Centennial Coal

Springvale Mine – SSD 5594 Modification 1
PAC Site Meeting 6 April 2017

Brian Nicholls, Nagindar Singh, Peter Corbett

www.centennialcoal.com.au

1

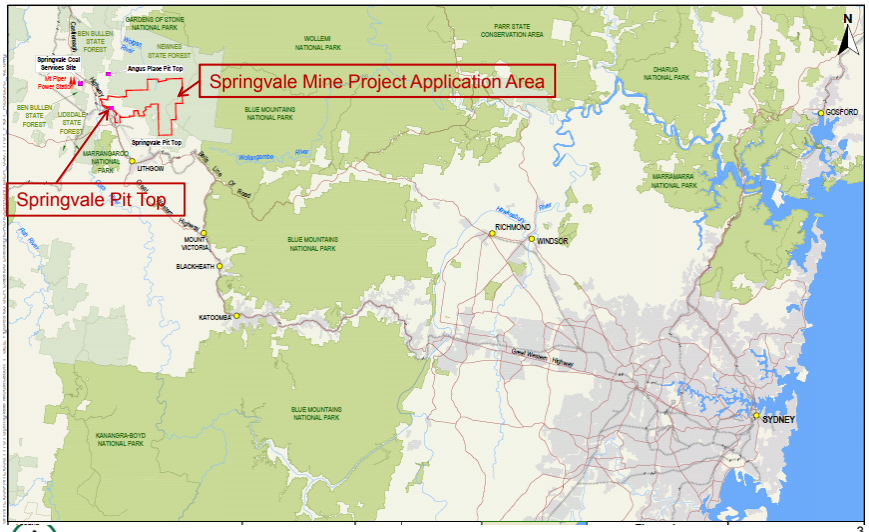
Springvale Mine Operations

- Springvale Mine is located in the western coalfields of NSW 15 km northeast of Lithgow and 120 km west-northwest from Sydney.
- Springvale Mine commenced mining operations in 1995 under consent DA 11/92. Currently the mine operates under State consent SSD 5594 and Federal approval EPBC 2013/6881.
- Coal from Springvale Mine is supplied to domestic and overseas markets via the Western Coal Services Project (SSD 5579).
- SSD 5594 allows:
  - extraction of 20 longwalls:
    - LW416 to LW 423 (Northern Longwall Block)
    - LW424 to LW432 (Southern Longwall Block)
    - LW501 to LW501
  - Construction of surface infrastructure:
    - Dewatering bores 9 and 10
    - Mine services borehole area.
- SSD 5594 consent will lapse on 31 December 2028.

Centennial Coal

2

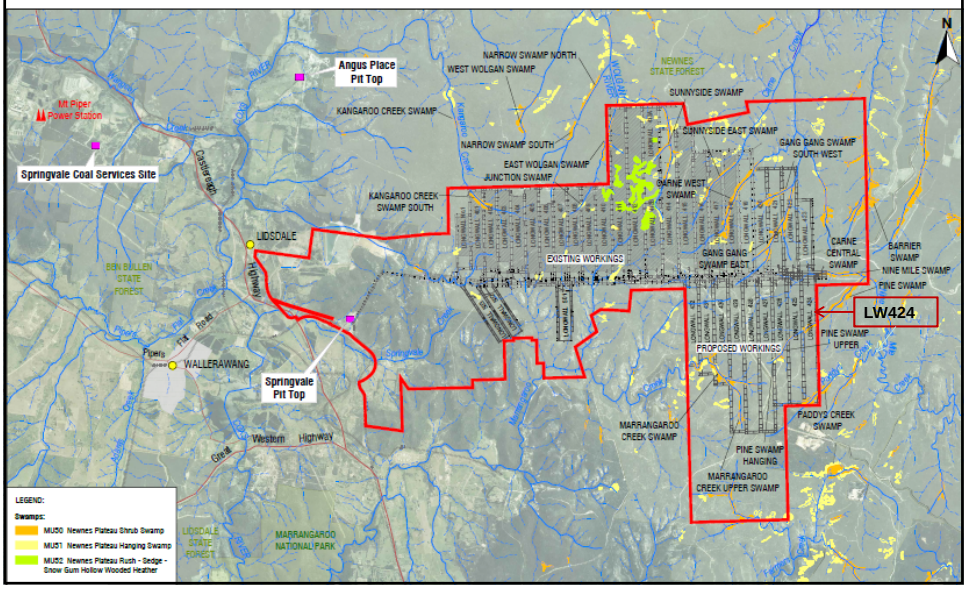
Springvale Mine – Regional Location



Centennial Coal

3

Springvale Mine – Approved Mine Plan in SSD 5594 (LW 416 – LW432, LW501 – LW503)



Mining and Future Changes to Mine Plan at Springvale

- **May 2014 – October 2015**: Submission and assessment of Springvale Mine Extension Project EIS
  - Mining of longwalls from LW416 to LW417
- **October 2015:** commenced LW418 extraction after State approval on 21 September 2015 and Federal approval on 13 October 2015
- **2017 and onwards**:
  - LW421: Shorten by 288 metres (*reduction in coal reserve by 356,778 tonnes*)
  - LW423: No extraction due to proximity to Carne Central and Barrier Swamps (*reduction of coal reserve by 1,381,505 tonnes*)
  - LW422: Relocation to LW425 following LW421 extraction, delaying the extraction of LW422 to allow monitoring data from LW420 and LW421 to be collected, analysed and understood.

    In the event that a decision not to mine LW422 is made in the future, *a further reduction in coal reserves of 2,346,595 tonnes* would be incurred.
  - LW424: Currently planned to mine L424 later in the southern mining area extraction sequence.
- **No change in mine life is proposed.**

Centennial Coal

5

Centennial Coal

Proposed Modification 1 to SSD 5594

Nagindar Singh

www.centennialcoal.com.au

6

Proposed Modification Elements and Technical Assessments

- **Modification Elements**:
  - An increase in the workforce from the approved 310 full time equivalent (fte) personnel, including contractors, to 450 fte personnel
  - An increase in run-of-mine (ROM) coal production from the approved 4.5 million tonnes per annum (Mtpa) to 5.5 Mtpa
  - An increase in the existing ROM coal stockpile at the pit top from the approved 85,000 tonnes capacity to 200,000 tonnes capacity with an increase in the coal stockpile footprint by 0.3 ha northeast of the existing stockpile area.
- **Technical Assessments:**

• Traffic and transport	• Air quality
• Greenhouse gas emissions	• Groundwater resources
• Surface water resources	• Socio-economic
• Ecology (due diligence)	• Cultural heritage (due diligence)
• Noise (qualitative)	• Visual amenity (qualitative)

Centennial Coal

7

Stockpile Extension Area at Springvale Pit Top

Centennial Coal

8

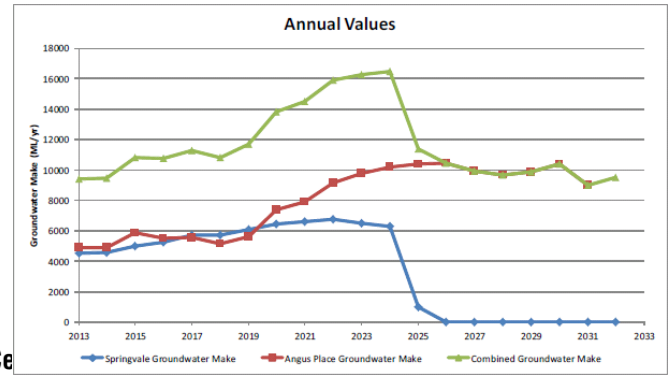
Outcomes of Assessments

Traffic and Transport	Increased workforce means additional vehicle trips, however: • Traffic generation due to modification is considered a minor impact • No significant impact upon the capacity, efficiency and safety of the local, sub-regional and regional road network • Sufficient car parking at the pit top is available.
Air Quality	Emissions are predicted to meet relevant air quality criteria for Total Suspended Particulates (TSP), PM_{10}, $PM_{2.5}$ concentrations and dust deposition rate at the sensitive receptors.
Greenhouse gas emissions	Combustion of additional 1 Mtpa of ROM coal will: • Result in annual increase in direct (Scope 1) GHG emissions of 15% and a 22% increase in indirect (Scope 3) emissions • Represents 0.0032% of annual NSW GHG emissions and 0.0008% of annual national emissions.
Ecology (due diligence) and cultural heritage	Coal stockpile area is heavily disturbed: • No native vegetation clearing is proposed • No impacts on Aboriginal sites or artefacts will occur.
Noise	Noise emissions during the construction of the stockpile extension area will be minor and temporary.
Visual Amenity	Coal stockpile height will not change, no impacts on the receptors.

9

Groundwater Resources

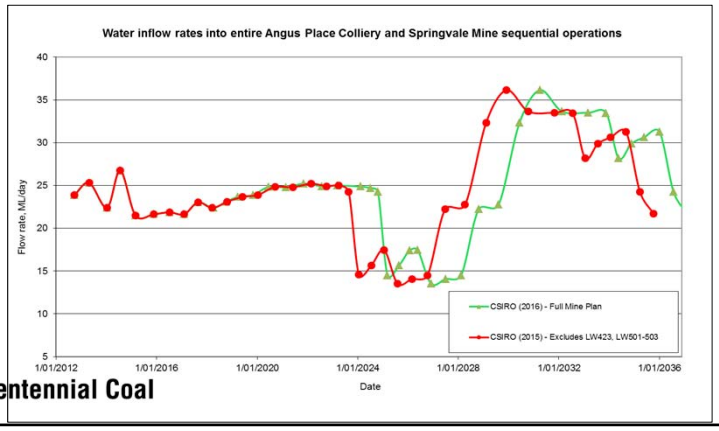
- Springvale Mine and Angus Place concurrent operations mine inflow predictions (CSIRO (2013)) – assessed in SVMEP EIS
- Springvale maximum 19 ML/day (210 L/s) in 2022 and Angus Place maximum of 29 ML/day in 2026
- Maximum of 44 ML/day in 2024 from both mines



10

Angus Place and Springvale Sequential Operations

- Angus Place extraction commences only after Springvale completes extraction in 2024 (CSIRO (2015) and CSIRO (2016))
- Mine inflow predictions for Angus Place 4.0 Mtpa and Springvale 5.5 Mtpa production rates

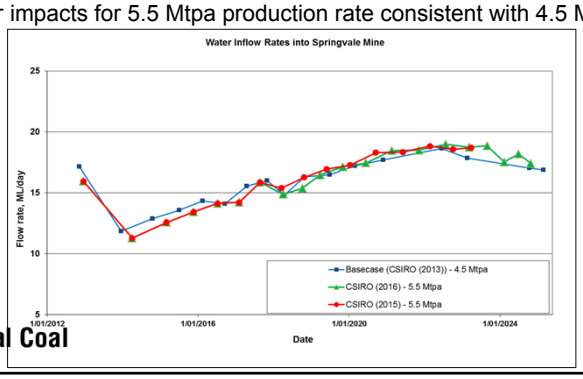


Centennial Coal

11

Springvale Mine Inflows in Sequential Operations – CSIRO (2013), CSIRO (2015) and CSIRO (2016) Mine Inflow Predictions

- Maximum of 18.6 ML/day (2022) for 'base case' approved in SSD 5594 for 4.5 Mtpa, increases to 19.0 ML/day (2022) for 5.5 Mtpa production rate, difference of +0.4 ML/day
- CSIRO (2015) predictions (LW424, LW501 – LW501 not included)
- Given the above mine inflows, baseflow predictions with respect to modelled watercourses (includes shrub swamps) for CSIRO (2016) are consistent with CSIRO (2015) and CSIRO (2013) predictions
- Groundwater impacts for 5.5 Mtpa production rate consistent with 4.5 Mtpa rate

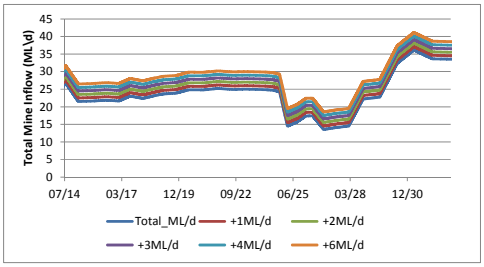


Centennial Coal

12

Surface Water Resources

- Site water (and salt) balance for the proposed modification does not change significantly from that included in the SVMEP EIS due to only a minor increase in mine inflows (+0.4 ML/day)
- Given no proposed change in rate of mine water discharge there will be no change to the potential for scour within Sawyers Swamp Creek as a result of the modification.
- Regional water quality impact assessment modelling (RWQIAM) predicts negligible change in water quality and flows in the modelled locations in the Coxs River catchment.
- Sensitivity analyses for constant and maximum increase of +1, +2, +3, +4, and +6 ML/day mine water discharge rate
- Modelling period:
  30 June 2014 – 31 December 2032



Centennial Coal

Sensitivity Analyses for Mine Water Discharges

- Prediction Statistics for Salinity (mg/L) in **Lake Wallace**

	OBSERVED	NUL[1]	WS1[1]	WS1-S[1]	WS2b-S-10[1]	WS2b-S-10_V11.1[2,4]	WS2b-S_2ML[4]	WS2b-S_3ML[4]	WS2b-S_4ML[4]	WS2b-S_6ML[4]
Minimum	218	140	121	122	121	121, 0%	120,-1%	120,-1%	119,-2%	118,-3%
5%	398	197	279	268	271	271, 1%	273, 2%	275, 3%	277, 4%	282, 5%
10%	402	209	351	324	328	329, 1%	332, 3%	336, 4%	339, 5%	346, 7%
20%	436	239	427	411	415	415, 1%	420, 2%	425, 3%	429, 4%	437, 6%
50%	519	280	540	523	527	527, 1%	531, 2%	535, 2%	539, 3%	547, 5%
80%	603	327	622	611	615	615, 1%	618, 1%	622, 2%	626, 2%	632, 4%
90%	637	354	655	648	652	652, 1%	656, 1%	659, 2%	662, 2%	669, 3%
95%	754	374	688	670	674	674, 1%	678, 1%	681, 2%	685, 2%	691, 3%
Maximum	771	427	732	746	748	748, 0%	751, 1%	753, 1%	756, 1%	760, 2%

Note 1. *NUL* is Null Case, *WS1* is Water Strategy 1 and comprised concurrent development of Angus Place Mine Extension Project (APMEP) and SVMEP, *WS1-S* is the sequential development of APMEP and SVMEP ('assessed and approved in SSD 5594 till 30 June 2017'), *WS2b-S-10* is simulation WS1-S plus 10 L/s.
Note 2. *WS2b-S-10_V11.1* is a re-run of *WS2b-S-10* to demonstrate the change in software version did not lead to a change in model prediction.
Note 3. *WS2b-S_2ML*, *WS2b-S_3ML*, *WS2b-S_4ML* and *WS2b-S_6ML* are the uncertainty analysis simulations considering a constant and maximum +2 ML/d, +3 ML/d, +4 ML/d and +6 ML/d increase in mine water discharge
Note 4. Change (expressed as %) compared to WS1-S.

14

Centennial Coal

Sensitivity Analyses (cont'd)

- Prediction statistics for Salinity (mg/L) in **Lake Burragorang**

	OBSERVED[4]	NUL[1]	WS1[1]	WS1-S[1]	WS2b-S-10[1]	WS2b-S-10_V11.1[2,5]	WS2b-S_2ML[5]	WS2b-S_3ML[5]	WS2b-S_4ML[5]	WS2b-S_6ML[5]
Minimum	n/a	87	89	89	89	89, 0%	89, 0%	89, 0%	89, 0%	90, 0%
5%	n/a	90	92	92	92	92, 0%	92, 0%	92, 0%	92, 0%	92, 0%
10%	n/a	91	93	93	93	93, 0%	93, 0%	93, 0%	93, 0%	93, 0%
20%	n/a	94	97	97	97	97, 0%	97, 0%	97, 0%	98, 0%	98, 1%
50%	n/a	98	104	103	103	103, 0%	103, 0%	103, 1%	103, 1%	104, 1%
80%	n/a	99	107	105	106	106, 0%	106, 0%	106, 1%	106, 1%	107, 1%
90%	n/a	101	107	107	107	107, 0%	107, 1%	108, 1%	108, 1%	108, 2%
95%	n/a	101	109	108	108	108, 0%	108, 1%	109, 1%	109, 1%	110, 2%
Maximum	n/a	102	112	109	110	110, 0%	110, 0%	110, 1%	111, 1%	111, 2%

Note 1. *NUL* is Null Case, *WS1* is Water Strategy 1 and comprised concurrent development of Angus Place Mine Extension Project (APMEP) and SVMEP, *WS1-S* is the sequential development of APMEP and SVMEP ('assessed and approved in SSD 5594 till 30 June 2017'), *WS2b-S-10* is simulation WS1-S plus 10 L/s.
Note 2. *WS2b-S-10_V11.1* is a re-run of *WS2b-S-10* to demonstrate the change in software version did not lead to a change in model prediction.
Note 3. *WS2b-S_2ML*, *WS2b-S_3ML*, *WS2b-S_4ML* and *WS2b-S_6ML* are the uncertainty analysis simulations considering a constant and maximum +2 ML/d, +3 ML/d, +4 ML/d and +6 ML/d increase in mine water discharge
Note 4. Observed data was not available at the time of construction of the RWQIAM in 2014 Note 5. Change (expressed as %) compared to WS1-S.

Sensitivity Analyses Results

- **Lake Wallace**:
  - Modelled median salinity increases from 523 mg/L (781 µS/cm) (base case) to:
    - 527 mg/L (787 µS/cm) for +1 ML/day discharge rate, or 1% increase
    - 547 mg/L (816 µS/cm) for +6 ML/day discharge rate, or 5% increase
  - Modelled increase in salinity in Lake Wallace due to increasing mine water discharge rate to Sawyers Swamp Creek is considered to be a minor change (≤ 5%) compared to the base case and will have insignificant effect on water quality
  - The potential increase is consistent with historical salinity observation.
- **Lake Burragorang**
  - Modelled median salinity increases from 103 mg/L (154 µS/cm) in base case to:
    - 103 mg/L (154 µS/cm) for each of +1 to +4 ML/day simulations, or 0% increase
    - 104 mg/L (155 µS/cm) for +6 ML/day, or 1% increase compared to the base case
  - Neutral effect with respect to the Neutral or Beneficial Effect (NorBE) is the base case is defined as the EPL limit of 1,200 µS/cm at LDP009 existing at the time of the development application.
- Discharge rates assessed in excess of the EPL limit of 30 ML/day at LDP009.

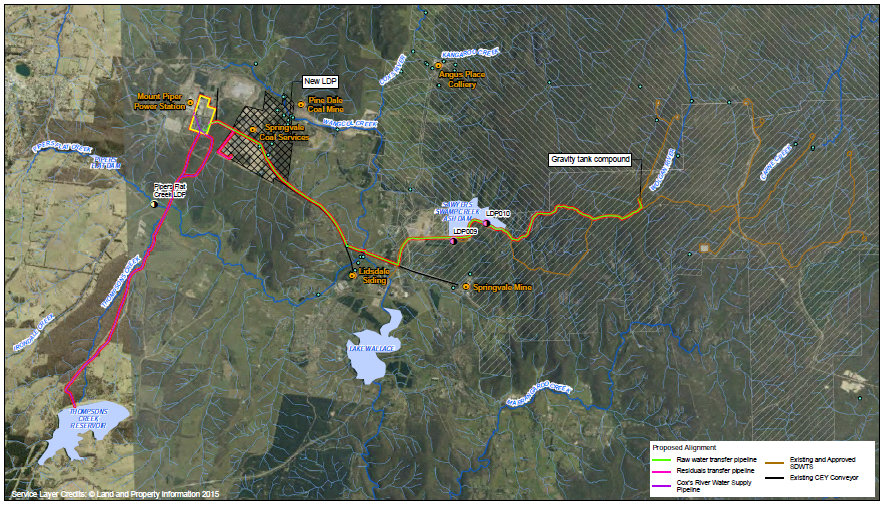
Springvale Water Treatment Project (SSD 7592)

- Developed to meet the 2019 mine water quality criteria in Springvale Mine's consent (Schedule 4 Condition 12), 500 µS/cm at 90th percentile
- **Water Transfer System:**
  - Raw water transfer system from Gravity Tank compound to a water treatment plant (WTP) at Mt Piper Power Station
  - Residuals transfer pipeline from the WTP to REA at Springvale Coal Services Site
  - Treated water pipeline from the WTP to:
    - MPPS cooling water system
    - Thompsons Creek reservoir
  - Network of pipelines from the WTP to brine management system
- **Water Treatment System:**
  - New pre-treatment clarifier and new desalination facilities (RO) for treatment of all mine water
  - Integration with existing MPPS water treatment system
  - A new crystalliser for brine management
- **Nil Discharge Development:** environmental outcomes exceed Springvale consent conditions.

Centennial Coal

17

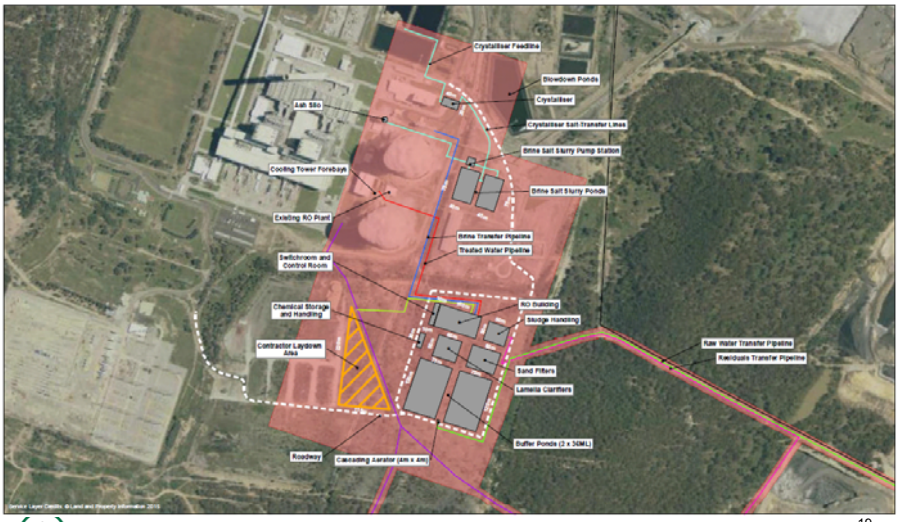
Springvale Water Treatment Project – Project Area Boundary



Centennial Coal

18

Water Treatment Plant Indicative Layout



Centennial Coal

19

Centennial Coal

Mine Design Process

Peter Corbett

www.centennialcoal.com.au

20

Mining History 1979 - 2015

Analysis of longwall width and subsidence for entire history of mines

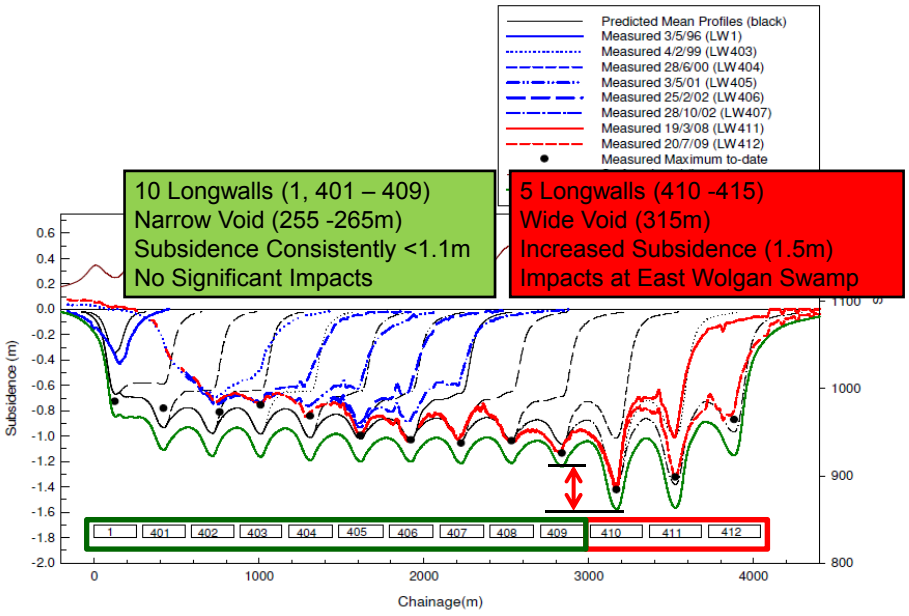
Springvale Longwalls

Longwall	Width (m)	Start Date	Finish Date
No 1	254	10/02/95	31/01/96
401	256	31/03/96	31/01/97
402	255	28/02/97	30/11/97
403	255	31/01/98	30/11/98
404	265	31/01/99	28/02/00
405	265	10/04/00	26/03/01
406	265	27/05/01	23/01/02
407	265	28/03/02	9/01/03
408	266	20/02/03	18/12/03
409	266	18/02/04	10/12/04
410	315	9/02/05	19/01/06
411	315	10/03/06	26/10/07
412	315	14/12/07	22/06/09
413A	315	7/08/09	1/04/10
413B	315	20/05/10	29/12/10
414	315	11/02/11	21/11/11
415	261	15/03/12	16/09/13
416	261	23/09/13	19/08/14
417	261	11/10/14	30/06/15

Angus Place Longwalls

Longwall	Width (m)	Start Date	Finish Date
1	144	31/08/79	25/05/80
2	144	26/08/80	8/12/80
3	144	16/02/81	6/07/81
4	144	11/08/81	13/11/81
5	144	16/02/82	15/06/82
6	144	13/07/82	18/11/82
7	144	17/01/83	1/08/83
8	214	10/08/83	14/12/84
9	214	28/03/85	8/07/86
10	214	18/08/86	27/08/87
11	214	10/11/87	24/10/88
12	212	8/12/88	2/09/89
13	212	28/09/89	25/06/90
16	212	24/10/90	9/09/91
17	212	4/11/91	28/10/92
18	212	4/01/93	13/12/93
19	212	19/03/94	5/03/95
20	230	25/04/95	7/05/96
21	260	17/06/96	17/10/97
22	260	2/12/97	11/12/98
23	260	4/01/99	26/11/99
24	260	20/12/99	29/12/00
25	260	21/02/01	19/12/01
26	260	14/02/02	11/12/02
26N	260	20/02/03	30/09/03
(27) 920	252	2/03/04	18/10/05
930	252	19/12/05	11/02/07
940	252	27/03/07	23/06/08
950	283	8/08/08	15/02/10
960	284	7/04/10	5/07/11
970	284	24/08/11	8/12/12
980	268	29/11/12	11/03/14
900W	284	30/04/14	15/02/15

Predicted / Actual Subsidence Springvale

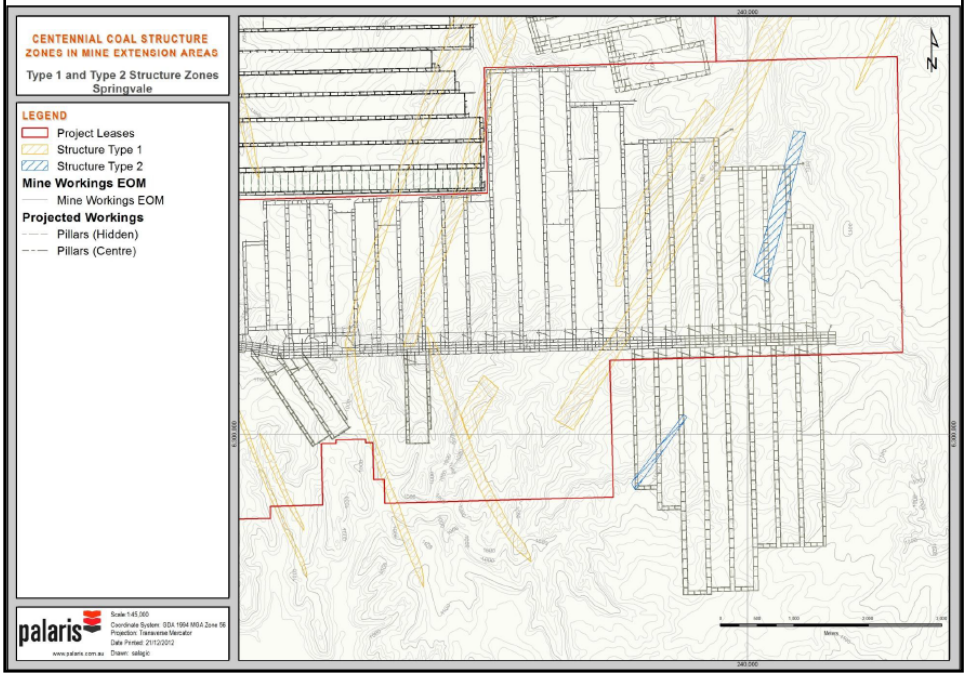


Actions By Centennial To Prevent Damage To Swamps

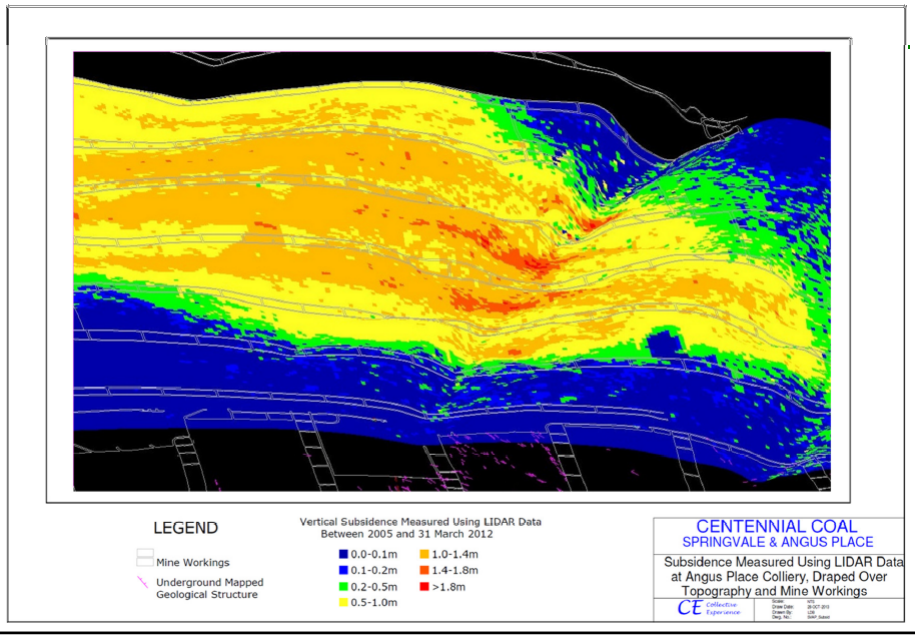
- **Mine re-design to reduce subsidence**
  - Void width reduced from 315m to 261m
  - Pillar width increased from 45m to 58m
  - w/H ratios reduced from >1 to ~0.75
- **No further mine water discharges to swamps**
- **Studies to understand swamp formation and *interactions* of:**
  - Geology and Hydrogeology
  - Swamp Hydrology
  - Mine Design and Subsidence
  - Swamp Flora

Centennial Coal

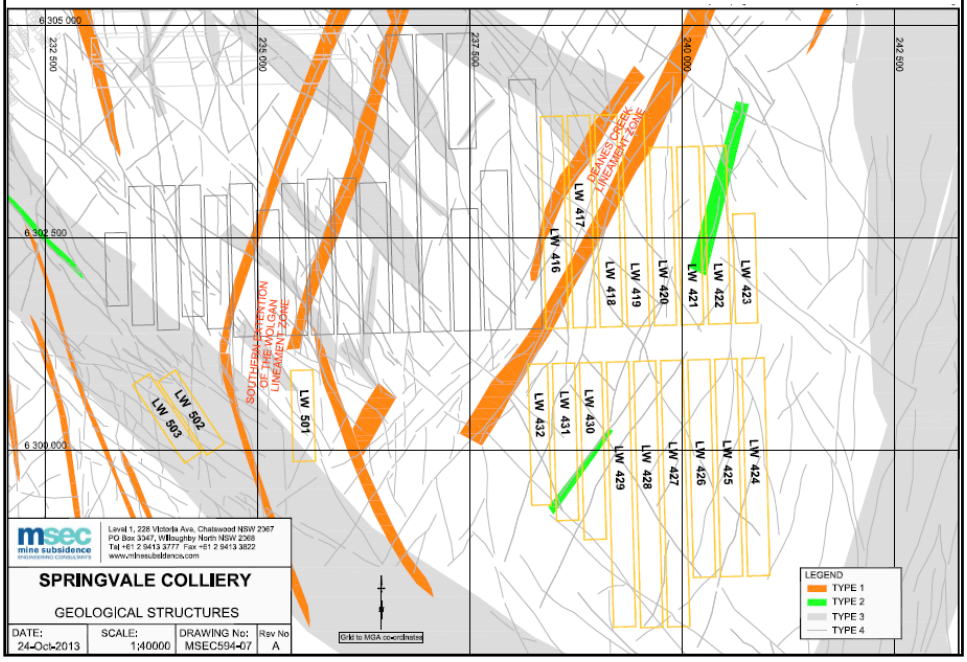
Springvale MEP Major Lineaments (Palaris 2013)



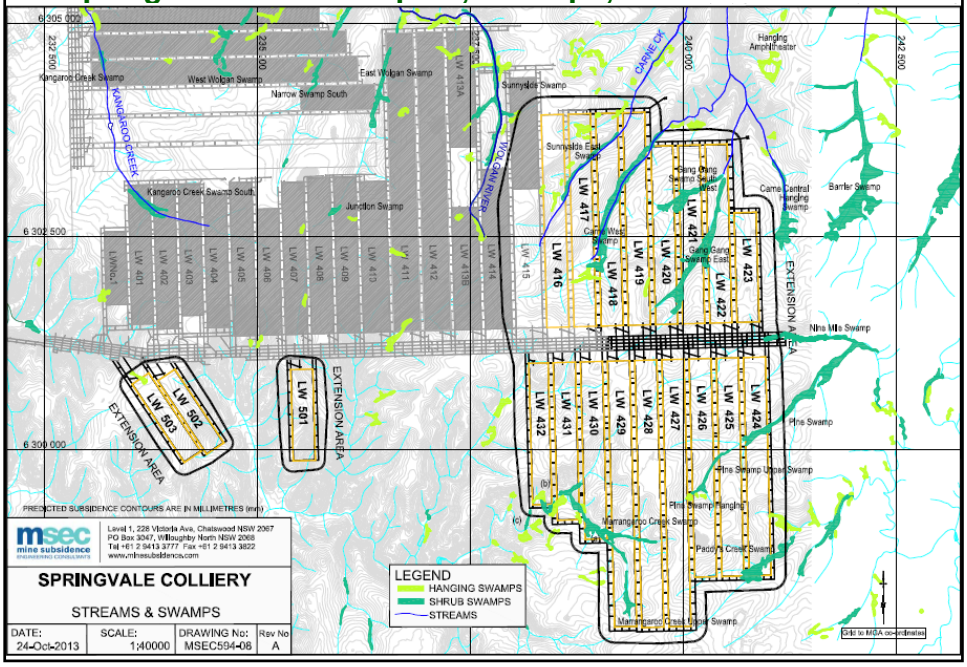
LiDAR Subsidence Monitoring



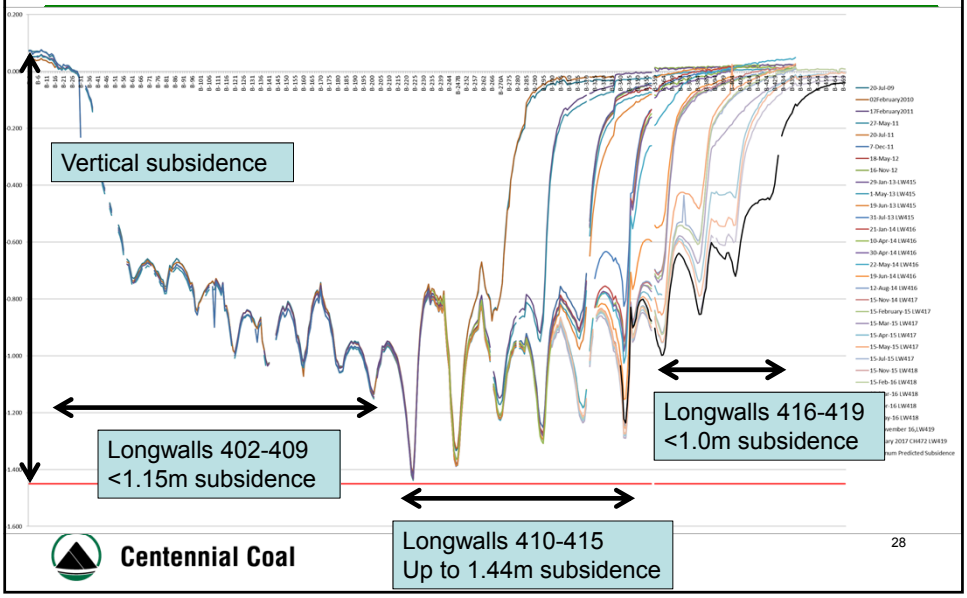
Lineaments Assessed by MSEC in SVMEP SIA



Springvale MEP mine plan, swamps, 26.5º AoD



Springvale Measured Subsidence (B-Line)



Centennial Coal

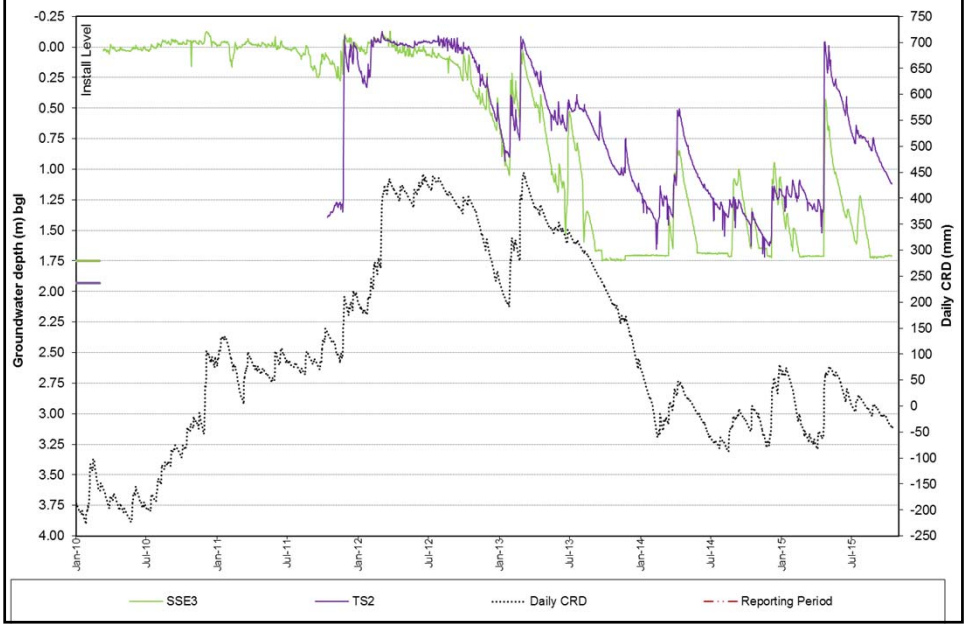
Evolution of Understanding of Subsidence Interaction with Groundwater Systems

Presented to IMP 22 March 2016

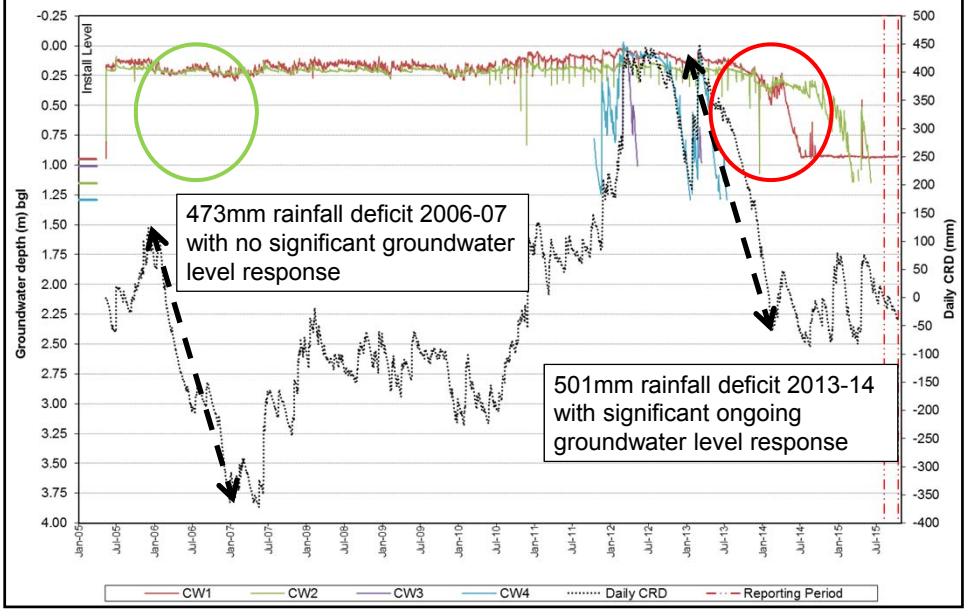
www.centennialcoal.com.au

29

Sunnyside East Swamp Compared to Tri-Star Swamp (Control)



Carne West Swamp Hydrographs



Centennial Coal

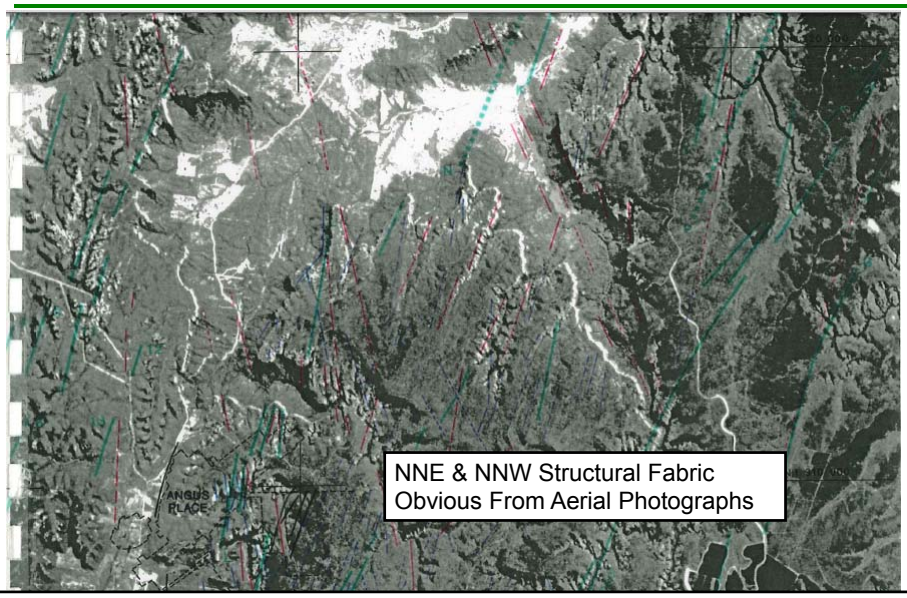
Use of ExtoChart Visual Analysis

Enable understanding of location and behaviour of major geological fault zones in the context of mine subsidence and groundwater

www.centennialcoal.com.au

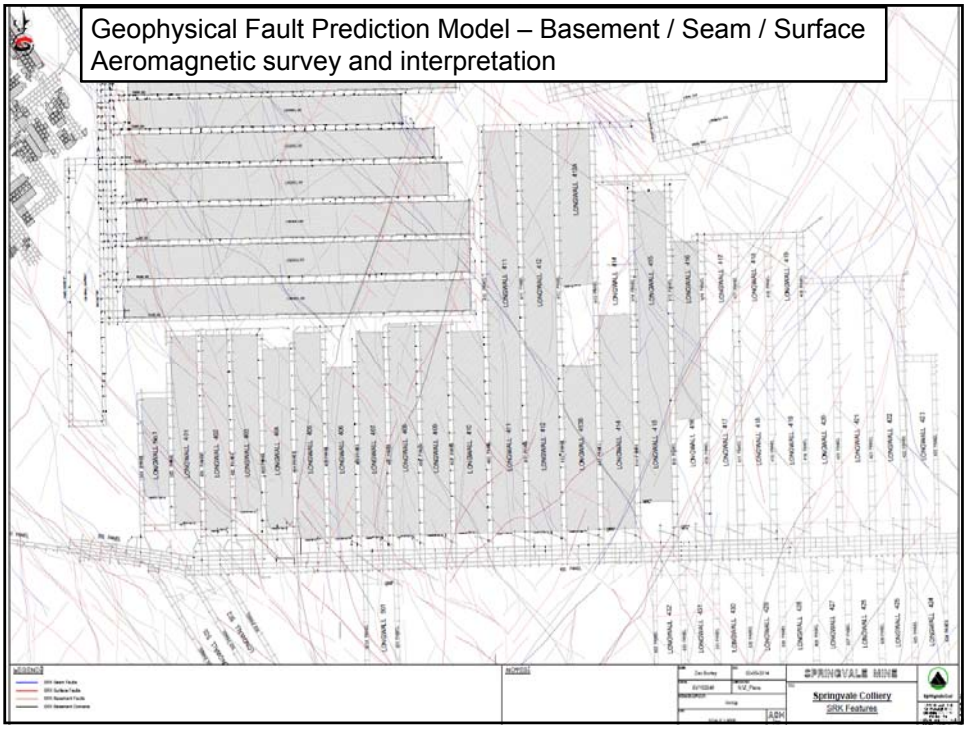
32

Surface “Lineament” Analysis



Mapped Underground Faults

Geophysical Fault Prediction Model – Basement / Seam / Surface
Aeromagnetic survey and interpretation



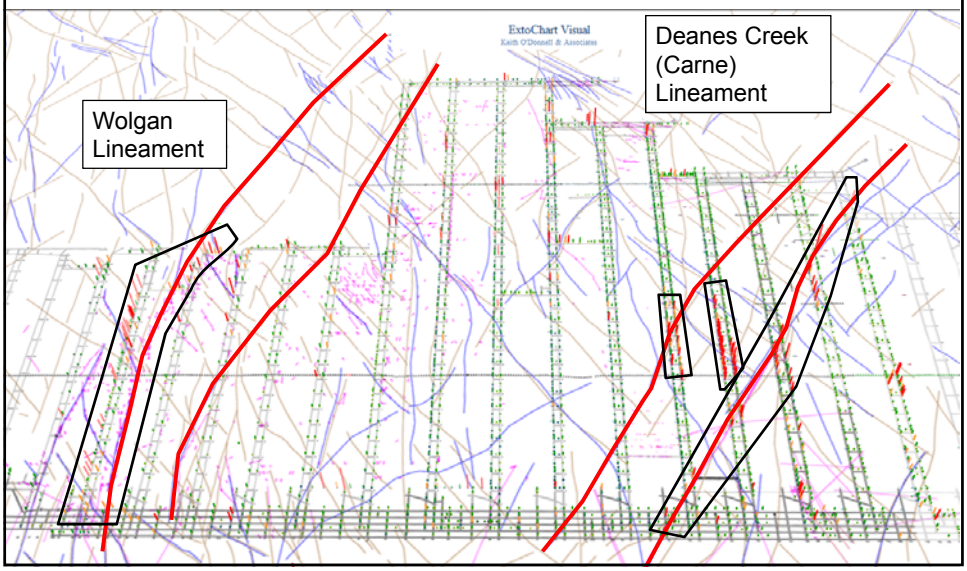
Centennial Coal

Underground Extensometer Monitoring Data

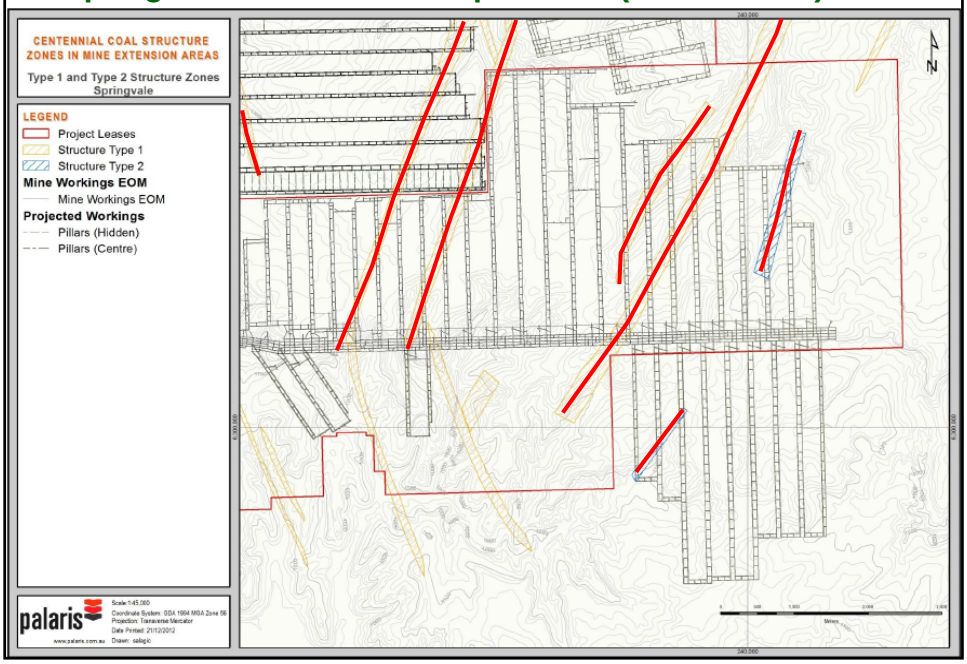
www.centennialcoal.com.au

36

Underground Extensometer Data
Strain response to in-situ stress around major geological structure zones (lineaments)



Springvale Lineament Interpretation (Palaris 2013)



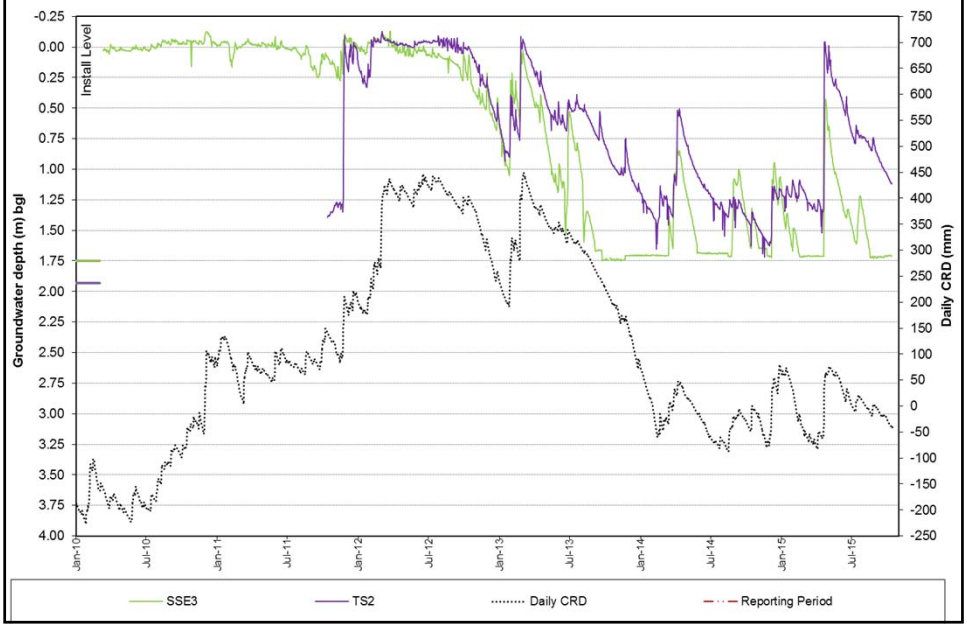
Centennial Coal

Sunnyside East Swamp Case Study

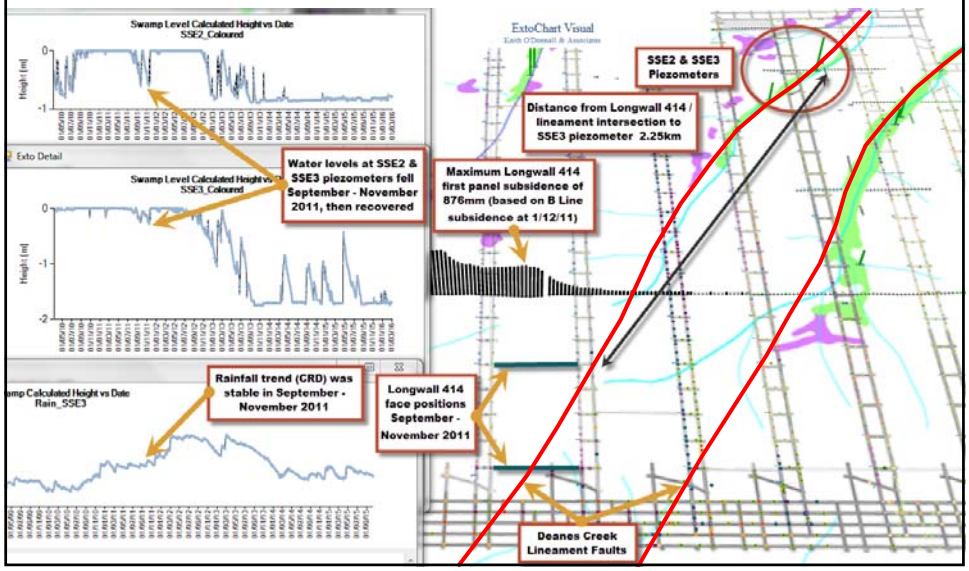
www.centennialcoal.com.au

39

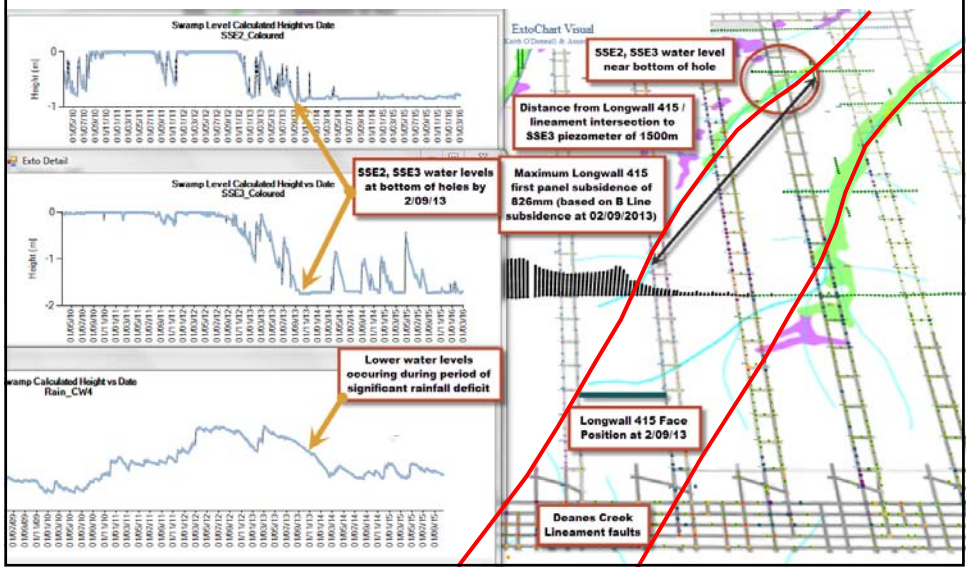
Sunnyside East Swamp Compared to Tri-Star Swamp (Control)



Longwall 414 / Sunnyside East Swamp



Longwall 415 / Sunnyside East Swamp



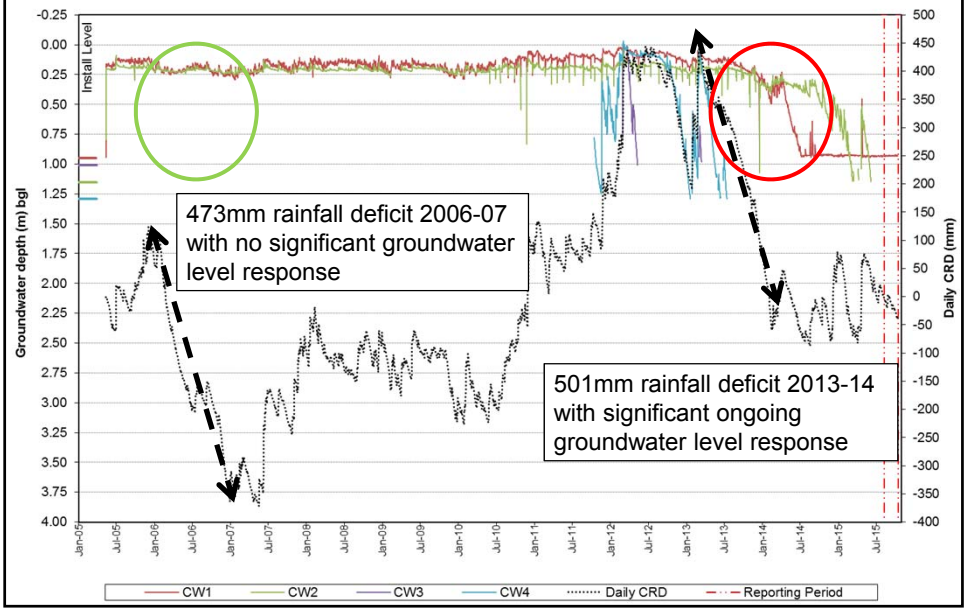
Centennial Coal

Carne West Swamp Case Study

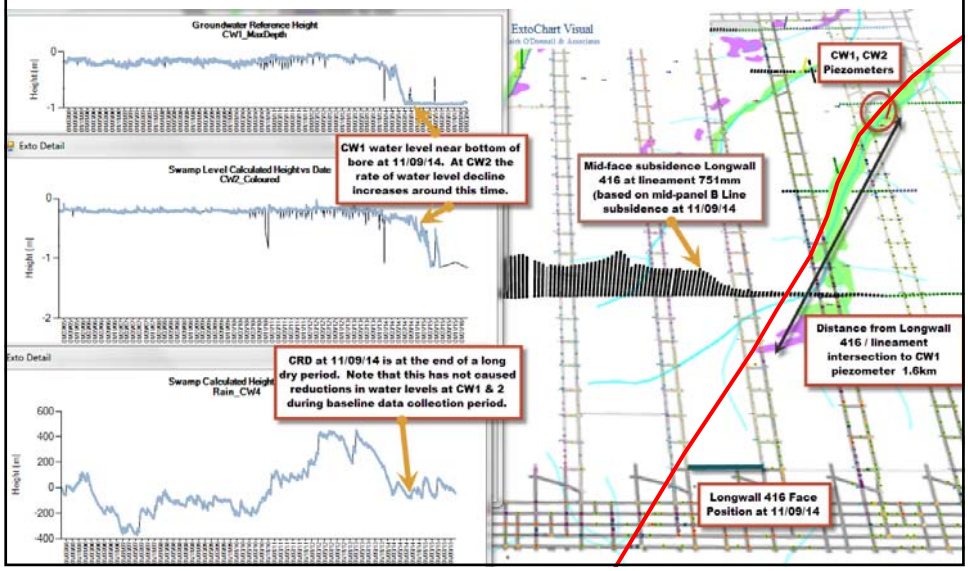
www.centennialcoal.com.au

43

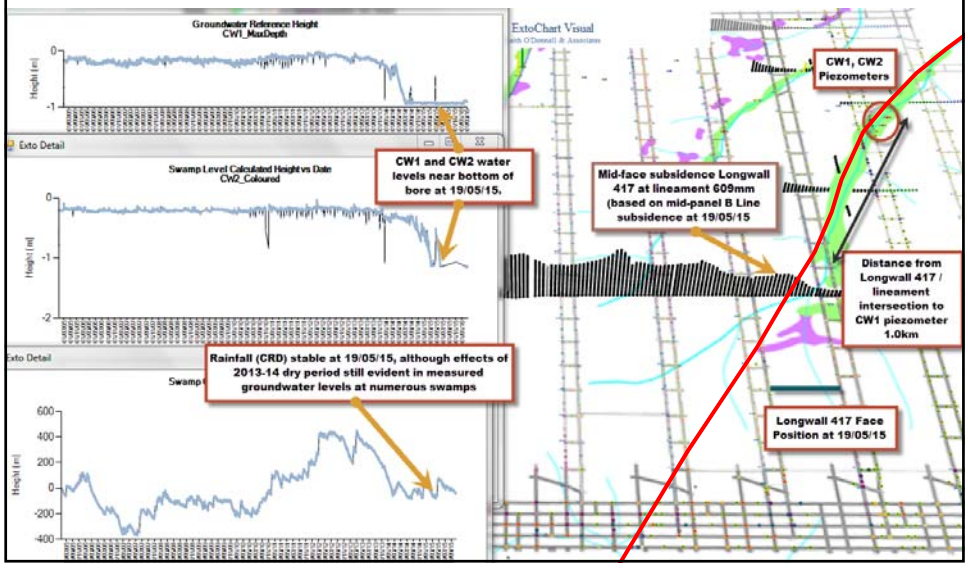
Carne West Swamp Hydrographs



Longwall 416 / Carne West Swamp



Longwall 417 / Carne West Swamp



Centennial Coal

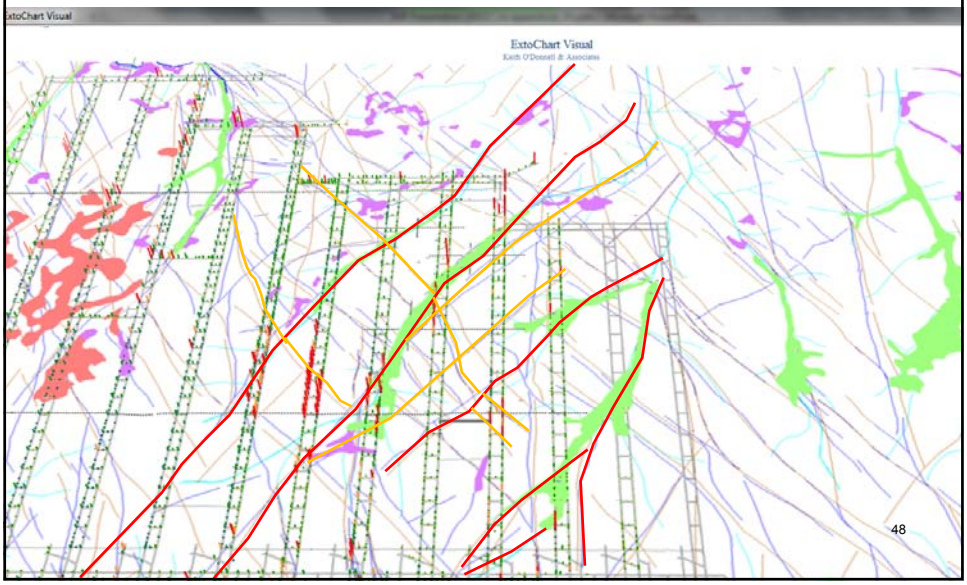
Current and Predicted Significant Fault Zones

Presented to IMP 6 March 2017

www.centennialcoal.com.au

47

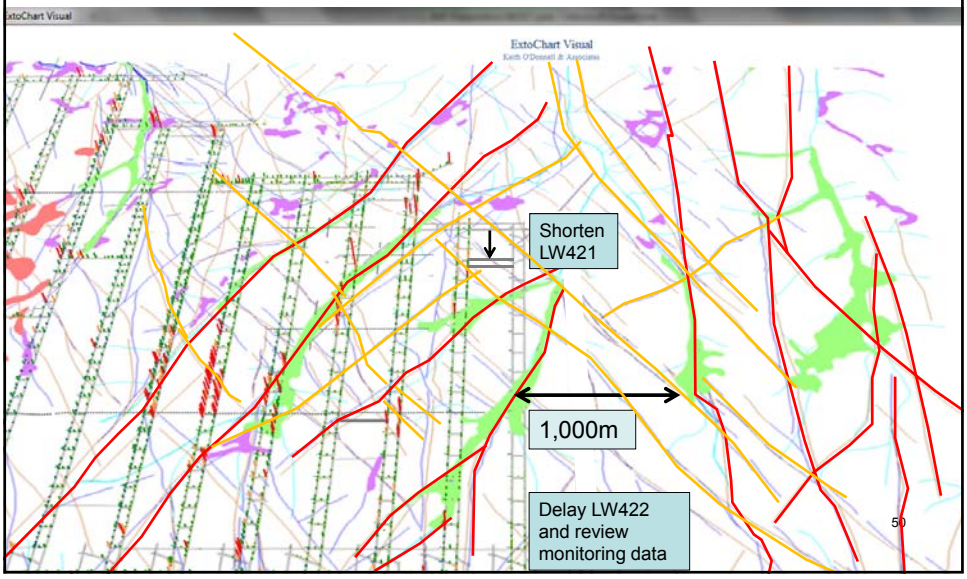
Currently identified significant fault zones



48

Predicted significant fault zones

Adaptive Management – Mine Design & Sequencing



Centennial Coal

Adaptive Management

Proposed mine design and sequence changes

www.centennialcoal.com.au

51

Adaptive Management - Hierarchy of Controls

1. Avoid
   - Change mine design (remove longwall 423)
   - Change mine design (shorten longwalls 420, 421, 422, 424)
2. Mitigate
   - Modify mine design (narrower mining voids, wider chain pillars for all Springvale longwalls in SSD5594 approved area)
3. Rehabilitate
   - East Wolgan / Narrow Swamp
4. Monitor
   - Understand vegetation response to groundwater level change
5. Offset
   - Centennial Swamp Offset Package

Centennial Coal

52

Centennial Coal

1. Avoid

Mine Design Changes to avoid impacts to swamps

www.centennialcoal.com.au

53

Proposed mine design and sequence changes

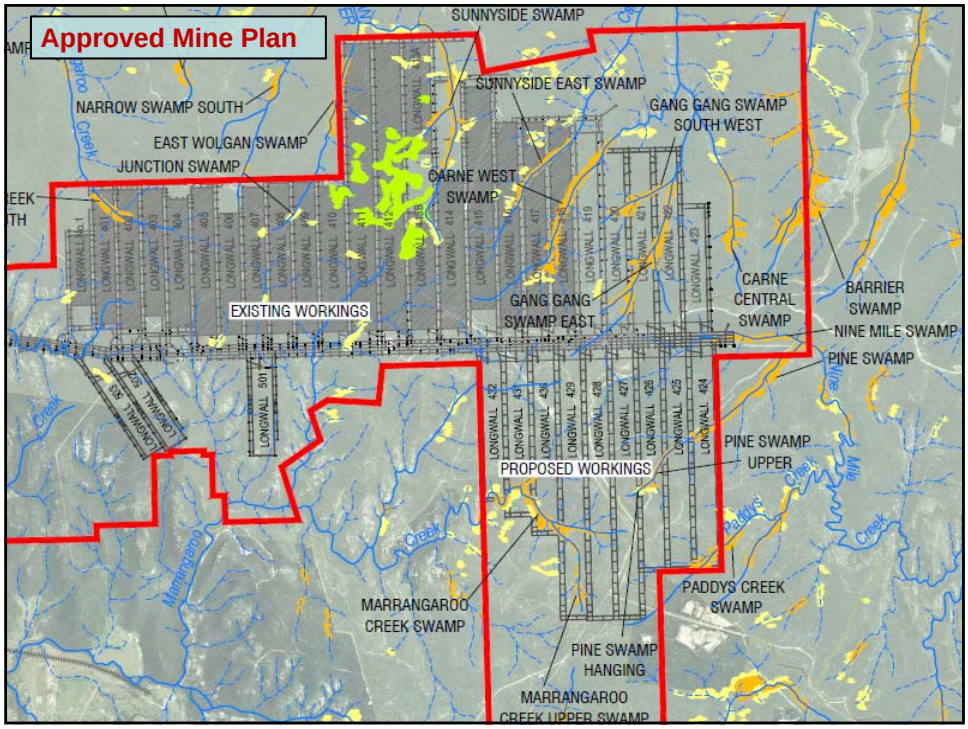
- Remove Longwall 423 from mine plan
- Shorten Longwall 421 and 424 to avoid lineaments underlying swamps

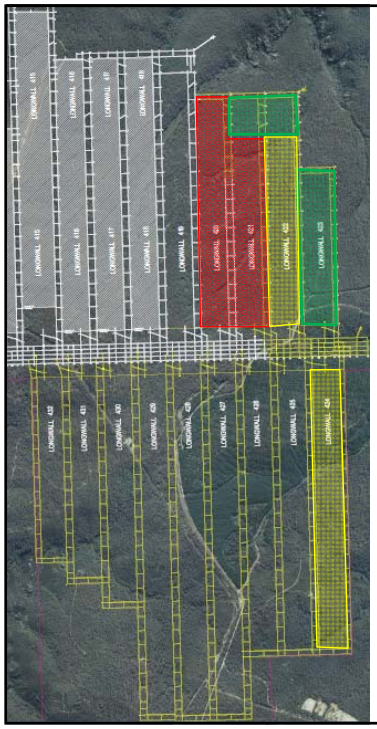
Move from the northern mining area to the southern mining area sooner than planned:

- mining Longwall 425 immediately after Longwall 421 (before Longwall 422 or Longwall 424, which are the most easterly longwalls)
- This will allow Springvale and the IMP more time to evaluate data collected from Longwalls 420 and 421

Centennial Coal

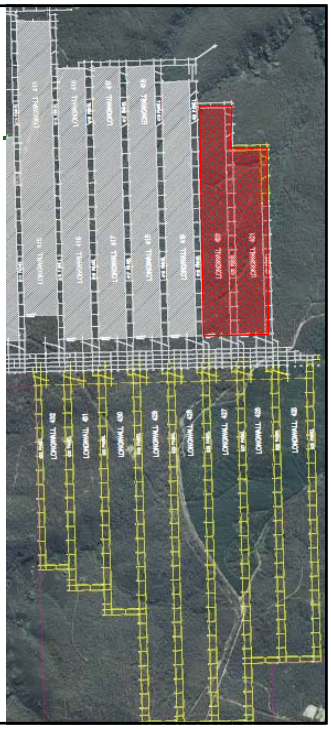
54





Adaptive Management Mine Design Changes

- Longwall 423 removed
- Longwall 421, 422 shortened
- Longwall 422 and 424 delayed to allow review of monitoring data



Centennial Coal

2. Mitigation

Reduction in mining void width and increase in chain pillar width

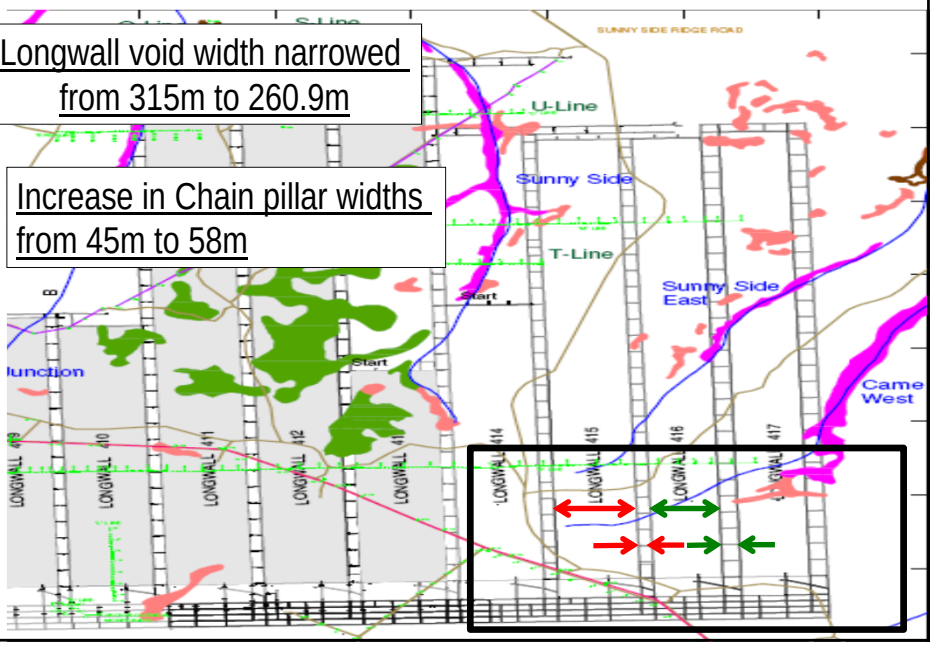
www.centennialcoal.com.au

57

Impact Mitigation (Springvale Mine Plan)

Longwall void width narrowed from 315m to 260.9m

Increase in Chain pillar widths from 45m to 58m



Centennial Coal

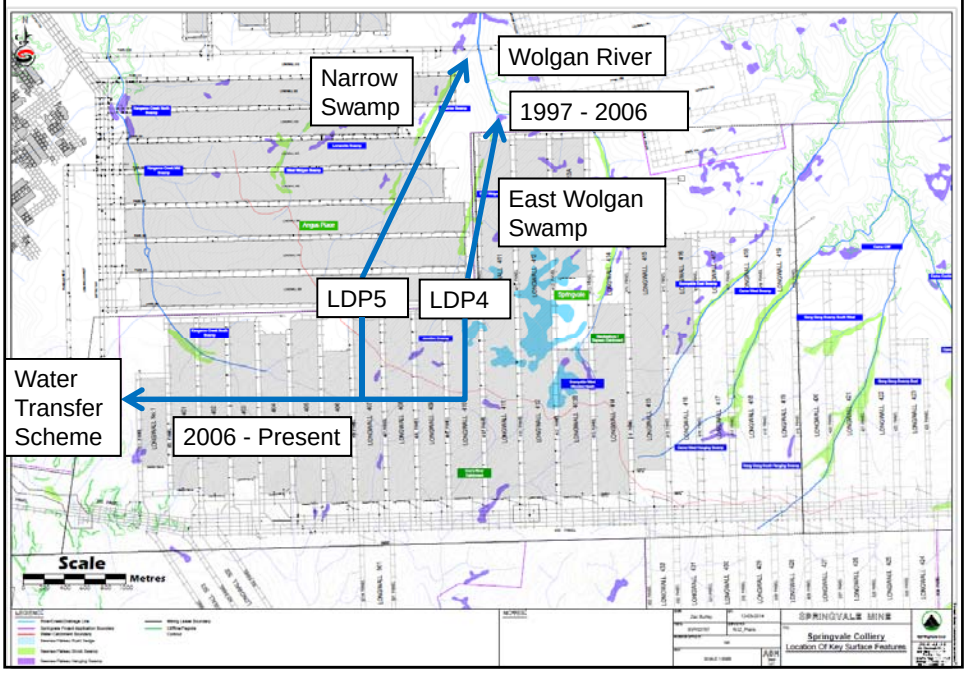
3. Rehabilitation

East Wolgan and Narrow Swamps

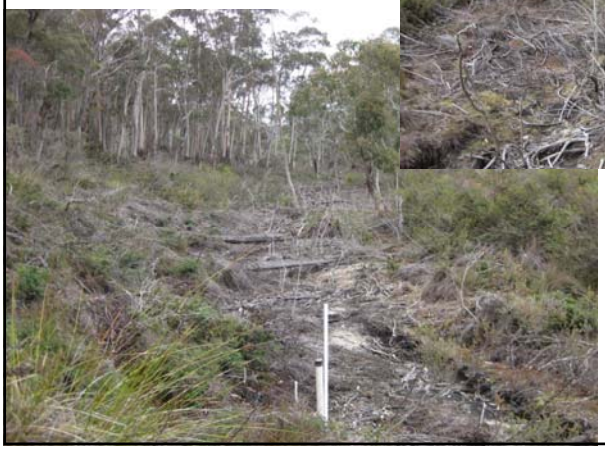
www.centennialcoal.com.au

1

Springvale and Angus Place Mines and THPSS



East Wolgan Swamp at WE2 Piezometer 16/07/2013



3

East Wolgan Swamp at WE2 Piezometer 22/02/2016

East Wolgan Swamp Rehabilitation

Water retention and distribution structures

Woven jute covered with brush matting to create shade and retain moisture to encourage plant growth

Regrowth of Leptospermum in Narrow Swamp

Centennial Coal

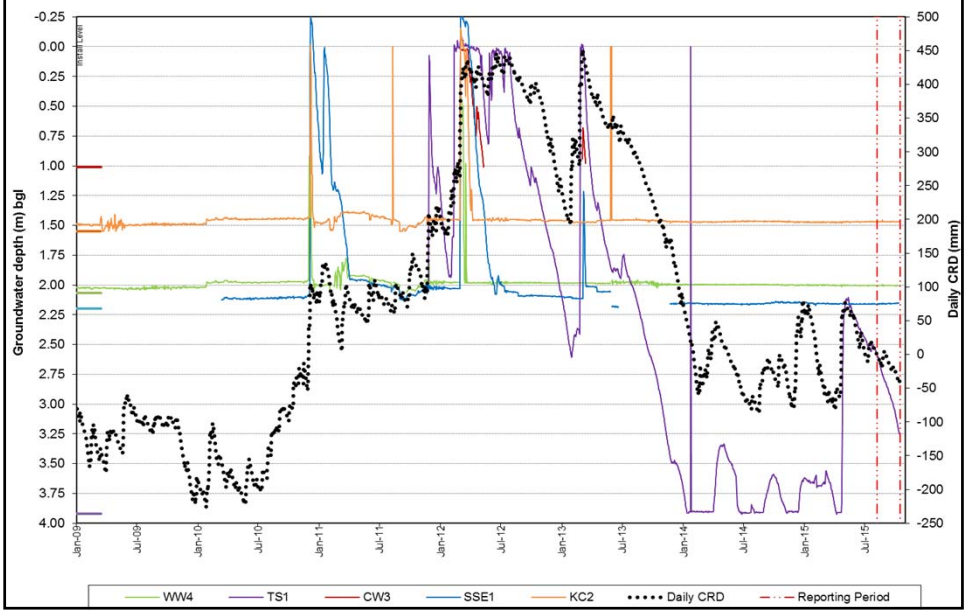
4. Monitoring

Quantifying Impacts through monitoring

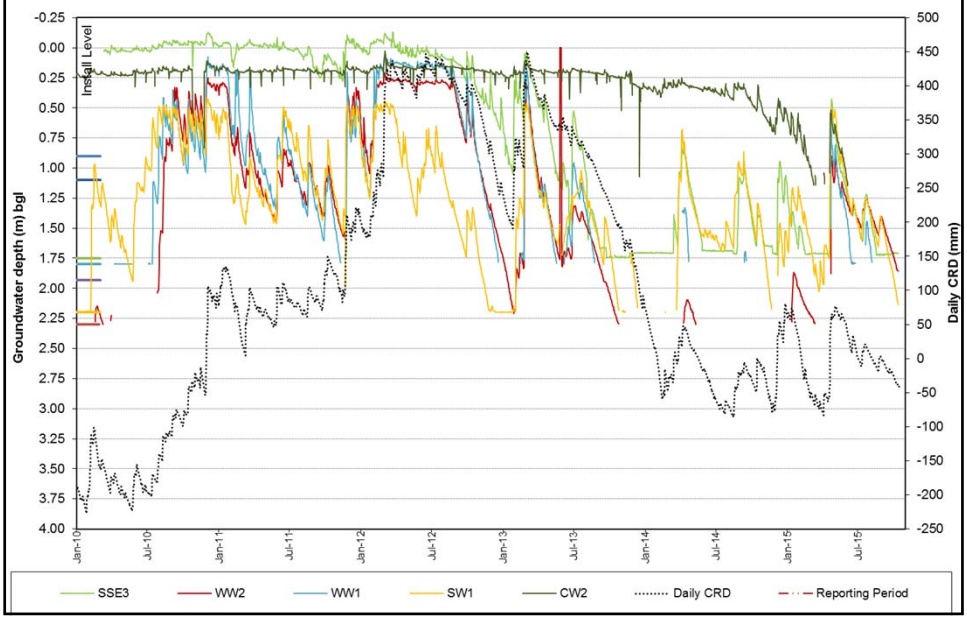
www.centennialcoal.com.au

7

Pre-mining Very Dry Baseline Hydrology (Impact and Control Sites)



Periodically Wet Swamp Locations with CW2 post-mining



Defining Negligible Environmental Consequences (SSD5594)

- Changes in shallow groundwater (compared to control swamps); and
- Erosion of the swamp surface; and
- A change in the size of the swamp; and
- A change in ecosystem functionality of the swamp; and
- A change in the composition or distribution of species within the swamp; and
- A change in the structural integrity of the bedrock base of any controlling rockbar/s of the swamp

Centennial Coal

10

Measuring Environmental Consequences (Extraction Plan Swamp Monitoring Program)

Performance Indicators	Preliminary Trigger Level
Increase in the extent of non-vegetated area (excluding areas covered by standing water)	20% increase
Decrease in the proportion of spatial area sampled that is scored as green (i.e. live photosynthetic) vegetation cover.	20% reduction
Reduction in amphibious (A) vegetation as a proportion of total vegetation cover.	30% reduction
Increase in terrestrial dry habitat (Tdr) vegetation as a proportion of total vegetation cover.	10% increase
Increase in terrestrial damp habitat (Tda) vegetation as a proportion of total vegetation.	10% increase
Decrease in Tda vegetation as a proportion of total vegetation cover.	10% decrease
Increase in exotic vegetation as a proportion of total vegetation cover.	10% increase
Increased establishment of eucalypt and/or pine seedlings (1m in height).	30% increase in frequency (presence/absence quadrats)

Centennial Coal

Centennial Coal

Swamp Ecology Research

www.centennialcoal.com.au

12

Swamp Ecology Research (University of Queensland)

- University of Queensland Monitoring Handbook, titled Flora monitoring methods for Newnes Plateau Shrub Swamps and Hanging Swamps (2014).
- Brownstein, G, Blick, R, Johns, C, Bricher, P, Fletcher, A, Erskine, P.D. *Optimising a Sampling Design for Endangered Wetland Plant Communities: Another Call for Adaptive Management in Monitoring,* Wetlands 35 (2015) 105 to 113.
- Johns, C, Brownstein, G, Fletcher, A, Blick, R, Erskine, P. *Detecting the effects of water regime on wetland plant communities: Which plant indicator groups perform best?* Aquatic Botany 123 (2015) pp 54 to 63.
- Tierney, D, Fletcher, A, and Erskine, P, *Standard survey designs drive bias in the mapping of upland swamp communities,* Ecological Society of Australia (2015)

Centennial Coal

13

Implementation of UQ Flora Monitoring Handbook Methodology (Brownstein et al 2015)

This survey aimed to capture baseline data on the following indicator variables, at the swamp scale:

- Proportion of area sampled that is not vegetated or disturbed
- Proportion of area sampled covered with live green (i.e. photosynthetic) vegetation.
- Proportion of area sampled that contains large trees, such as eucalypts, which obstruct the aerial view of wetland vegetation.
- Proportion of area with recent tree fall events.

Centennial Coal

14

Centennial Coal

Sunnyside East and Carne West Case Studies

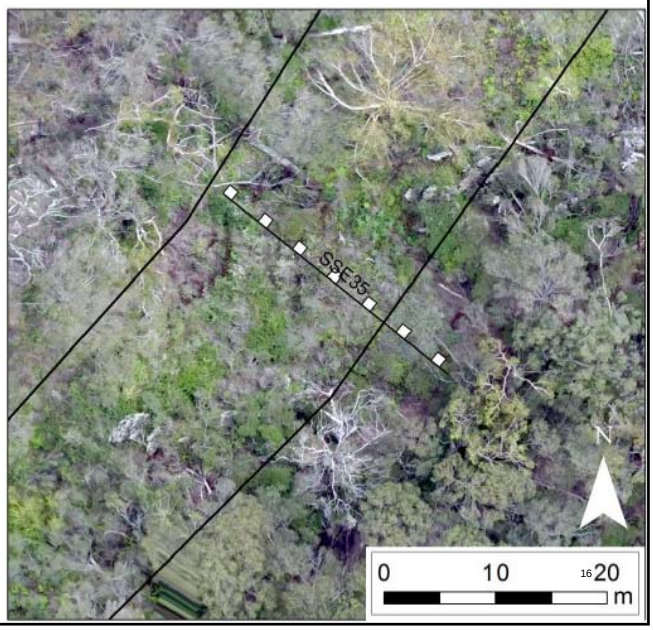
www.centennialcoal.com.au

15

Sunnyside East Swamp – Aerial Image with Ground Based Transect

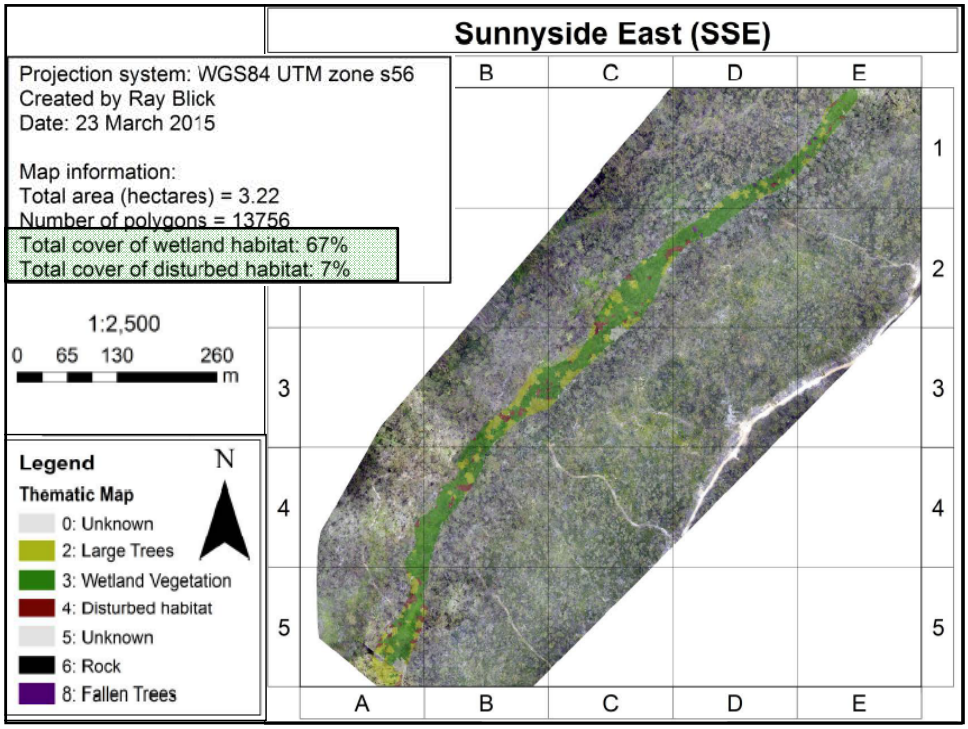
Aerial imagery over Sunnyside East (downstream).

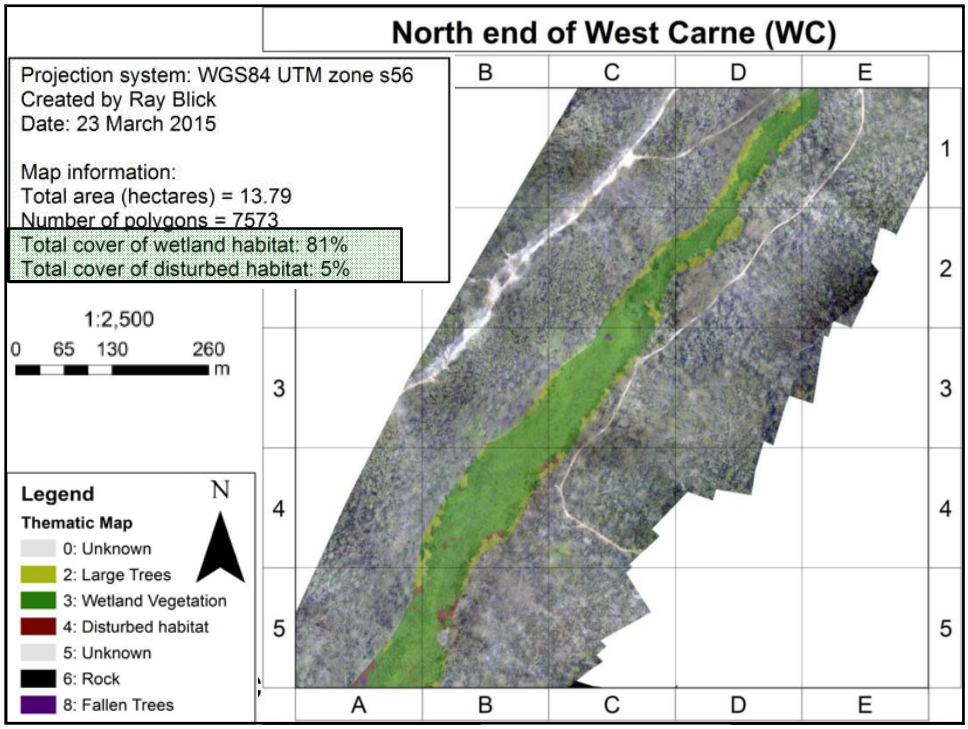
This area of wetland is also monitored with the transect-based methodology



Centennial Coal

16


Sunnyside East (SSE)
Projection system: WGS84 UTM zone s56
Created by Ray Blick
Date: 23 March 2015
Map information:
Total area (hectares) = 3.22
Number of polygons = 13756
Total cover of wetland habitat: 67%
Total cover of disturbed habitat: 7%
1:2,500
0 65 130 260
m
Legend
Thematic Map
0: Unknown
2: Large Trees
3: Wetland Vegetation
4: Disturbed habitat
5: Unknown
6: Rock
8: Fallen Trees
N
A B C D E
1 2 3 4 5


North end of West Carne (WC)
Projection system: WGS84 UTM zone s56
Created by Ray Blick
Date: 23 March 2015
Map information:
Total area (hectares) = 13.79
Number of polygons = 7573
Total cover of wetland habitat: 81%
Total cover of disturbed habitat: 5%
1:2,500
0 65 130 260
m
Legend
Thematic Map
0: Unknown
2: Large Trees
3: Wetland Vegetation
4: Disturbed habitat
5: Unknown
6: Rock
8: Fallen Trees
N
A B C D E
1 2 3 4 5

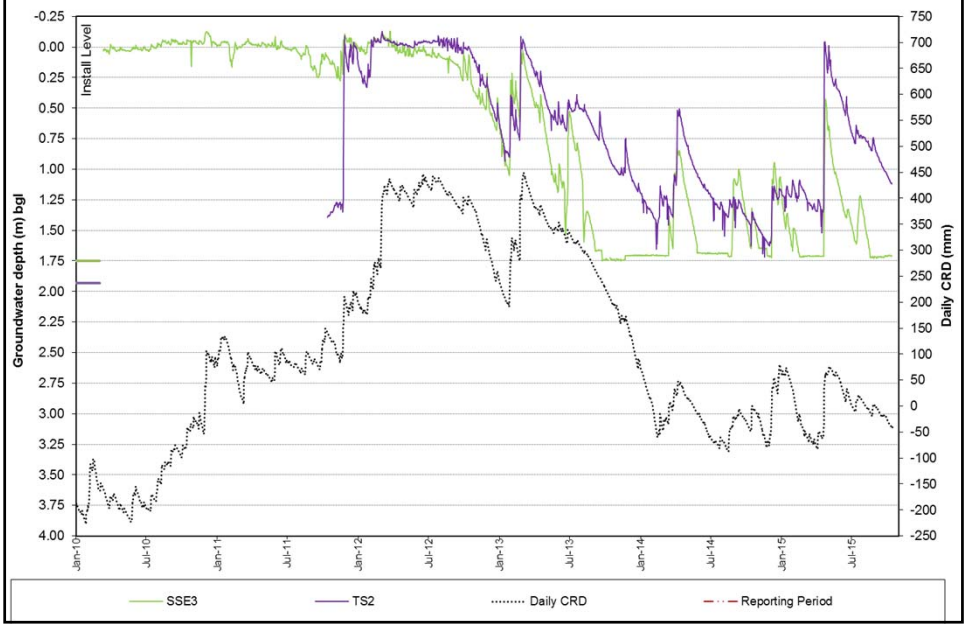
Centennial Coal

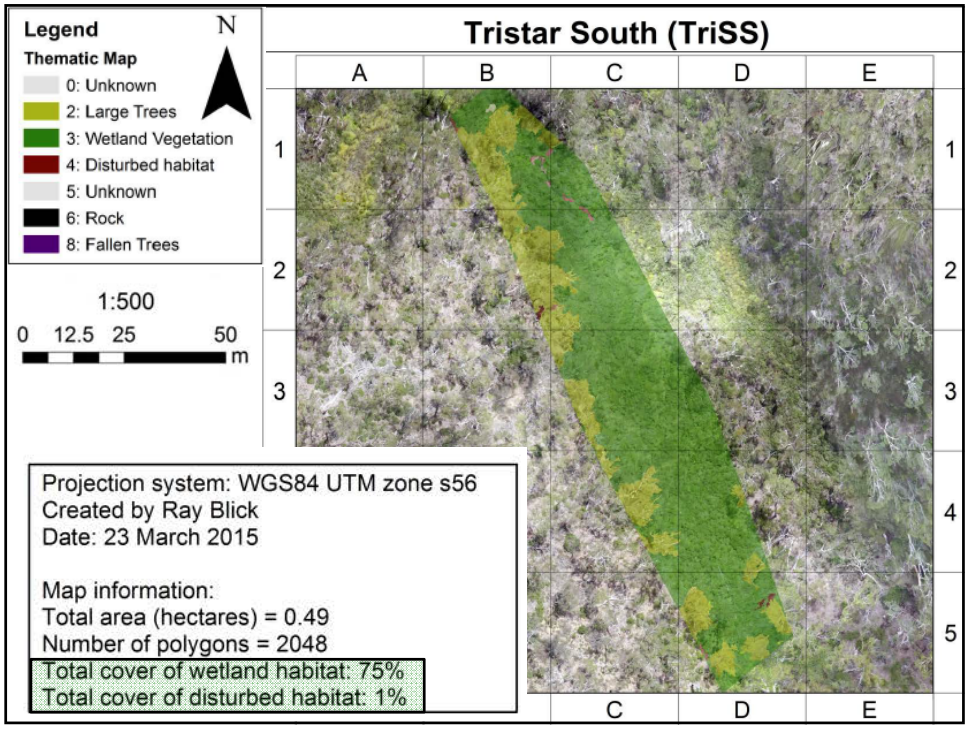
Tri-Star Swamp Case Study

www.centennialcoal.com.au

19

Sunnyside East Swamp Compared to Tri-Star Swamp (Control)





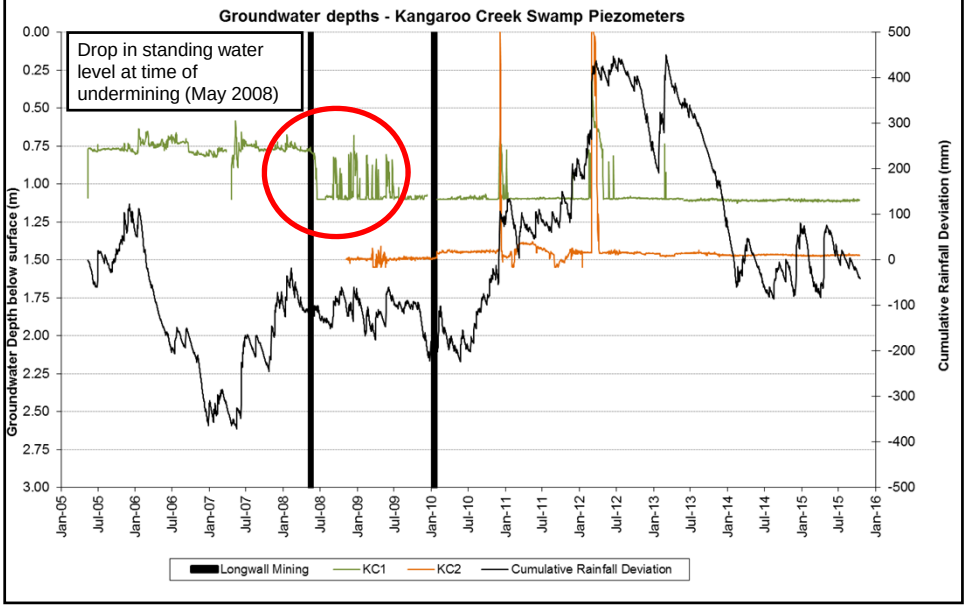
Centennial Coal

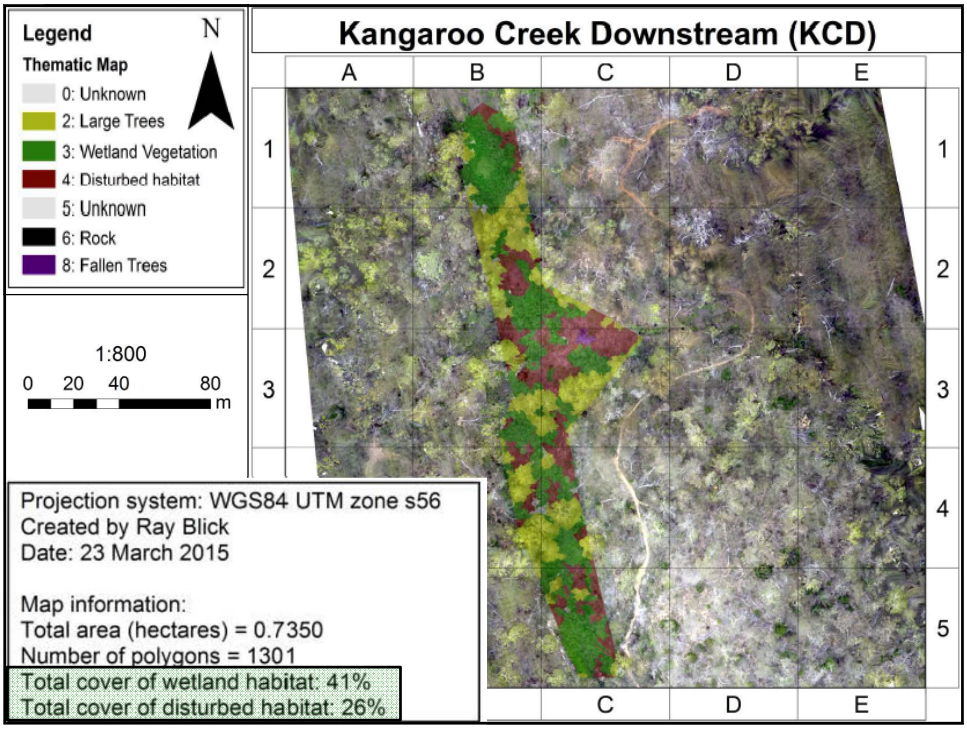
Kangaroo Creek Swamp Case Study

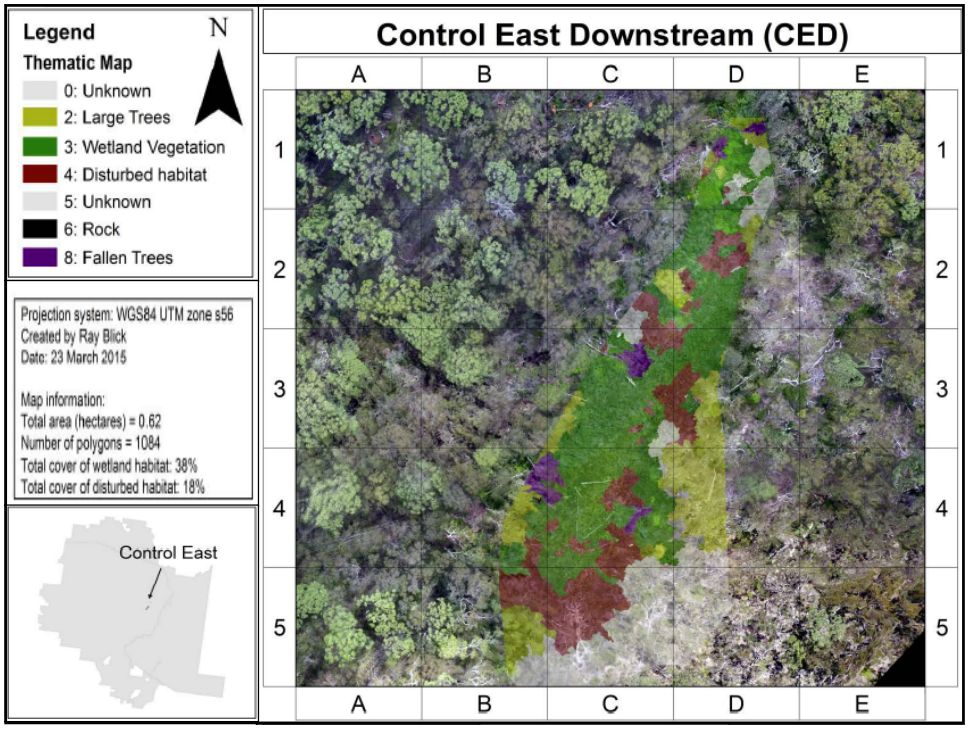
www.centennialcoal.com.au

22

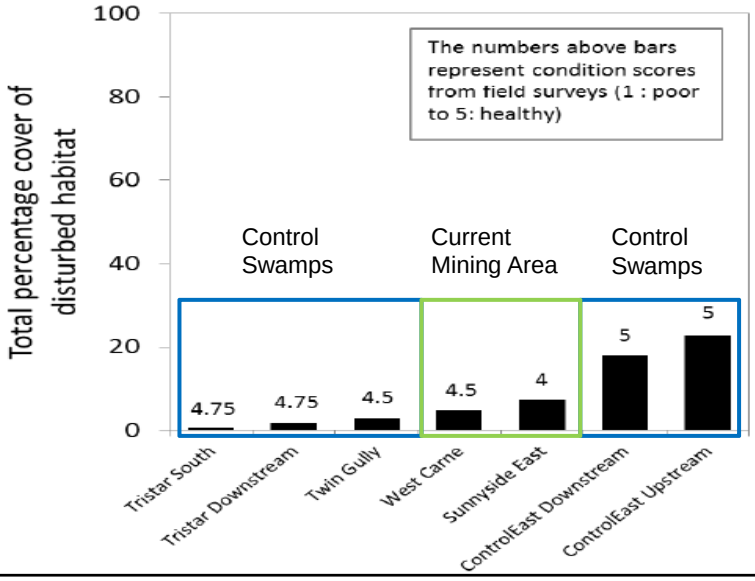
Kangaroo Creek Swamp Piezometer Hydrographs







Total percentage cover of disturbed habitat as interpreted from the UAV imagery.



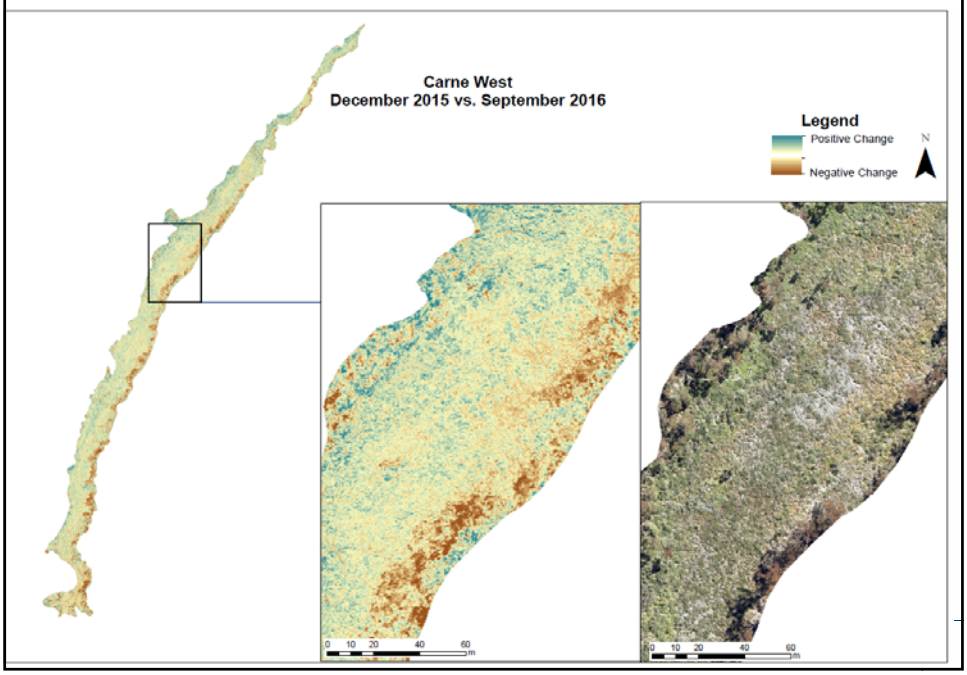
Centennial Coal

UQFM Baseline compared to 2016 survey

www.centennialcoal.com.au

27

'Plant Health' Net Change @ Carne West



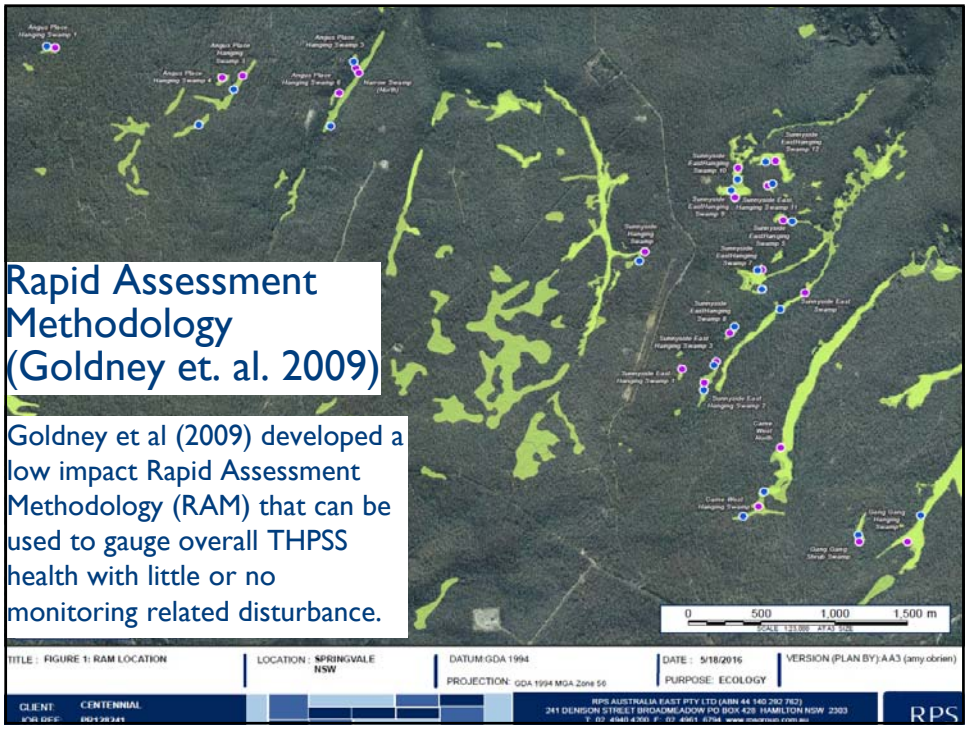
Newnes Plateau Hanging Swamp Monitoring

Flora monitoring methods for Newnes Plateau Shrub Swamps and Hanging Swamps:

- (Brownstein et al 2014); and
- Rapid Assessment Methodology (Goldney et al 2009)

Centennial Coal

29



Ground Control Data: Baseline Year 1 (Spring 2015 – Winter 2016)

Summary Statistics	Treatment	n	Live (%) (Mean)	Live (%) (SD)	Dead (%) (Mean)	Dead (%) (SD)	Exotic (%) (Mean)	Exotic (%) (SD)
All								
Reference Shrub Swamps	R-SS	280	84.6	7.3	13.6	6.6	1.3	2.0
Impact Shrub Swamps	I-SS	88	75.5	9.2	22.4	10.9	1.3	1.8
Reference Hanging Swamps	R-HS	24	65.7	10.1	29.5	13.7	5.7	9.9
Impact Hanging Swamps	I-HS	8	88.9	7.2	11.1	7.2	0.9	1.0
Snow Gum Sedge Swamp	I-SNOW	4	55.0	5.0	38.8	7.4	10.5	17.1
	Total	404						
Impact Swamps								
Sunnyside East Hanging Swamp	I-HS	8	88.9	10.7	11.1	10.7	0.9	1.7
Sunnyside East	I-SS	16	**67.3**	**20.2**	29.9	20.3	0.1	0.3
West Carne	I-SS	24	80.0	**37.7**	16.5	30.0	0.1	0.2
Gang Gang Swamp	I-SS	48	79.1	19.2	14.7	17.1	2.9	7.5

Sunnyside East has the lowest live vegetation cover

UQ Monitoring Methodology

- Based on extensive published research
- Comprehensive baseline flora surveys (entire swamp community)
- Ability to quantify change over time
- Opportunity to quantify partial impact
- Opportunity to quantify partial offset requirement

Centennial Coal

5. Offsetting

Establishing the Offset Liability

- Maximum offset liability for each swamp calculated using the FBA as part of each Extraction Plan.
- Requirements using the Maximum offset liability calculation are unrealistic.
- Offset liability calculation report includes a methodology for calculating actual impacts required to be offset.
- BACI monitoring program implemented to identify mining induced changes.

Establishing the Offset Liability

- Offsets for swamps only required if:
  - greater than negligible environmental consequences identified after 12 months following the completion of all mining within 400 metres of a swamp; and
  - Remediation is not considered feasible.
- Specific performance measures for swamps to be monitored against have been established.
- Remediation plan being developed for consideration for Carne West and Gang Gang South West Swamp.
- Ongoing consultation with DRE, OEH, DoE and DPE regarding a strategy for securing swamp offsets should they be required.

Centennial Coal

35