Is that the Cordeaux Cougar ???
Hazelwood Mine – *Filling in the Cracks*

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What am I talking about?

1. Latrobe Valley Brown Coal Reserve & Regional Geology
2. Hazelwood Mine & Power Station
3. Previous Ground Movements
4. Development of Risk Based Ground Control Management Plan
5. New Survey Monitoring Strategy
   - Coordinate Systems and Control Networks
   - ‘Continuous’ LiDAR dataset
   - 3D Discrete Point Monitoring Networks
6. Concluding Remarks
Latrobe Valley Brown Coal Reserve & Regional Geology

Latrobe Valley
- 150km east of Melbourne
- 65 billion tonnes of Brown Coal resource
- 3 current open cut mining operations
- Supply Brown Coal for electricity production
- Over 80% of Victoria’s power

Geology
- 9 – 16m of overburden
- M1 coal seam up to 165m thick (30 – 135m at Hazelwood)
- M1 Aquifer 15 -25m thick
- M2 Coal ~55m thick
Hazelwood Mine & Power Station

**Mine**
- Perimeter of mine - ~16km
- Area of mine – 1165 ha
- Average depth – 100m
- Volume of overburden removed – 174 Mm$^3$
- Volume of coal removed – 720.5 Mt

**Power Station**
- Direct feed from mine
- 1760 MW / hr
- 20 – 25% Victoria’s Power
Previous Ground Movement...... ‘Issues’

2007 Yallourn Mine batter collapse

2011 Hazelwood Mine
Princess Freeway sink hole
and movement

2012 Yallourn Mine flooded conveyors
and Morwell River diversion
### Risk Assessment (sample data only)

#### Descriptors

<table>
<thead>
<tr>
<th>Domain</th>
<th>Sub-domain</th>
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<tbody>
<tr>
<td>East Field</td>
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<td>EF1</td>
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<td>Northern Batters</td>
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<td>Morwell Main Drain</td>
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<tr>
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<td>WF1</td>
</tr>
<tr>
<td></td>
<td>Southern Batters</td>
<td>WF2</td>
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<tr>
<td></td>
<td>Operating Faces</td>
<td>WF3</td>
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<td>Western Batters</td>
<td>SEF1</td>
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<tr>
<td></td>
<td>Southern Batters</td>
<td>SEF2</td>
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<td>Mine Floor</td>
<td>Sector 1</td>
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#### Risk Categories

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<th>Risk Categories</th>
<th>Out People's Safety</th>
<th>Public Safety</th>
<th>Commercial Loss</th>
<th>Environment</th>
<th>Image / Reputation</th>
<th>HP Asset Integrity</th>
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<td>Mine Floor</td>
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#### Consequence Thresholds

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<th>Legend</th>
<th>People / Public Safety</th>
<th>Environment</th>
<th>Image / Reputation</th>
<th>Other Assets</th>
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<tbody>
<tr>
<td>Minor injury</td>
<td>Slight / Minor release</td>
<td>Minimal impact</td>
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<td>Up to $50K damage / loss</td>
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<td>Serious injury</td>
<td>Onsite release</td>
<td>Localised impact</td>
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<td>$50 - $500k damage / loss</td>
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<td>Fatality</td>
<td>Offsite release / impact</td>
<td>Statewide impact</td>
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<td>$500 - $5M damage / loss</td>
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<td>Multiple Fatalities</td>
<td>Castastrophic / regional impact</td>
<td>National / international impact</td>
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<td>&gt; $5M damage / loss</td>
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</tbody>
</table>
Coordinate Systems

No Michael this is just too dry........

Even for most Surveyors

Move on ........NOW!
Control Framework
Discrete Point Monitoring Systems

- Measurement of Easting, Northing and Height (ie: 3D)

- 2 Methods used at Hazelwood:
  - RTK GNSS (reduced to ~100 points down from 400+)
    - labour intensive
    - approx. 40 points / day / person (20 using the old methodology)
    - requires physical access to all points
    - ideally suited to mine surrounds where point density is low and flat ground presents line of site issues for TS
    - simple, quick, low cost mark installation
  - Total Station (currently ~600 points)
    - highly efficient – automated measurement sequences
    - > 500 points / day / person (capable of far more depending on application)
    - No access required
    - ideally suited to mine area where large number of points observed from each instrument station
    - setup and installation costs greater than for simple RTK points
Total Station based monitoring networks

Hazelwood East Field + HARE Network

- 2 Instrument Stations, ~100 monitoring points (fixed prisms)
- Survey time, 1.5 hours, 1 person
- Survey Precision $\leq 10$mm 3D @SD1
LiDAR Coverage

- 16km X 11km
- ~3 points / m²
- ± 0.1m accuracy
- 1D only
- ‘Continuous’
Concluding Remarks

Ground movement events of the past have highlighted the need for rigorous ‘risk based’ Ground Control Management Plans (GCMP)

Survey (spatial) monitoring plays a major role in Hazelwood’s GCMP

GIS used to aid in the development of understanding the correlations between ground movements and other site factors eg: coal extraction, hydration levels

Survey system is now providing Hazelwood Management with high confidence ground movement data in combination with other site monitoring datasets to facilitate timely, informed decision making

My 2 bobs worth (again):

• **Control Control Control**......*without a rigorous control framework and protocol you have nothing*

• **Understand what has to be measured**
  – Parameters
  – Accuracy
  – Frequency

*Only once these factors are crystal clear should we start to consider which ‘tool’ is most suitable for the job.*