

Optimizing Drill & Blast Recovery in Thin Seam Mining

March 30, 2011: OZMINE 2011 Jakarta

NEXT GENERATION MINING: TRANSFORMING INDONESIA

**The Power
of Partnership**



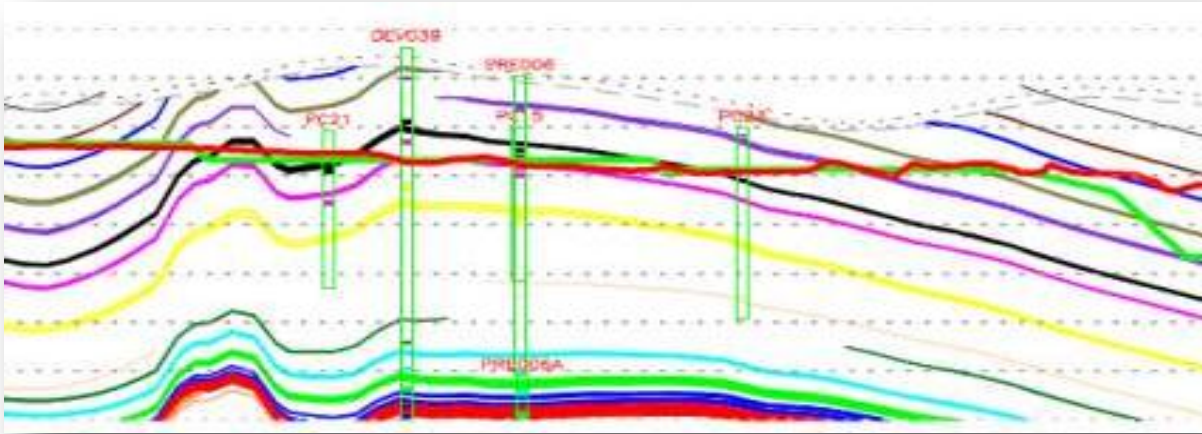
- **Situation**

- **Conventional Blasting**
- **Through Seam Blasting (TSB)**
- **Delivery of TSB**
- **Result and Benefits**

Situation

- Difficult geology
- Multiple thin seams with varying angles of dip, inter-burdens from 3 to 10 meters
- Seams as thin as 200mm are mined/recovered
- Several small blasts everyday to cope with production
- Significant safety risks – blast crew and drill rigs operate on sloping benches

Situation



The Power
of Partnership



Situation



The Power
of Partnership



Situation



The Power
of Partnership



- **Situation**

- **Conventional Blasting**

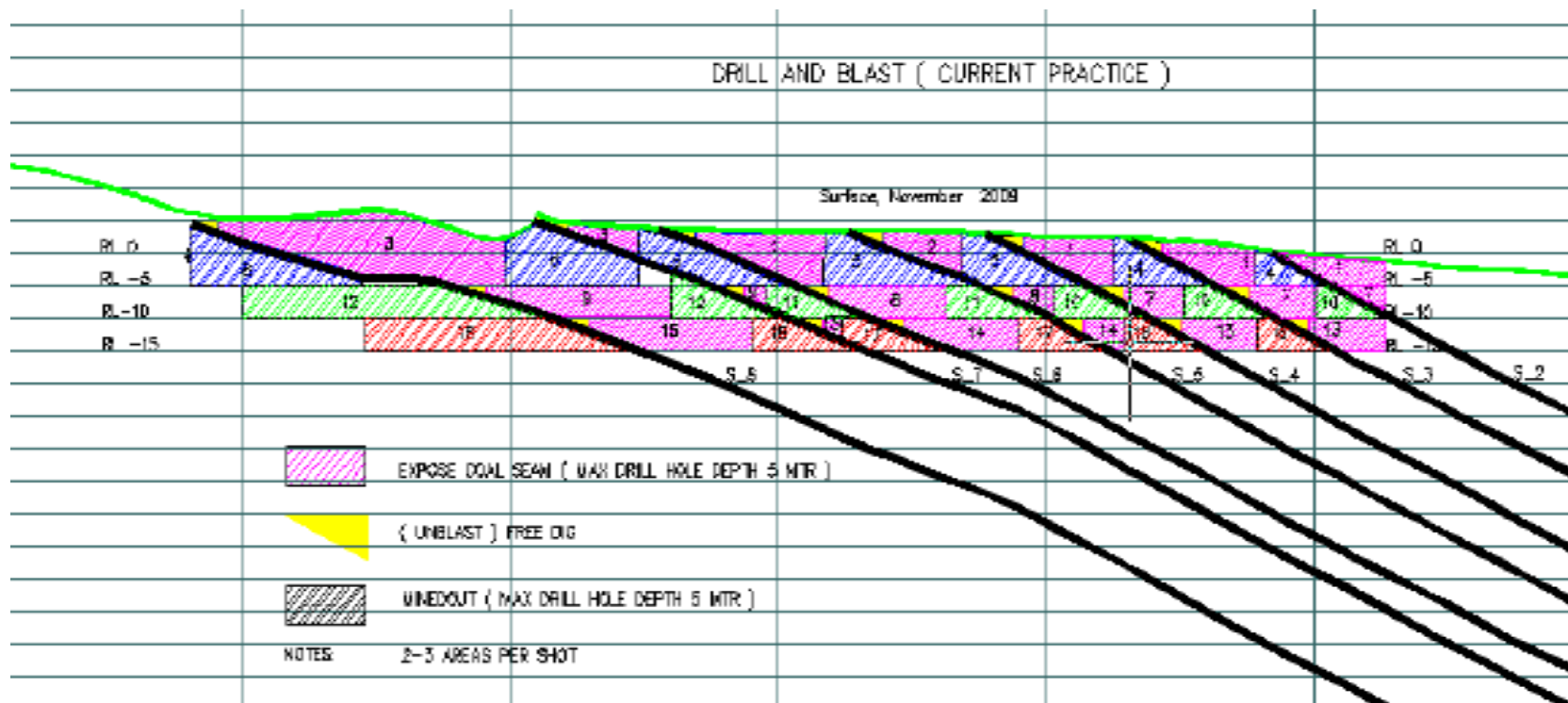
- **Through Seam Blasting (TSB)**

- **Delivery of TSB**

- **Result and Benefits**

Conventional Blasting

- For each 5m there are 10 individual blasting events
- The mine blast 2-3 areas together
- This is 30 blast events

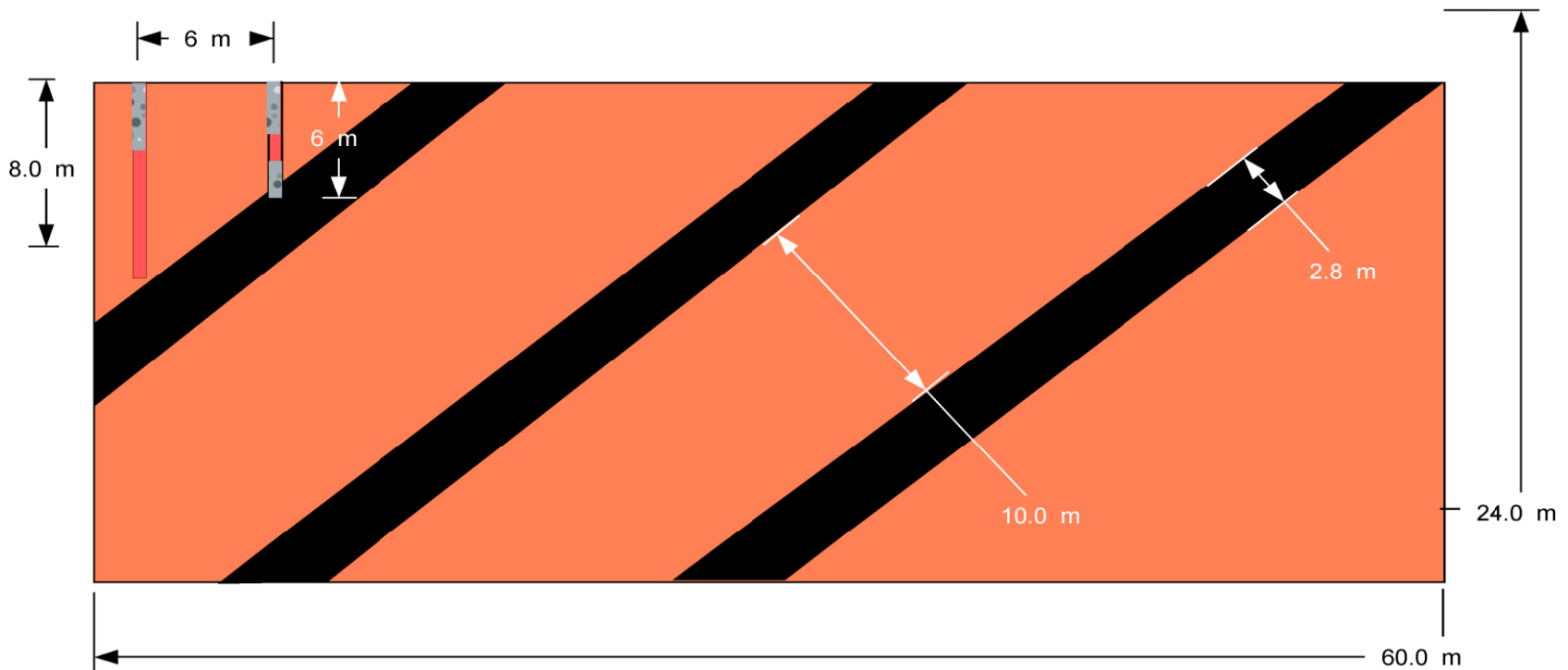


The Power
of Partnership



Conventional Blasting

Drill & Charge 'A' Interburden

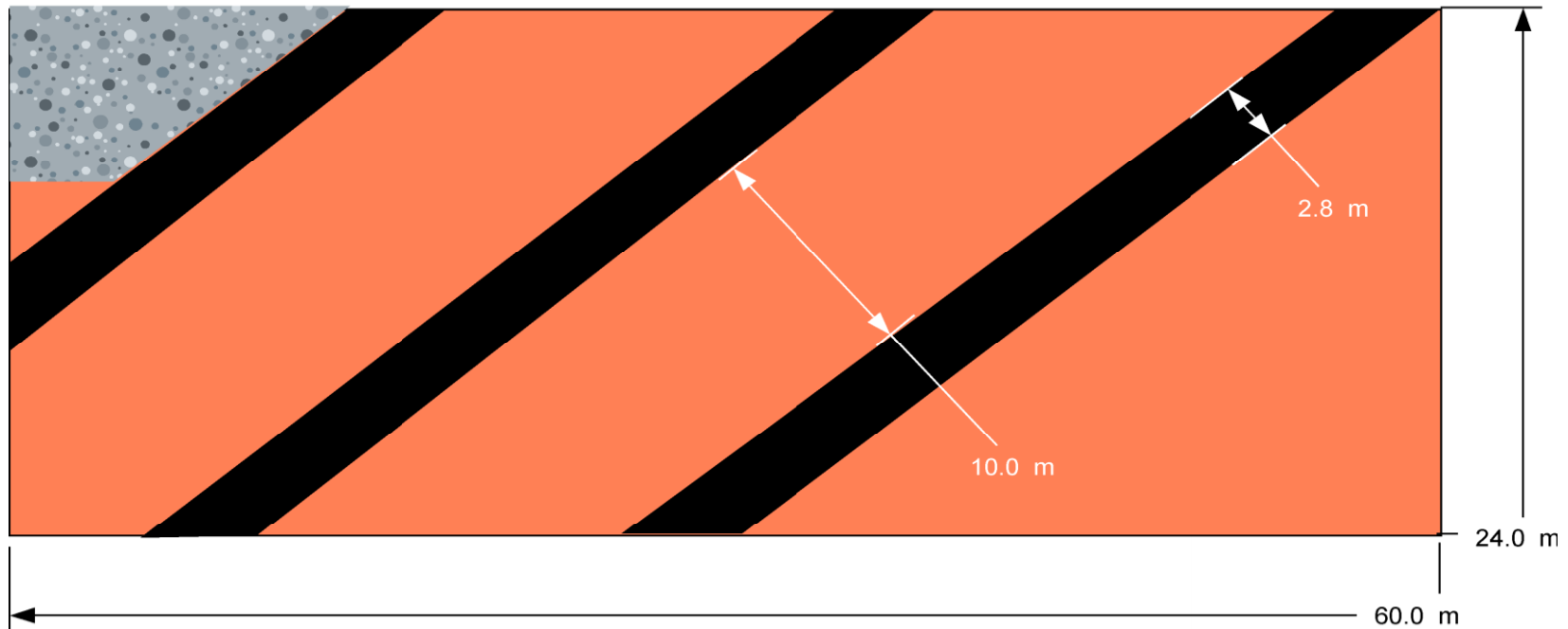


The Power
of Partnership



Conventional Blasting

'A' Interburden Blasted

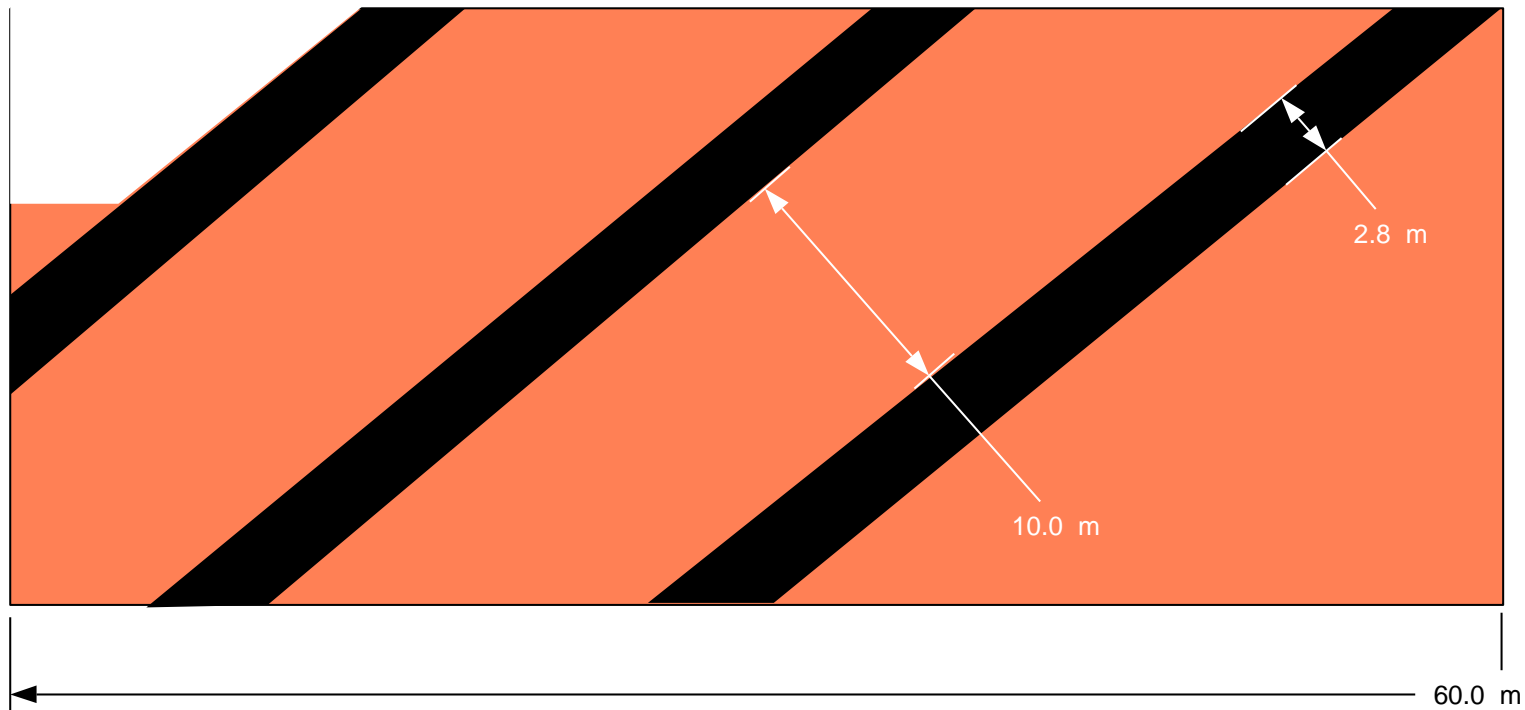


The Power
of Partnership



Conventional Blasting

'A' Seam Exposed

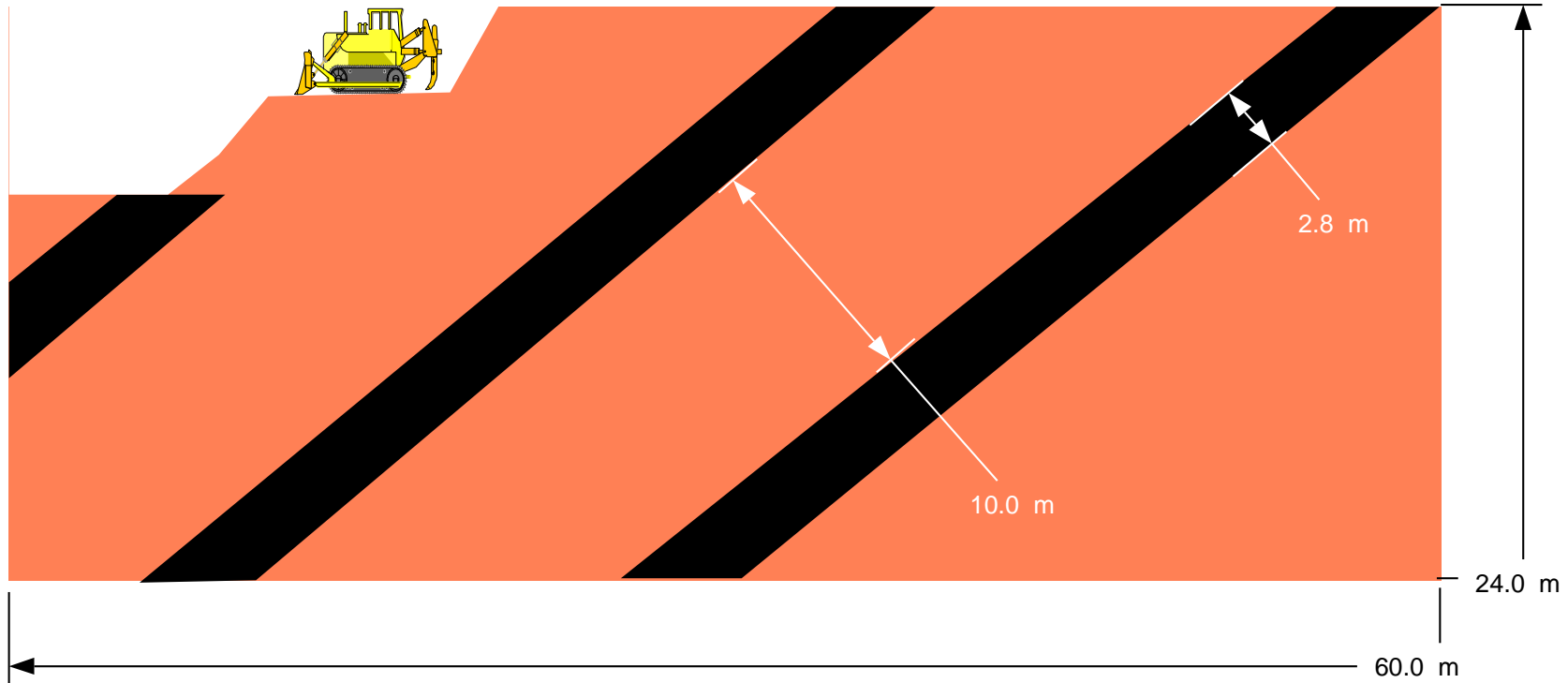


The Power
of Partnership



Conventional Blasting

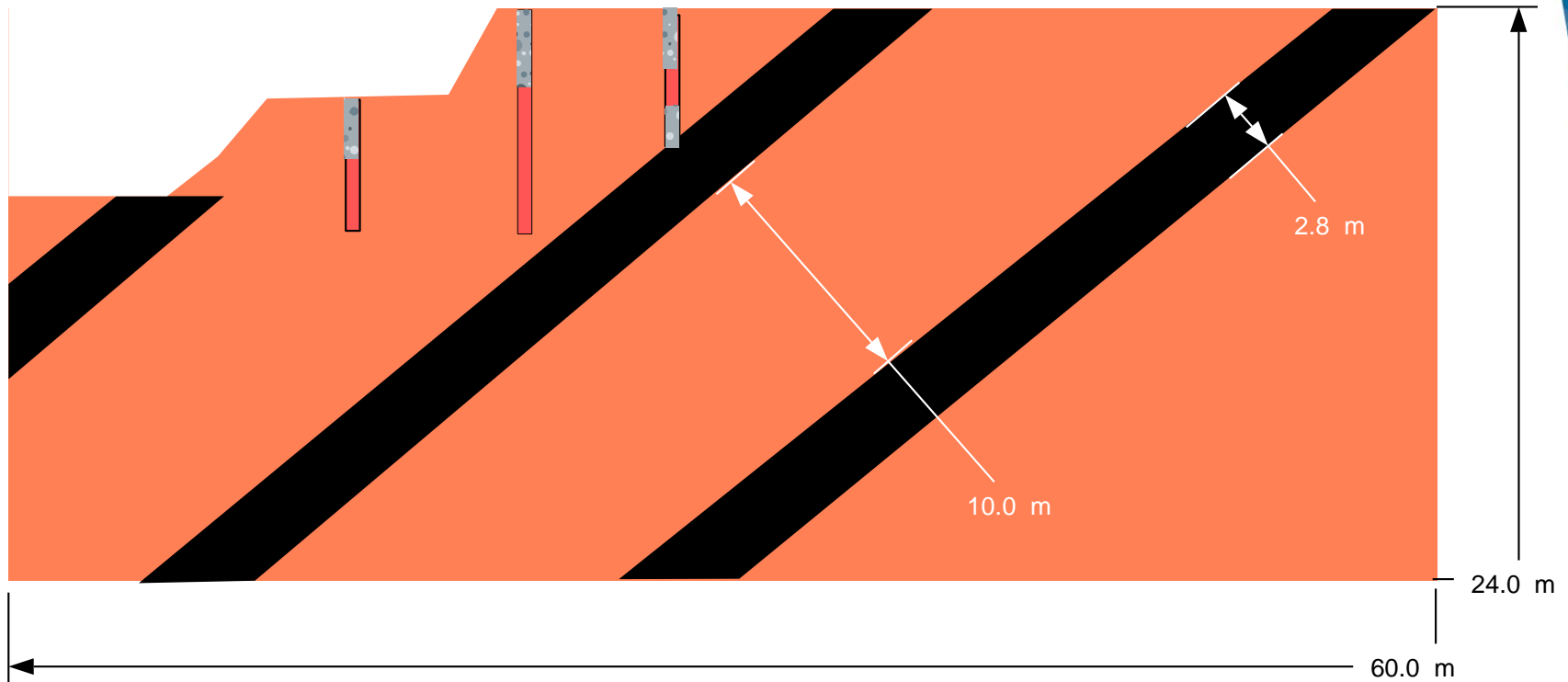
'A' Seam Extracted. Drill bench dozed in.



The Power
of Partnership



Conventional Blasting

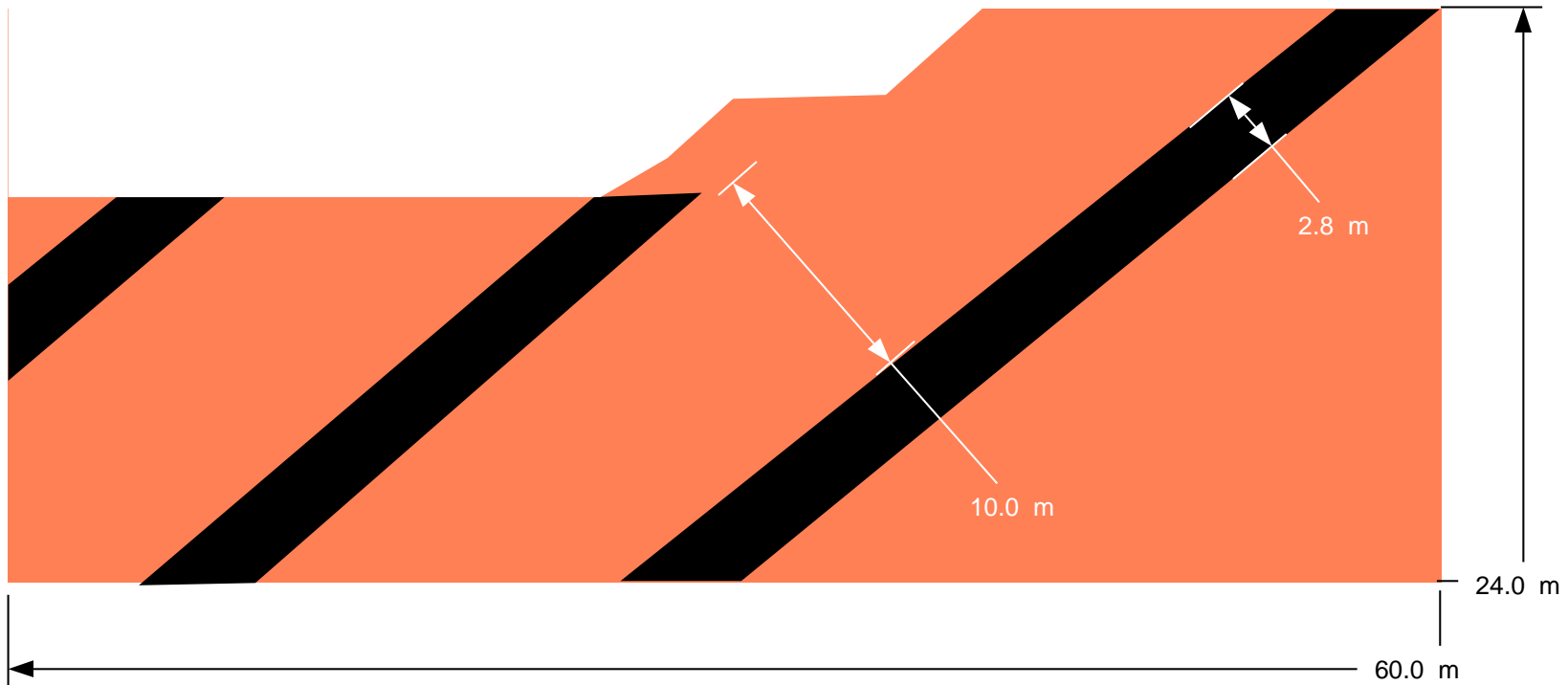


The Power
of Partnership



Conventional Blasting

'B' Coal Extracted. Drill Bench dozed in.

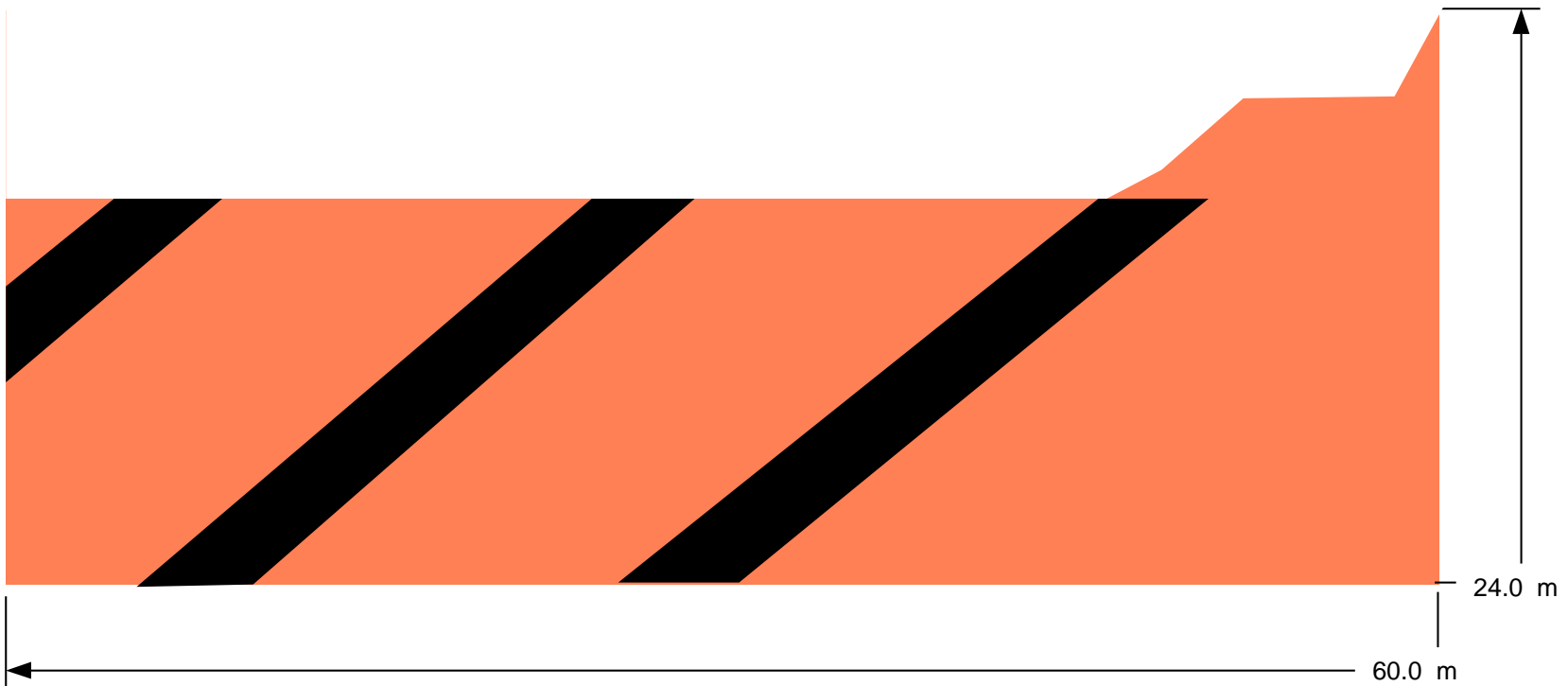


The Power
of Partnership



Conventional Blasting

'C' Coal Extracted. Drill Bench dozed in.

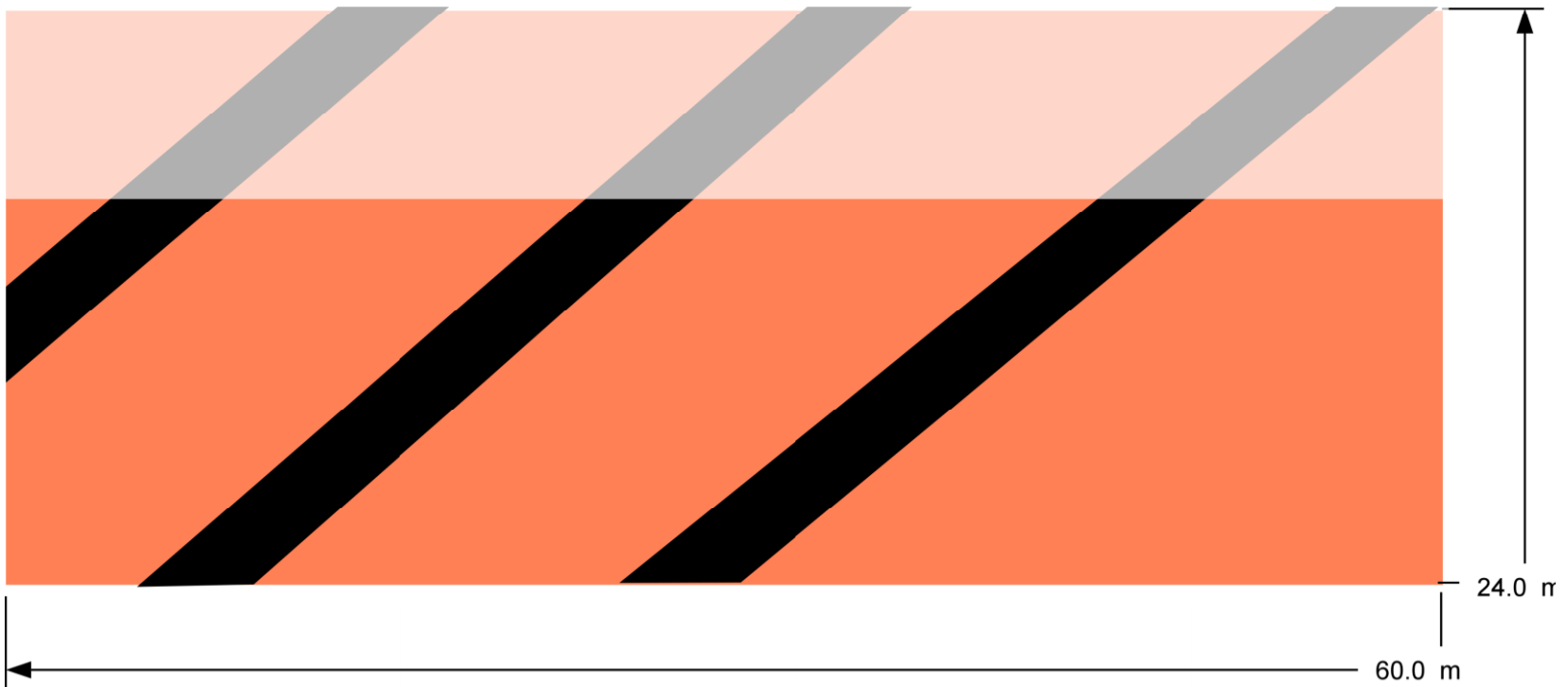


The Power
of Partnership



Conventional Blasting

'D' Interburden Removed. Bench 1 Complete.



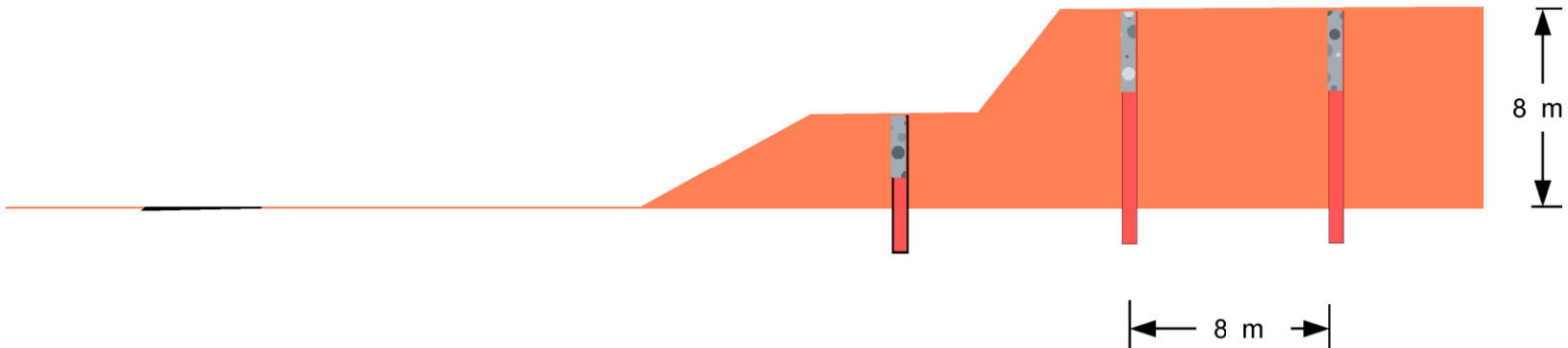
The Power
of Partnership



Conventional Blasting

'D' Interburden Drilled and Charged.

Note: Full 8x8 pattern
due to good bench width



The Power
of Partnership



Conventional Blasting

- **Key Issues**

- Difficult geology, variable dipping seams
- Geological model accuracy
- Low Drilling efficiency due to short holes, sloping benches, varying drill sizes
- Slower product loading due to smaller holes and bench accessibility

Conventional Blasting

- **Key Issues**

- Small blast sizes affects available broken stocks, increase delays to production, edge affects
- Coal loss through dilution – uncertain coal horizons cause losses through blasting and excavation
- Dozer cleanup and bench preparation

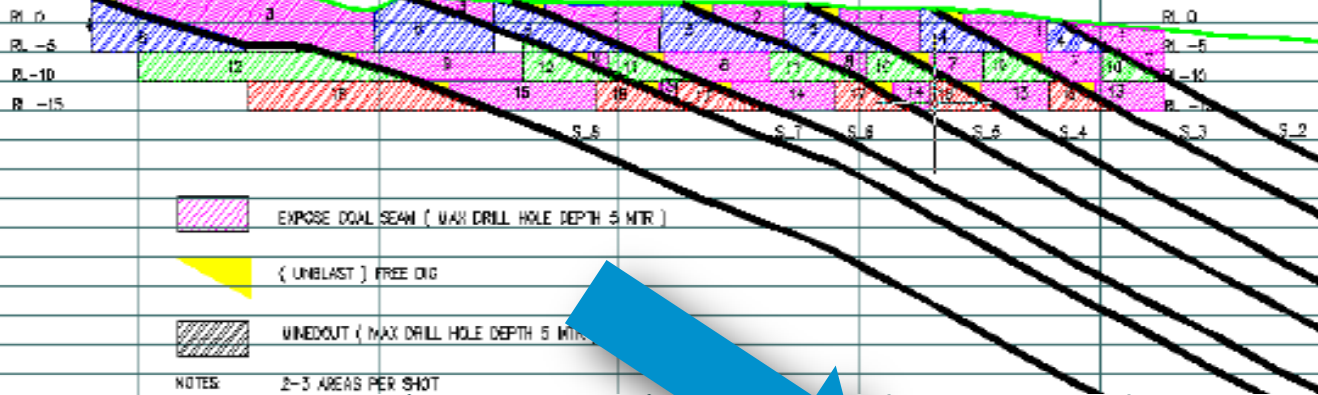
- Situation
- Conventional Blasting
- Through Seam Blasting (TSB)
- Delivery of TSB
- Result and Benefits

Through Seam Blasting

25kBCM

DRILL AND BLAST (CURRENT PRACTICE)

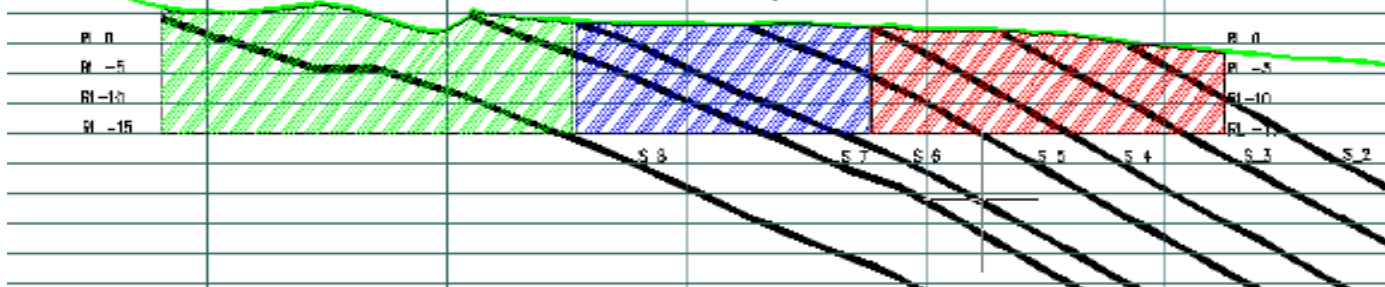
Surface, November 2009



DRILL AND BLAST (TSB)

to >250kBCM

Surface, November 2009



The Power
of Partnership



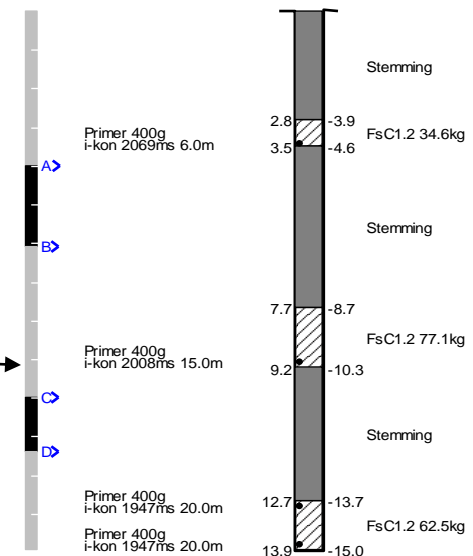
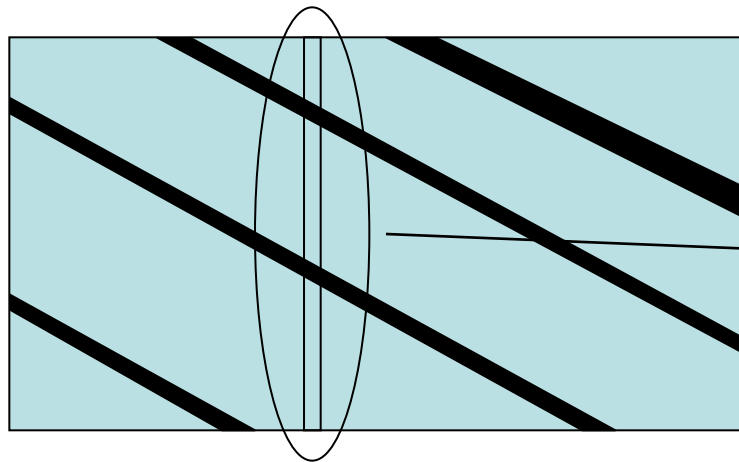
Through Seam Blasting



Through Seam Blasting

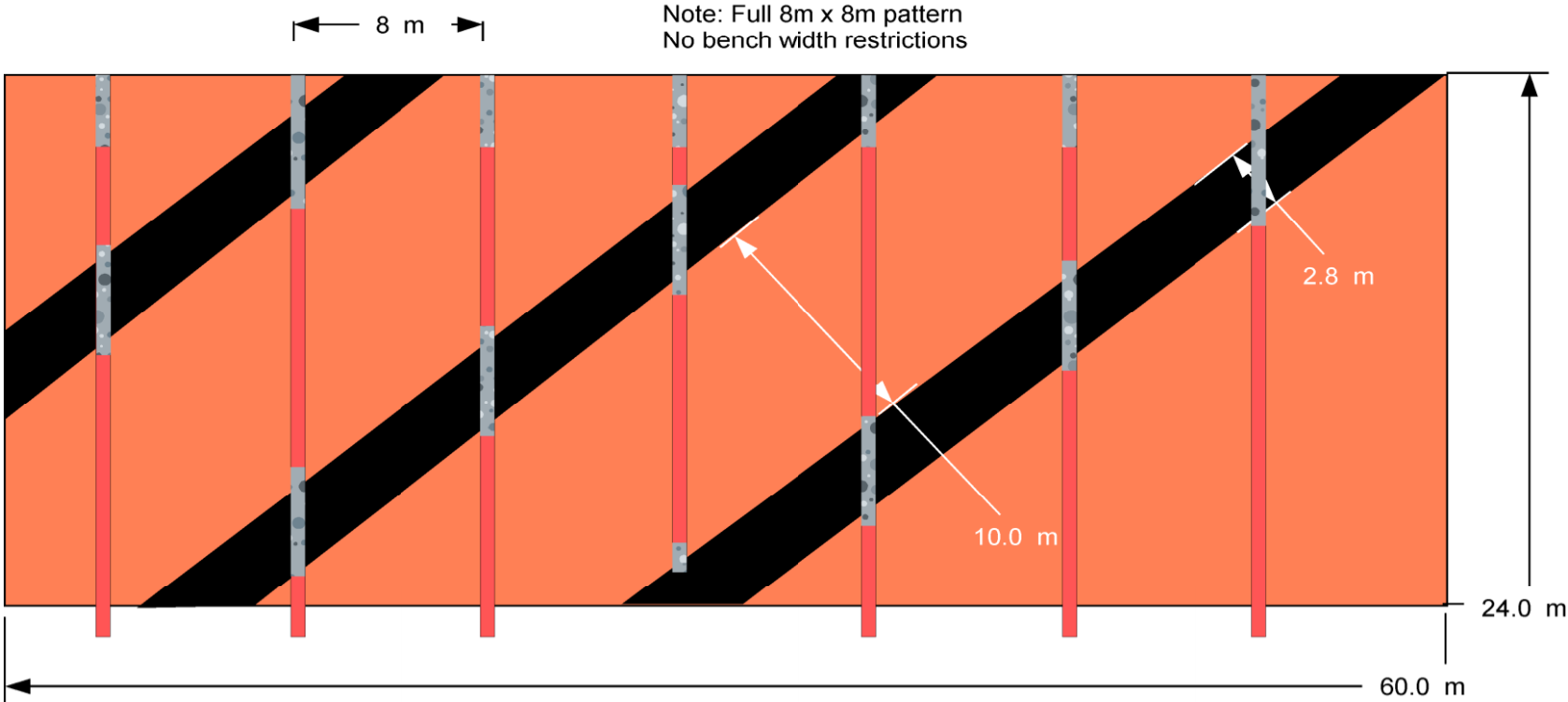
- Accurately identifying seam location.
- Blasting overburden without damaging coal
- Blasting above and below coal seams in one event

- Accurately loading blasthole in relation to coal
- Flexible & Accurate timing to control movement



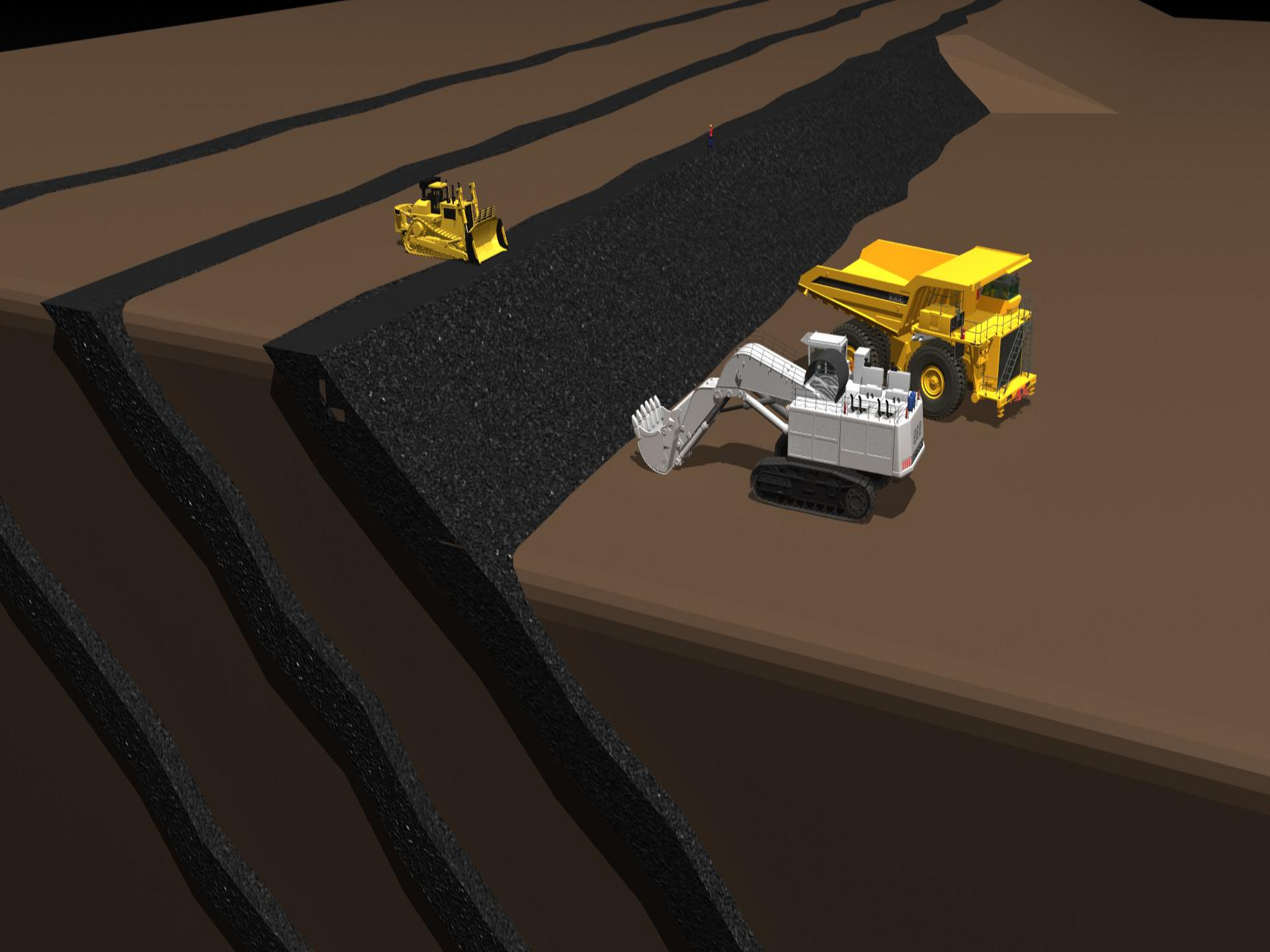
Through Seam Blasting

Through-Seam, Multi-bench drilled and charged



The Power
of Partnership







- Situation
- Conventional Blasting
- Through Seam Blasting (TSB)
- Delivery of TSB
- Result and Benefits

Delivery

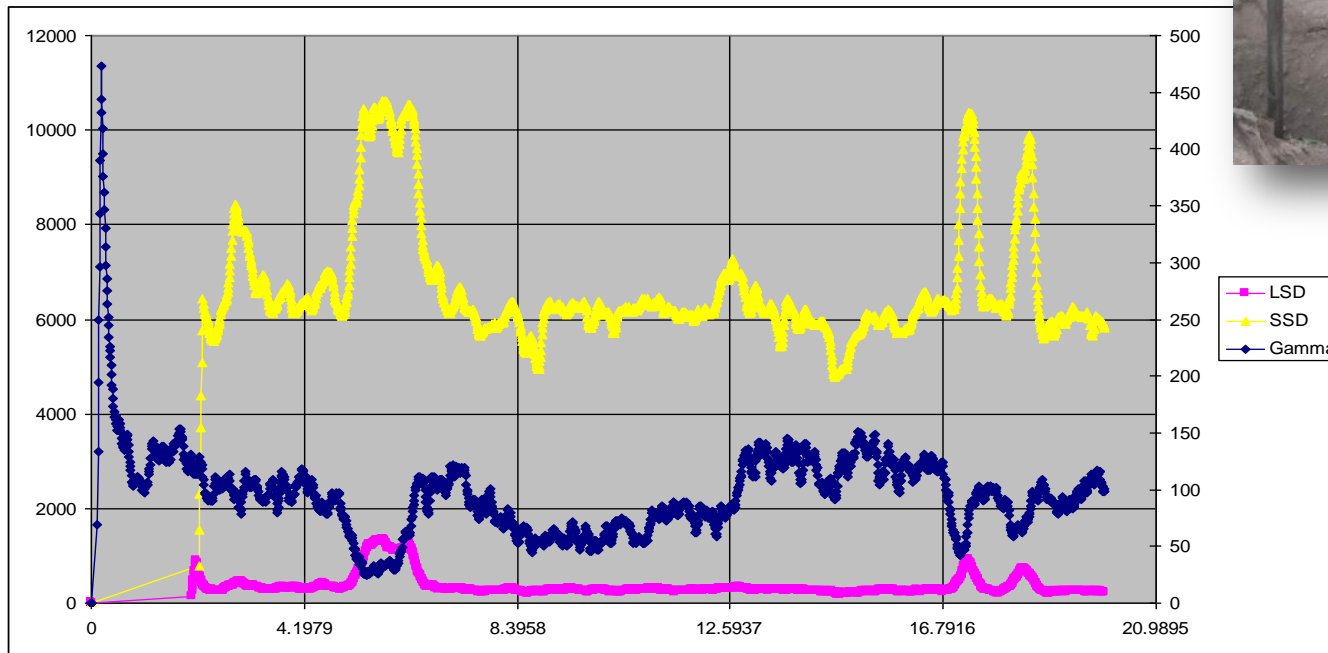
- Strata Logging & input into design models
- Predictive blast modeling
- Accurate holes locations (GPS) & explosives charging
- Specialist blast design – each blasthole has its own design.
- Use of ikon™ electronic detonator system – Safe, flexible & accurate
- Data capture and analysis

The Power
of Partnership



Strata Logging

40 to 60 % of total holes

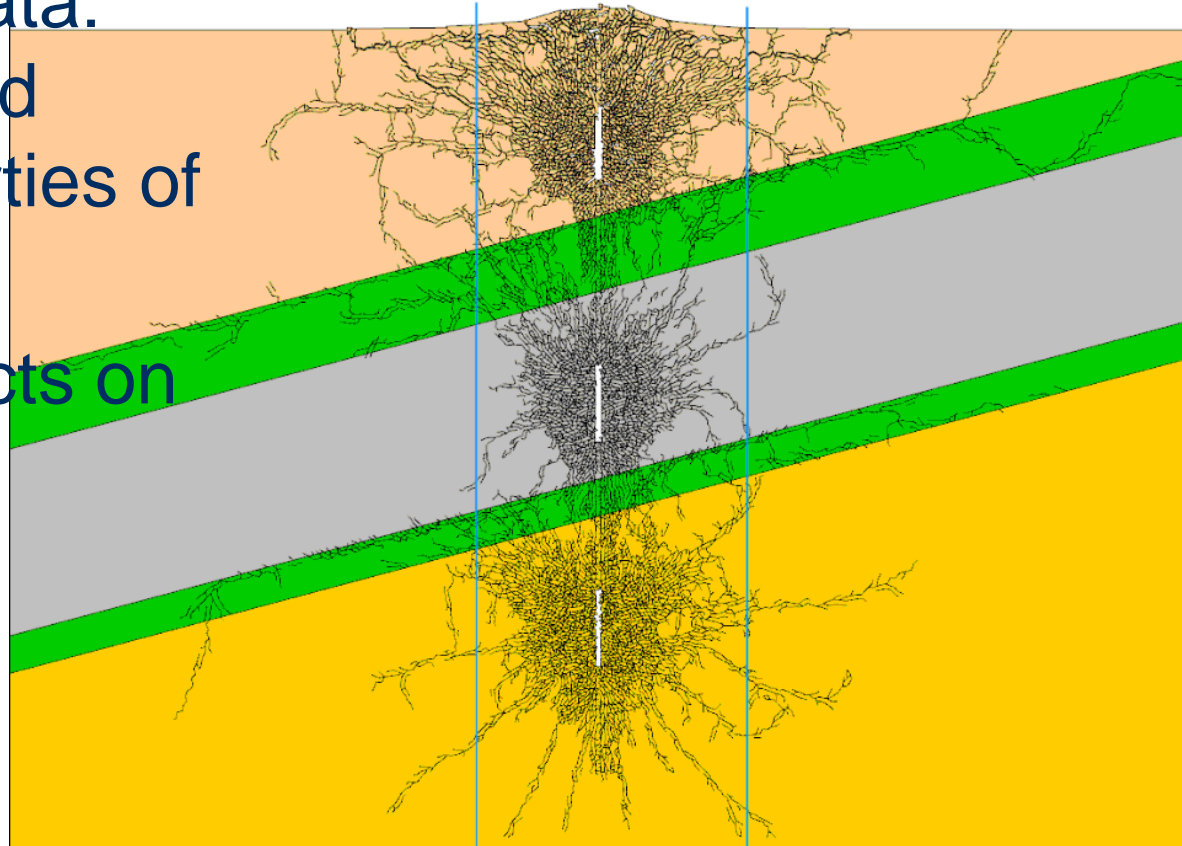


The Power
of Partnership



Predictive Blast Modelling

- Need accurate data: elastic, plastic and geological properties of each rock type
- Blast design effects on the coal seam is simulated.

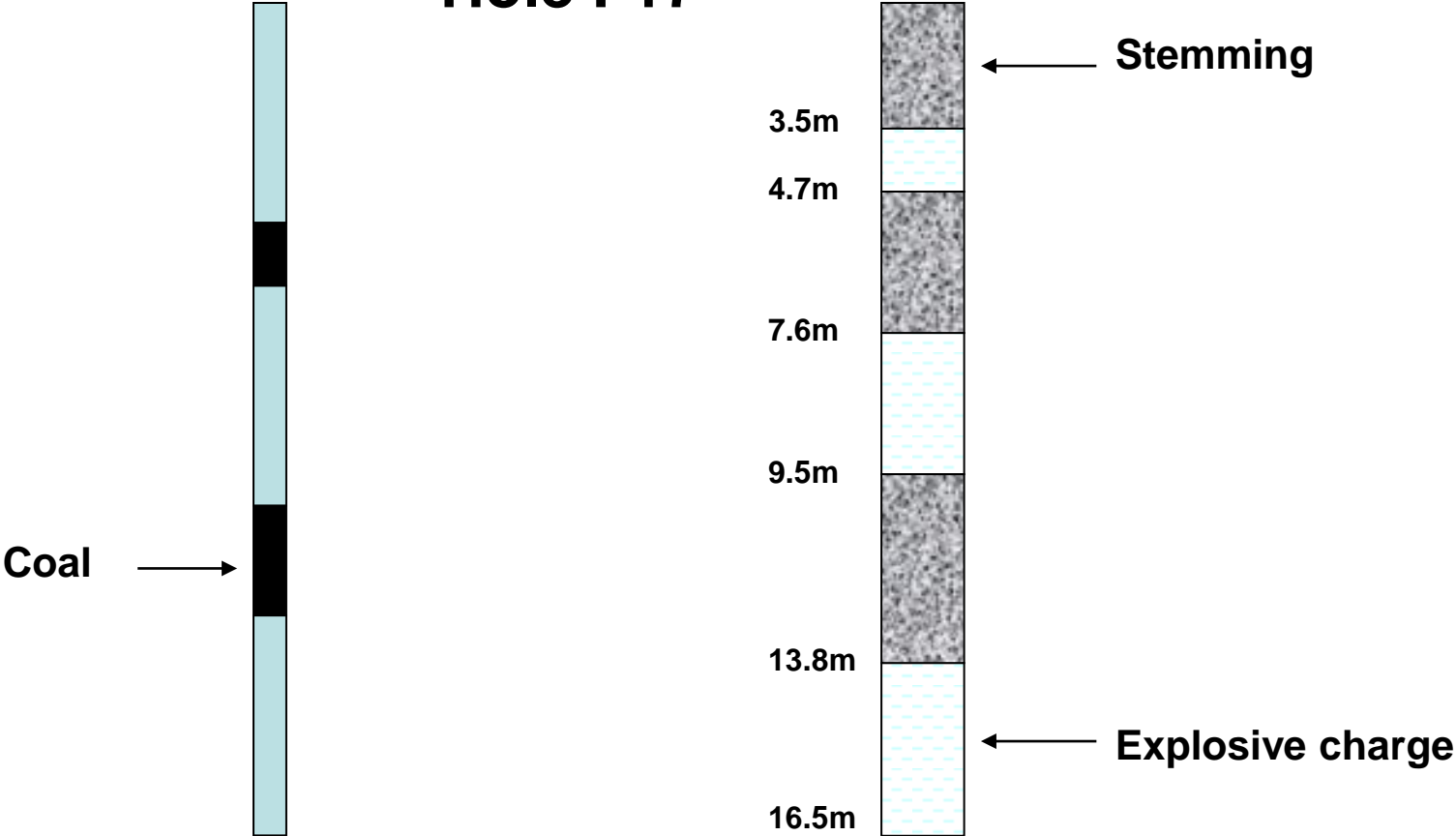


The Power
of Partnership



Load Sheet

Hole F17



The Power
of Partnership

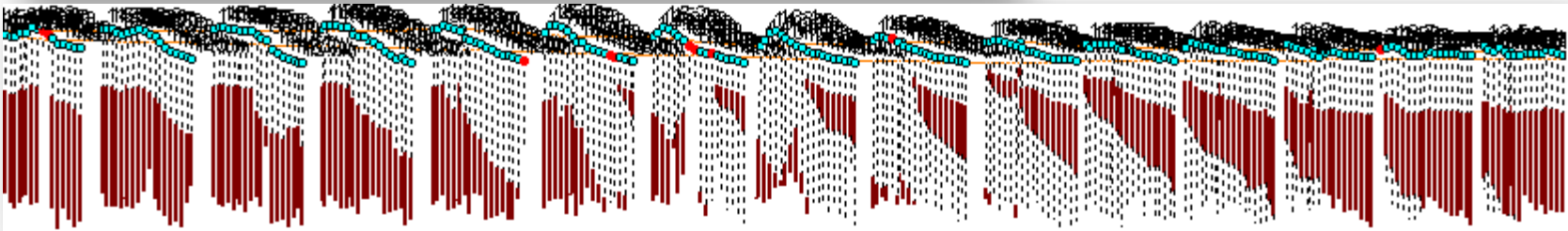


Coal Recovery Control



Gravel is used for stemming

± 20cm loading accuracy



The Power
of Partnership



i-kon™ System

- Programmable detonator from 0 - 15000 ms (increment 1 ms)
- Delay accuracy +/- 0.01%
- Each have unique ID
- Two way communication



i-kon™ Detonator



SHOTPlus®-i



Blaster



Logger

The Power
of Partnership



- Situation
- Conventional Blasting
- Through Seam Blasting (TSB)
- Delivery of TSB
- Results and Benefits

Results



Disturbed zone coal



**The Power
of Partnership**



Results

Coal Model
277kt

Actual Recovered
296kt

| SEAM | MODEL_1004 | | Survey | | var (s- mdl) | | Remark |
|----------|-------------------|-------------------|-------------------|----------|------------------|-----------|---|
| | | | | | Mass(tons) | % | |
| | | | | | 125.21 | 131% | |
| | | | | | 13.95 | 61% | |
| | | | | | | | not mined by WBM instruction |
| | | | | | 51.11) | -2% | |
| | | | | | 864.72 | 14% | |
| | | | | | | | not mined by WBM instruction |
| | | | | | 0,831.79 | 16% | |
| S6L | | 1,149.44 | | | | | not mined by WBM instruction |
| S7 | | 57,611.60 | 73,933.47 | | | | |
| S8U | | 14,657.12 | 19,252.74 | | | | |
| S8L | | 14,716.35 | 12,517.96 | | | | |
| SM 1 | | 7,617.59 | 4,232.93 | | | | |
| SM 2 | 9,5 | 1.31 | 7,282.26 | 1,536.99 | | | |
| SL1 | 4,8 | 1.29 | 3,779.06 | 865.28 | | | |
| SL2 | 1,04 | 1.31 | 794.32 | | | | |
| | 308,5 | 226,298.86 | 296,408.84 | | | | |
| variance | 15,7 | 11,795.58 | | | | | not mined coal seam (4U,5L,6L) |
| | 15,45 | 11,855.64 | | | | | not exist at actual (SM2, SL1,SL2) |
| | 277,394.51 | 202,647.64 | 296,408.84 | | 19,014.33 | 7% | Excluding not mined seam and not at actual seam |

Results

- Coal resources can be classified as reserves
- Control coal movement & minimize coal loss due to blasting (maximize coal recovery)
- Increases mining productivity
 - Reduced delays due to blasting
 - Increase build up in broken stock inventory
 - Provide scheduling options to optimise mining equipment (improvement)
- Improvement in Coal model accuracy
 - Increases accuracy in reserve estimates

Benefits

- All blastholes are drilled to the same RL
 - Easier bench preparation
 - Increases drill productivity
- More efficient explosives distribution / PF reduction
 - Fragmentation
 - Optimized energy
- Drilling in sloping bench is minimized
 - Safety
 - Productivity

Results

- Blasting Volume
 - Conventional \pm 25,000 bcm
 - Normal Thru Seam blast
 - Volume 200,000 to > 500,000bcm
 - Charging duration 2 - 3 days
 - Planning process
 - Resources (MMU[®], blast crew)

Customer Testimonial

Wahana Baratama Mining has found real benefits at our mining project, through the introduction of Orica's Through Seam Blasting System. Our overall productivity / performance in both coal and overburden mining has increased, quicker coal exposure, more than 50% increase in the vertical advance of our mining blocks in the overall operation. Orica's gamma logging of drill holes also gives us the opportunity to update our current pit model with more accuracy, which assist our mine planning sequences and schedules.

Water management has also benefited from the introduction of Through Seam Blasting by developing sumps to meet our pumping requirements, which makes it much easier, quicker and developing the sumps much deeper, without the concerns of any coal loss. The Wahana project is still in its early stages of development, but we are looking forward to the future and the further benefits, which Through Seam Blasting will contribute to our project.

Trevor Newey
Mining Manager- Wahana Baratama Mining

**The Power
of Partnership**



Summary

- Through seam blasting can increase overall productivity and also allows the recovery of thin seams that were normally not recovered using:
 - Available technology
 - Accurate design execution

Thank you

The Power
of Partnership

