The Potential for Using Mine Water to Supply Electric Generating Stations

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Partnership with NETL

This research was conducted at West Virginia University with the technical and financial support of the USDOE/National Energy Technology Laboratory (NETL):

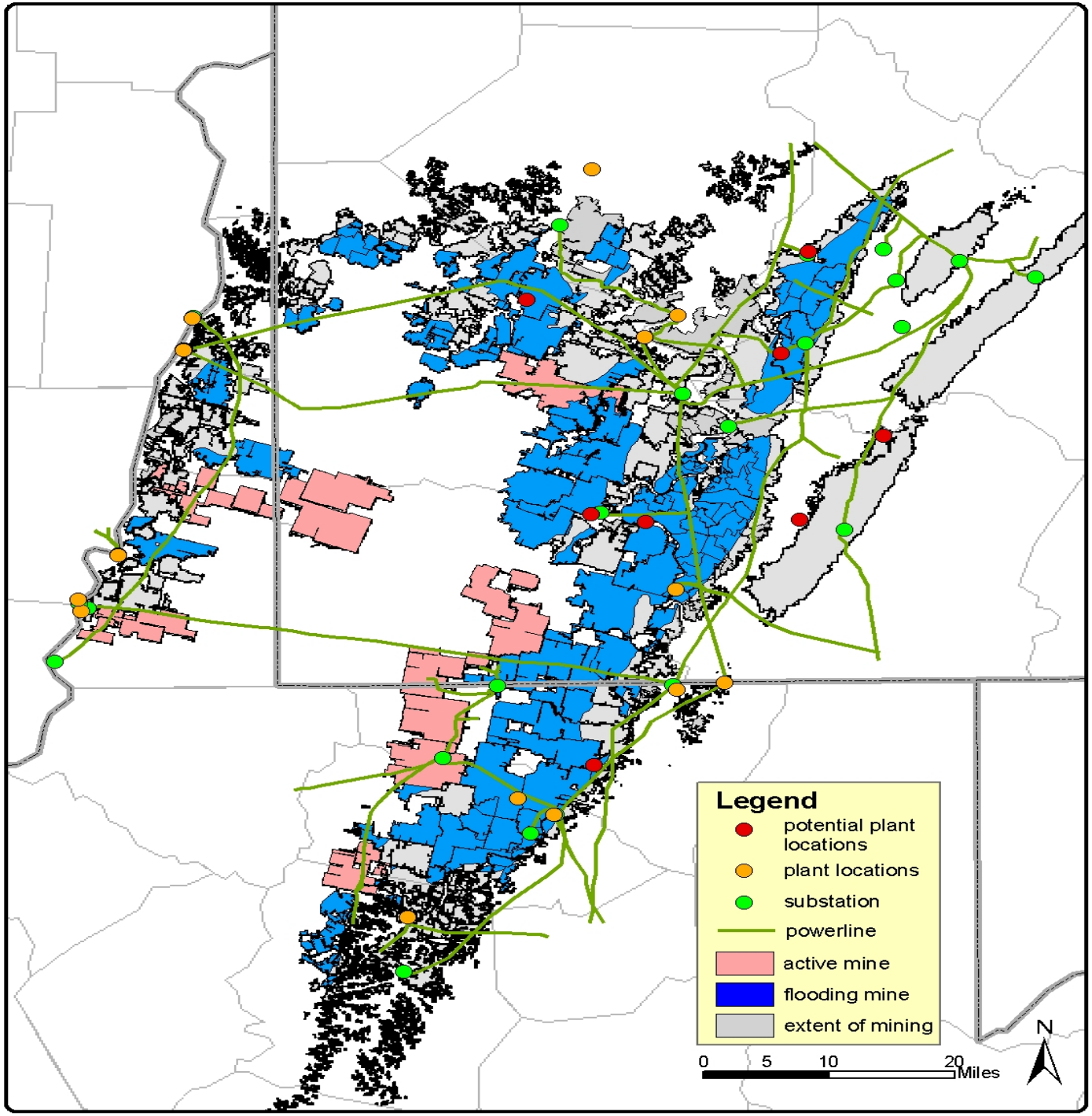
- Pittsburgh Basin Mine Flooding
- Strategies for Supplying Power Plants with Mine Water
- New project: FBC plant cooling

Regional Water Availability

- Principal Rivers: Monongahela, Allegheny, Ohio: 14 coal-fired power plants in Western PA, Eastern Ohio and Northern WV
- Groundwater: natural aquifers of low productivity
- Underground coal mines: currently used on a small scale in the northeastern PA anthracite region, not utilized in the western bituminous coal field

Pittsburgh Seam Aquifer

- About 1/3 of the Pittsburgh Coal Seam has been Mined
- It is about 6 ft. thick and laterally continuous from Clarksburg WV to Pittsburgh PA, from the Monongahela to the Ohio Rivers
- Second most productive eastern US aquifer after the Great Valley karst



Pittsburgh Coal Basin showing mines, electric power system, and potential plant locations.

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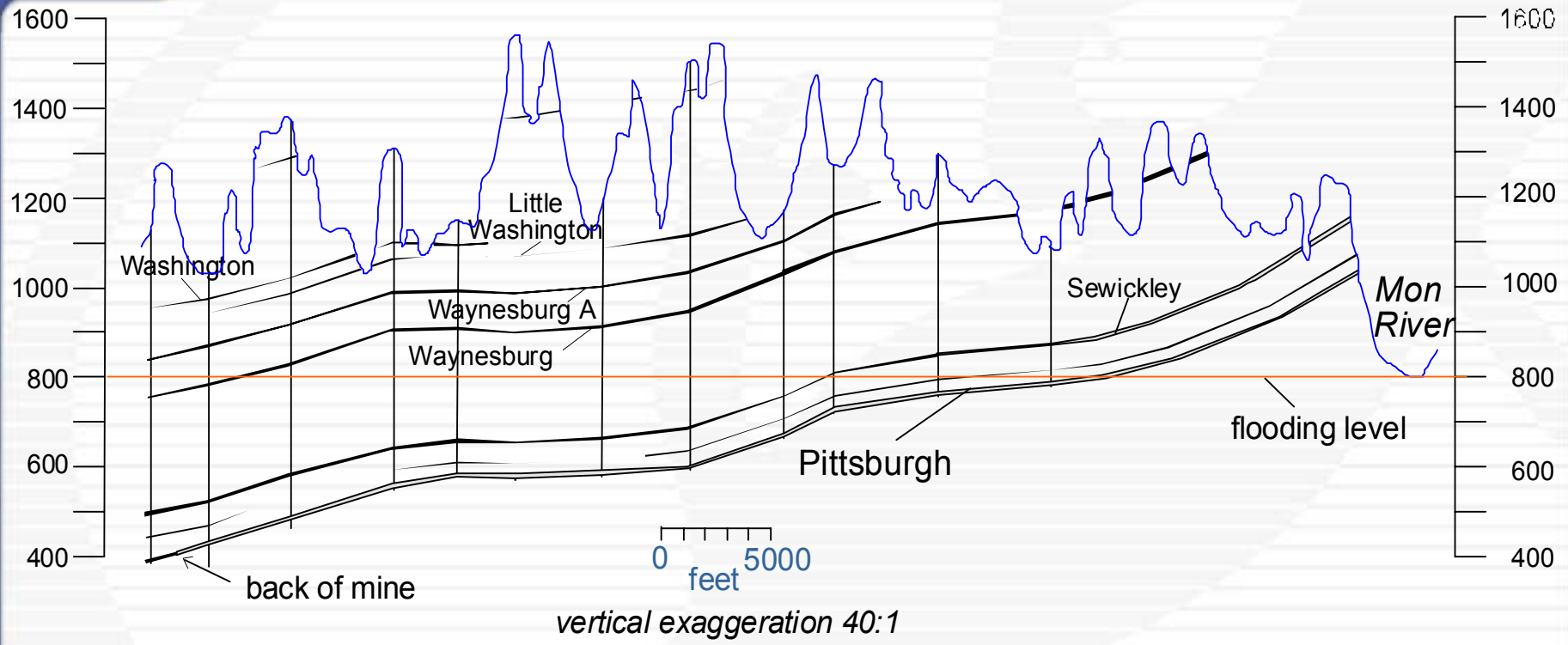
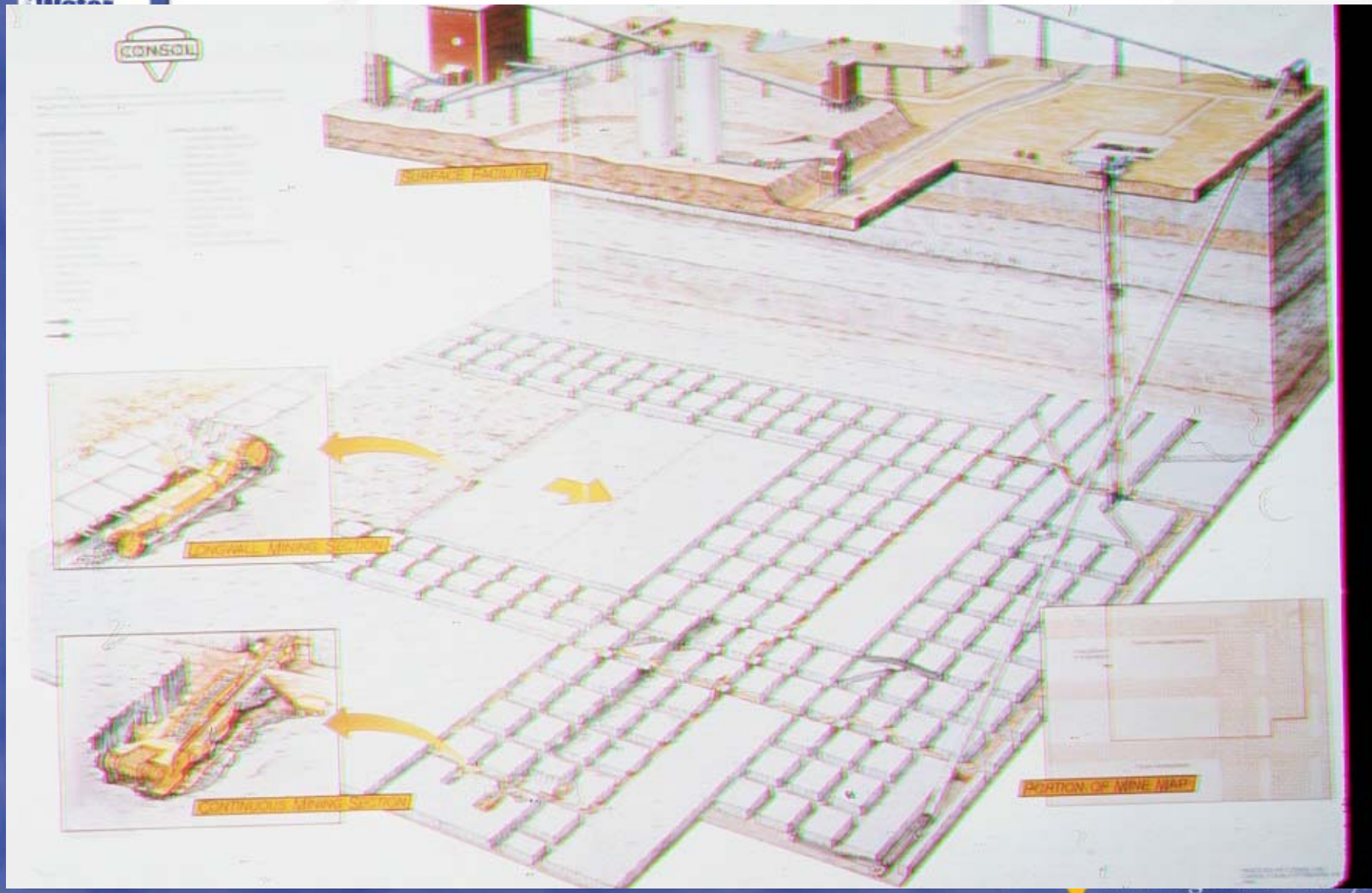
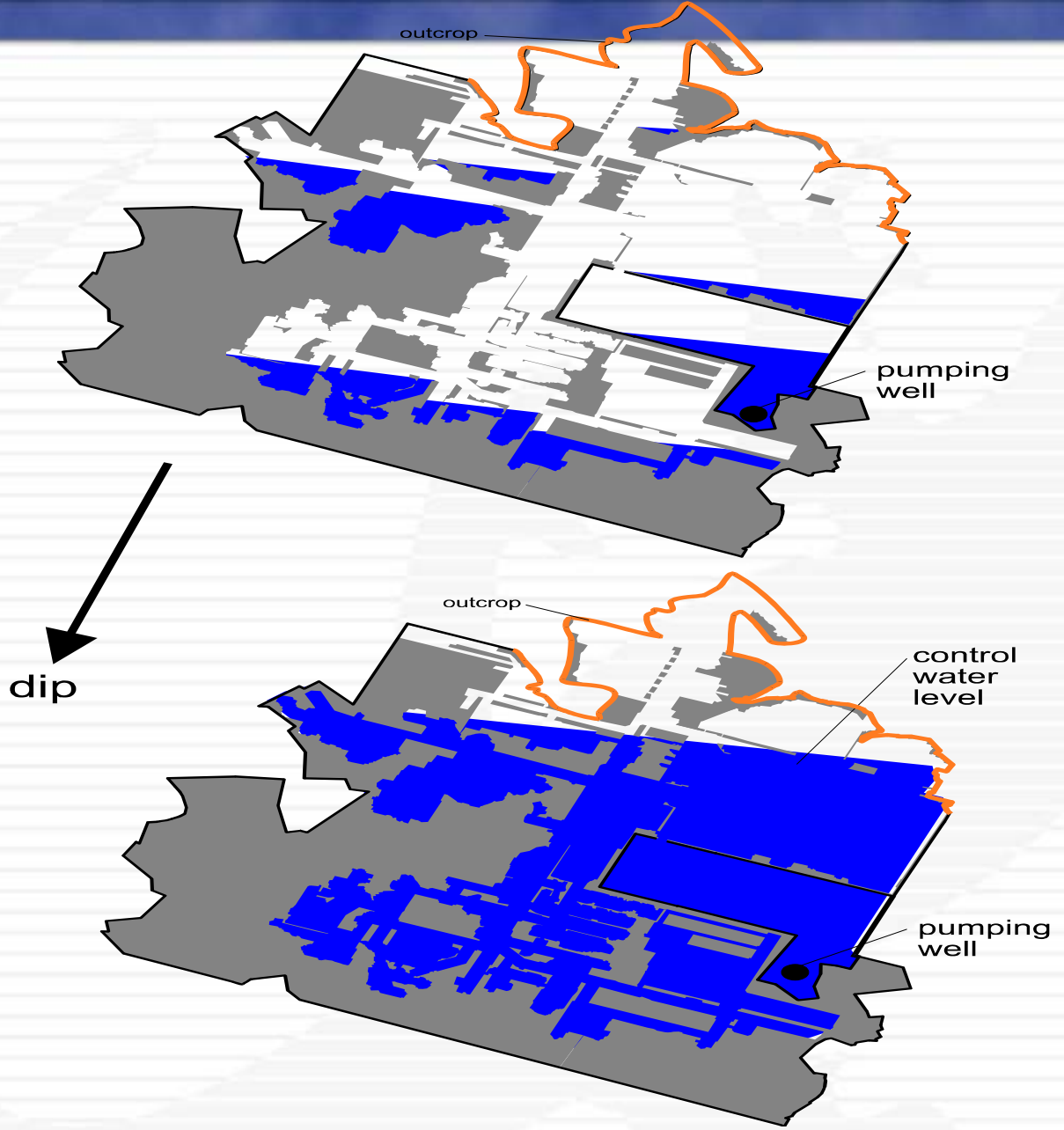


Schematic cross section of geology in the eastern portion of the Pittsburgh coal basin.

Layout of Typical Underground Coal Mine



Underground Coal Mine Void



Flooding of an abandoned coal mine

Abandoned Underground Mine Portal: Pittsburgh Coal Seam

Pittsburgh Seam Aquifer

- Water quality varies from net alkaline with low metals to strongly acidic with high metal (Fe, Al) concentrations
- Also high in Ca, Mg, sulfate
- Nearly all of the produced water would require treatment for metals, TDS
- Flooded, below-drainage mines generally have the best water

Pittsburgh Seam Aquifer

- Stored water:
  - 1.36 trillion gallons or
  - 4.16 million acre feet
- Lateral extent:
  - 1,942 sq. miles

Pittsburgh Seam Aquifer Productivity

- 95,000 gallons per minute or
- 212 cubic feet per second

Power plant water consumption

Source	Capacity MW	Water Consumption gallons/MWh	Water Consumption GPM	Heat Rejection MBTU/hr
EPRI	600	480	4,800	
Bruce Mansfield Avg.	850	459	6,500	
Mount Storm Unit 1	533	506	4,500 est.	2,038
Mount Storm Unit 2	533	458	4,070 est.	1,975
Mount Storm Unit 3	521	528	4,585 est.	2,226

Power Plant Water Requirements

- 600 MW pulverized coal station:
  - Boiler feed: 360 gpm
  - FGD: 500 gpm
  - Cooling water: 4,800 gpm
  - Ash handling, etc: 2,500 gpm

  Total: 8,160 gpm

Power Plant Water Requirements

- 80 MW Fluidizided Bed Combustion Unit:
  - Boiler feed: 48 gpm
  - FGD: 0 gpm
  - Cooling water: 640 gpm
  - Ash handling, etc: 0 gpm

  Total: 688 gpm

‘Theoretical’ Capacity

If 100% of this water were utilized, the aquifer could support:

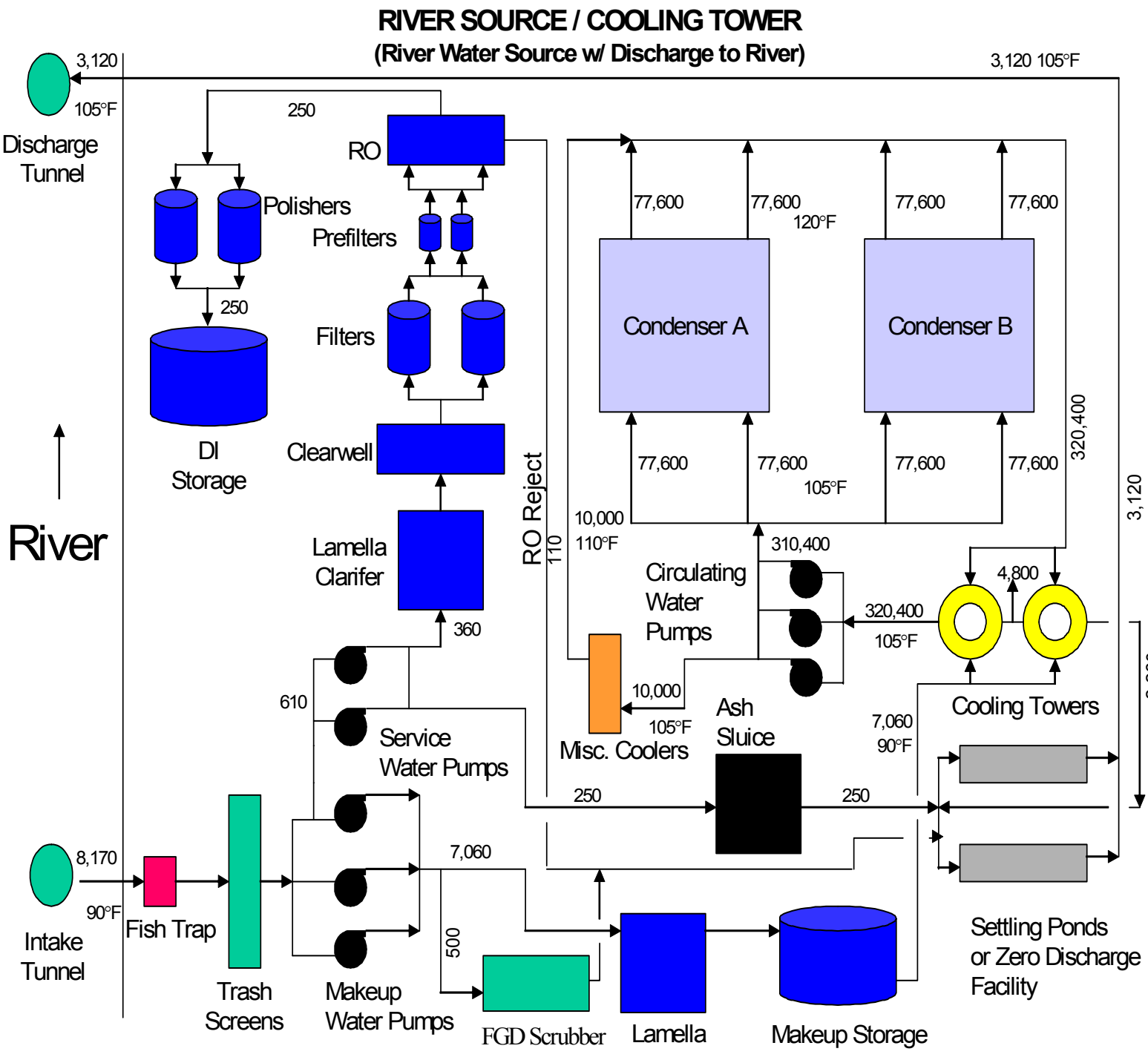
- 12 x 600 MW PC units (we found 8 sites)
- 138 x 80 MW FBC units

Logistics, sourcing and other considerations will ensure that utilization will be much less than 100%

Example Cost Evaluation

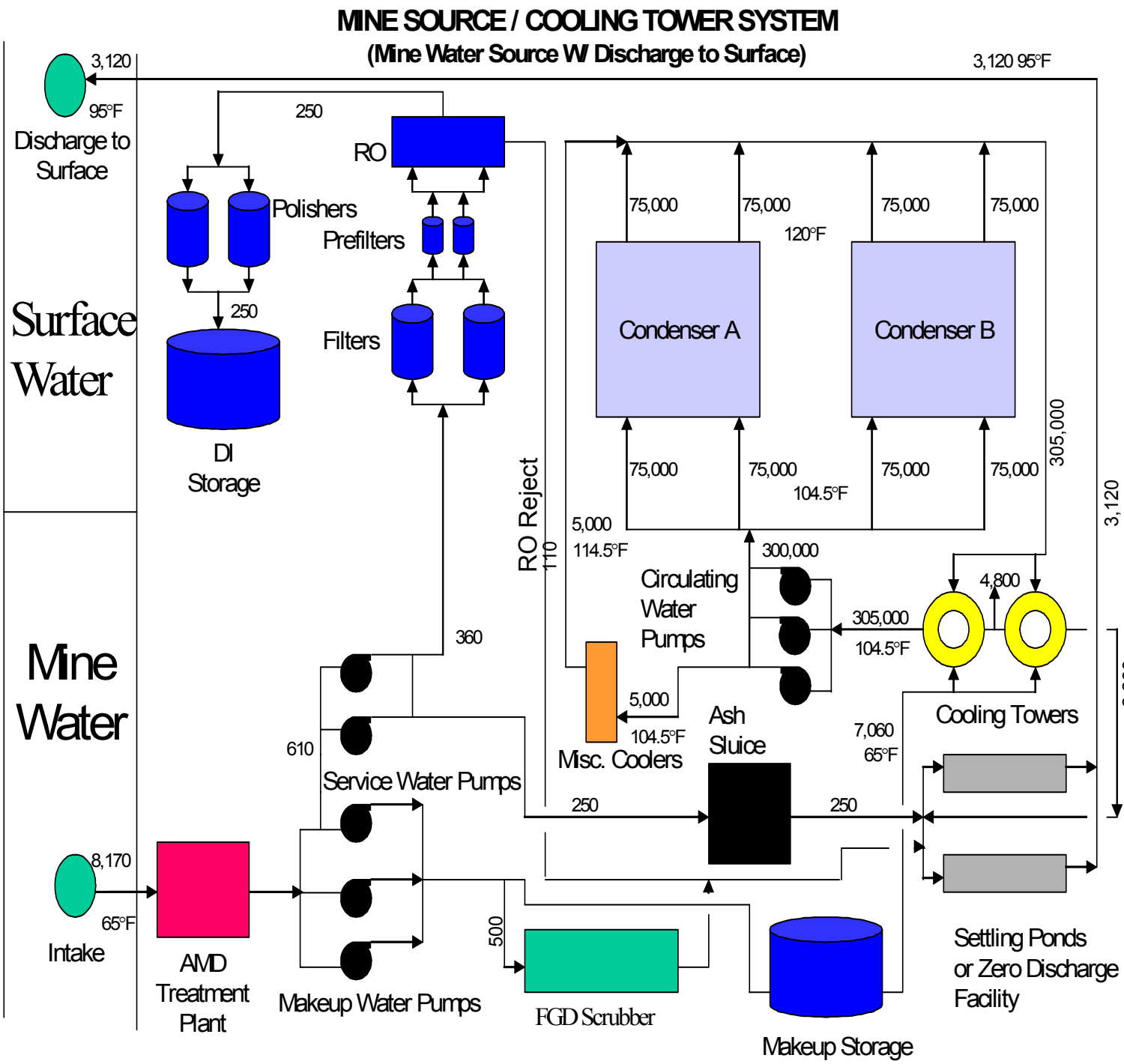
Base Case

Power plant cooling circuit diagram



Irwin & Uniontown

Power plant cooling circuit diagram for Irwin & Uniontown



Mine water/cooling tower,

Site	Makeup Water Demand gpm	Capital Cost	Operation and Maintenance	Cost of Water Treatment $ / MWh
Base Case	8,170	$55,277,400	$5,451,660	$0.08
Flaggy Meadows	8,135	$60,281,000	$6,111,000	$0.33
Irwin	8,170	$54,241,275	$5,464,338	$ 0.15
Uniontown	8,170	$55,821,970	$5,539,338	$ 0.18

Cost Analysis Summary Type A Cooling

	Capital Cost	Percent of Base Case	Operating Cost	Percent of Base Case
Base Case	$55,277,400	100.0 %	$ 5,451,660	100.0 %
Flaggy Meadows	$60,281,000	109.0 %	$ 6,111,000	112.1 %
Irwin	$54,241,275	98.1 %	$5,464,338	100.2 %
Uniontown w / Transmission	$55,821,970 $59,961,970	100.0 % 108.5 %	$ 5,539,338	101.6 %

Benefits

- ‘New source’ of water, no competing uses
- Mine drainage discharges are reduced or eliminated
- Reduce or eliminate demand on surface water
- Mine water is not subject to summer heating like surface water (55 deg. F.)
- No biological entrainment with the use of mine water

Conclusions: Mine water/cooling towers

- Flooded Pittsburgh Seam mines are a major potential source of power plant water
- Feasible using existing technology
- Eight suitable sites were identified in the Pittsburgh Coal Basin for 600 MW units
- The use of alkaline mine water for power plant cooling is competitive with river water.