Coarse Coal Reject ML/ARD Management

21st Annual BC/MEND ML/ARD Workshop
December 3-4, 2014

Darren Cowan
Bruce Mattson

Quinsam ML/ARD Management

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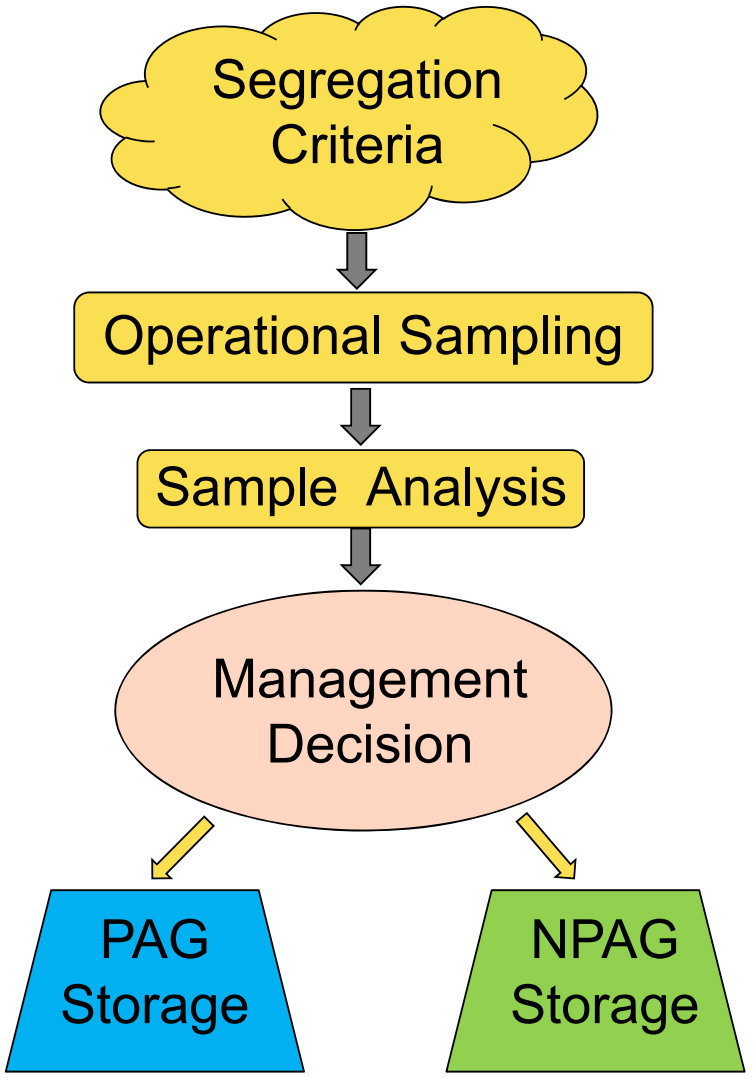
Outline

1. Discuss components of the Quinsam Coarse Coal Reject (CCR) ML/ARD Management Plan
2. Overview of the mine, coal seam and CCR
3. Development of Segregation Criteria
4. Present operational sampling procedure and results
5. 2S Flooded Surface Storage Facility
   - Operation
   - Monitoring
6. 7S Flooded Underground Storage Facility
   - Operation
   - Monitoring

Components of ML/ARD Waste Management

- Develop scientifically defensible Segregation Criteria
- Conduct operational sampling to evaluate material characteristics relative to the criteria
- Rapid sample analyses required to allow management decisions to be made in a timely fashion
- Management decision based on PAG or NPAG designation

- Construct and Operate storage facilities with necessary capacity to manage PAG and NPAG coarse coal reject



Coal Washing
(what is coarse coal reject?)

Wash Plant Produces

- Clean Coal product
- Coarse Coal Reject (CCR)
- Fine reject

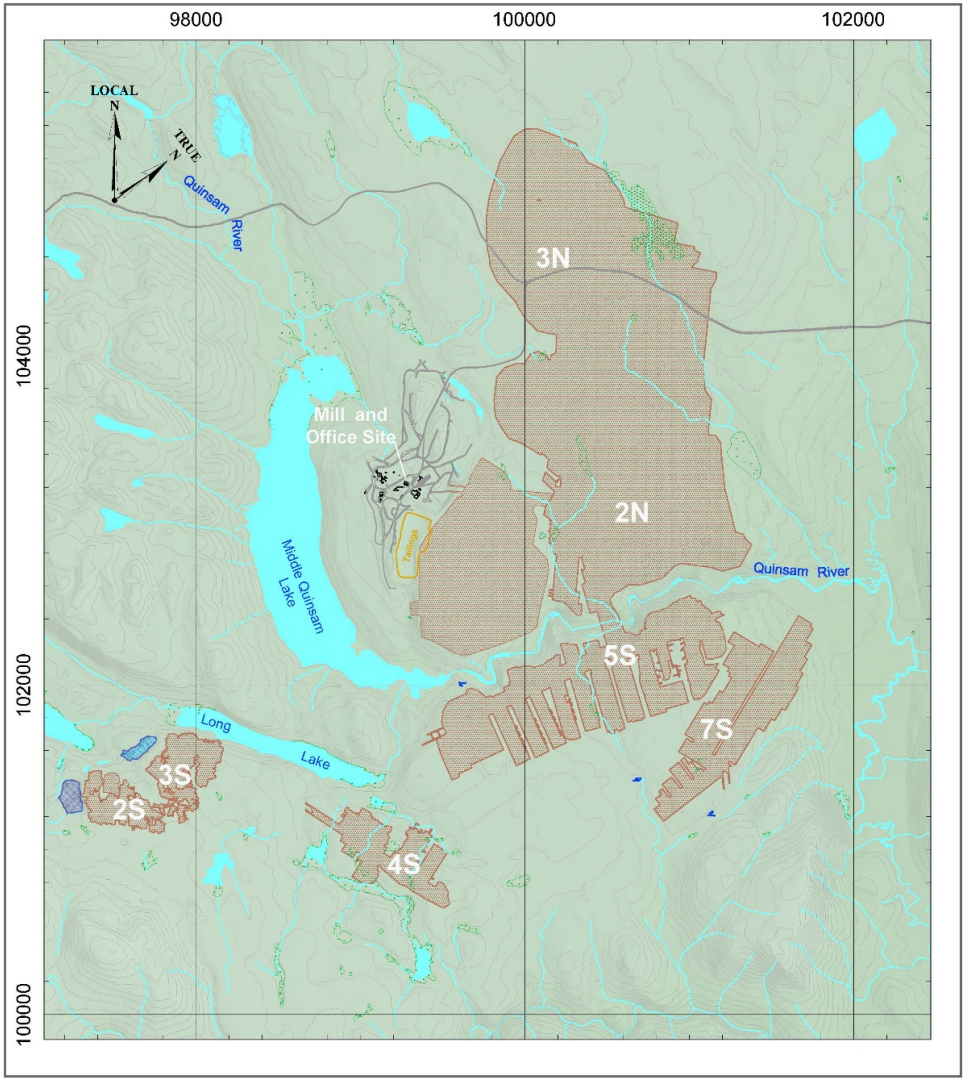
Coarse Reject comprised of

- Shale partings
- In-seam ash
- Sandstone roof
- Coal

The ARD characteristics of the CCR are the cumulative effect of these discrete components

Background on No. 1 Coal Seam

- Quinsam Mine operated on Vancouver Island west of Campbell River since 1988
- Produced coal from open pit and room and pillar underground mining methods
- Historically the majority of coal production derived from No. 1 Seam
- Stratigraphically - near the base of the Cumberland member of the Nanaimo Group sediments
- No. 1 Seam coal produced from:
  - 2N, 3N, 2S, 3S, and 5S mines



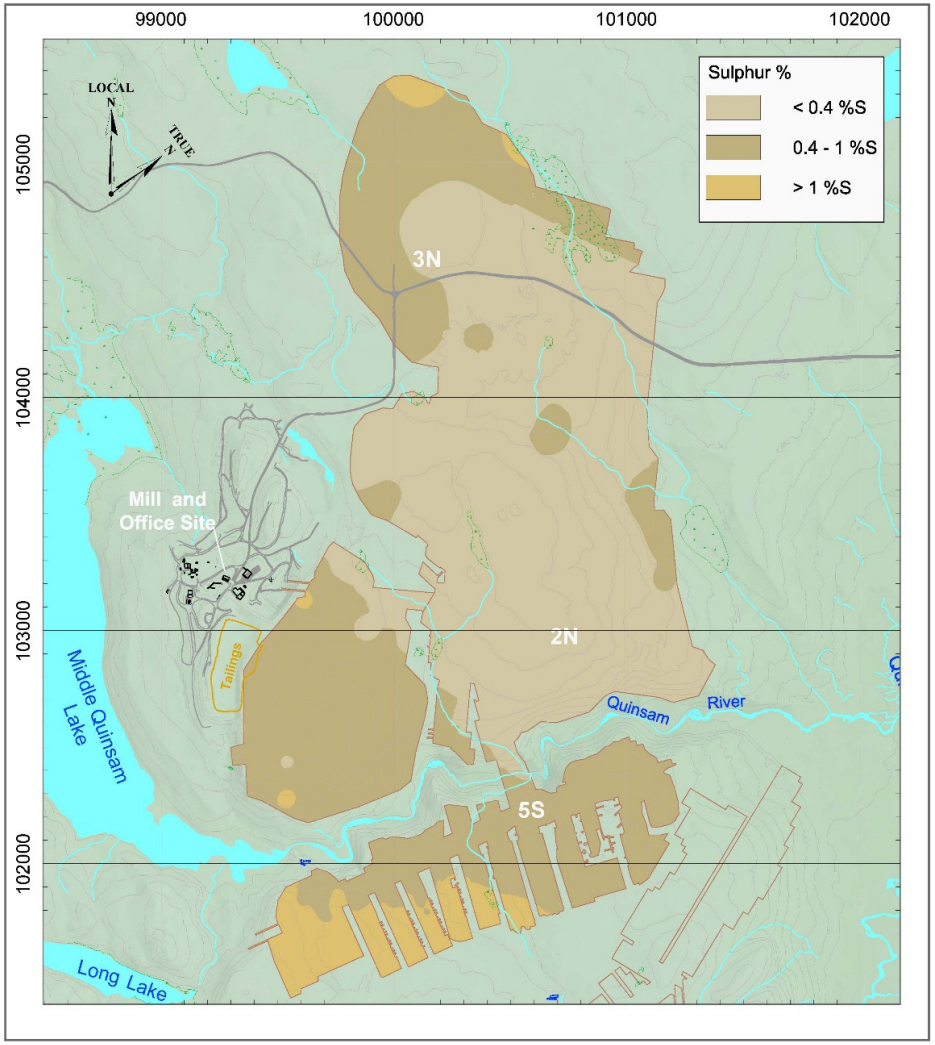
No. 1 Coal Seam Stratigraphy

- No. 1 Coal Zone comprised of:
  - Rider Seam,
  - Rider Parting,
  - No. 1 Seam Main (Upper),
  - Middle Parting,
  - No.1 Seam Main (Middle)
- Higher S content in the Rider Seam and Roof

Lithology and Thickness	0		Ash %	S(Tot) %
Rider Roof	0.19 m		58.2	6.2
1 Rider Seam	0.70 m		18.2	4.42
Rider Parting	1.49 m		77.6	1.31
1 Main Seam (Upper)	2.89 m		12.4	0.55
1 Main Seam (Middle) (includes parting)	3.99 m		9.3	0.48

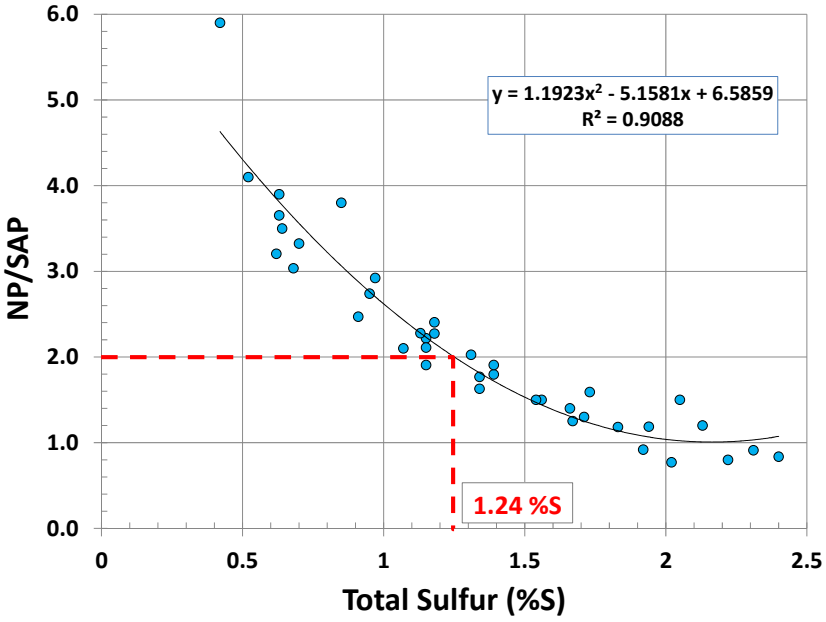
No. 1 Coal Seam Sulphur Content

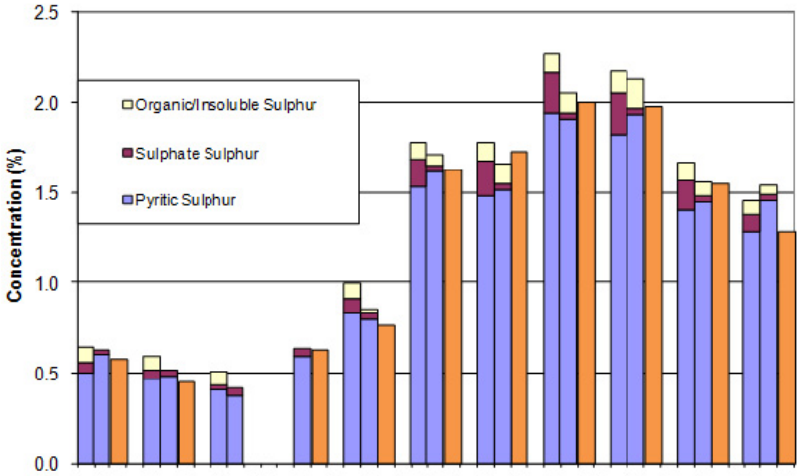
- No.1 Coal Seam typically has sulphur content < 1%S
- Higher S content observed in the southwest portion of the 5-South mine
- Rider Parting sulphur content
  - > 2 %S in portions of 5-South
  - Lower in 2 North (<1 %S)
- Rider Seam higher content > 2%S
- Variable sulphur content in raw coal requires frequent monitoring of CCR to evaluate acid generating potential



Segregation Criteria

- A total S criterion derived using NP/SAP ratio calculated with modified Sobek NP and sulphide S
- NP/SAP ≥ 2.0 when S < 1.24 %S
- 1.24 %S criterion accounts for the potential effects of organic S and Fe-carbonate
- A criterion based on Total S selected because Total S can be determined by the on-site laboratory
- On-site lab S analyses checked with commercial lab results
- Leaching characteristics evaluated with kinetic testing





Operational Monitoring

Hourly Sampling

- Belt sampled once every hour of production
- 1 composite sample for each 40 tonne truck load
- Truckloads of CCR are sequentially stockpiled on the temporary storage pad
- CCR disposal method selected based on the S content of the individual stock piles

Daily Composite

- Hourly samples combined proportional to production

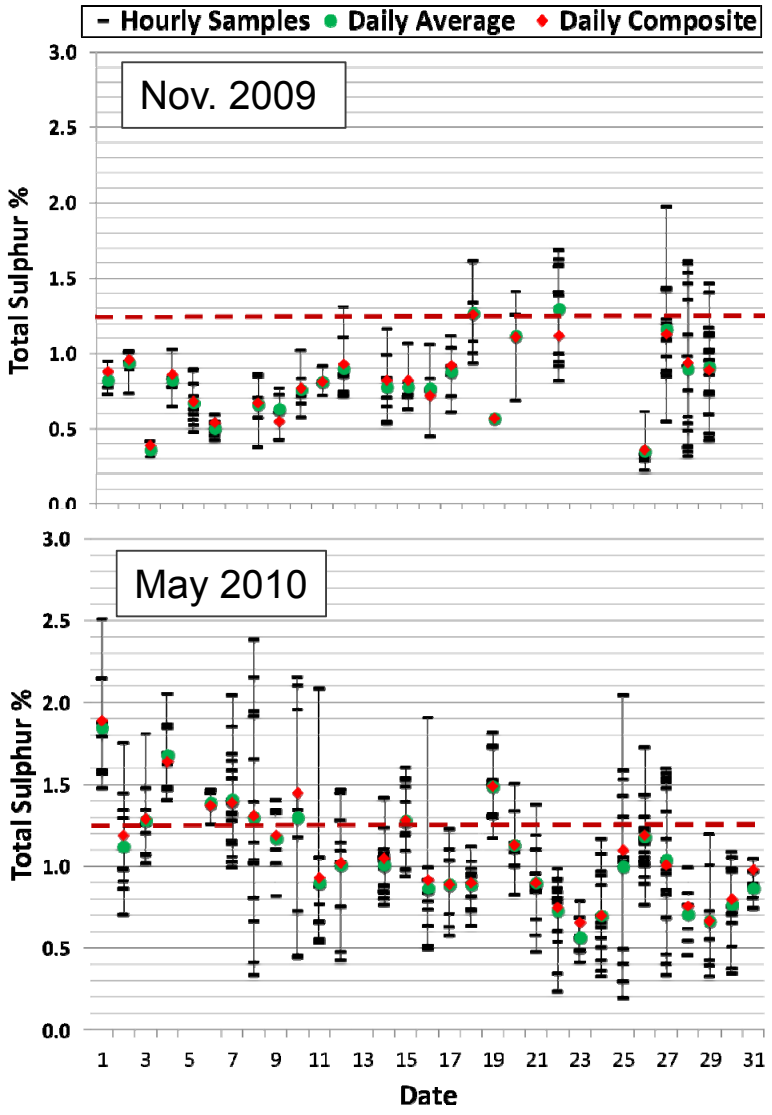
Bi-Monthly Composite

- Daily samples combined proportional to production

Sample Frequency	On-Site Analysis	Off-Site Analysis	Data Usage
40 t Truck - Hourly	Total S	-	Management Decision
Daily Composite	Total S	-	Confirmation
Bi-Monthly Composite	Total S	Complete ABA	Annual Reclamation Report

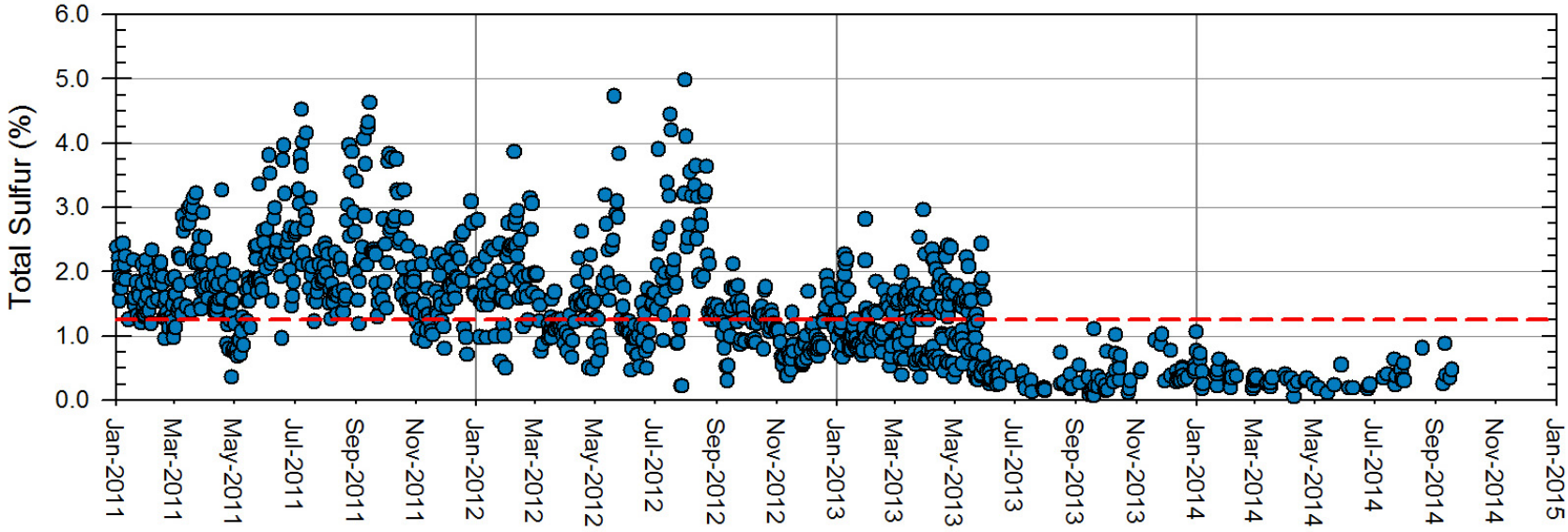
Hourly Monitoring Results

- Total S values for hourly samples taken each day wash plant operated in Nov. 2009 and May 2010
- Monitoring indicates that total S in the CCR product varies from 0.2 %S to 2.5 %S
- Daily Composite sample provides a good estimate of average of all samples collected in a day



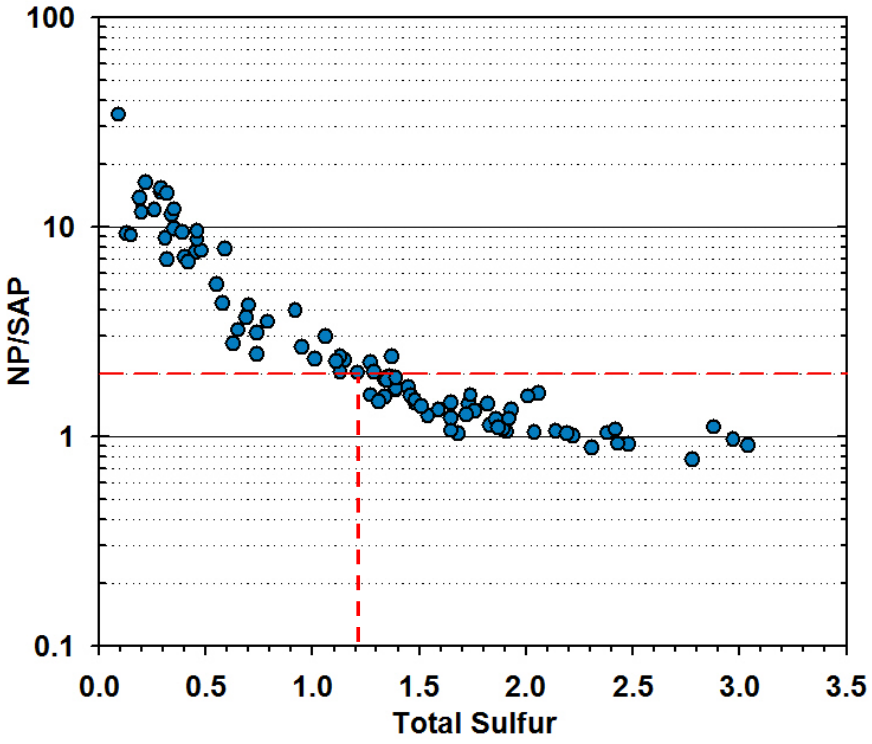
Daily Monitoring Results

- Daily composites produced since the development of the criteria in 2010 used to evaluate general PAG or NPAG proportion of CCR
- High S CCR predominated during 2011 directed to PAG storage
- Higher proportions of low S CCR produced from No. 1 Seam in 2012, 2013 and 2014



Confirmation Monitoring Results

- Bi-monthly composites produced since the development of the criteria in 2010 used to confirm the total S criterion
- Total S criteria developed for No 1 Seam CCR remains effective to differentiate PAG and NPAG



Operational Management
Disposal Options

PAG CCR

Flooded underground storage

PAG CCR

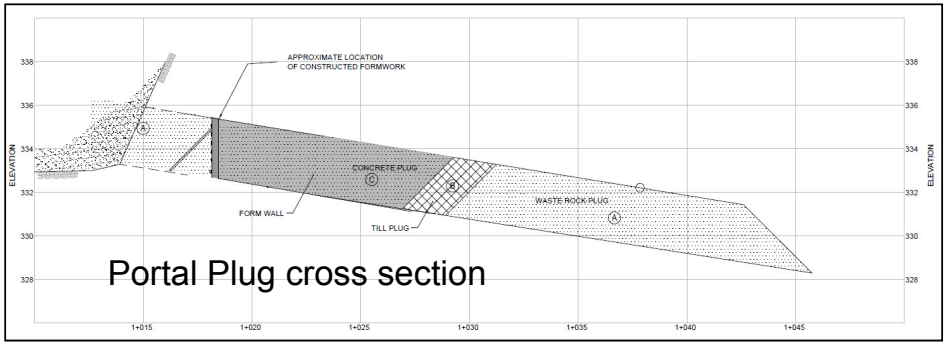
In Pit sub-aqueous storage

NPAG CCR

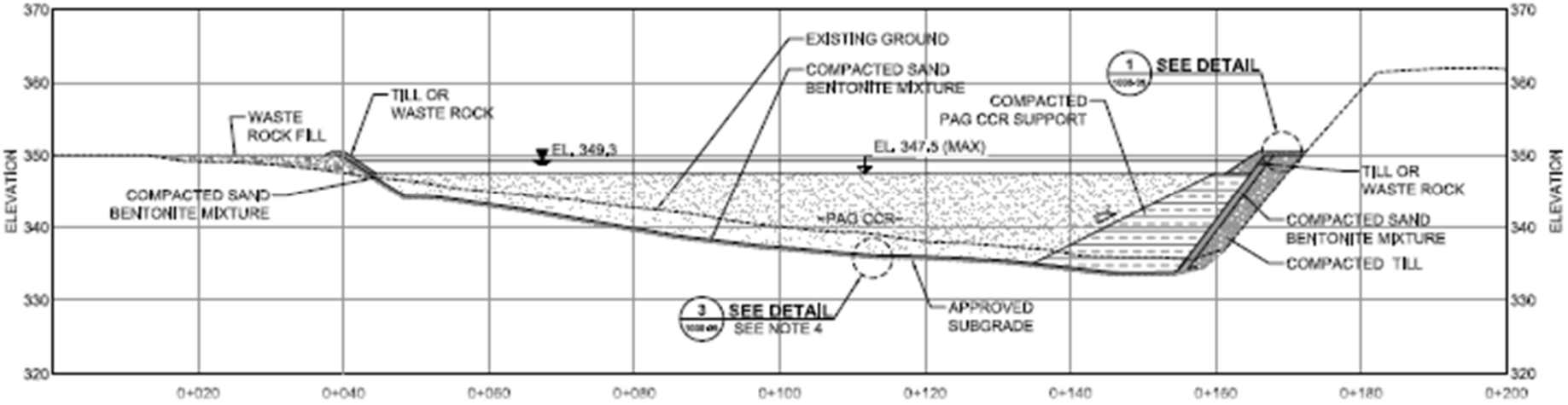
- construct tailings embankment

2-South Storage Facility

- Converted 2-South portal pit into storage facility for PAG CCR.
- Three grouted plugs (each roadway) to seal off U/G Workings
- 40cm thick sand-bentonite liner @ 8% bentonite by wt.
  - Design permeability <= 10^{-9} m/s
  - Design Capacity = 155,000 m^3 PAG CCR



Portal Plug cross section



2 South Portal Pit cross section

2-South Storage Facility

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Sand-bentonite manufacturing

- Waste rock crushed and screened to meet sand particle-size specifications
- Bentonite mixed with sand @ 8% by wt. using pug mill
- Sand-bentonite loaded into 40t-50t haul trucks and hauled into pit for placement

2-South Storage Facility

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Liner Construction

- Pit Floor:

Sand-bentonite placed in two lifts

- Final Compacted Thickness = 40cm

1. S-B spread with excavator or dozer and compacted with 11t vibratory smooth drum roller.
2. Once all QC testing passed, liner covered with 0.5m thick protective cover layer of PAG CCR and compacted

2-South Storage Facility

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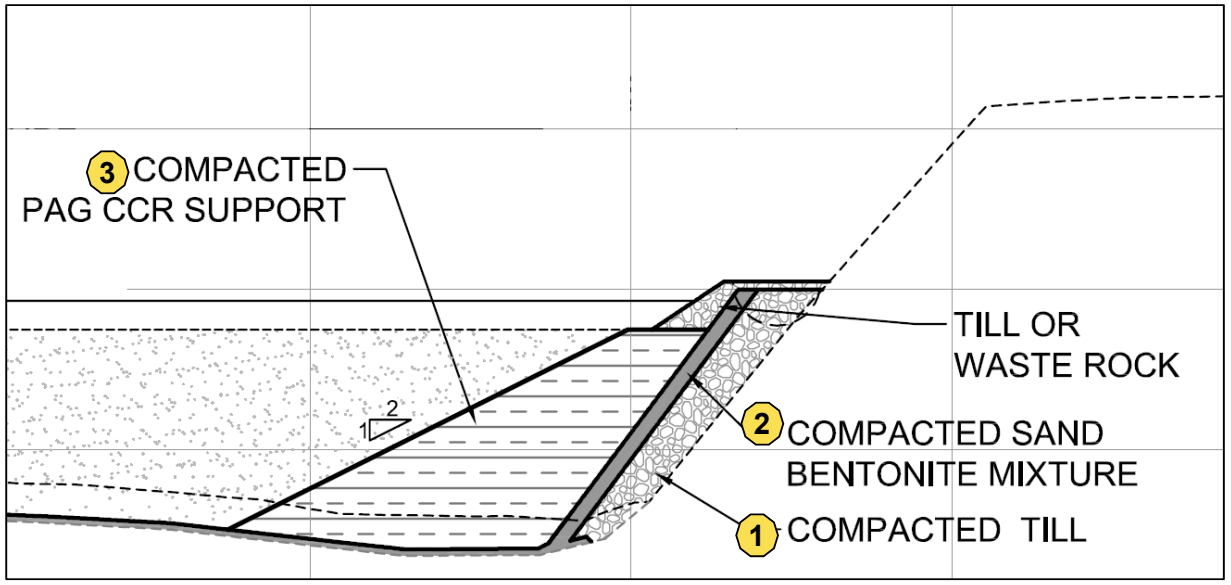
Liner Construction

- Highwall
  1. 3m wide (min.) till buttress constructed against existing pit HW in 1.0m lifts and compacted/tested
  2. 1m wide sand-bentonite liner constructed against till buttress in 0.3m (compacted) lifts using steel forms
  3. PAG CCR buttress constructed against sand-bentonite to provide lateral stability.



2-South Storage Facility

- Quality Control Program
  - Survey
  - Grain size
  - Density
  - Moisture Content / Moisture-Density Relationship
  - Bentonite Content
- Quality Assurance Program
  - Hydraulic Conductivity Testing
    - In-Situ = Air-Entry Permeameter, BAT Permeameter
    - Off-Site = Undrained Triaxial Compression Test

2-South Storage Facility

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2-South Storage Facility

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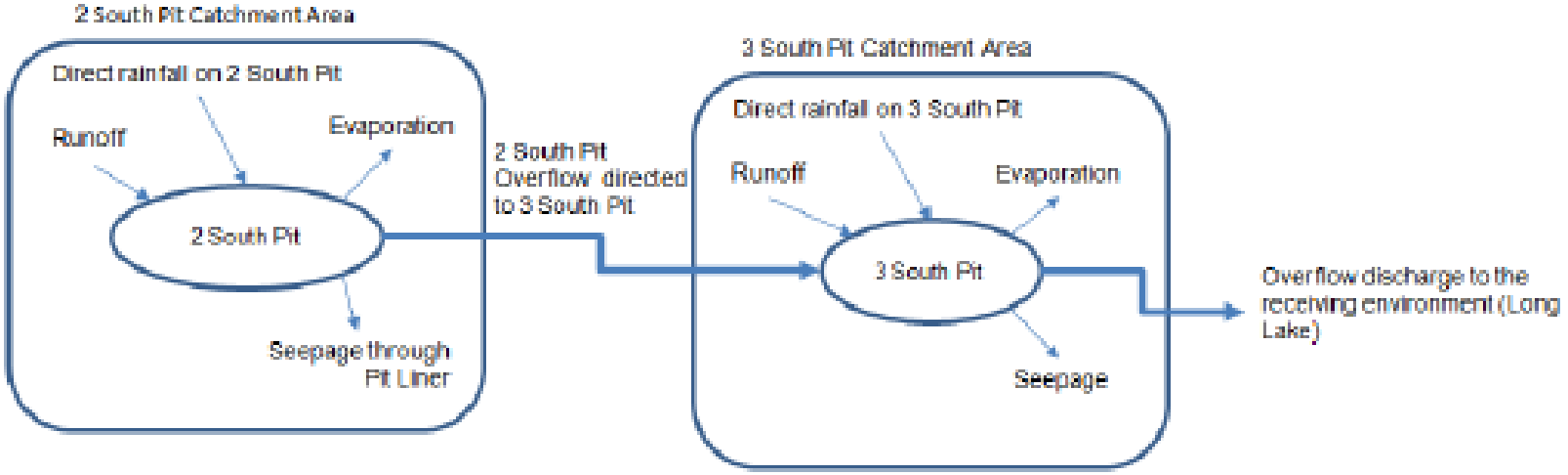
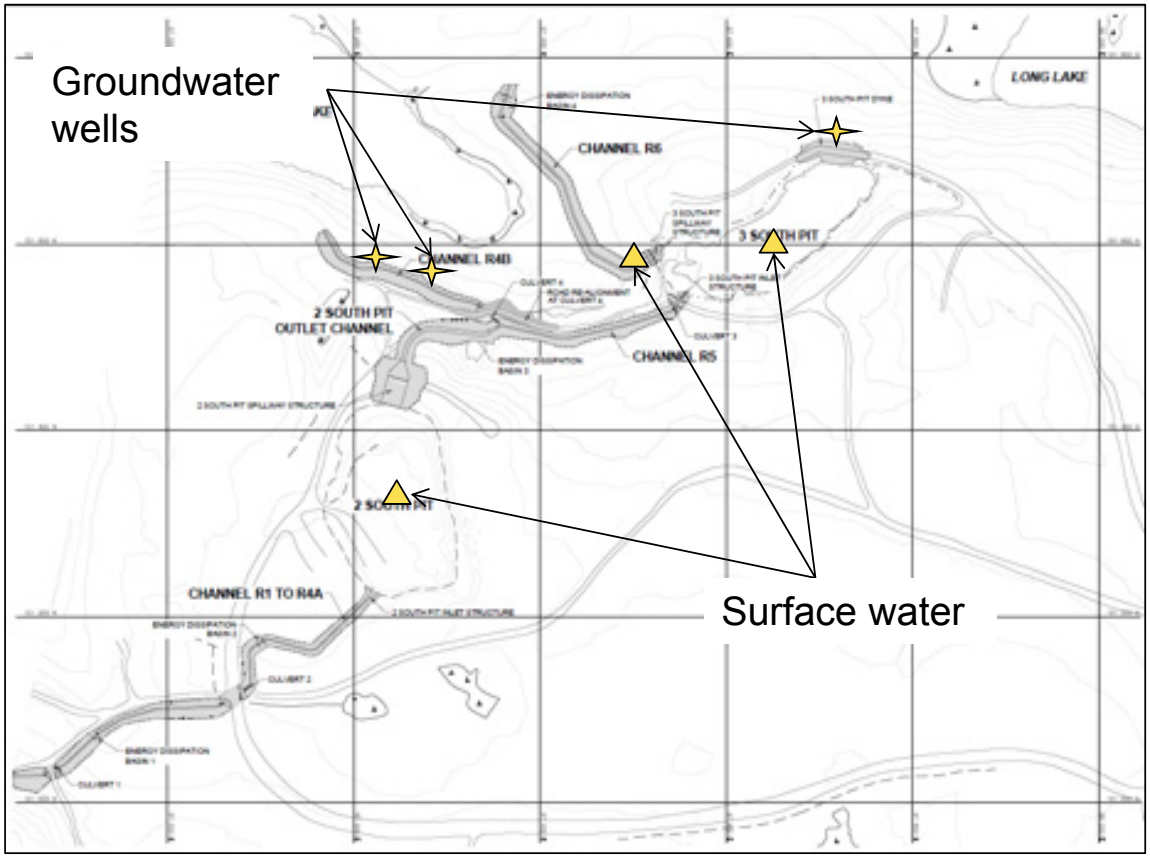
Operation/Closure

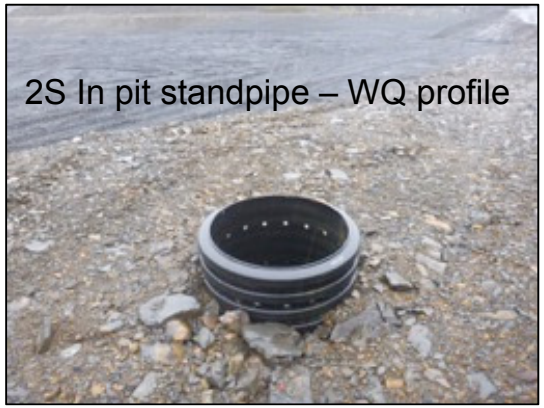
- CCR spread with dozer and compacted in ~ 1m lifts up to 347.5m elev.
- Operational/flooding water management controlled with high capacity pumps as well as inlet ditch and decant channel
- Flooded with mine water and natural runoff to limit amount of exposure time



2-South Facility Monitoring

- Seepage monitoring via GWW
- In situ and receiving environment surface water sampling

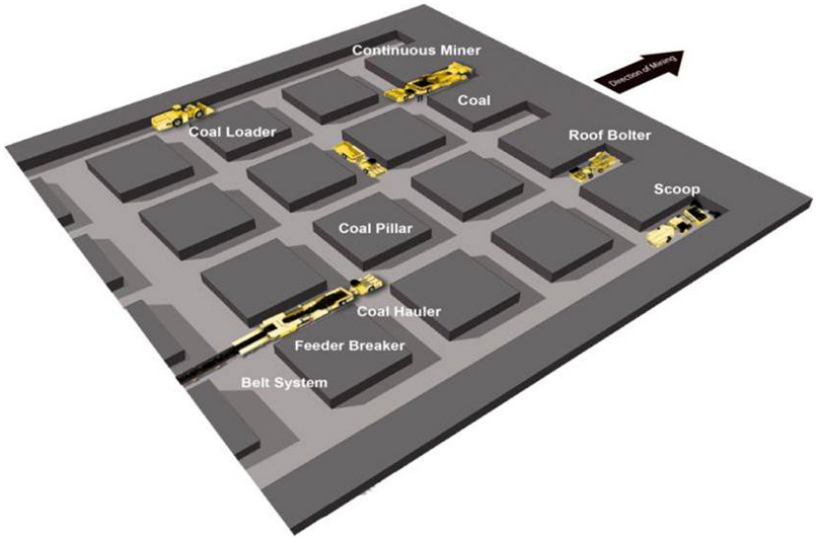




Flooded U/G Storage

Concept

- Storage areas created by small-centre room and pillar mining utilizing continuous miners.
- CM cuts coal and is shuttled back to conveyor to take it to surface for processing
- CCR conveyed underground and stowed in previously mined area
- Area allowed to flood to prevent oxidation of PAG material

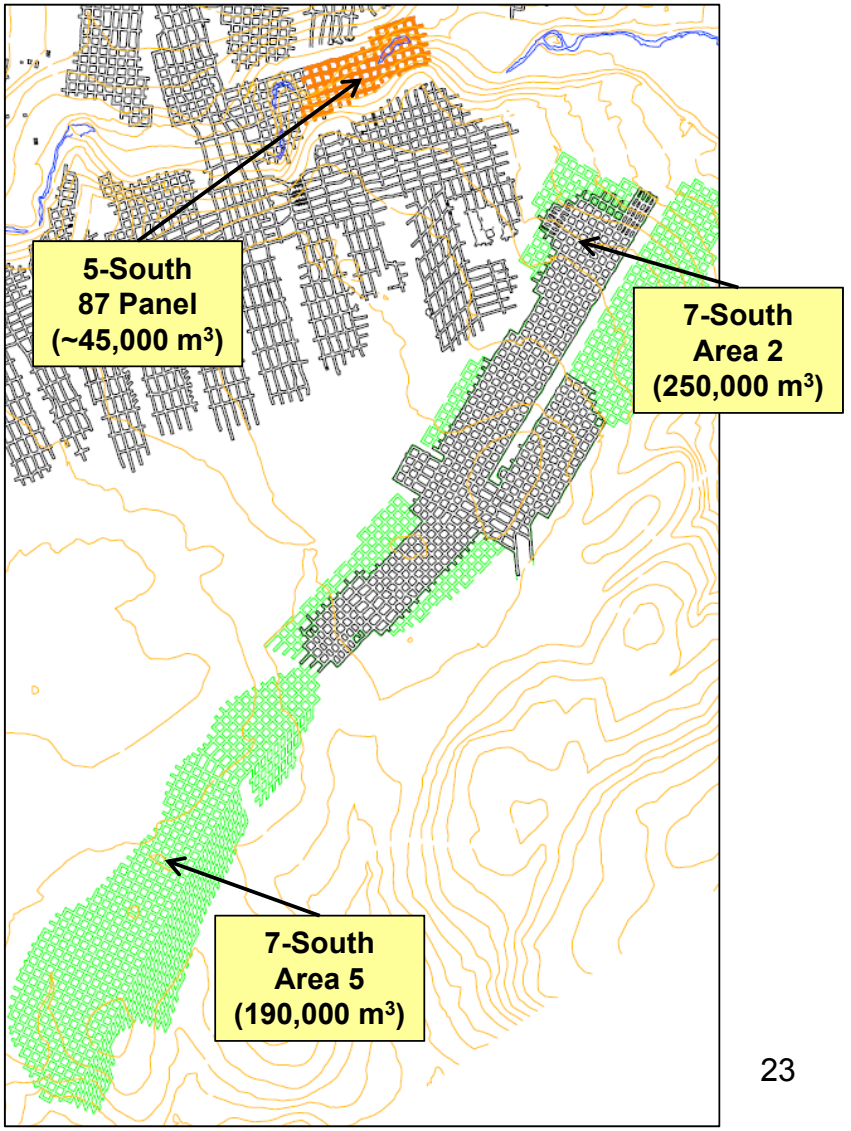


Flooded U/G Storage

Disposal Options

- **7-South**
- Permitted PAG CCR disposal areas:
  - Area 2 = 250,000 m^3
  - Area 5 = 190,000 m^3

- **5-South (87 Panel)**
- Permitted PAG CCR (trial) disposal area:
  - 87 Panel = 45,000 m^3

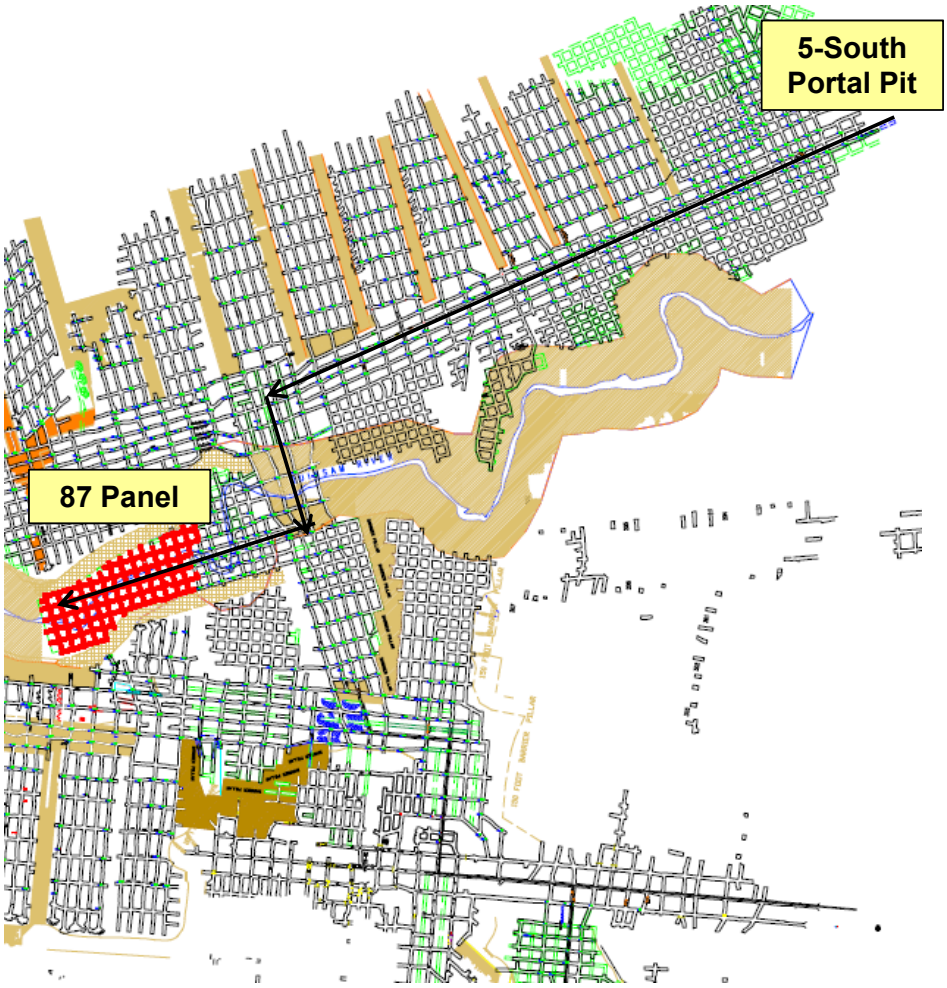


Flooded U/G Storage

87 Panel Trial

- Disposal concept tested in 87 panel (5-South) (75,000t PAG CCR)
- Hopper system constructed at 5-South portal for PAG CCR disposal
- PAG CCR conveyed U/G where scoop-trams muck and stow it.
- 87 panel allowed to flood naturally

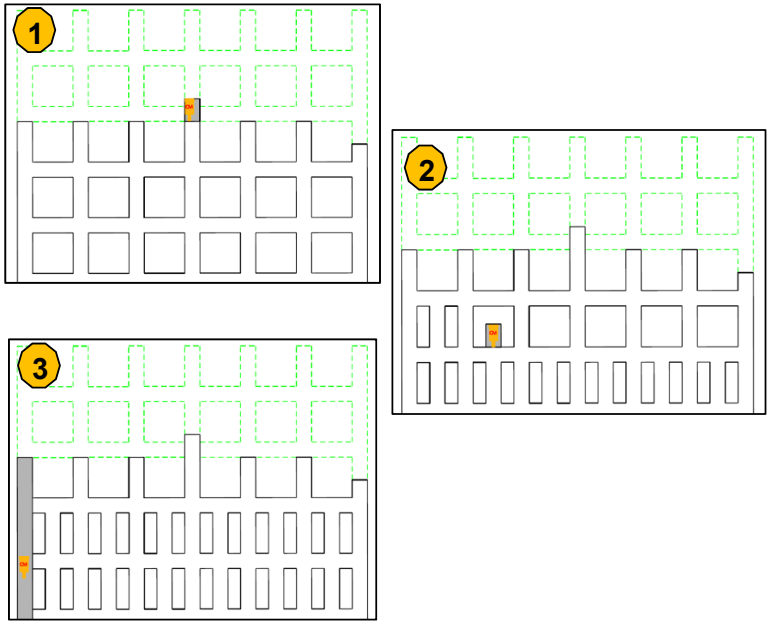
Photo: 5 South Portal Pit Hopper

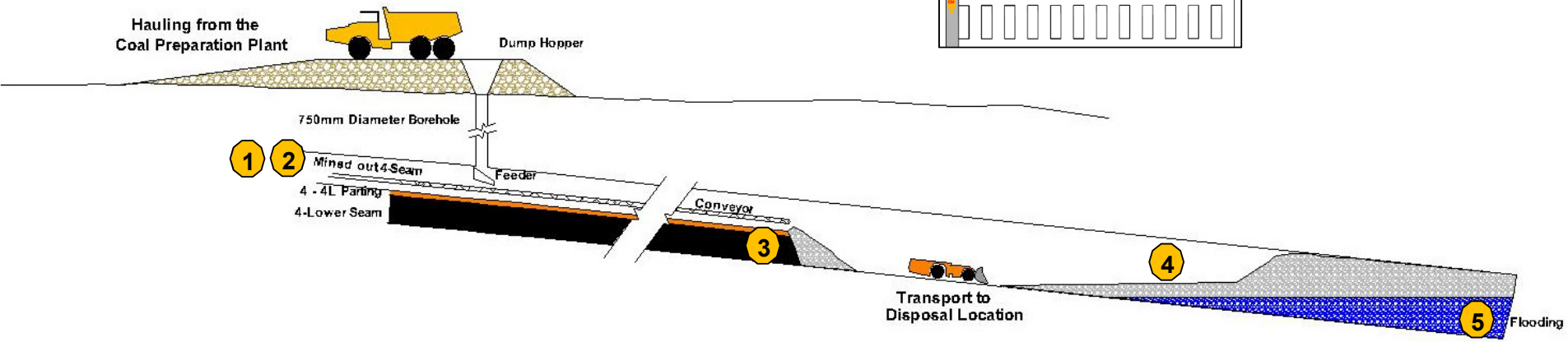


Flooded U/G Storage

7-South

1) Upper ply of coal removed – Room & Pillar
2) Coal pillars split. Upper ply removed
3) Lower ply of coal removed – Brushing
4) CCR stowed
5) Area allowed to flood





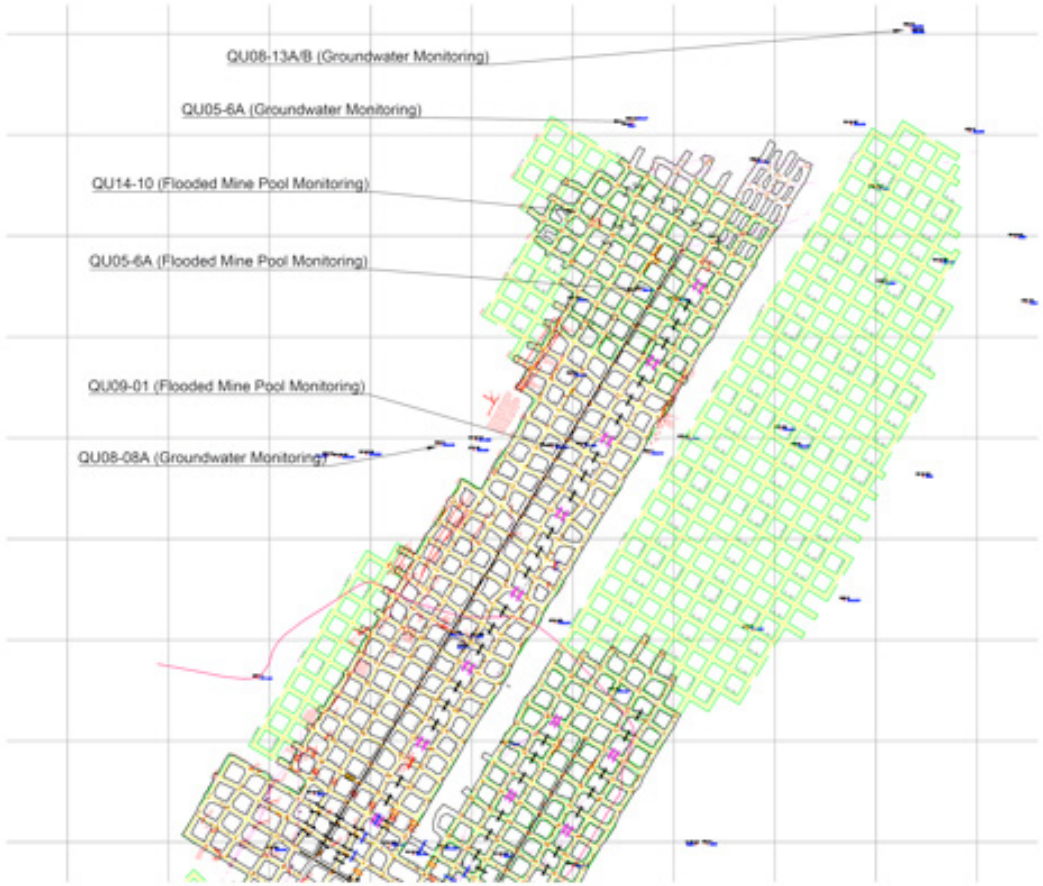
7-South Facility Monitoring

Material

- Bi-weekly sample of CCR during placement for inventory/tracking purposes

Water

- Series of groundwater wells to capture both flooded section and shallow/deep groundwater emanating from storage area
- Sump water (mine pool) sampled quarterly basis



- **Summary**
  - Understand general characteristics of waste in advance of mining to determine the type and extent of management required
    - Quinsam measuring S content of coal and near-seam strata
  - Develop segregation criteria
  - Commission on-site laboratory if necessary to allow rapid determination of material characteristics
  - Conduct monitoring at adequate frequency to direct operational material management
  - Quinsam ML/ARD management facilities invoke flooded storage strategy
  - 2-South employs a surface impoundment lined with sand-bentonite
  - 7-South employs disposal in underground workings that are allowed to flood
  - Conduct confirmatory monitoring of CCR and water in and discharging from the facilities

Acknowledgements

- Nick Williams
- Gary Gould
- Kathleen Russell

Thank you