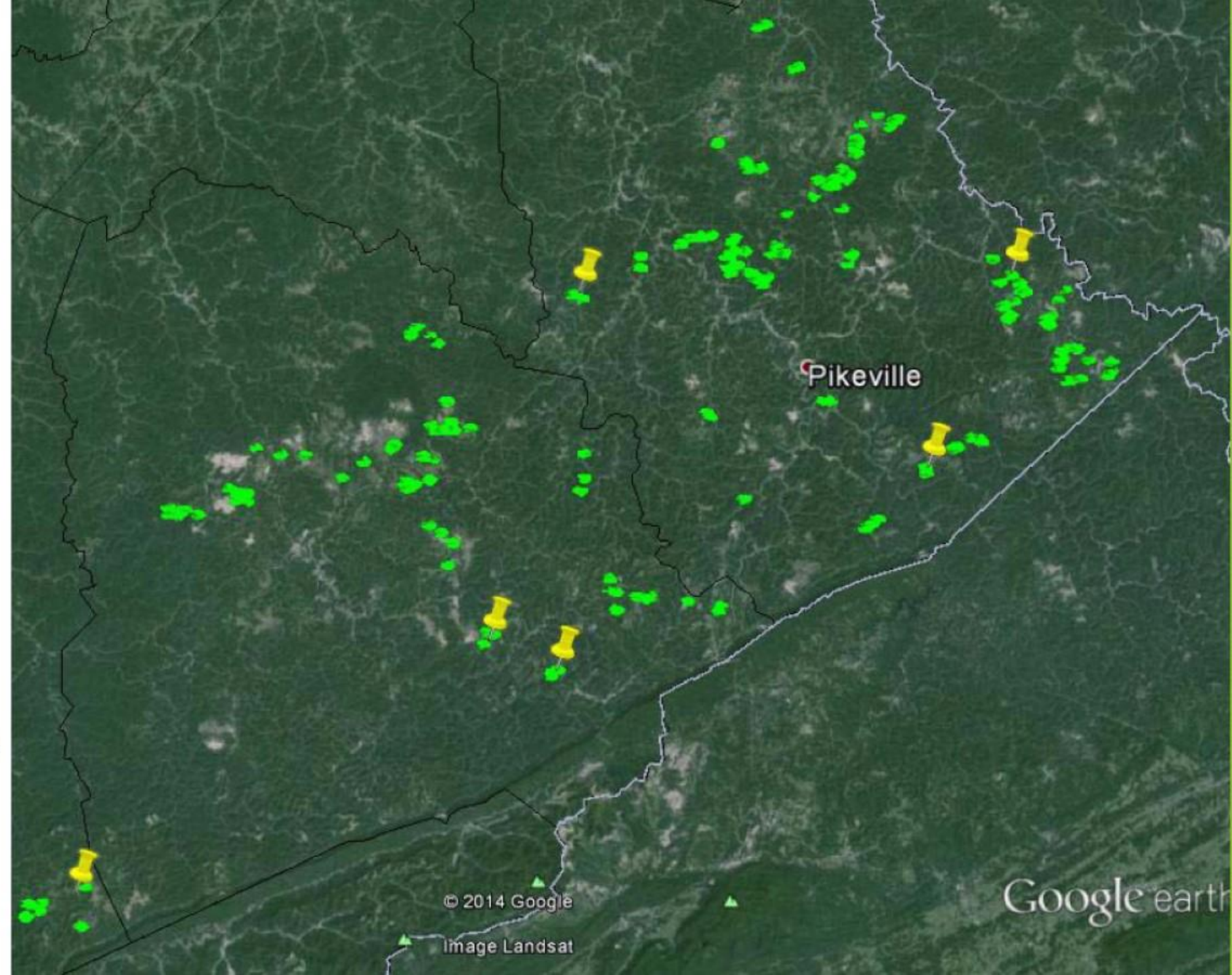
CIMEK Study Sample Site Locations (60) Right Fork Beaver Creek



Eastern Kentucky Hollow Fills

- ▶ EPA Region 4 and Headquarters oversight of contractors
- ▶ Monitoring downstream from individual hollow fills with Phase III bond release
- ▶ Collecting documentation on mining practices and any monitoring information collected in the SMCRA files
- ▶ Exploring potential relationships between water quality results and mining practices, dip direction, time since completion of reclamation, etc

- Water Chemistry ▶
- Sampling for:
- ▶ Bicarbonate Alkalinity (as CaCO₃)
 - ▶ Chlorides
 - ▶ Hardness (as CaCO₃)
 - ▶ Sulfates
 - ▶ Total Suspended Solids (TSS)
 - ▶ Total Dissolved Solids (TDS)
 - ▶ Total Recoverable Aluminum
 - ▶ Total Recoverable Cadmium
 - ▶ Total Recoverable Calcium
 - ▶ Total Recoverable Iron
 - ▶ Total Recoverable Lead
 - ▶ Total Recoverable Magnesium
 - ▶ Total Recoverable Manganese
 - ▶ Total Recoverable Nickel
 - ▶ SRP (soluble-reactive phosphorus) or Orthophosphate
 - ▶ Ammonia (NH₃)
 - ▶ Caffeine



EPA Region 4 Surface Mining Data Summary

- ▶ A report that summarizes many water quality studies conducted in KY and TN in association with the CWA 402 and 404 review of various proposed coal projects
 - ▶ 94 samples from sediment ponds (some influent and effluent)
 - ▶ Over 400 in-stream stations with in-situ data, along with chemical, habitat, macroinvertebrate and fish tissue samples at a subset of locations

Research Questions

What are your most pressing questions?
What can we work together on?

Conductivity and Ionic Stress Related

Alternative Mining Practices

- ▶ Identification and isolation of TDS generating materials in the mining process
- ▶ Water management to prevent a discharge
- ▶ Treatment and reclamation options for controlling existing sources of TDS

Monitoring TDS

- ▶ Refine understanding of the effects of TDS for varying durations and frequencies
 - ▶ What duration causes what effects?
 - ▶ How persistent are the effects?
 - ▶ How long does it take for the biological community to rebound?

Effectiveness of On and Offsite Projects

- ▶ Stream mitigation
 - ▶ Function of on site work
 - ▶ Comparability of off site projects
- ▶ Adaptive Management Plan
 - ▶ Individual actions
 - ▶ Cumulative results
- ▶ Offsets and fresh water dilution

Your Turn:

- Research Questions
- Current Projects
- Opportunities



Brian Topping

US EPA

Topping.brian@epa.gov

202-566-5680