



# Geomorphic Reclamation at BHP Billiton's New Mexico Coal - Successes, Challenges & Future



**bhpbilliton**  
resourcing the future

**Daphne Place**  
Environmental Engineer, Navajo Mine Extension Project  
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## New Mexico Coal

**Pride in our Heritage, *energizing* the future**

Nearly half a century ago, the Navajo Mine, and later San Juan and La Plata mines, were constructed to supply energy to a growing and developing population in the Southwest. Three generations of our coal miners have since created value for our workforce, our shareholders, our customers, and to the community in which we operate.

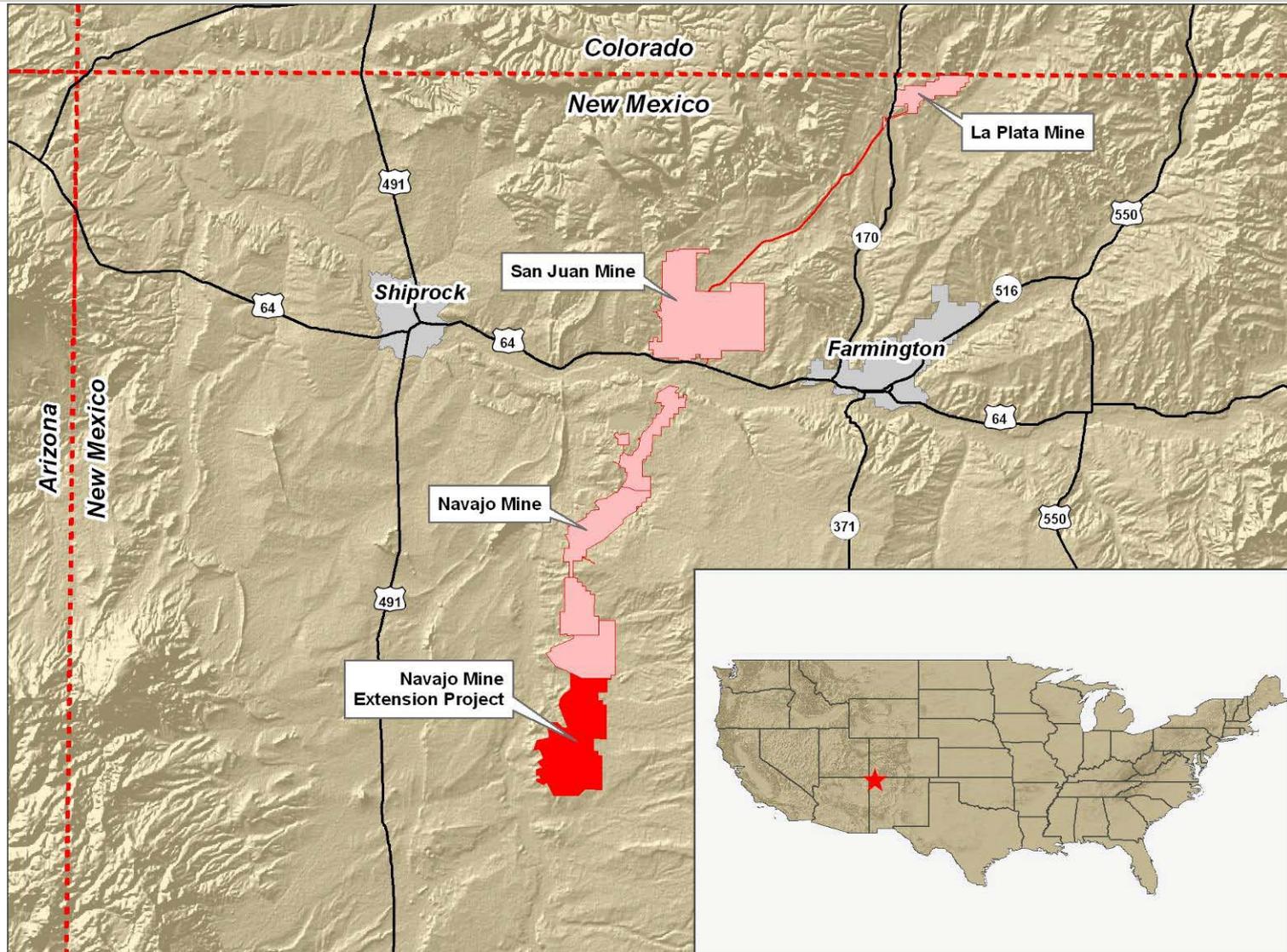
### **We have Pride in our Heritage**

We have an overriding commitment to health, safety, the environment and the community. We strive for Zero Harm.

We supply a vital fuel source to meet the energy needs of millions of homes and workplaces in the Southwest of the United States. Our wages, royalties, taxes, donations, and the things that we buy personally and for our business creates wealth for the community in which we live.

**We are *energizing* the future.**

# Regional Location of New Mexico Coal Operations



# Regional Topography



**Photographs showing undisturbed natural topography adjacent to the mine sites.**

**Photographs by EQ Dept. Personnel  
Unless otherwise noted**

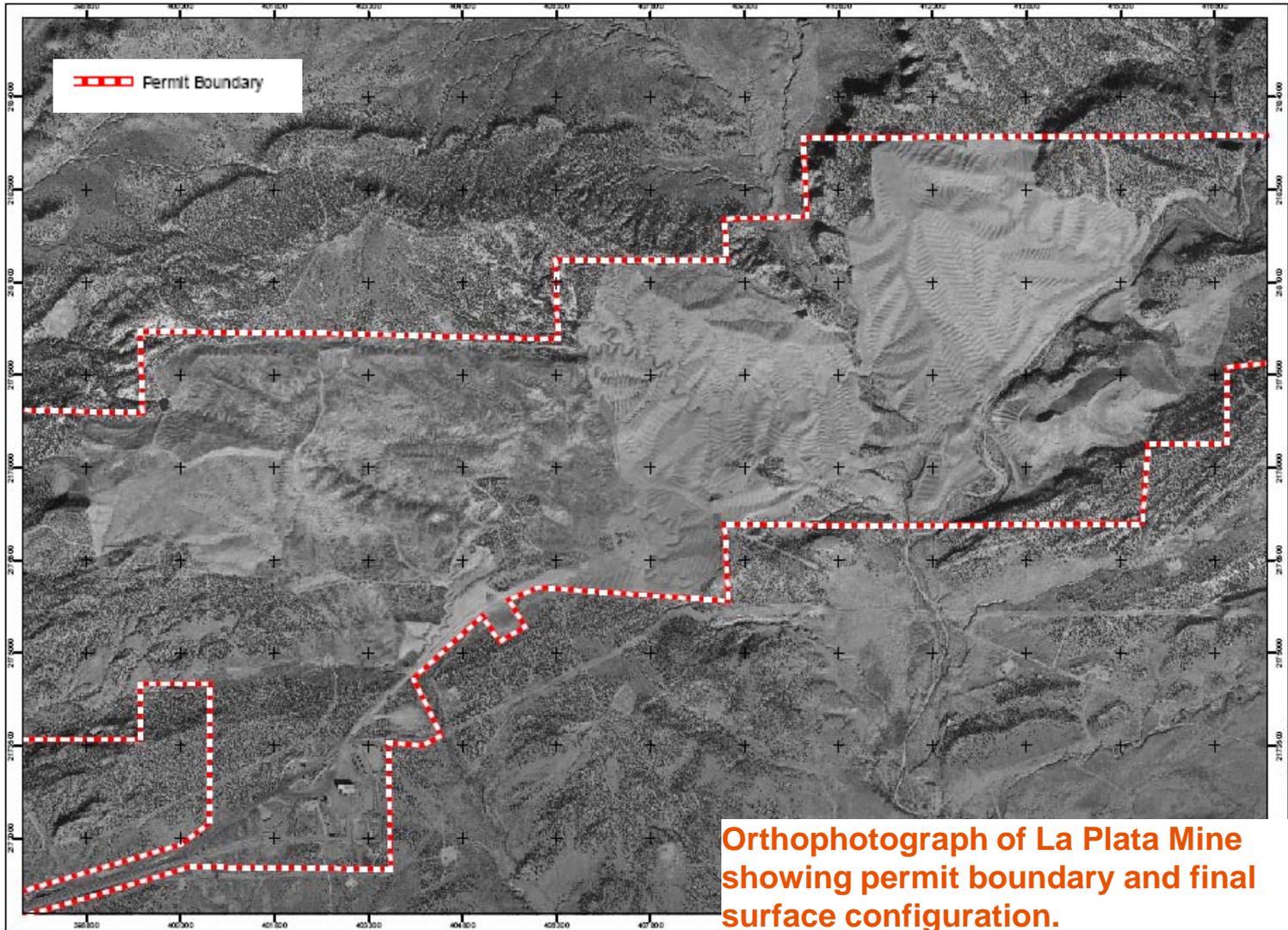
# SJCC - La Plata Mine

## Operational Details

- Operations began in 1986
- Truck/shovel operations
- Reclamation activities completed Spring 2009
- Over 1,650 acres reclaimed
  - 1,400 acres reclaimed using fluvial geomorphic approach



# SJCC - La Plata Mine



# SJCC - La Plata Mine

## Buckeye and Elk Point (Panel 5 Highwall)

- Deepest final pit at LPM



**Photographs showing final pit  
(upper right) and final construction  
(lower left).**

**Arrow indicates the same landmark  
pinion/juniper area.**

## Younger Bluffs

- Final highwall area
  - Adjacent to natural sandstone outcrop



**Photographs showing final pit (upper right) and final construction (lower left).**

**Arrow indicates the same landmark notch area.**

# SJCC – San Juan Mine

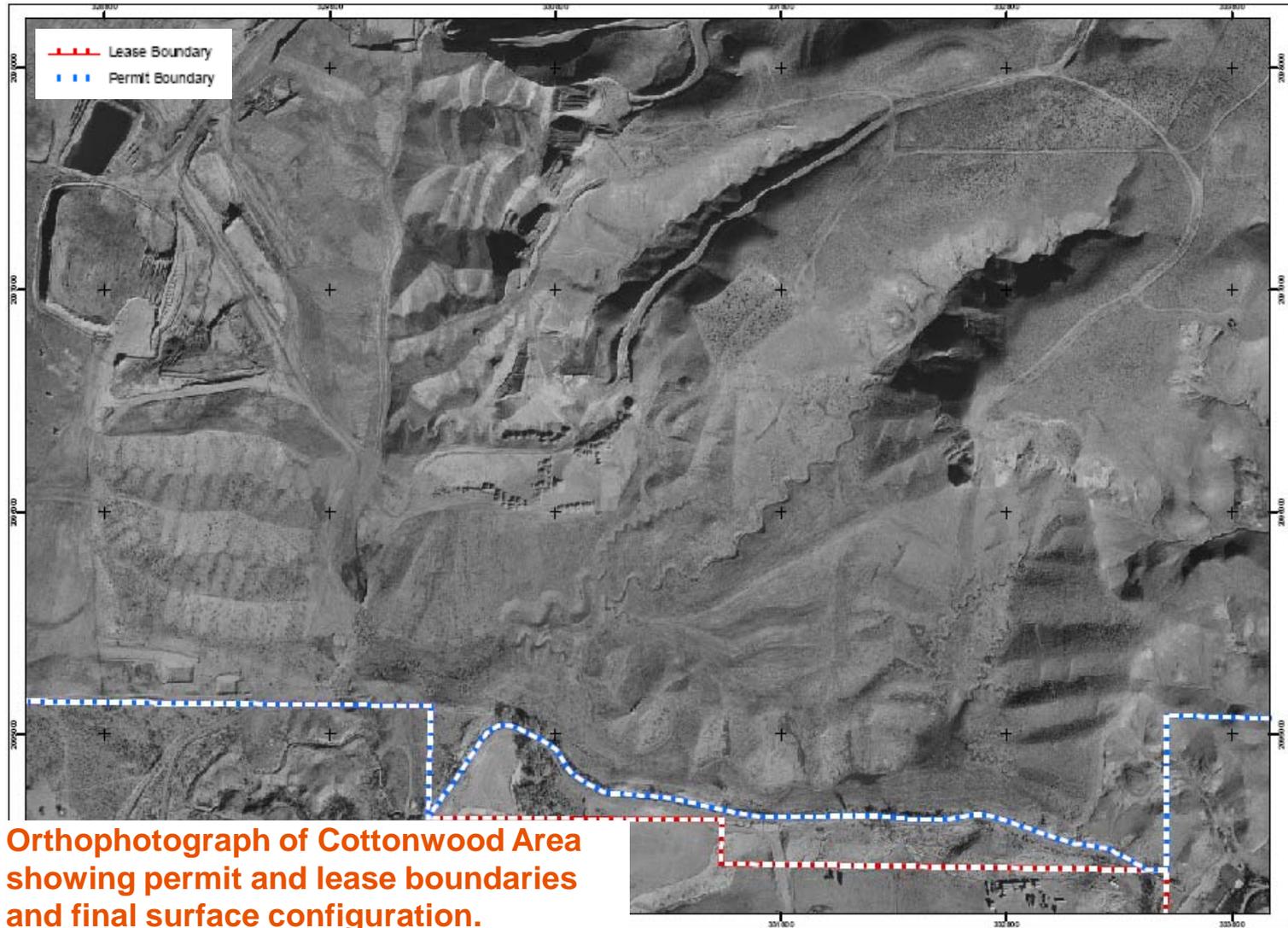
## Operational Details

- Mining began 1974
  - Surface dragline operation
- Transitioned to underground operation in 2002
- Reclamation activities ongoing
- Approximately 2,700 acres reclaimed
  - 400 acres reclaimed using fluvial geomorphic approach



**Photographs of San Juan underground mine portal area (lower left) and plant and stack out area (upper right).**

# SJCC – San Juan Mine



**Orthophotograph of Cottonwood Area showing permit and lease boundaries and final surface configuration.**

# SJCC – San Juan Mine

## Cottonwood Mining Area – During mining



**Photograph of Cottonwood Area during mining operations.**

**Arrow shows landmark reference.**

## Cottonwood Mining Area – During Landform Construction



# SJCC – San Juan Mine

## North Pinon Mining Area



Photographs showing final construction (lower left) and after topdressing and seeding (upper right).

Arrow indicates the same channel meander.

# BNCC – Navajo Mine

## Operational Details

- Multi-dragline surface mine
- Located entirely on the Navajo Reservation
- Mining began in 1963
- Produces 8.5M tons of coal annually
- Reclaimed 7,600 acres to date
  - 44 acres using fluvial geomorphic approach



Photograph by Ken Logan, Mine Engineer

# BNCC – Navajo Mine

## Barber Ramp 3 Project

- Haulage ramp to final dragline pit (44 ac.)
- Goals of project
  - Apply fluvial geomorphic approach
  - Optimize material handling
- Total construction time was 22 days over a span of 2 months
- To be seeded spring 2009



Photograph by Cary Cooper, Mine Engineer



# BNCC – Navajo Mine

## Channel Construction

- A-channels keyed into regrade
- A-channel excavation to build ridges



**Photographs showing construction process. Dozer used to key in channels to build ridges (upper right) and smoothing out channel and sub-ridge (lower left).**

**Photographs by Cary Cooper, Mine Engineer**

# Navajo Mine Slides

## Topdressing Activities

- Scrapers delivered topdressing
- Dozers spread topdressing
- Seeding and mulching this spring



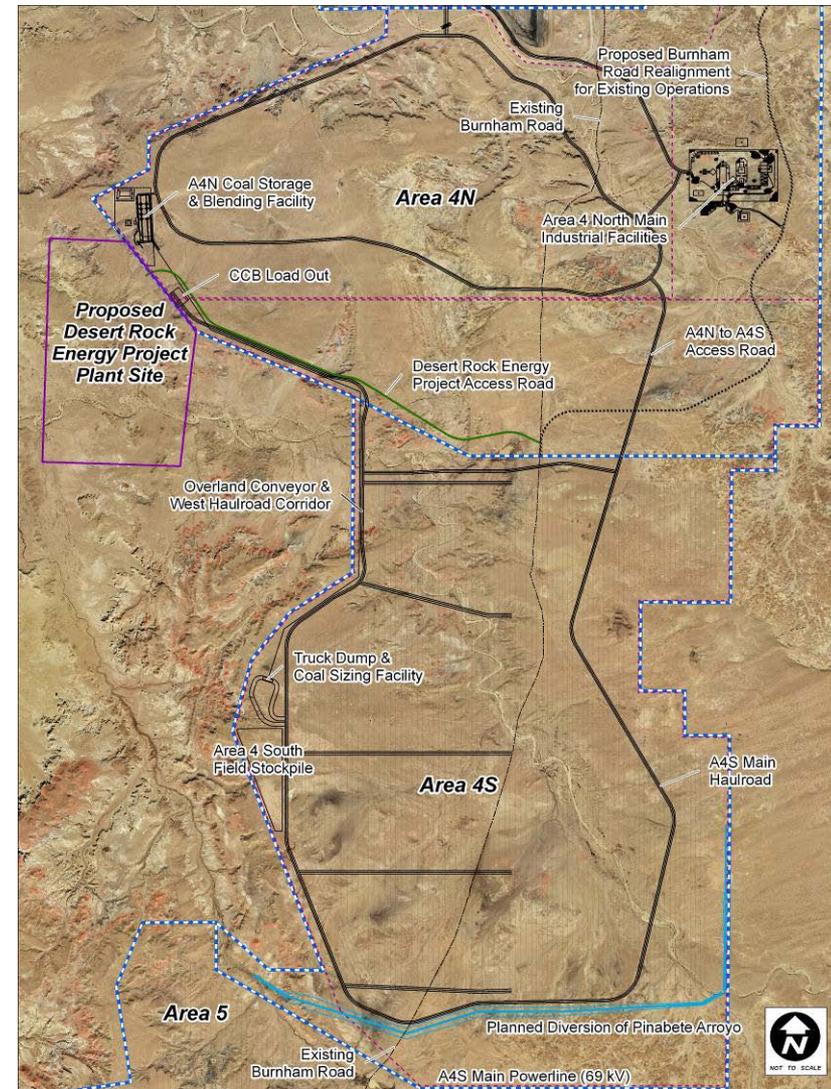
**Photographs showing final construction after topdress lay-down.**

**Photographs by Cary Cooper, Mine Engineer**

# BNCC – Navajo Mine Extension Project

## Operational Details

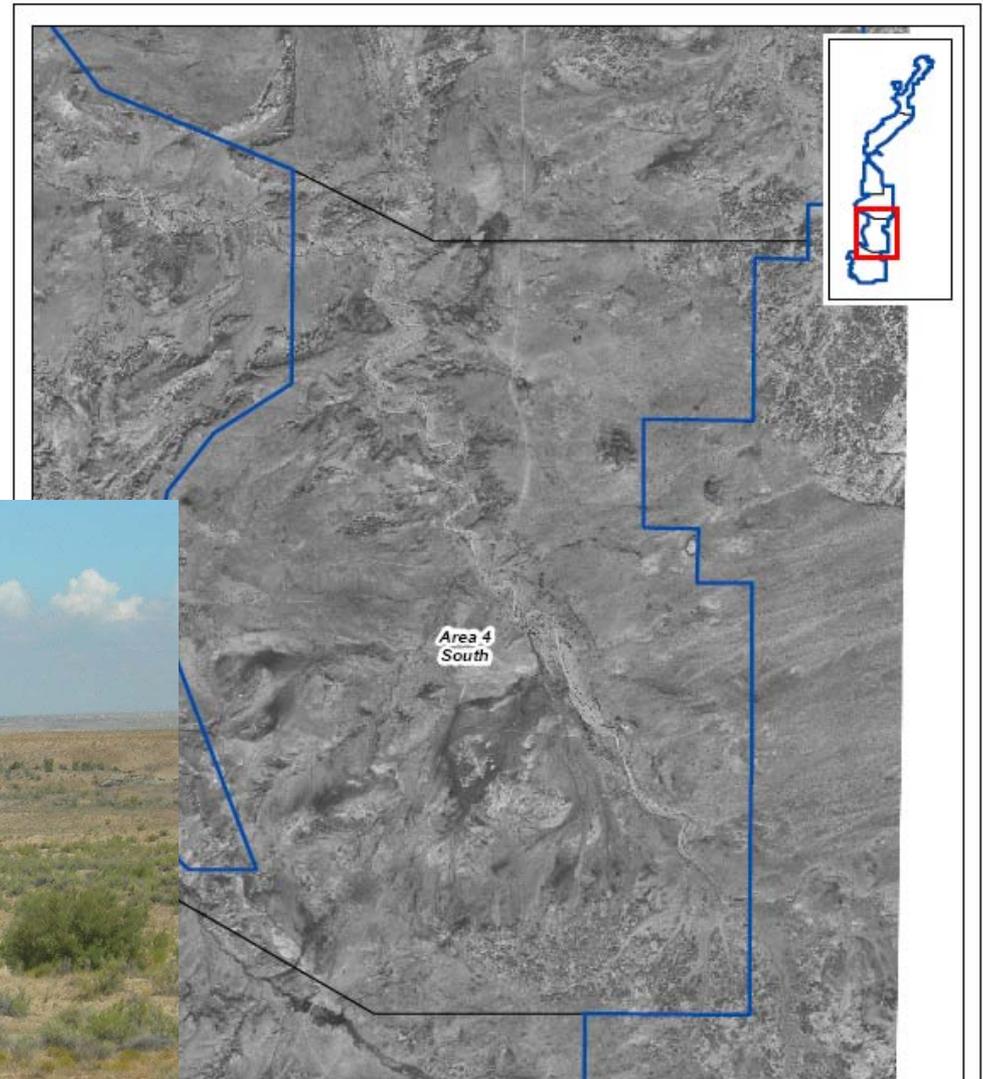
- Proposed surface operation
  - 50 year mine life
  - Multi-dragline operation
  - 13,000 acre permit area
  - SMCRA permit to be completed in 2009



# BNCC – Navajo Mine Extension Project

## Area 4 South

- Relatively flat terrain
- Area divided by Pinabete Arroyo
  - 44 square mile upstream watershed
  - Temporarily diverted during mining
- Arroyo to be reconstructed for watershed
- Used fluvial geomorphic approach



# BNCC – Navajo Mine Extension Project

## Fluvial Geomorphic Setting

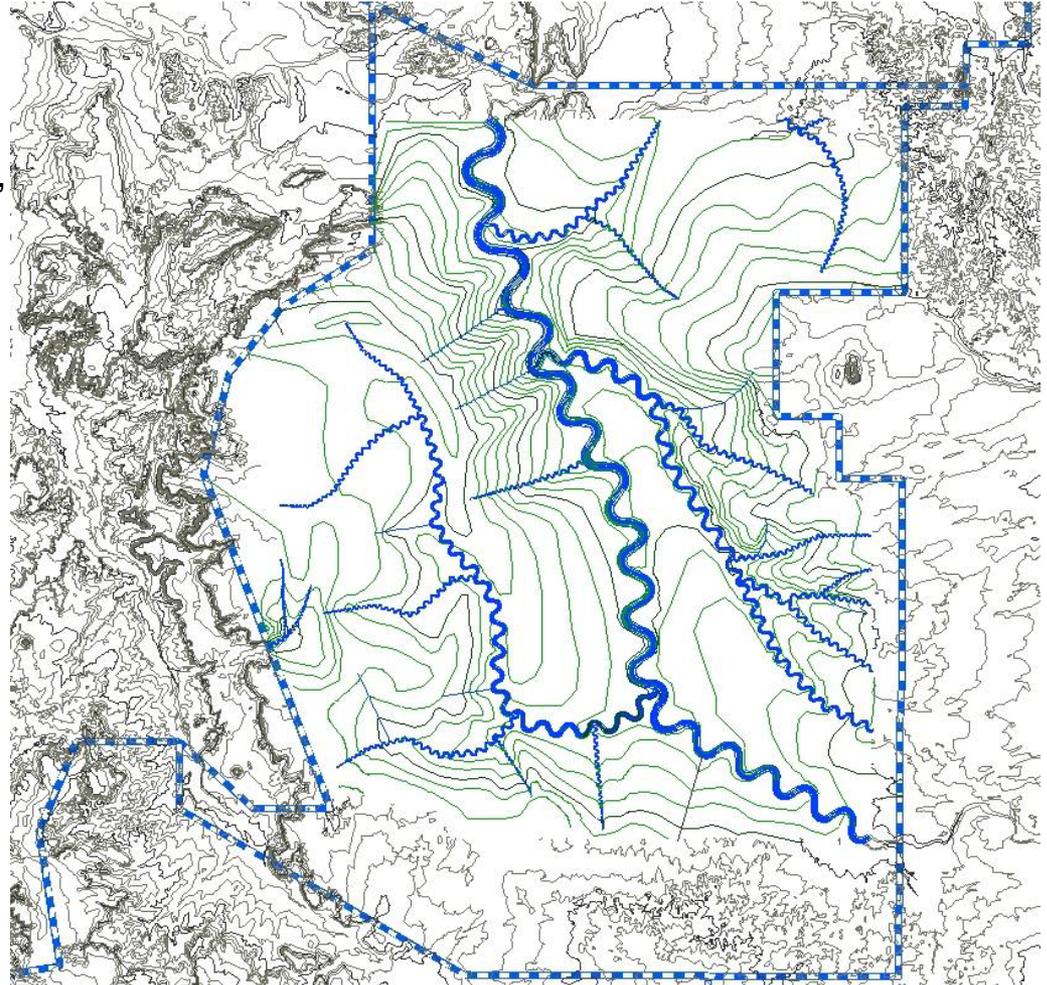
- Wide flat sandy arroyo
- Smaller areas of steeper topography with A-channels
- Bedrock control in channels



# BNCC – Navajo Mine Extension Project

## Conceptual AOC for Area 4 South

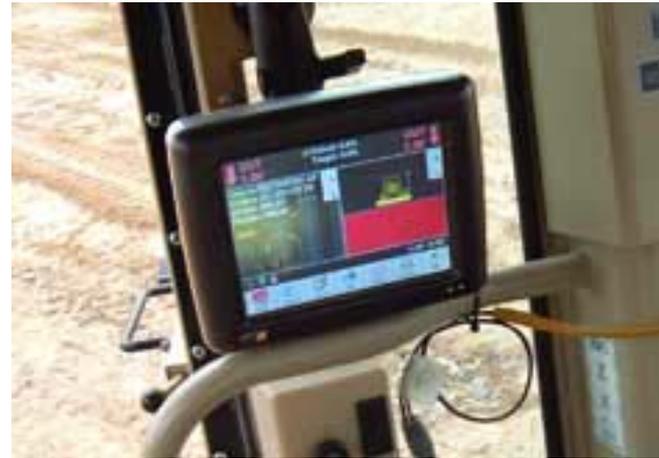
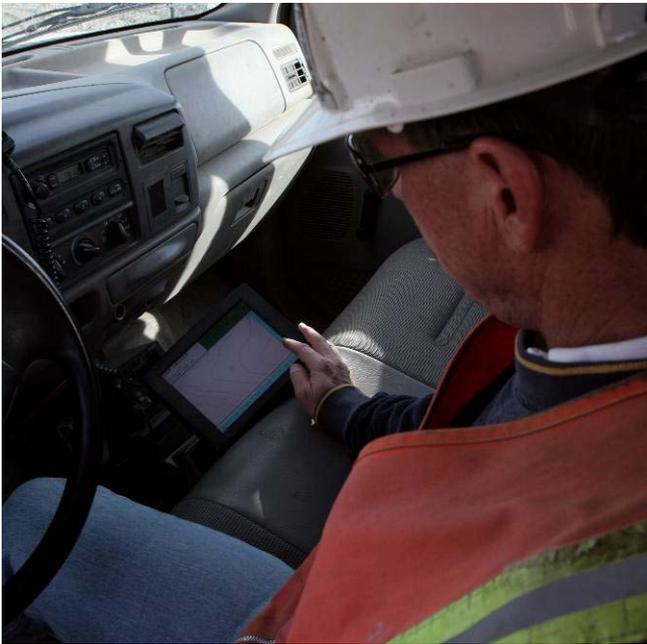
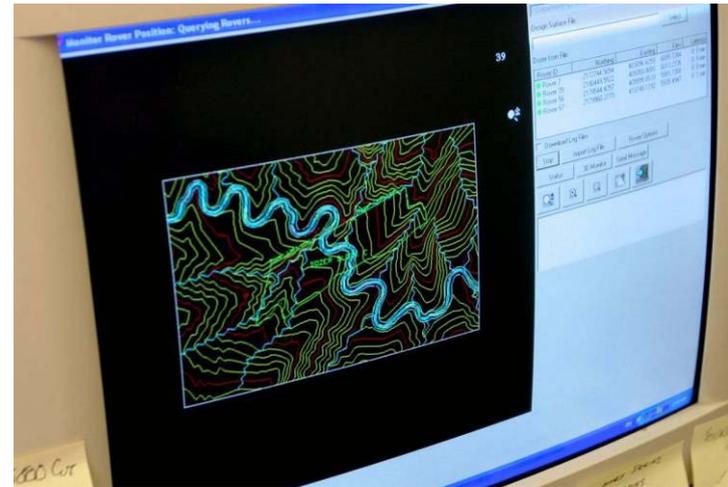
- Goals of AOC
  - Create a stable landform supporting vegetation that is compatible, diverse, effective and permanent
  - Incorporate applicable fluvial geomorphic reclamation principles
  - Meet material handling goals
  - Provide for stable and permanent placement of CCBs
  - Compatible with contemporaneous construction requirements
- Milestones of AOC
  - First fully integrated fluvial geomorphic reclamation design
  - Reconstruction of major arroyo



# General Reclamation Photos

## Landform Construction Activities

- Engineer designs can be communicated:
  - To the dozer fleet
  - To the shift foreman
- Foreman and dozer can track progress



# General Reclamation Photos

## Landform Construction Activities

- Primary grading
  - Truck/shovel or truck/loader
  - Dragline
- Final grading and drainage construction by dozer



**Photographs showing benches cut into spoil before primary regrade (upper right) and dozer using stakes as reference to construct channels (lower left) at LPM.**

# General Reclamation Photos

## Topdressing Activities

- Delivered by truck or scraper
- Spread by dozer



# General Reclamation Photos

## Seeding and Mulching Activities

- Seed bed may be prepared by deep chiseling
- Seed is broadcast or drilled
- Mulch is then spread and crimped



# General Reclamation Photos

## Irrigation Treatments

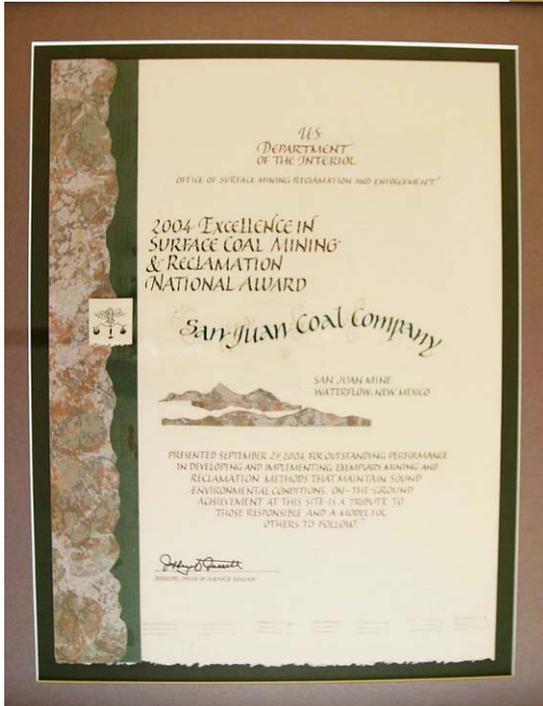
- San Juan Mine and Navajo Mine provide irrigation treatments
  - Germination
  - Support cycle
  - Second growing year



**Photographs showing irrigation treatments: SJM Cottonwood Area with irrigation network on steeper slopes (upper right) and Navajo Mine with irrigation network on flatter slopes after initial treatments.**



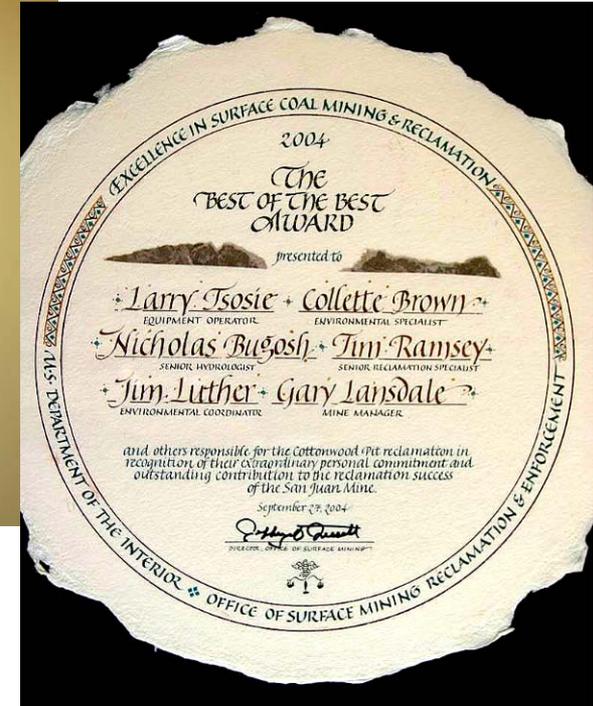
# 2004 U.S. Department of Interior National Reclamation Awards



2004 Excellence in Surface Coal Mining & Reclamation National Award



L to R: Collette Brown (EQ/SJCC)  
Tim Ramsey (EQ/SJCC)  
Gary Lansdale (Manger/SJCC)  
Steve Funk (Production/SJM)  
Larry Tsosie (Operator/SJM)  
Jim Luther (EQ/SJCC)

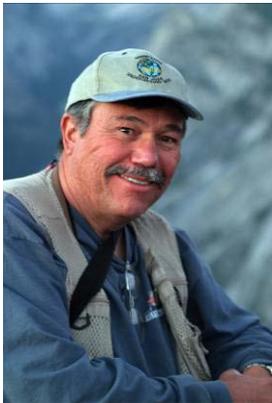


2004 The Best of the Best Award

# Acknowledgements



Left to right: Cary Cooper, Mining Engineer, Navajo Mine;  
Daphne Place, Environmental Engineer, Navajo Mine Extension Project; &  
Collette Brown, Environmental Specialist, Navajo Mine Extension Project  
(Co-authors)



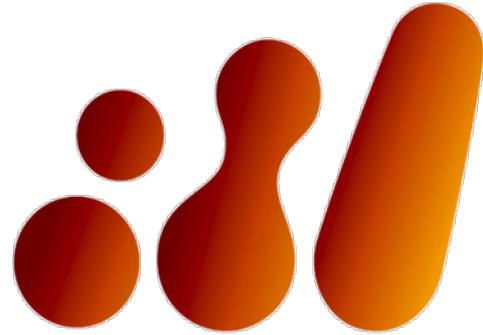
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