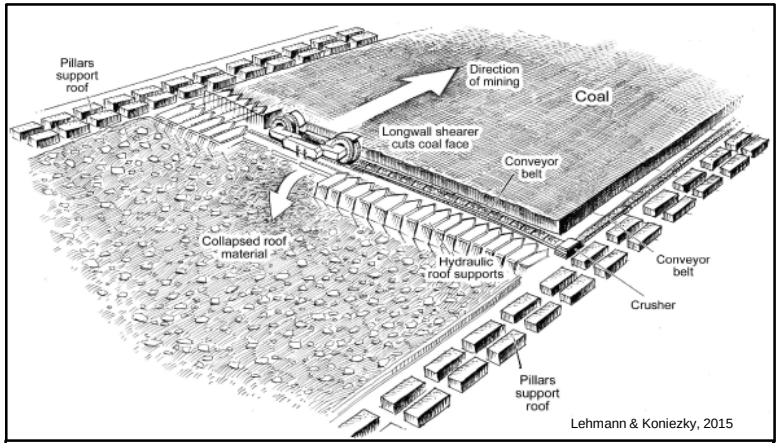
Planning Effective Management of Gas Emissions in an Underground Coal Mine

Dr Dennis Black
PacificMGM
Mining & Gas Management Consultants
www.pacificmgm.com.au

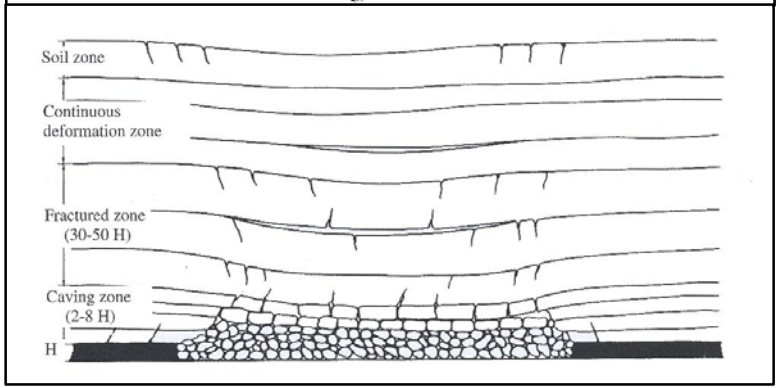
UNIVERSITY
OF WOLLONGONG
AUSTRALIA

Longwall Gas Emission

- Significant fracturing occurs above and below the mining horizon.
- Gas released from coal seams flows to the working seam.
- Mine planners should understand the significance of potential gas emissions.
- If the rate of gas emission exceeds the diluting capacity of the mine ventilation air the gas concentration may exceed the legal limit. The options to control and reduce high gas emissions include:
  - Reduce longwall coal production rate;
  - Increase mine ventilation air flow;
  - Use gas drainage methods to remove gas.



Lehmann & Koniezky, 2015

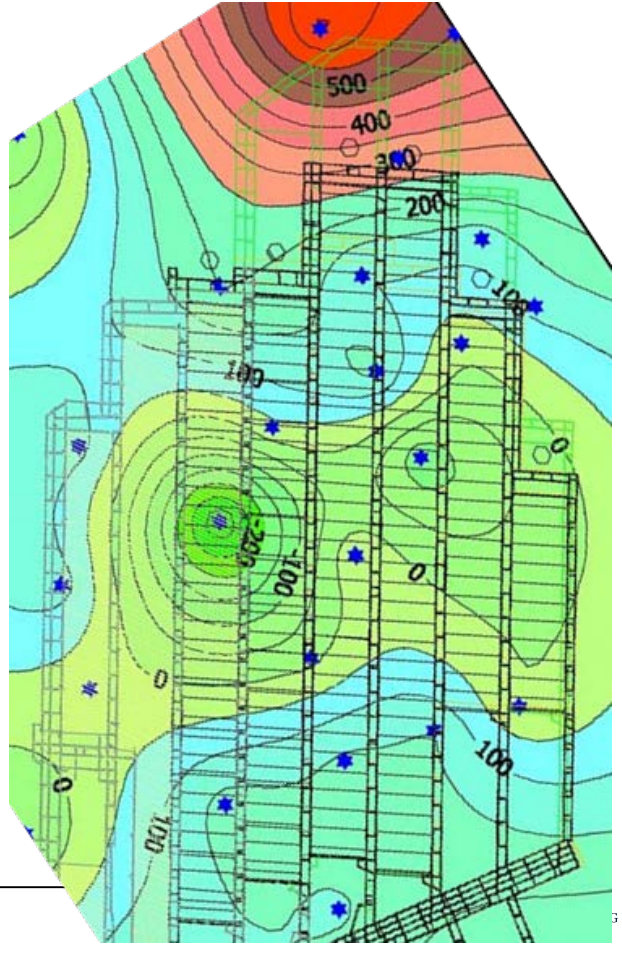


Lehmann & Koniezky, 2015

UNIVERSITY OF WOLLONGONG AUSTRALIA

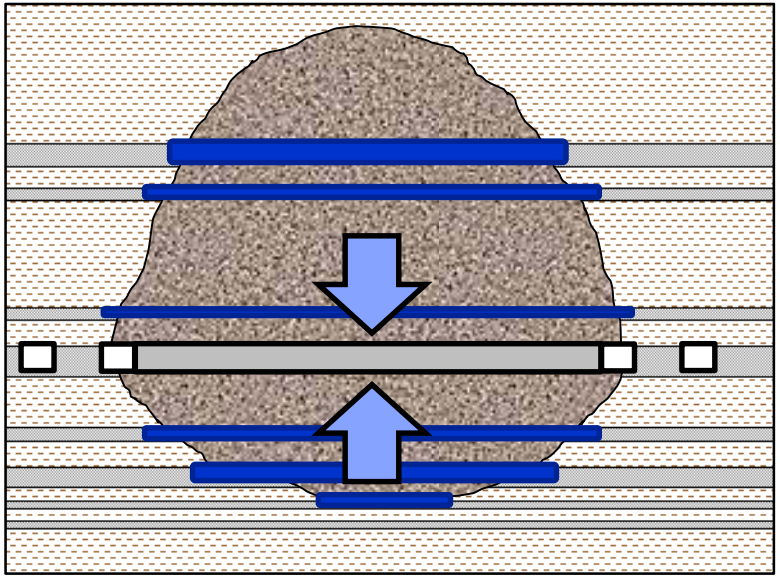
Need to Control and Manage Gas Emissions

- Many mines have experienced production delays due to gas.
  - Gas emissions exceeding the diluting capacity of the ventilation air; and
  - Gas content not reduced below safe threshold levels prior to scheduled mining.
- An increasing number of mines have sacrificed coal reserves due to a lack of awareness and understanding of the gas reservoir and inability to implement appropriate gas drainage in a timely manner.
- The example shows changes to a mine plan that resulted in a loss of greater than 3.0Mt.



Longwall Gas Emission

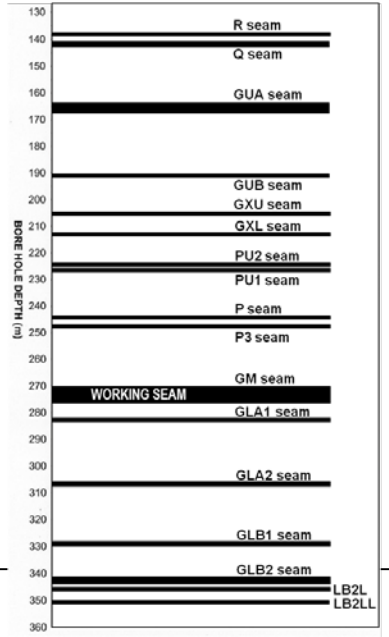
- Steps to determine rate of gas emission in response to longwall production include:
  - Gas in Place (m^3/m^2) – total volume of gas contained in all coal seams and gas bearing strata;
  - Degree of Gas Emission (%) – volume of gas released from each coal seam;
  - Specific Gas Emission (m^3/t) – total volume of gas released per tonne of coal mined;
  - Gas Emission Rate (L/s) – rate of gas emission into the mine ventilation system. Directly affected by coal production rate.

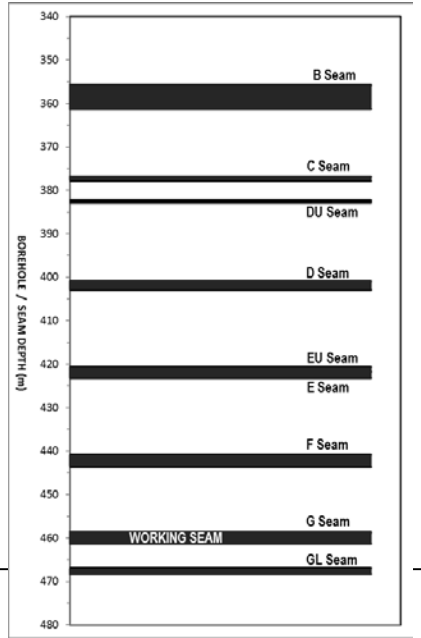


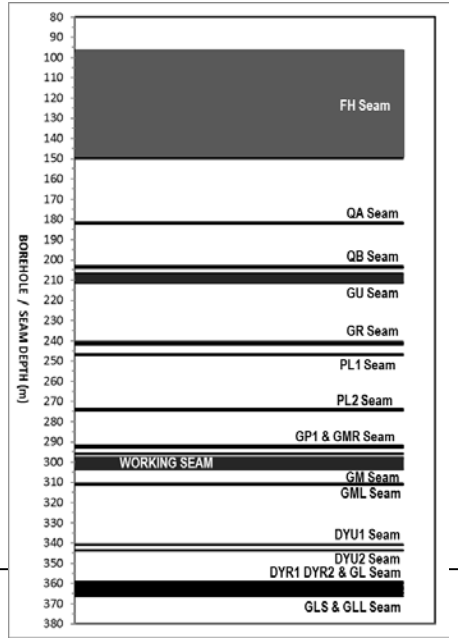
- Gas drainage options to reduce Gas Emission rate include:
  - Pre-drainage – draining gas from coal seams prior to mining to reduce SGE; and
  - Goaf drainage – draining gas from the goaf to reduce emissions into the ventilation air.

Stratigraphy – Potential Gas Sources

- Coal measures typically include multiple coal seams above and below the target mining seam.
- Coal seams vary in gas emission potential – thickness, gas content, gas composition, ash content and distance above/below the working seam.
- Exploration typically focusses on the Working Seam and limited information is collected from adjacent coal seams, particularly coal seams below the working seam.



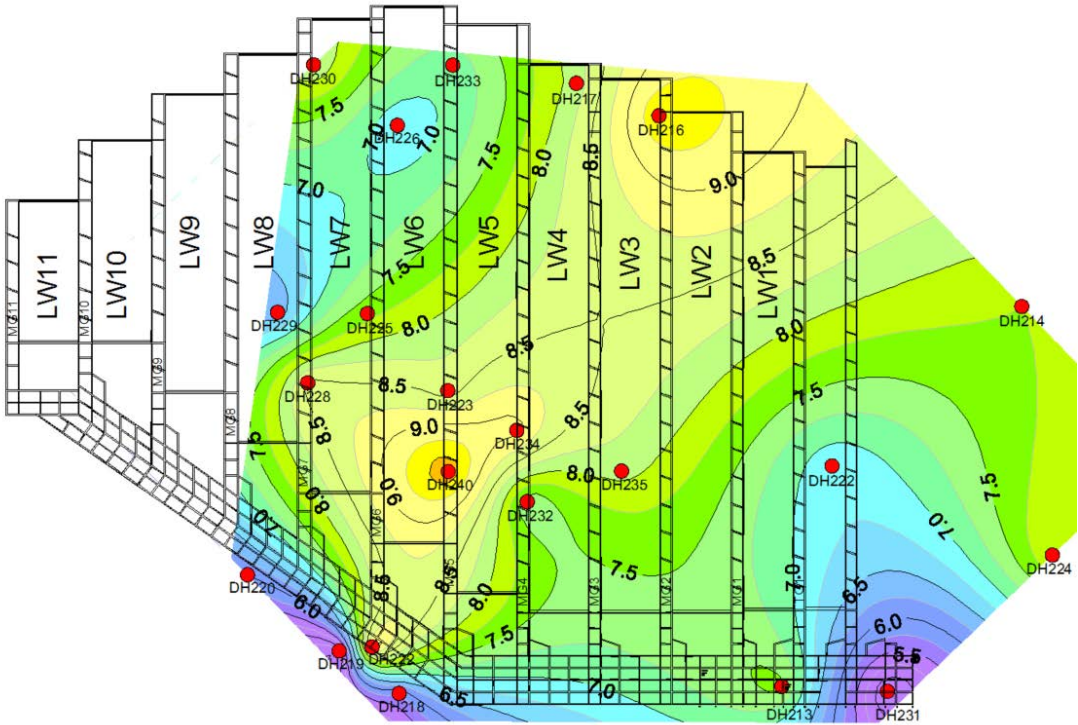




UNIVERSITY OF WOLLONGONG AUSTRALIA

Coal Seam Gas Content

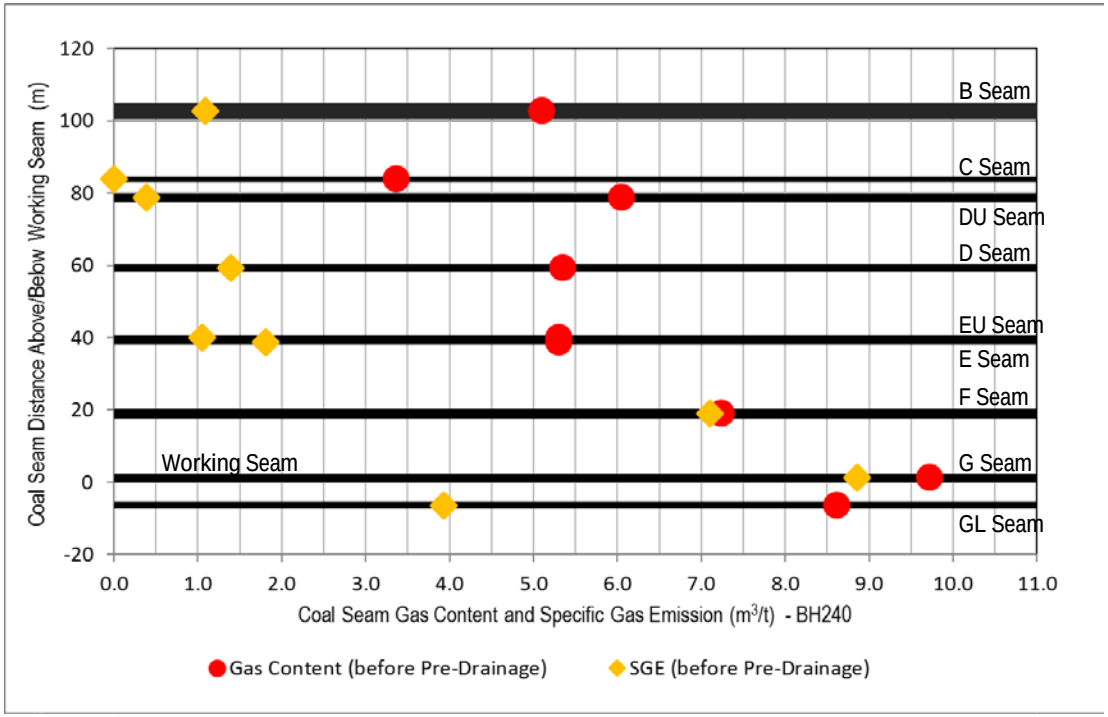
- Coal seam gas content is not constant and will change over a mining area.
- Exploration is needed to measure gas content.
- Accurate gas content information will significantly improve mine planning and gas drainage design.
- In this example, no information is available beyond LW8.
- Accurate gas content and gas reservoir data are used to design gas drainage programs to reduce the gas content prior to scheduled mining (e.g. 3.5m^3/t).



UNIVERSITY OF WOLLONGONG AUSTRALIA

Reservoir Model to Forecast Future Gas Emissions

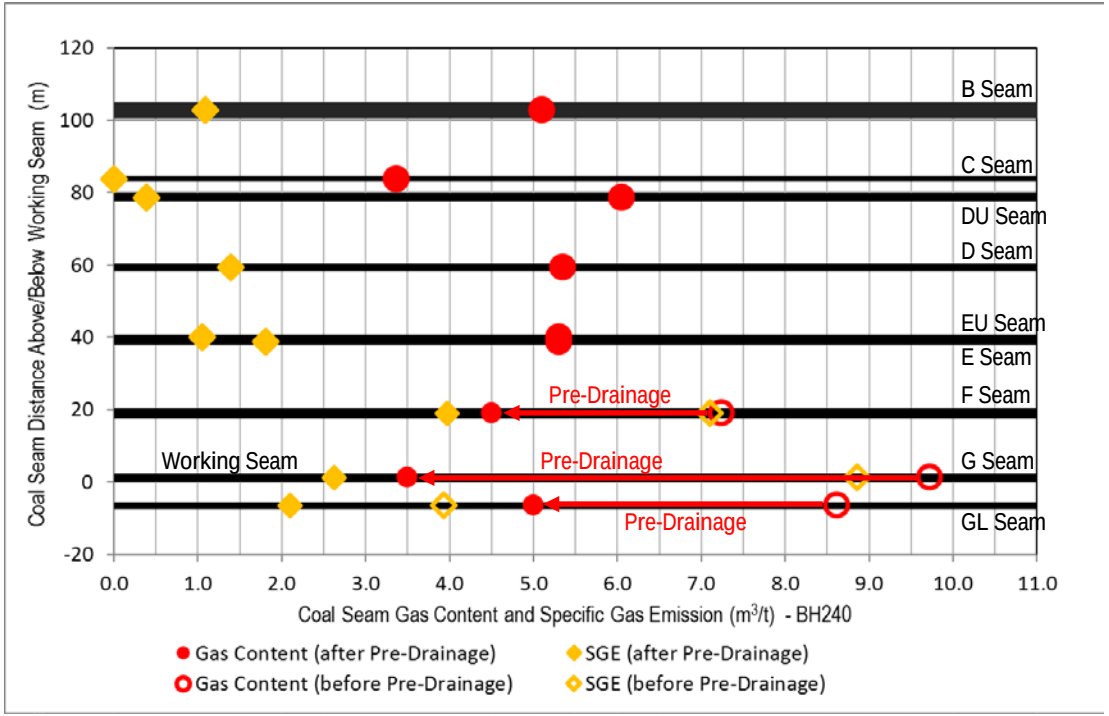
- Reservoir modelling is used to determine gas emission from each coal seam.
- Effective reservoir modelling requires accurate input data:
  - Depth and thickness of gas sources (coal seams) above / below the working seam;
  - Gas content;
  - Gas composition;
  - Ash content.



UNIVERSITY OF WOLLONGONG AUSTRALIA

Gas Drainage to Reduce Specific Gas Emission

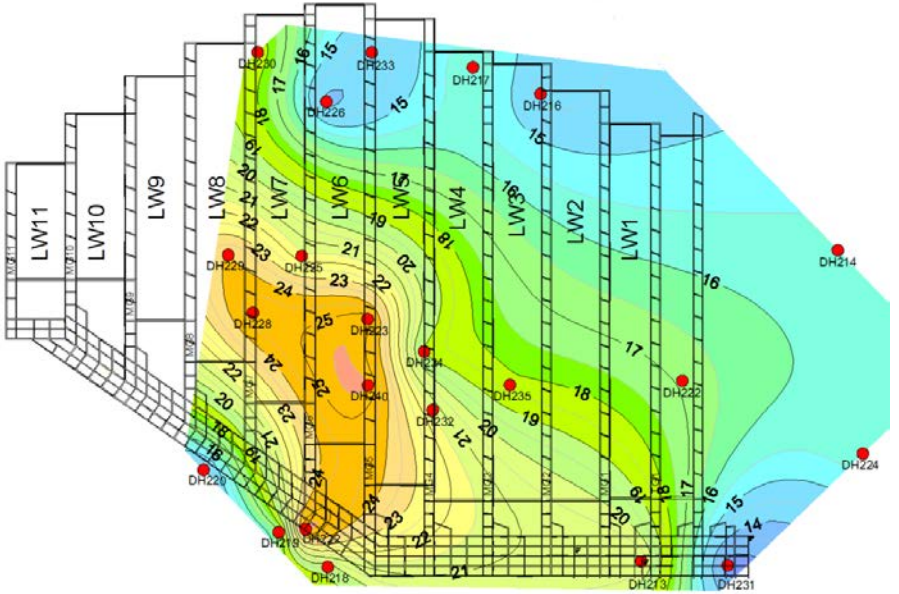
- Coal seams that have a high SGE contribution can be targeted for pre-drainage to reduce total SGE.
- In this example, pre-draining three (3) coal seams reduces SGE from 27.7m^3/t to 14.4m^3/t.
- Pre-drainage gas content reduction:
  - F seam drained to 4.5m^3/t
  - G seam drained to 3.5m^3/t
  - GL seam drained to 5.0m^3/t

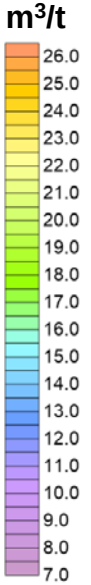


UNIVERSITY OF WOLLONGONG AUSTRALIA

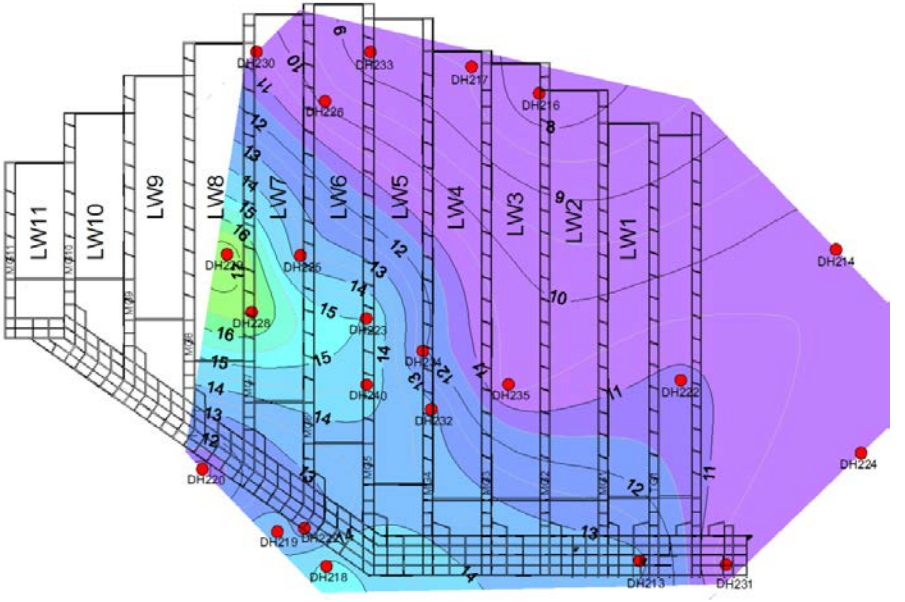
Specific Gas Emission

Specific Gas Emission (before pre-drainage)





Specific Gas Emission (after pre-drainage)

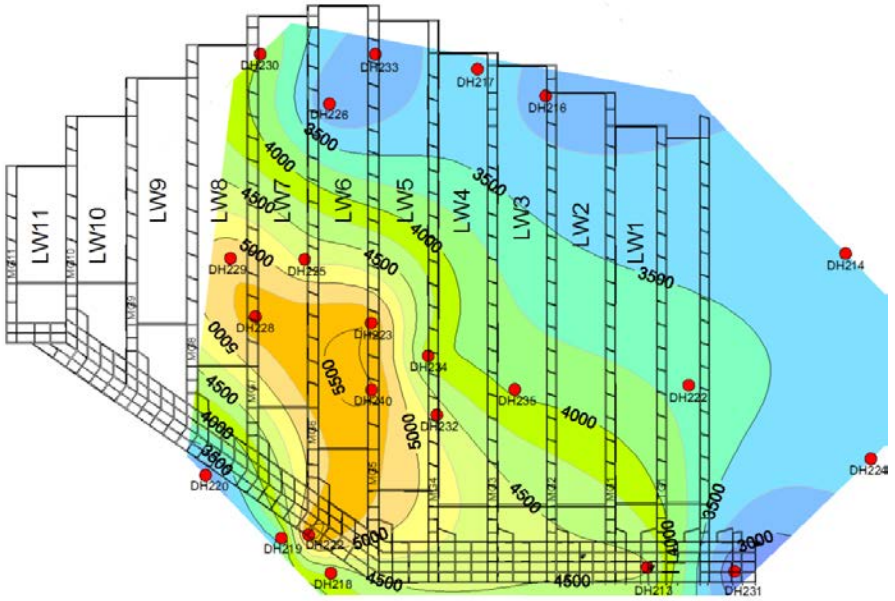


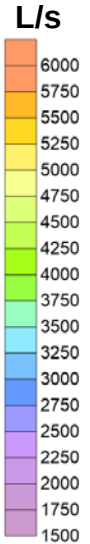
- Gas released from combined sources = m^3 CH_4 per LW tonne produced.
- Pre-drainage in three coal seams achieves an average 35% reduction in SGE.
- Gas emission rate is variable, subject to SGE and LW production rate.

UNIVERSITY OF WOLLONGONG AUSTRALIA

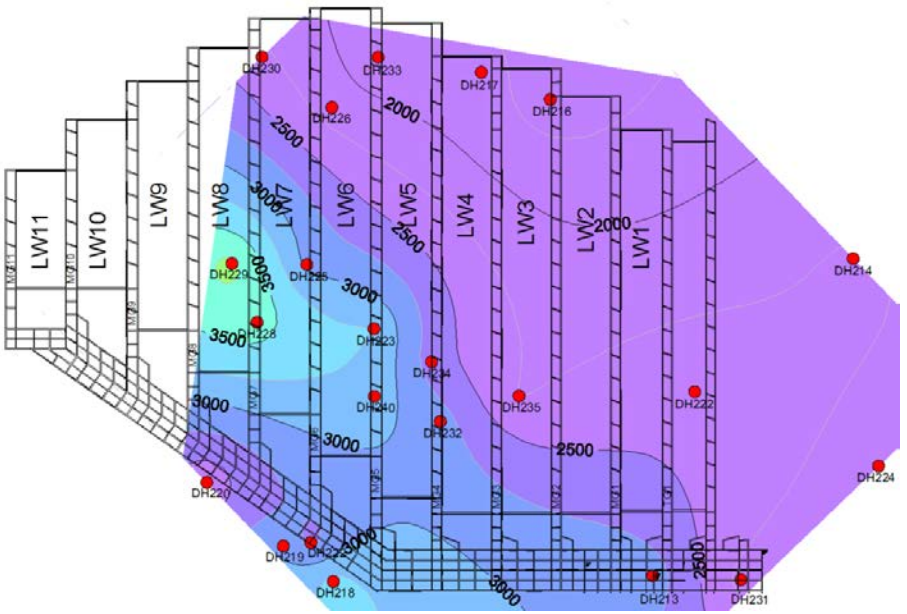
Longwall Gas Emission

Longwall Gas Emission (before pre-drainage)





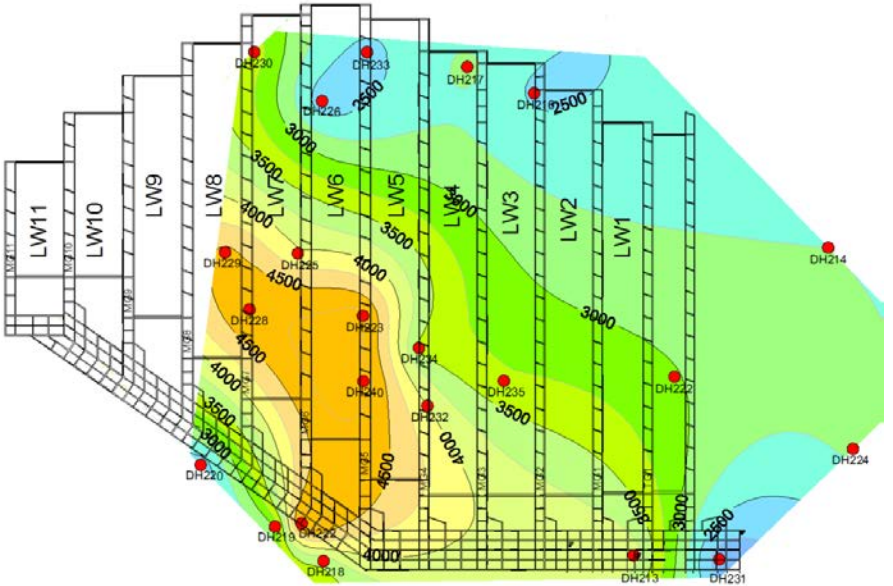
Longwall Gas Emission (after pre-drainage)



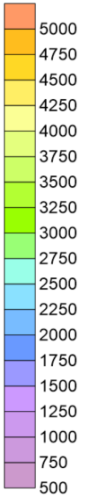
- Gas released from combined sources based on LW production at 3.0Mtpa.
- Ventilation airflow at 65m^3/s can dilute 650L/s to maintain 1.0% CH_4.
- Varying longwall production rate will affect longwall gas emission rate.

Goaf Gas Drainage Rate

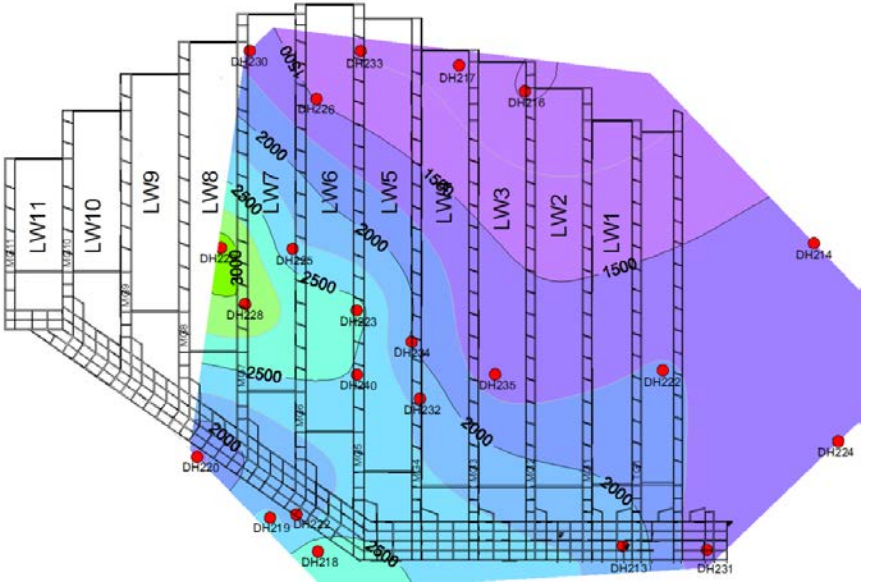
Goaf Gas Drainage Rate (before pre-drainage)



L/s



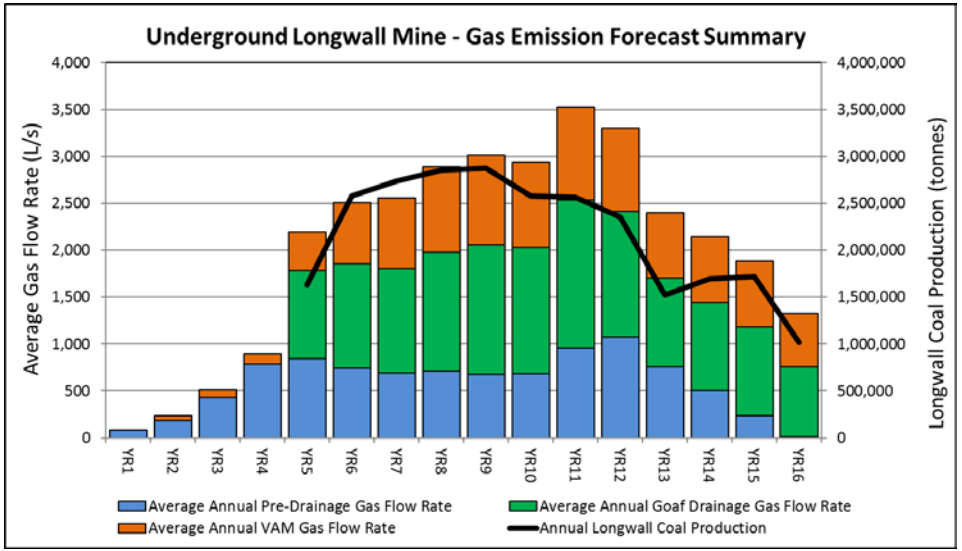
Goaf Gas Drainage Rate (after pre-drainage)



- Goaf drainage is used to extract gas from the goaf prior to contaminating ventilation air.
- Gas drainage method(s) are selected based on source(s) of gas emission and the rate of gas extraction required to support longwall production.

Gas Emission Forecast

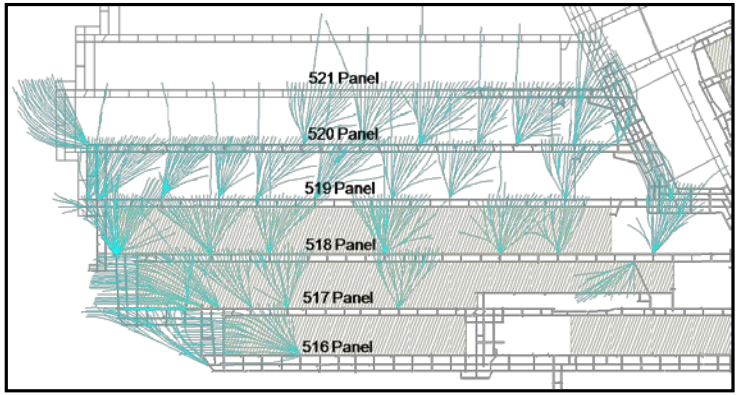
- Changes in coal production rate will affect gas emission rate.
- Gas emissions that are not removed by goaf drainage will flow through the mine and exit as ventilation air methane (VAM).
- Increasing goaf gas extraction rate has a positive effect on reducing VAM.
- Increasing pre-drainage has a positive effect on reducing SGE and therefore reduces potential gas emissions in goaf drainage and VAM.

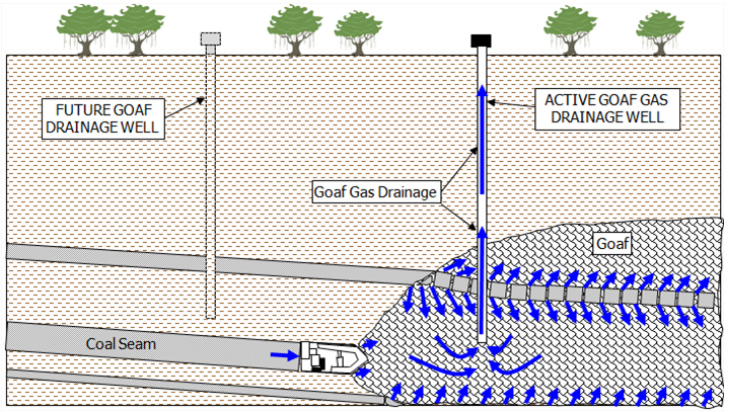


UNIVERSITY OF WOLLONGONG AUSTRALIA

Gas Drainage Method Selection

- Many factors must be considered when selecting a suitable drilling / gas drainage method:
  - Area to be drained i.e. pre-drainage or goaf drainage;
  - Coal seam characteristics e.g. thickness, permeability, ash content, gas composition, gas content;
  - Access for drilling and gas production equipment; and
  - Time available to drain area ahead of mining.
- Pre-drainage of the working seam is typically achieved using underground-to-inseam (UIS) drilling methods;
- Goaf drainage is typically achieved using vertical goaf drainage wells, drilled from surface in advance of longwall extraction.





Utilisation of Gas to Reduce Carbon Emissions

- Options to utilise gas drained from coal mines include:
  - Flaring;
  - Power Generation; and
  - Pipeline Sales.
- Technologies to utilise low concentration methane in ventilation air (VAM) are also being developed.

Summary

- Collect sufficient information to fully understand the gas reservoir in areas where mining operations are planned.
- Determine if gas emissions will exceed the diluting capacity of the mine ventilation air (at the planned mining rate).
- Consider pre-drainage to reduce SGE (target high emission coal seams).
- Consider goaf drainage to reduce gas emissions into mine ventilation air.
- Timely use of appropriate pre-drainage and goaf drainage methods will not only reduce gas constraints on longwall production but will also reduce fugitive gas emissions.
- Thorough planning and design will significantly reduce the risk of poor performance.

U O W

Thank You.

Pacific **MGM**

Mining & Gas Management Consultants

www.pacificmgm.com.au

UNIVERSITY
OF WOLLONGONG
AUSTRALIA