Promoting Abandoned Mine Methane in Kazakhstan: International Experiences

Promoting Coal Mine Methane (CMM) for Energy, Safety, and the Environment: Legislation and Project Development in Kazakhstan

September 25, 2015

Astana, Kazakhstan

Michael Coté, President
Ronald Collings, Vice President
Ruby Canyon Engineering, Inc.

RUBY CANYON ENGINEERING

Global Methane Initiative

International AMM Experiences

- Introduction to AMM as an Energy Source
- Identifying the AMM Resource
- Assessing the AMM Resource
- Case Study 1 – Corinth AMM Project
- Case Study 2 – Golden Eagle Mine AMM Project

Global Methane Initiative

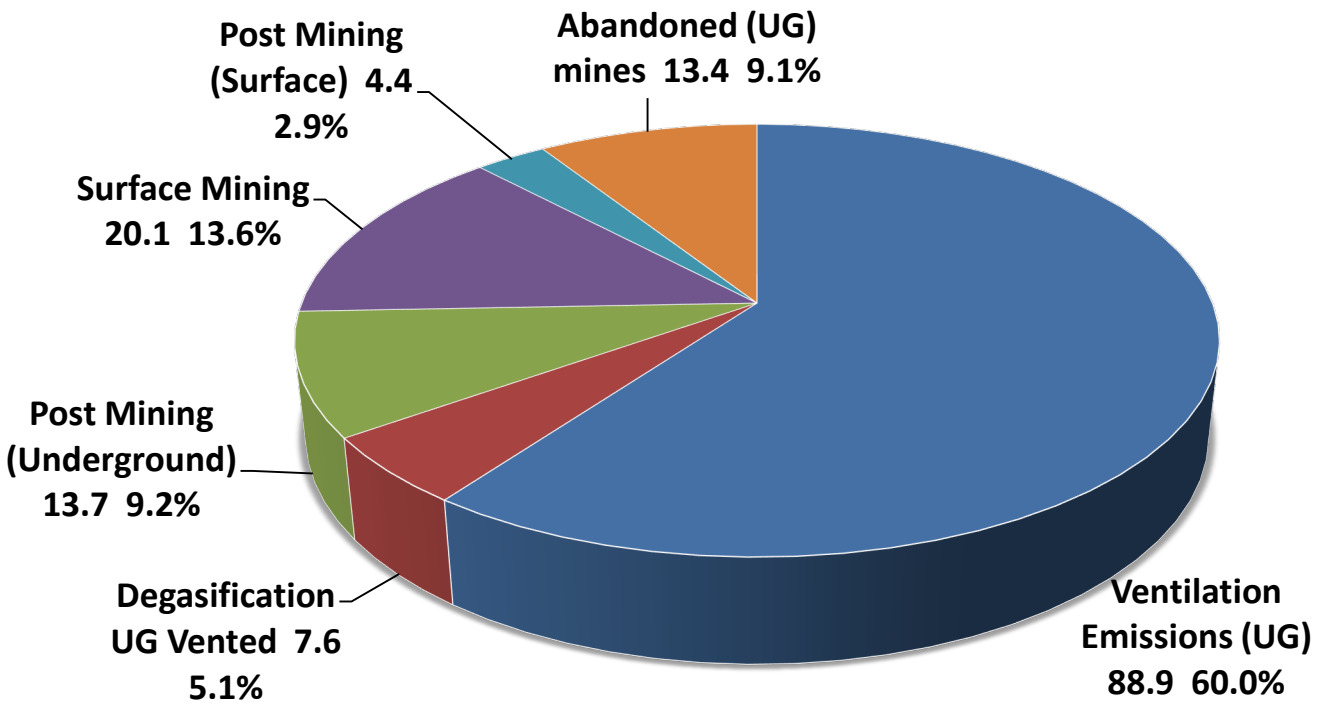
Introduction to AMM as an Energy Source

- An abandoned coal mine can be a very large reservoir of methane
  - Gas is stored in the void volume of the workings
  - Gas is also stored in the coal remaining in contact with the void space
- Abandoned mine gas has favorable characteristics
  - Generally contains between 60% and 90% methane, nitrogen, and with small amounts carbon dioxide
  - The gas is recovered under low pressure which keeps equipment costs low
  - Just a few wells can drain large areas
- Abandoned mines are often nearby active underground mines and CMM projects

Global Methane Initiative

Identifying AMM Resources – Inventory of Abandoned Mines

2013 U.S. Coal Mine Methane Emissions Inventory



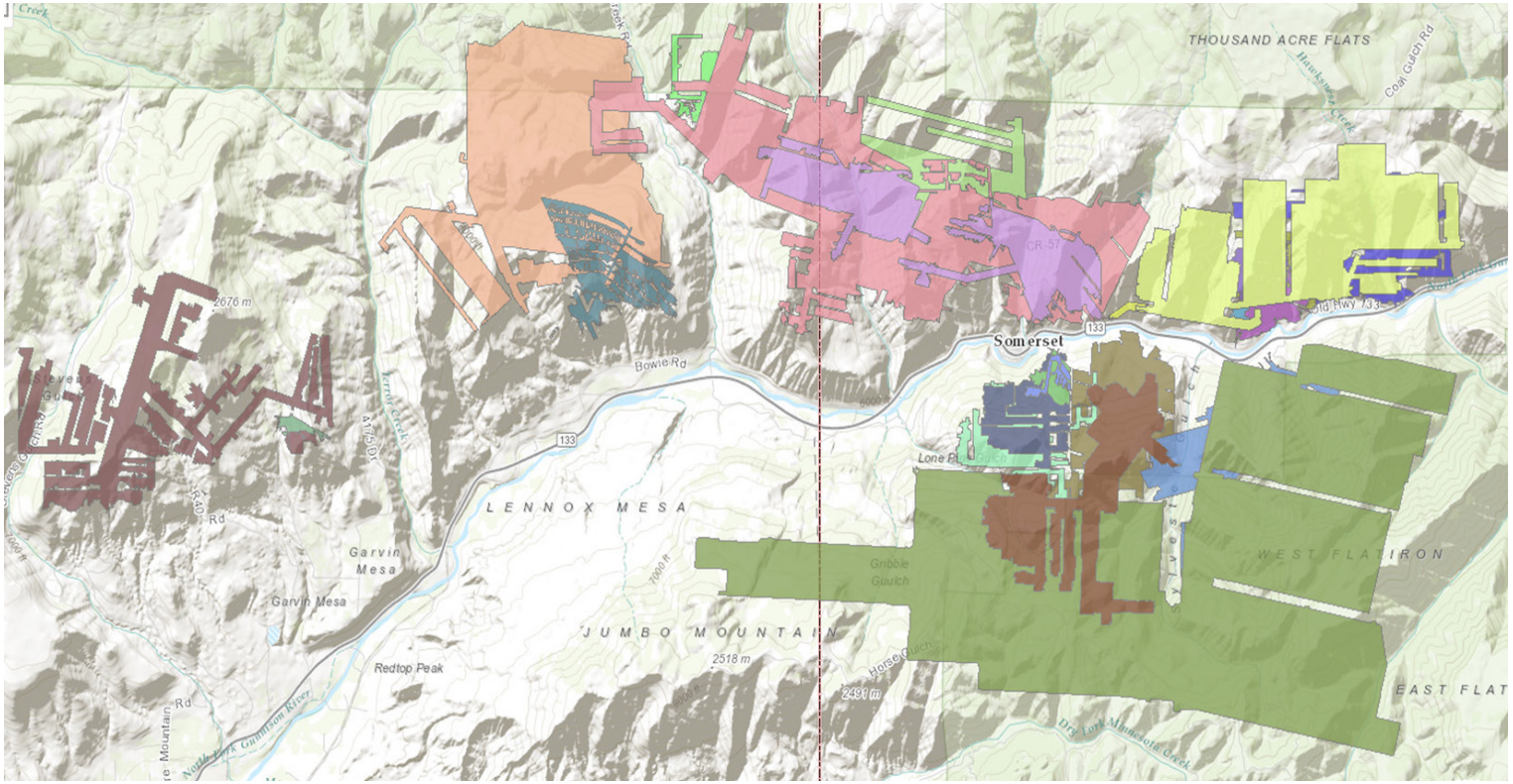
Global Methane Initiative

Identifying AMM Resources - Using Publically Available GIS Information

- Mine map information (coordinates, wells locations, and geologic data) can be coupled with state-based GIS data (surface topography, cities, roads, waterways)
- Meta data and shape files usually available to develop project working maps
- Old mine maps can be digitized

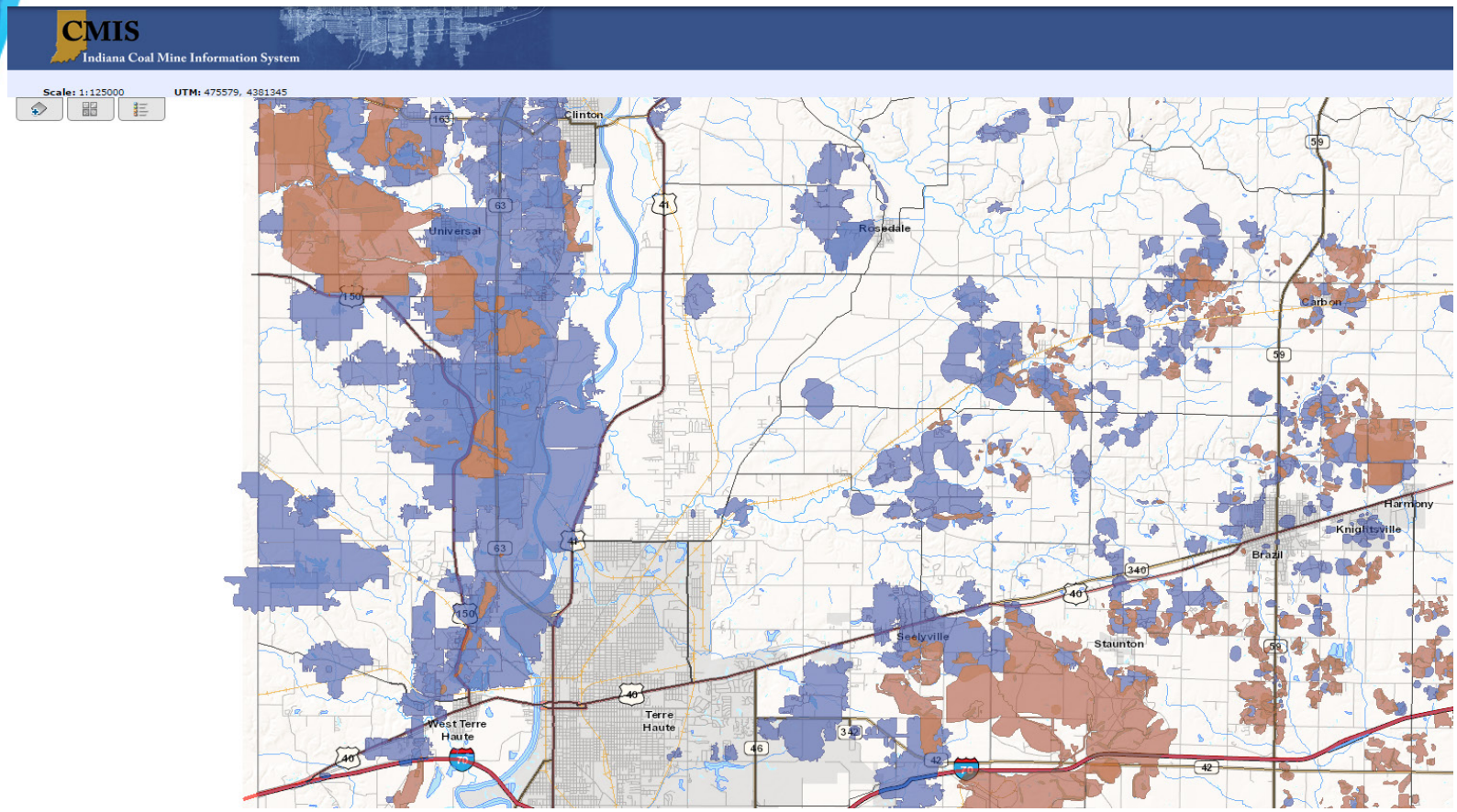
Global Methane Initiative

Abandoned Mines in Historic Mining Area of Western Colorado



Global Methane Initiative

Abandoned Mines in Historic Mining Area of Southwest Indiana



Global Methane Initiative

Assessing the AMM Resource

- It is generally accepted that all abandoned coal mines can leak methane to the atmosphere
  - Through poorly sealed shafts and utility or gas drainage boreholes
  - Through fractures in the overburden caused by removal of the coal
  - This implies that recovering AMM soon after closure is important for both energy conservation and environmental reasons
  - Diffuse emissions difficult to monitor and measure

Global Methane Initiative

Assessing the AMM Resource

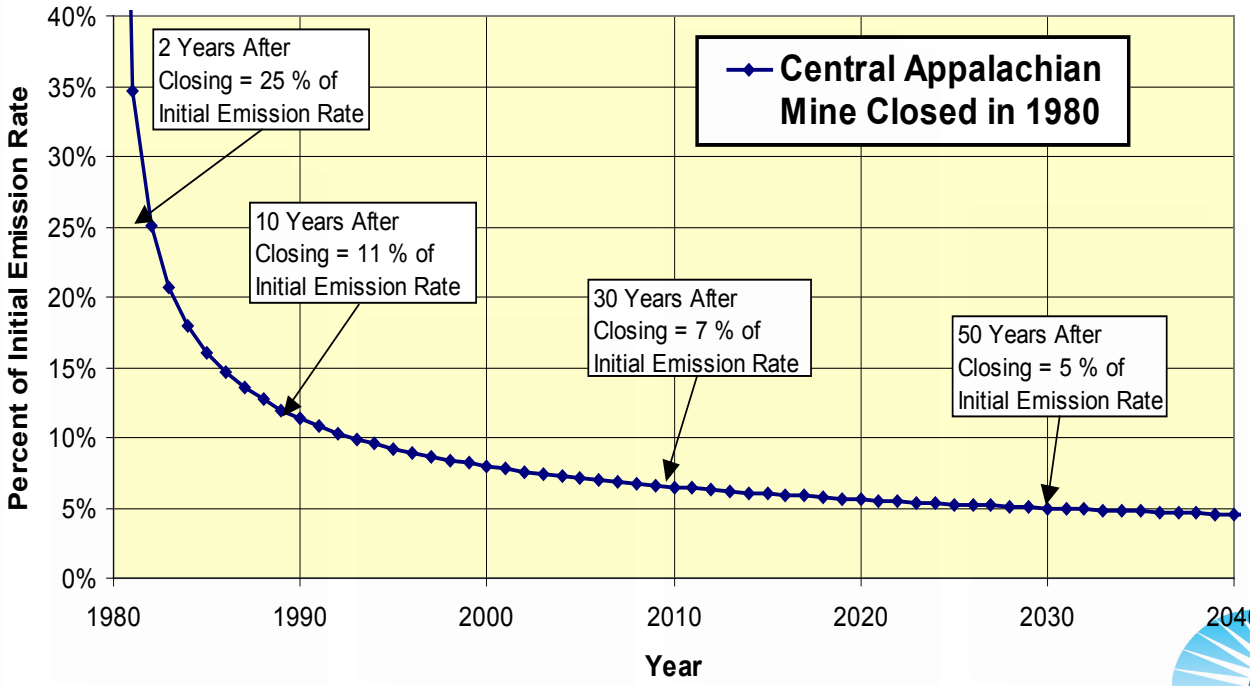
- The primary attribute for a successful AMM project is the size of the methane resource, which relates to:
  - Mine gassiness when active – high emissions rate
  - Mine size – larger mines hold more gas
  - Years from closure – recent closure means less gas has escaped to the atmosphere
  - Degree of water flooding of the void space – water blocks gas production
    - Flooding decline curve reaches zero after 15 years

Assessing the AMM Resource

- Estimating reserves using material balance and flow equations
  - Determine the original volume of methane in-place in the mine area including in the vertical zone of influence
    - based on original gas contents
  - Determine the amount of methane liberated during mining based on measured emissions per tonne of coal recovered
  - Estimate the amount of methane emitted to the atmosphere from the time mine closure
    - Methane continues to be released into the old workings - eventually being released into the atmosphere.
    - Adsorption pressure in the coal is reduced resulting an emission rate decay curve through time

Identifying AMM Resources – Inventory of Abandoned Mines

- Using a decline curve method to estimate emission rates for AMM Inventory
  - IPCC Guidance includes AMM decline curve tables



Global Methane Initiative

Assessing the AMM Resource

- Technical Considerations for Successful Project:
  - Geologic section of coal beds (or other gas-bearing strata) located above and below the mined seam
  - Gas contents
  - Communication with atmosphere pressure
  - Degree of sealing or flooding
  - High methane emission rates during mining operations
  - CMM drainage system in place, or existing wells
  - Accurate mine maps
  - Closure date

Case Study 1 - Corinth Project, USA

- Mines' Characteristics
  - 14 mines in close proximity
  - Mostly room & pillar mines
  - Range in depth from 100 to 200 meters
  - Shaft mines tightly sealed from atmosphere with confining shale layer over coals
  - Abandonment dates from 1926 to 1996
  - Some existing wells drilled into mine void areas
  - Average mine gas composition is 72% methane, 20% nitrogen and 8% carbon dioxide

Case Study 1 - Corinth Project, USA

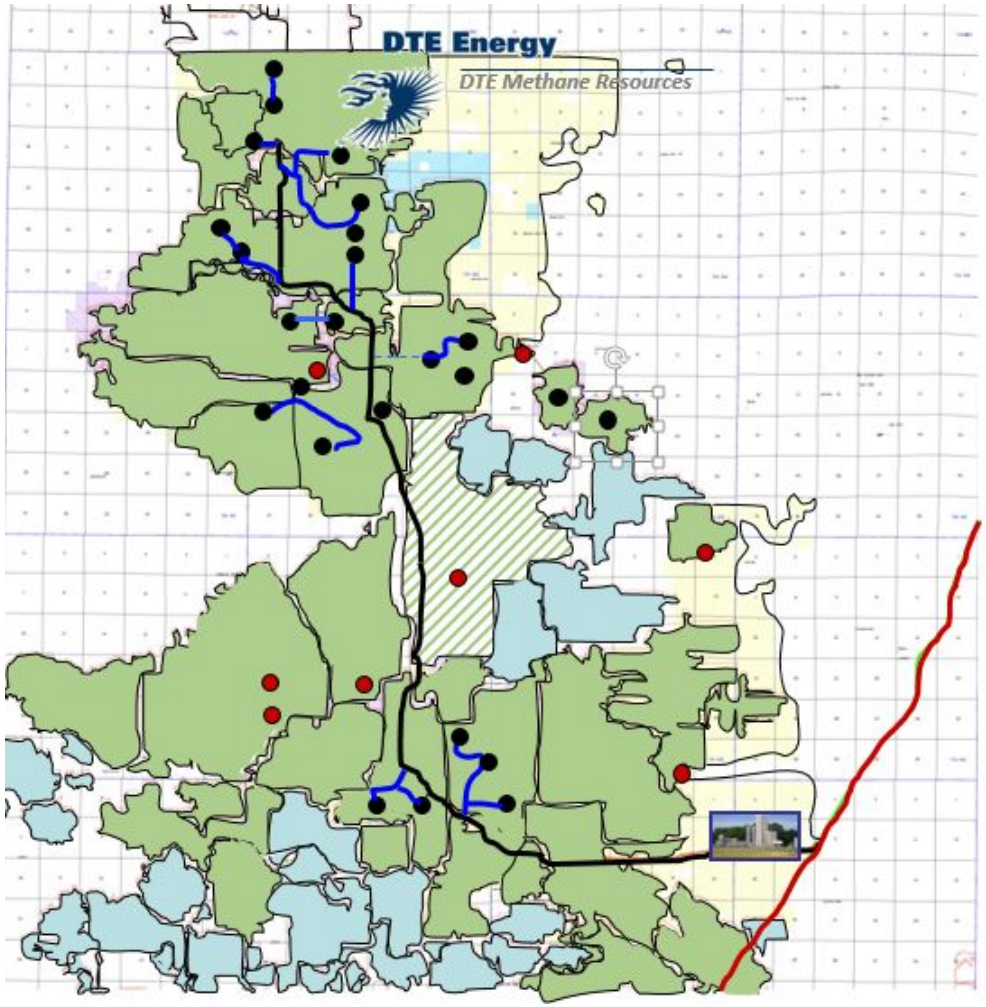
14 mines

31 wells

34,000 hectares

11 field stations

358 Million m3 CH4 produced

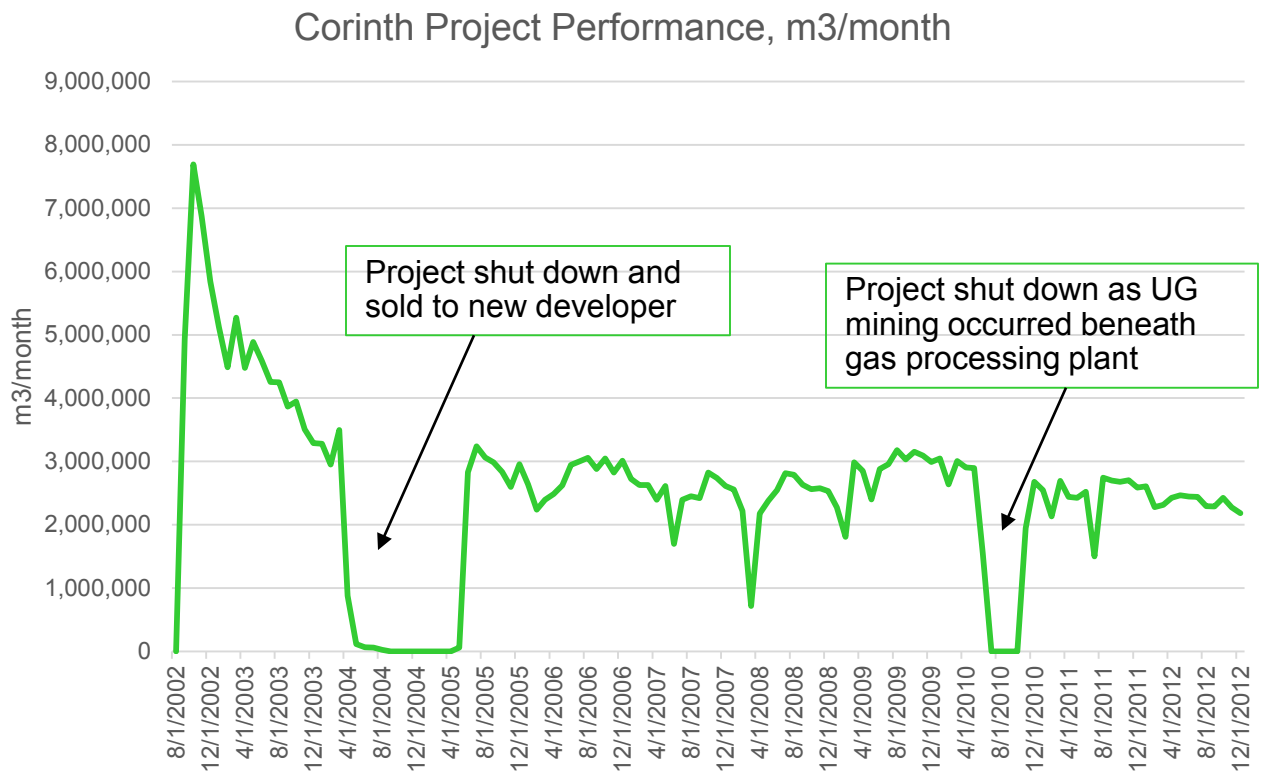


Global Methane Initiative

Case Study 1 - Corinth Project, USA

- Well Specifications
  - Drilled using truck-mounted rigs commonly used for coring of coal exploration wells
  - 140 mm well diameter
- Gas Gathering System
  - Wells connected to individual field stations by HDPE pipelines
  - Field stations use gas compressors use methane
- Gas Processing System
  - Nitrogen rejection unit (NRU), CO_2, H_2S, and O_2 removal
  - Compressed to 700 psi and sold to interstate natural gas pipeline

Case Study 1 - Corinth Project USA



Global Methane Initiative

Case Study 2 - Golden Eagle Mine, USA

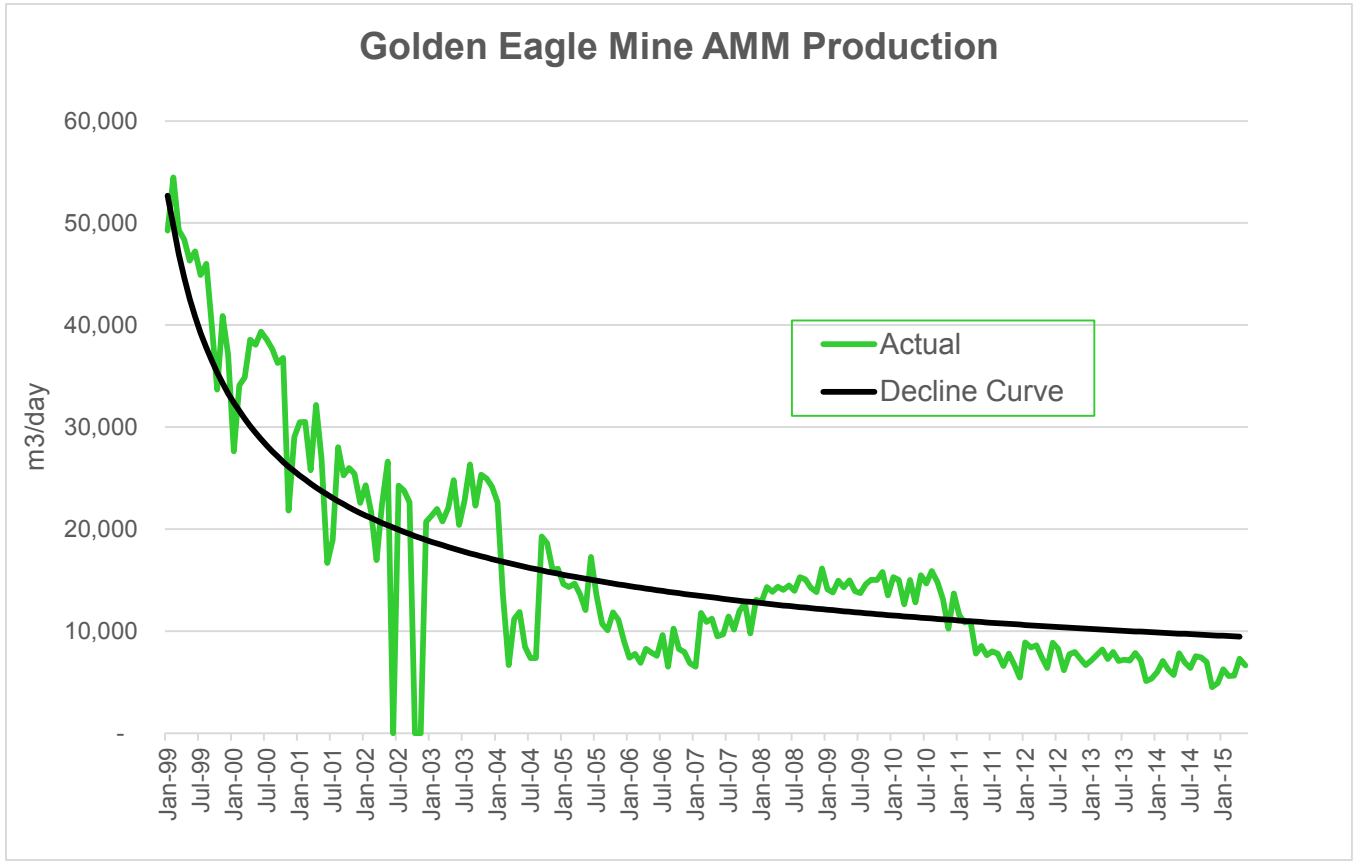
- Mine's Characteristics
  - Mined seam 1.5 to 3.0 meters thick
  - Depth 150 to 370 meters
  - Area 626 hectares
  - Surface gob vent holes used to drain gas
  - Mine closed in 1995
  - Located in actively producing coalbed methane (CBM) field

Global Methane Initiative

Case Study 2 - Golden Eagle Mine, USA

- Wells and Production
  - Gas production started in 1996
  - Operating for 19 years
  - Initially used up to seven gob vent wells to produce AMM
  - Soon realized that three wells could produce total volume
  - Three wells continued to produce into 2015
  - Cumulative production of over 98 million m3 of pipeline quality gas

Case Study 2 - Golden Eagle Mine, USA



Global Methane Initiative

Future for Kazakhstan AMM Projects?

- Compile active mine emissions information
- Develop AMM Inventory
- Identify High-Probability AMM targets
- Pre-feasibility studies
- Analytical data, mine maps, well flow testing
- Project Development

Global Methane Initiative

Thank you for your attention!

Michael Coté, President
Tel: +1-970-241-9298 ext.11
Email: mcote@rubycanyoneng.com
Website: www.rubycanyoneng.com

RUBY CANYON ENGINEERING

Global Methane Initiative