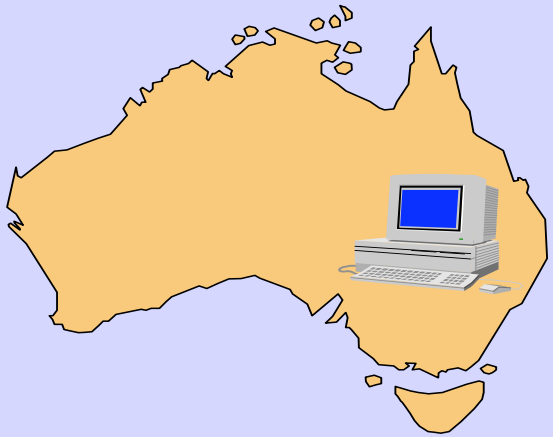
'Coal mine goaf gas predictor' (CMGGP)

ACARP C17058 '07project



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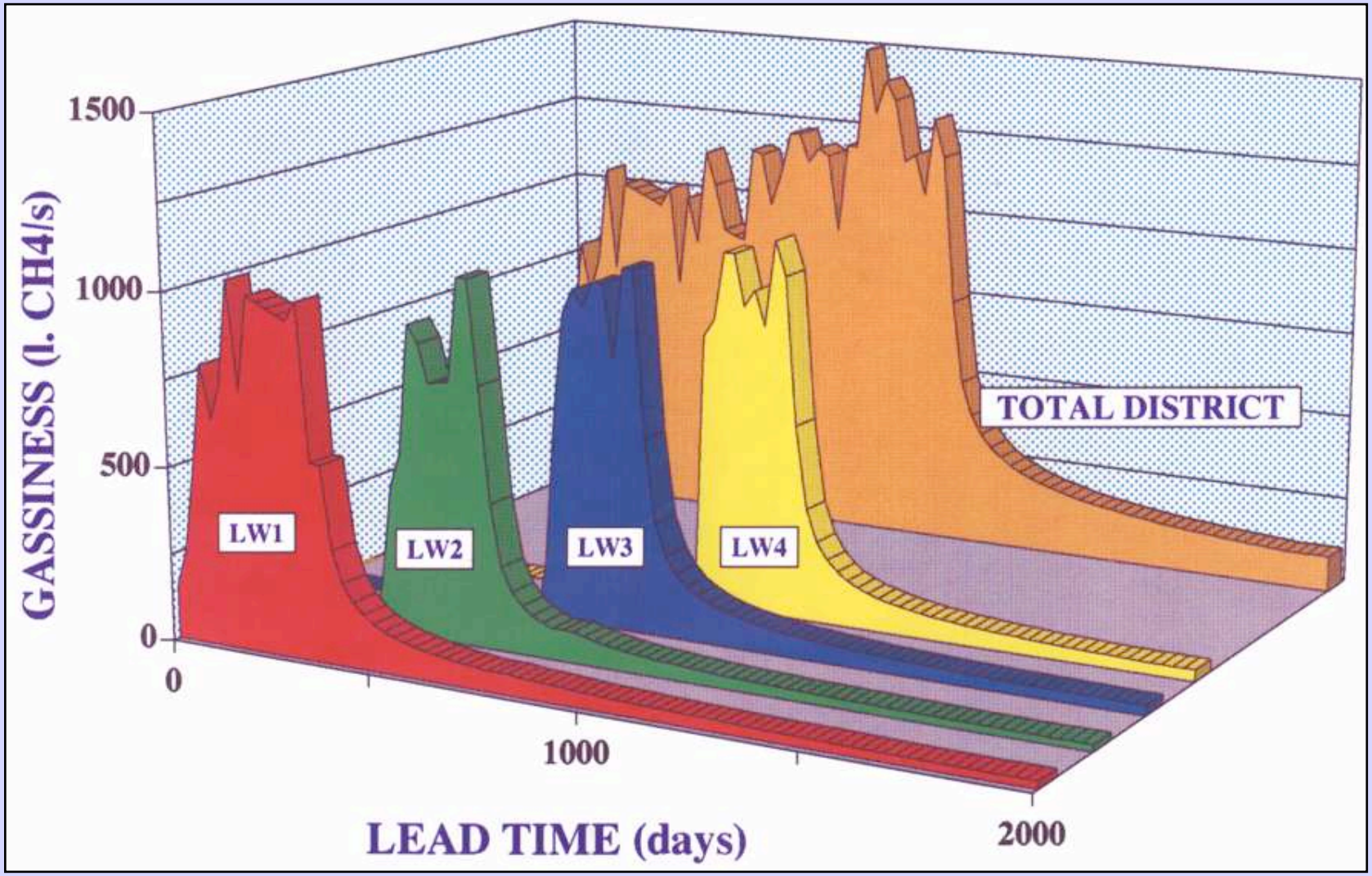
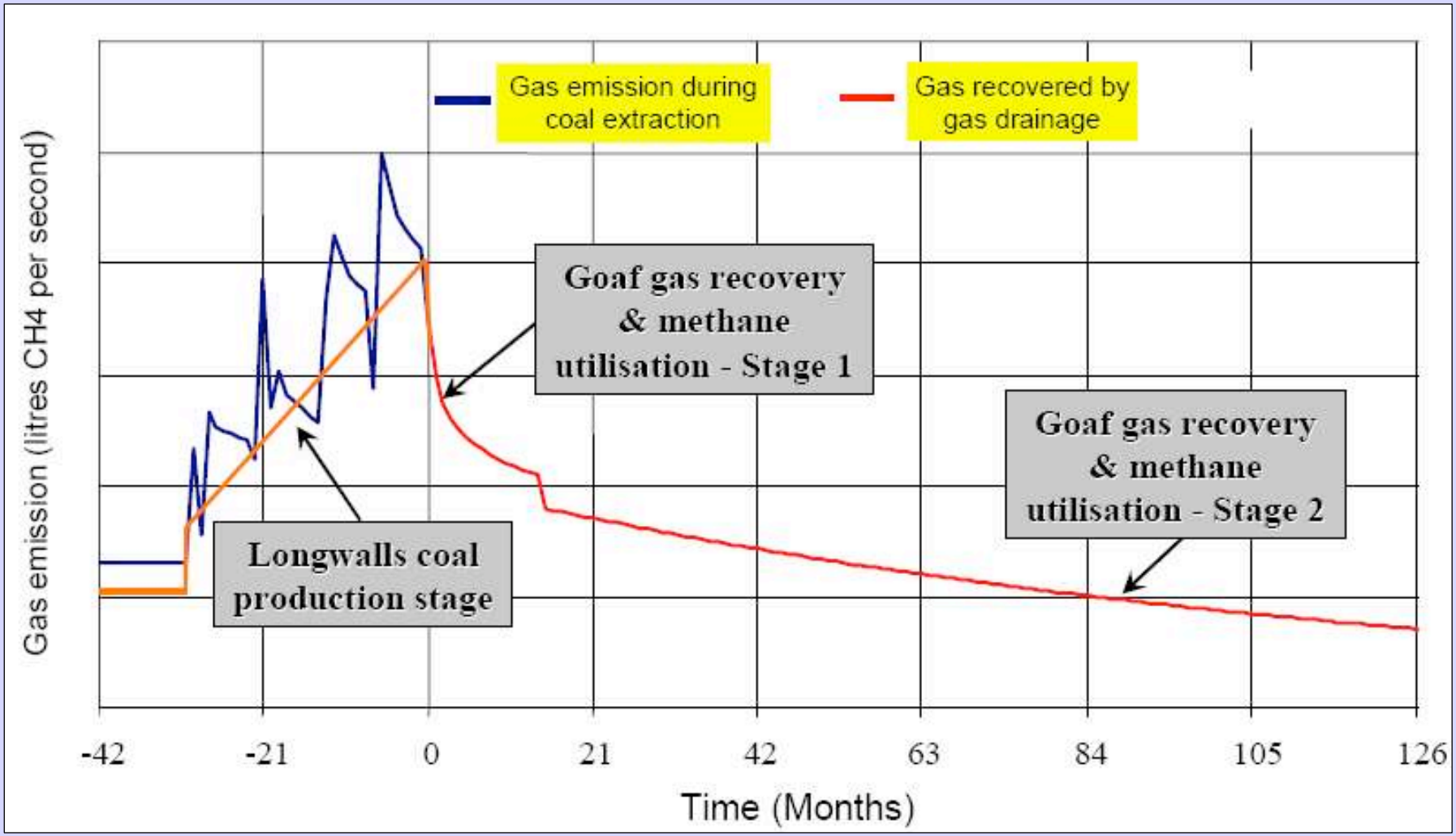
Lunagas Pty Limited

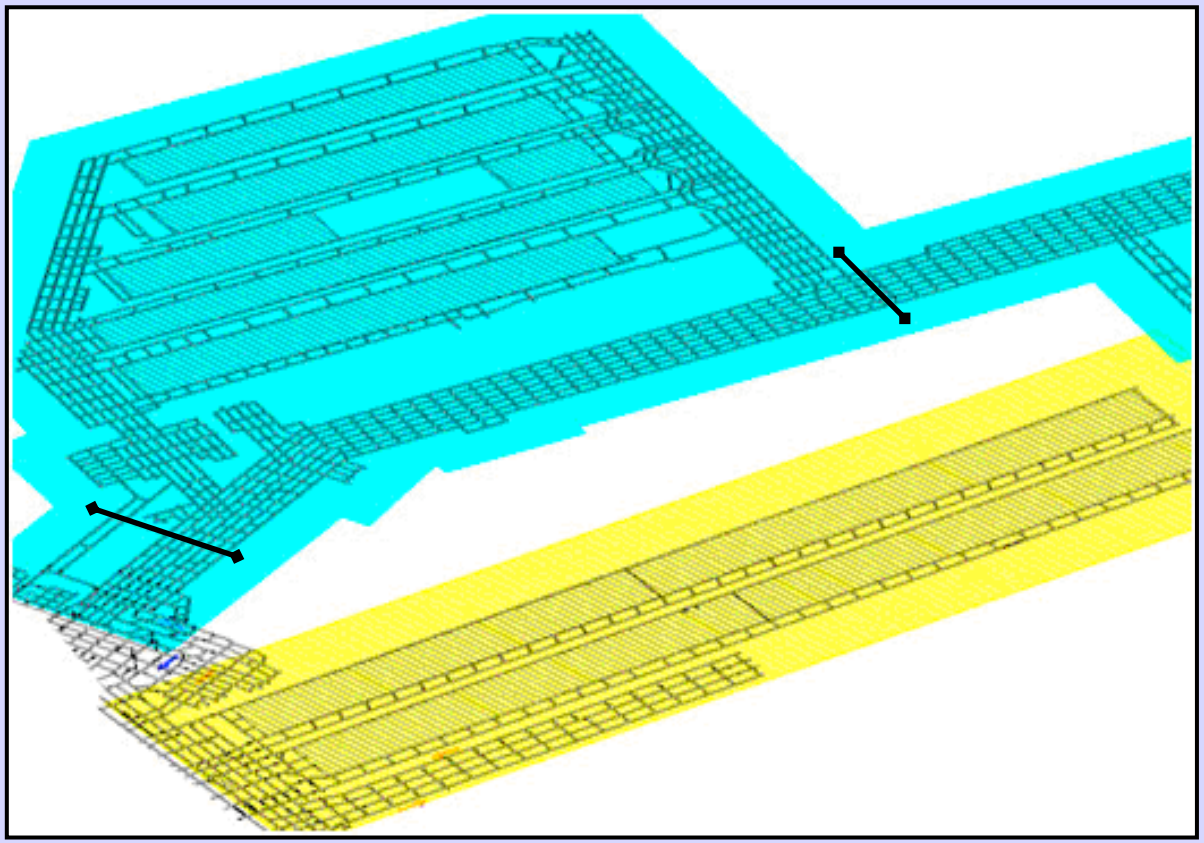
Wollongong
24 June 2009

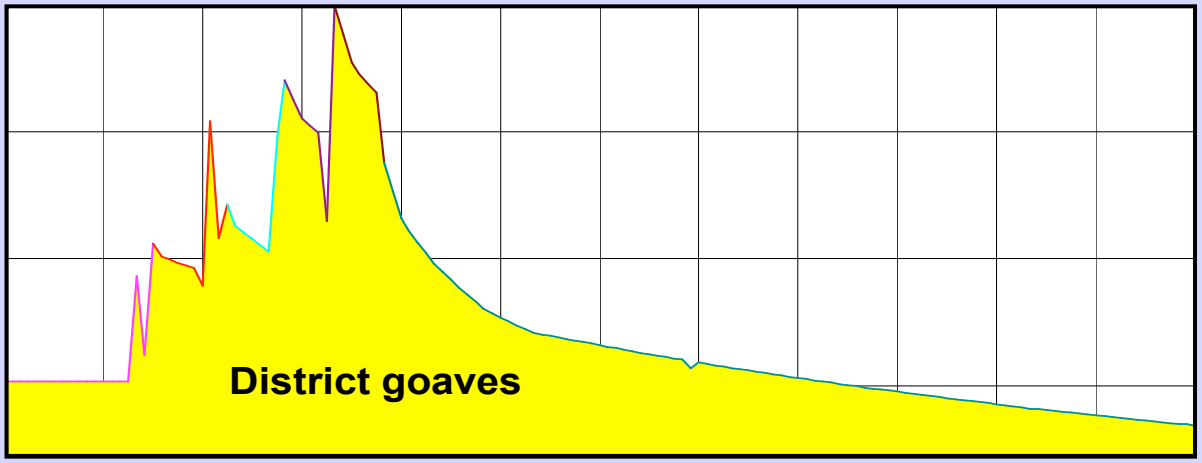
Multi longwall & district or whole mine gas emission versus time



Multi longwall extraction & closed mine gas emission decline curves





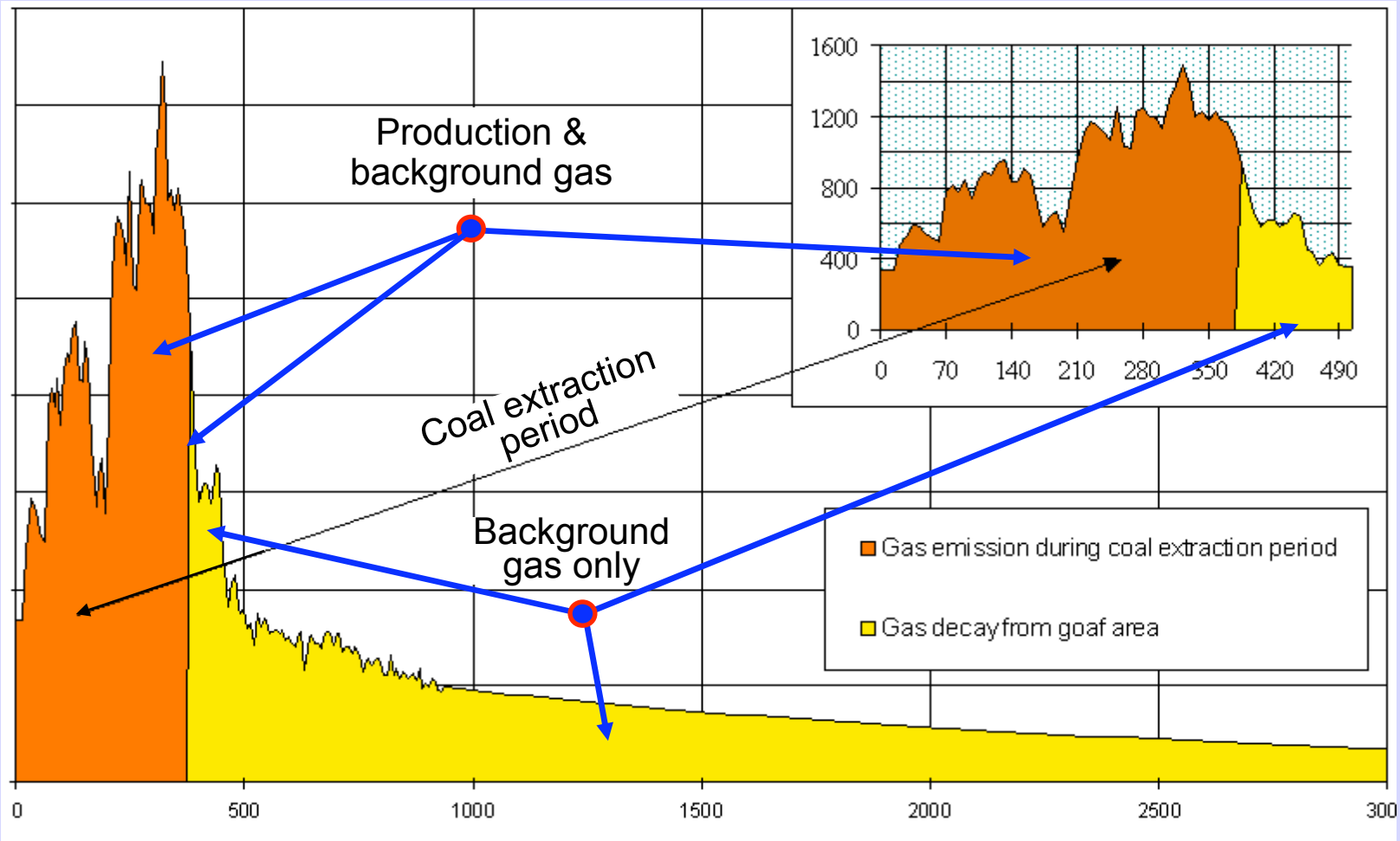


Selected district gas emission & goaves decline curve

U/G gassy coal mines classification

Classification	Mine entries and surface boreholes	Ventilation	Coal production	Water pumping	Responsibility	Time
Temporary closed	Opened, not permanently or partially sealed	Operating on reduced capacity	Ceased Possible future production	Optional	Mine operator (maintenance)	Not a factor
Closed	Partially or fully sealed	Optional	Ceased No future production	Terminated Goaves gradually flooding	Mine operator	
Decommissioned	Permanently sealed				Transferred from mine operator to the relevant Government Authority	1-20 years Once transfer occurs
Abandoned						
Sealed longwall or district				Optional	Mine operator	Not a factor

Production & background gas emission



CMGGP formulae for rapid and long term decline curves

Stage 1. Production & background gas

Up to 12 months

The logarithmic approximation curve

$$Q = -A * \mathrm{Ln}(\mathrm{Time}) + B$$

Stage 2. Background gas only

Up to 30 years

The exponential approximation curve

$$Q = C * e^{-D * (\mathrm{Time})}$$

Mathematical equation coefficients

A - Gas emission decay rate
B - Gas emission initial magnitude & strata permeability
C - Gas reservoir capacity & characteristics
D - Rate and quickness of decline

CMGGP formulae for long term background methane decline curve

$$F(x) = a * e^{-b*x}$$

Where:

x - time (months)

a - quantity constant

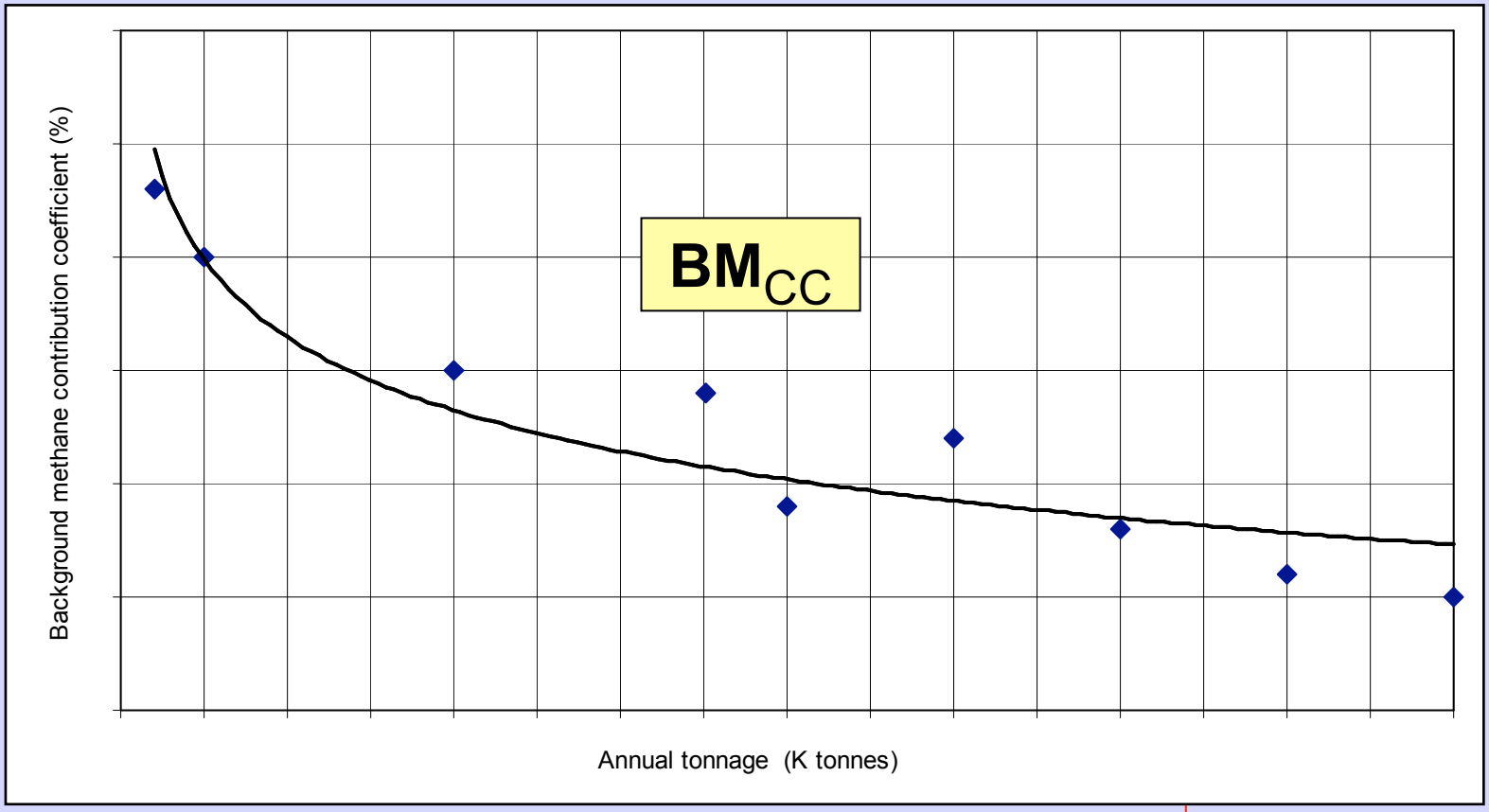
b - decline constant, or

$$BM_{DE} = BM_{IN} * EXP(-b * months)$$

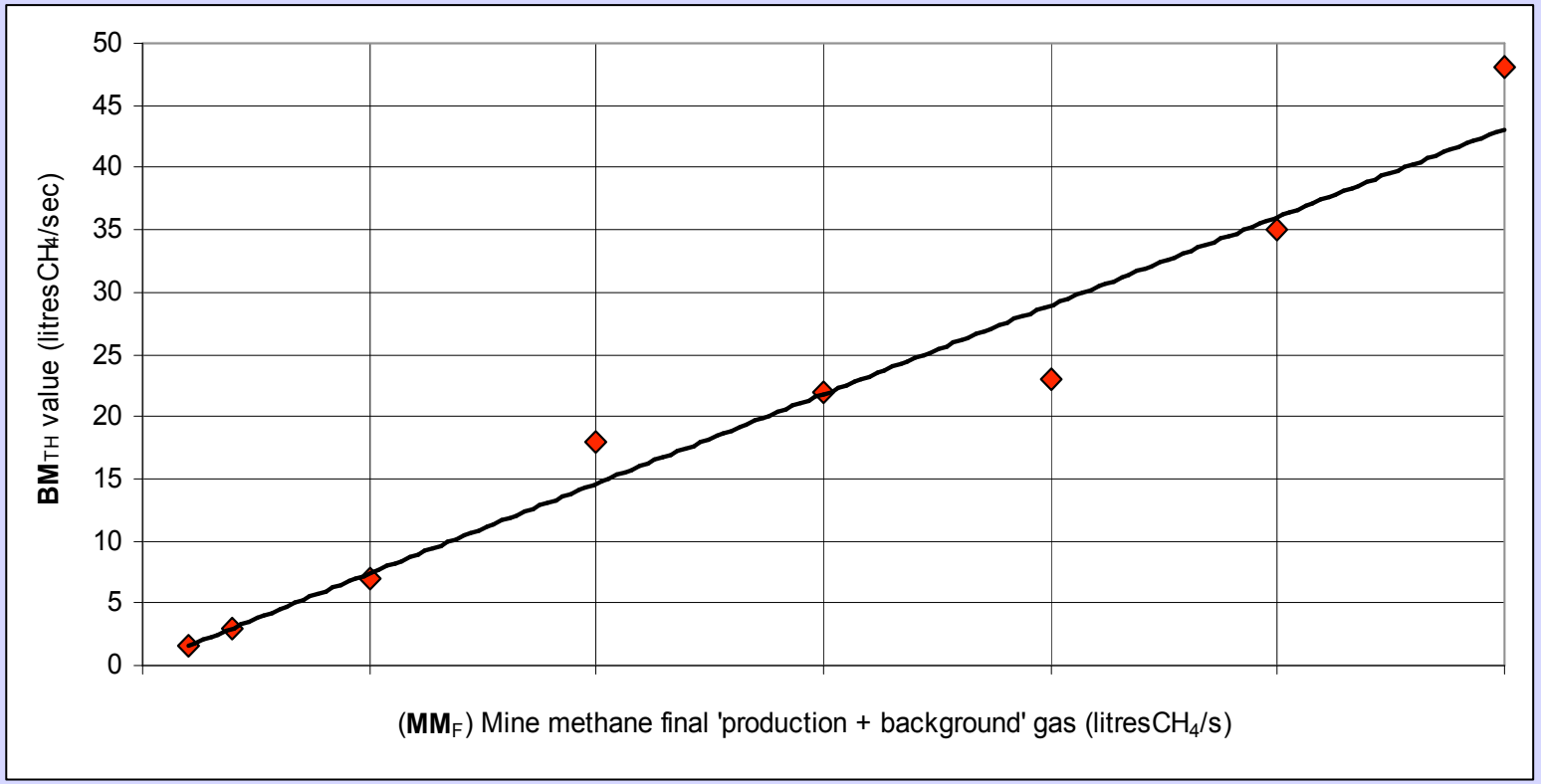
Where:

BM_{DE}	-	Background methane decline emission (methane make)
$BM_{IN} = MM_F * BM_{CC}$	-	Background methane initial quantity (3 -12 months after ceases coal production)
MM_F	-	Mine methane final (1 month before ceases coal production)
AT	-	Annual tonnage (last 5 years average coal production)
BM_{CC}	-	Background methane contribution coefficient (either related to the annual coal production and/or various mine categories geological & mining conditions) Cat I & II = $c * AT^{-d}$ Cat III, V & VIII = **e** Cat IV, VI & VII = **f**

Background methane contribution coefficient vs last 5 years annual tonnage



Background methane threshold BM_{TH} vs dry mine methane final MM_F



GRM software simulation sequence

Two stages of coal mine gas quantity decline phenomenon

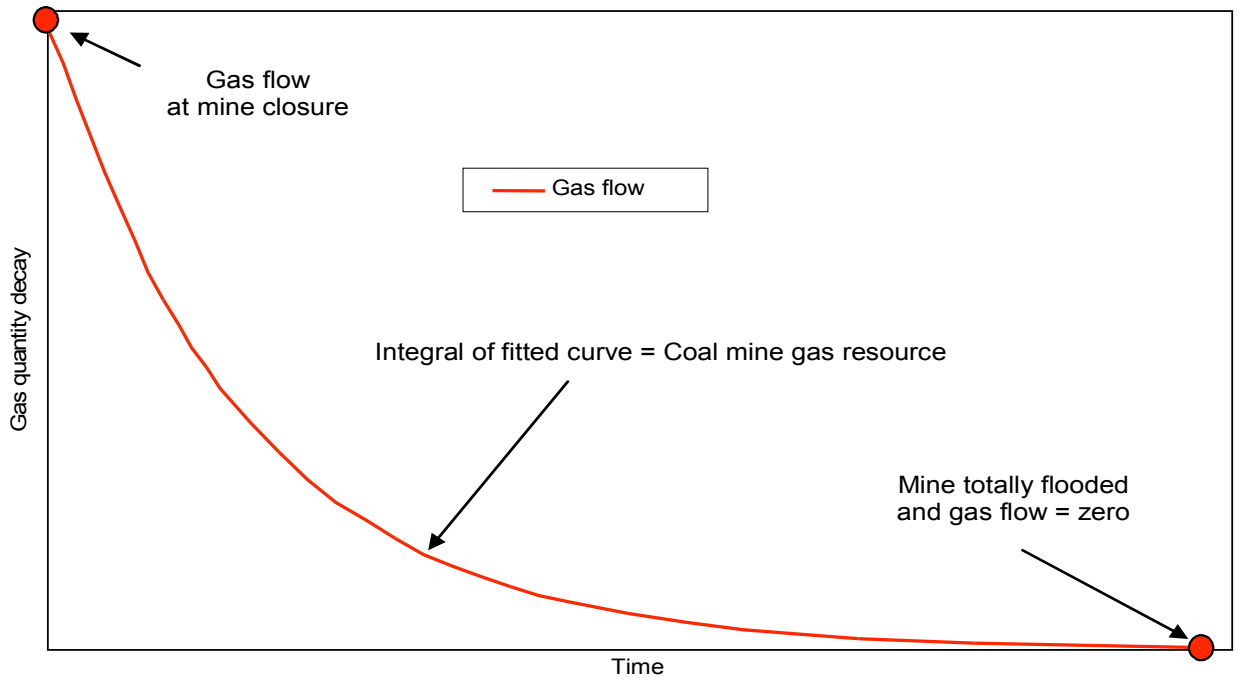
- **PRODUCTION gas - rapid decline phase**
- **BACKGROUND gas - slow/long term decline phase**

Outputs: Gas emission decline curve

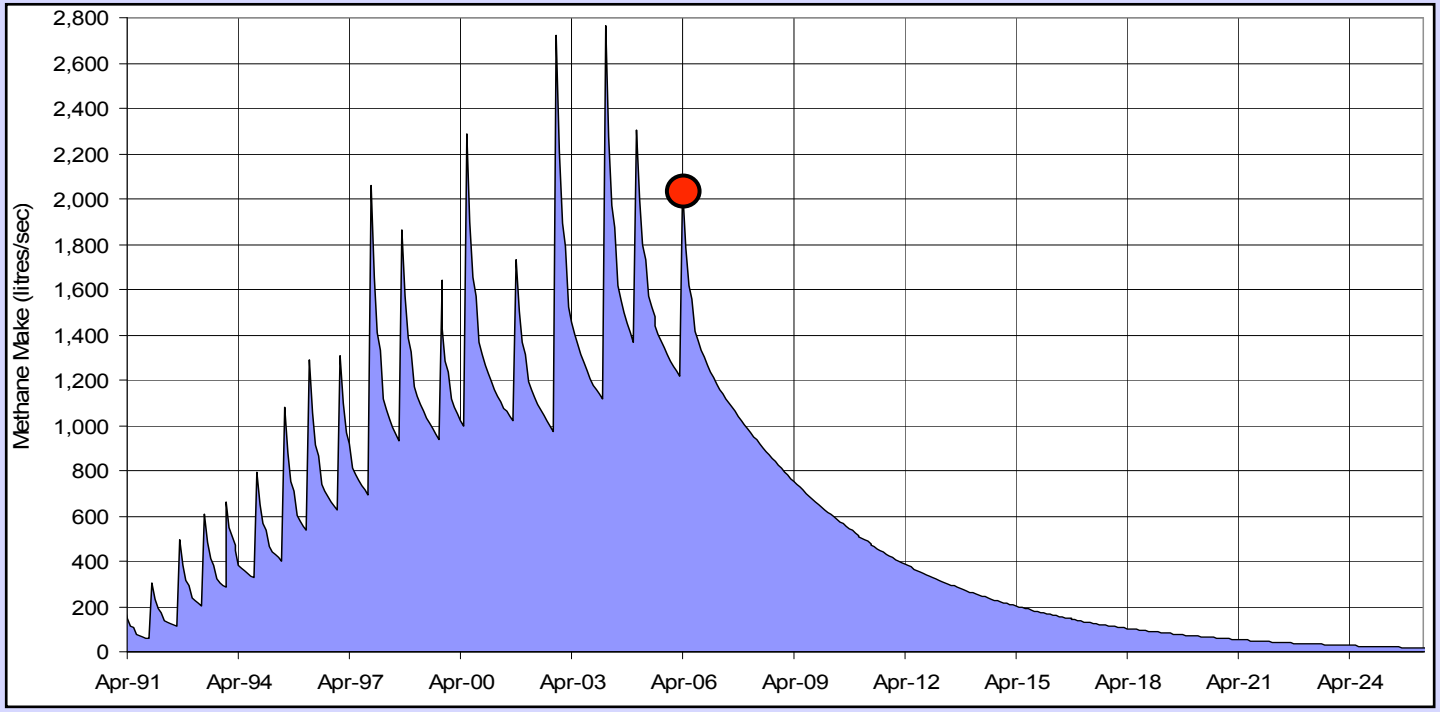
- **DRYSIM - Dry mine gas decline rate vs time and,**
- **WETSIM - Flooded mine gas decline rate vs time**

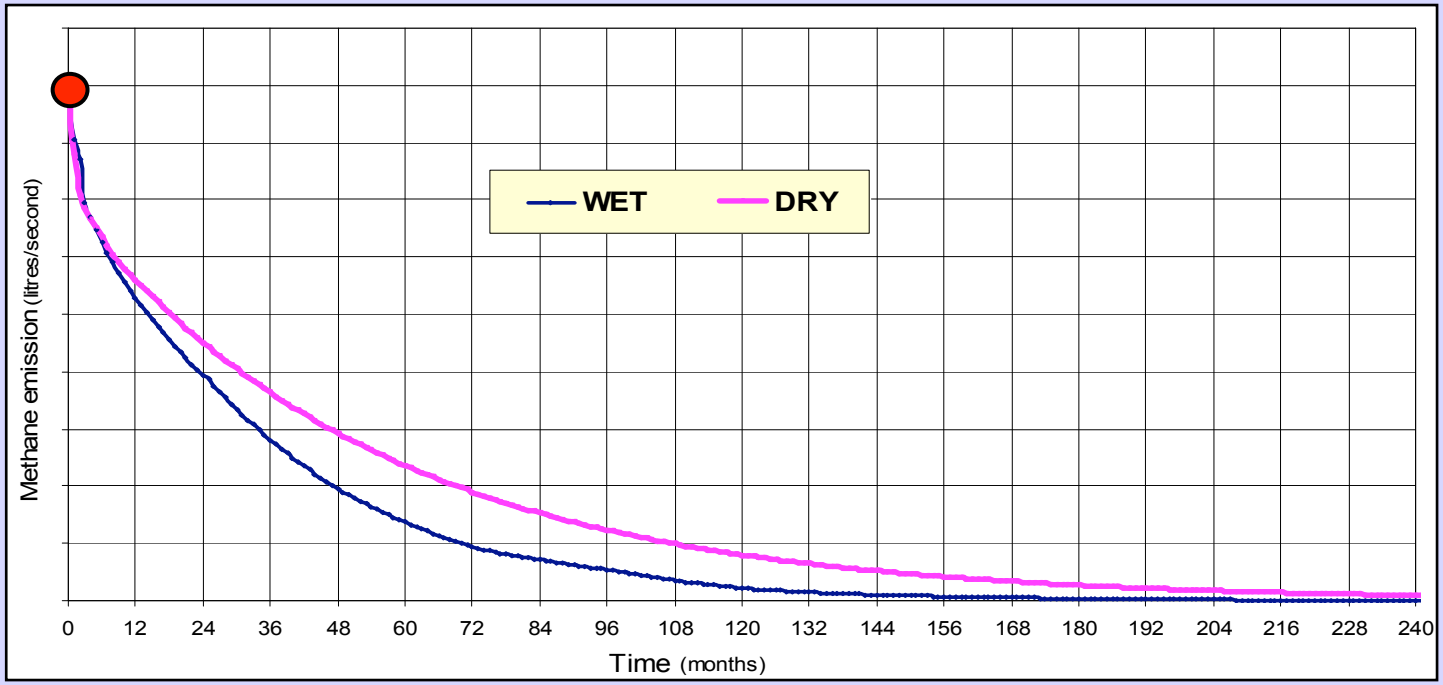
WETSIM curve concept using zero methane emission

Gas emission will be zero when the mine is finally flooded and the time when this occurs is estimated from the void and water inflow data.



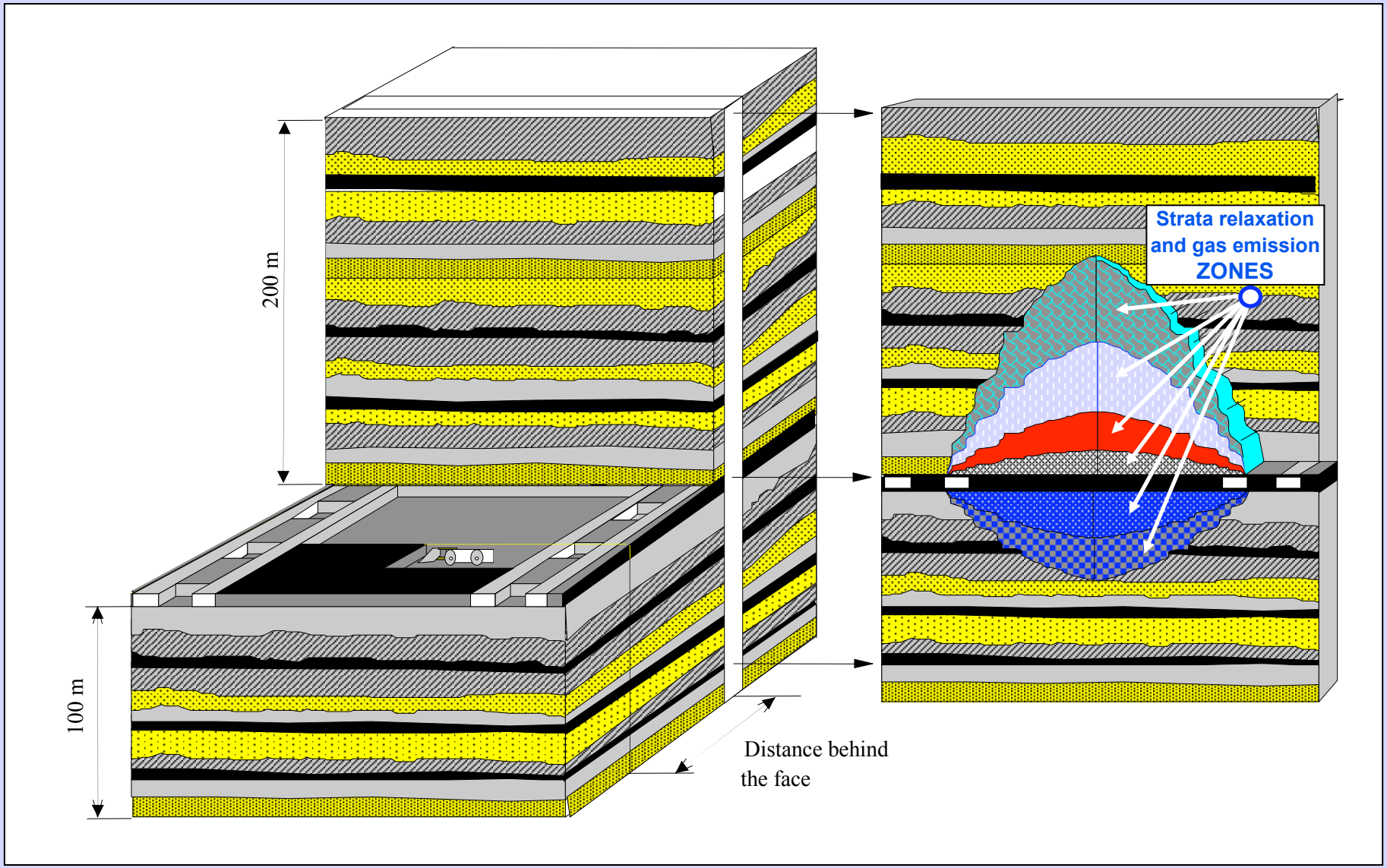
Example of high gassy mine methane emission & goaves gas decline curves prediction for 20 years





Strata relaxation & gas release zones

Lunagas Pty Limited 'GRM' software - simplified concept



Gas reservoir calculations

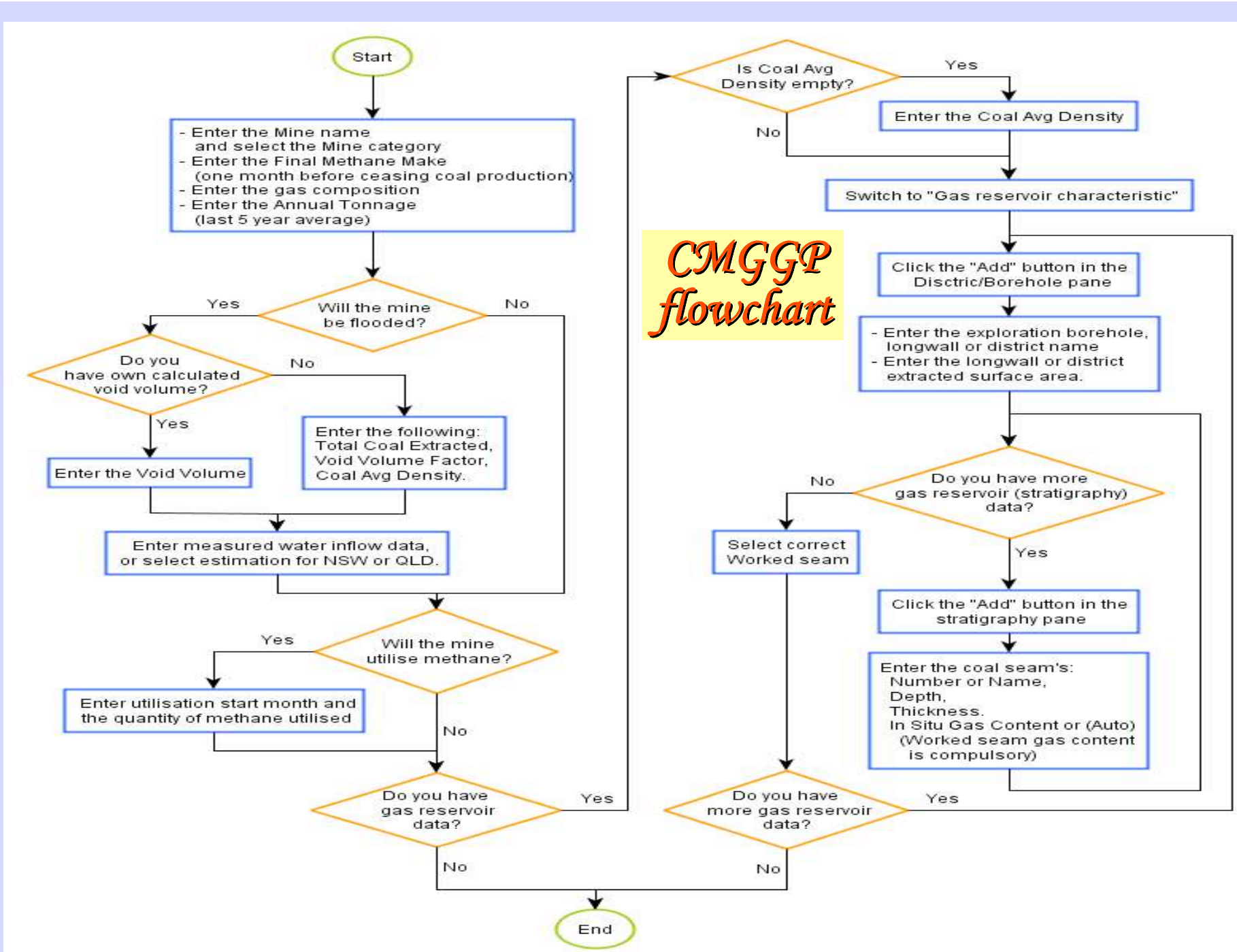
Area of mining influence (m^2):			982,000						
Coal density (t/m^3):			1.30						
Coal seam name	Depth	Thickness	Distance from Worked Seam	In situ gas content	Remaining gas quantity factor	Residual desorbing gas		Coal volume	Available gas
	m	m	m	m^3/t	-	m^3/t	m^3/m^3	Mm^3	Mm^3
n	155.00	0.65	159.23	4.34	0.89	3.87	5.03	0.6	3.21
-	-	-	-	-	-	-	-	-	-
4	190.25	1.42	123.98	5.33	0.81	4.32	5.61	1.39	7.83
3	276.83	1.02	37.40	7.75	0.24	1.88	2.45	1.00	2.45
2	283.92	0.97	30.31	7.95	0.15	1.21	1.57	0.95	1.50
1	293.84	0.80	20.39	8.23	0.00	0.00	0.00	0.79	0.00
WS	**314.23**	**2.05**	**0.00**	**8.80**	**0.00**	**0.00**	**0.00**	**2.01**	**0.00**
1	321.75	0.65	7.52	9.01	0.00	0.00	0.00	0.64	0.00
2	341.63	1.50	27.40	9.57	0.47	4.53	5.89	1.47	8.67
-	-	-	-	-	-	-	-	-	-
n	362.00	0.30	47.77	10.40	0.87	9.10	11.83	0.29	3.48
								Grant total ($M m^3$):	**27.15**

U/G gassy coal mines categories For CMGGP simulation

$$F(x) = a^{*}e^{-b^{*}x}$$

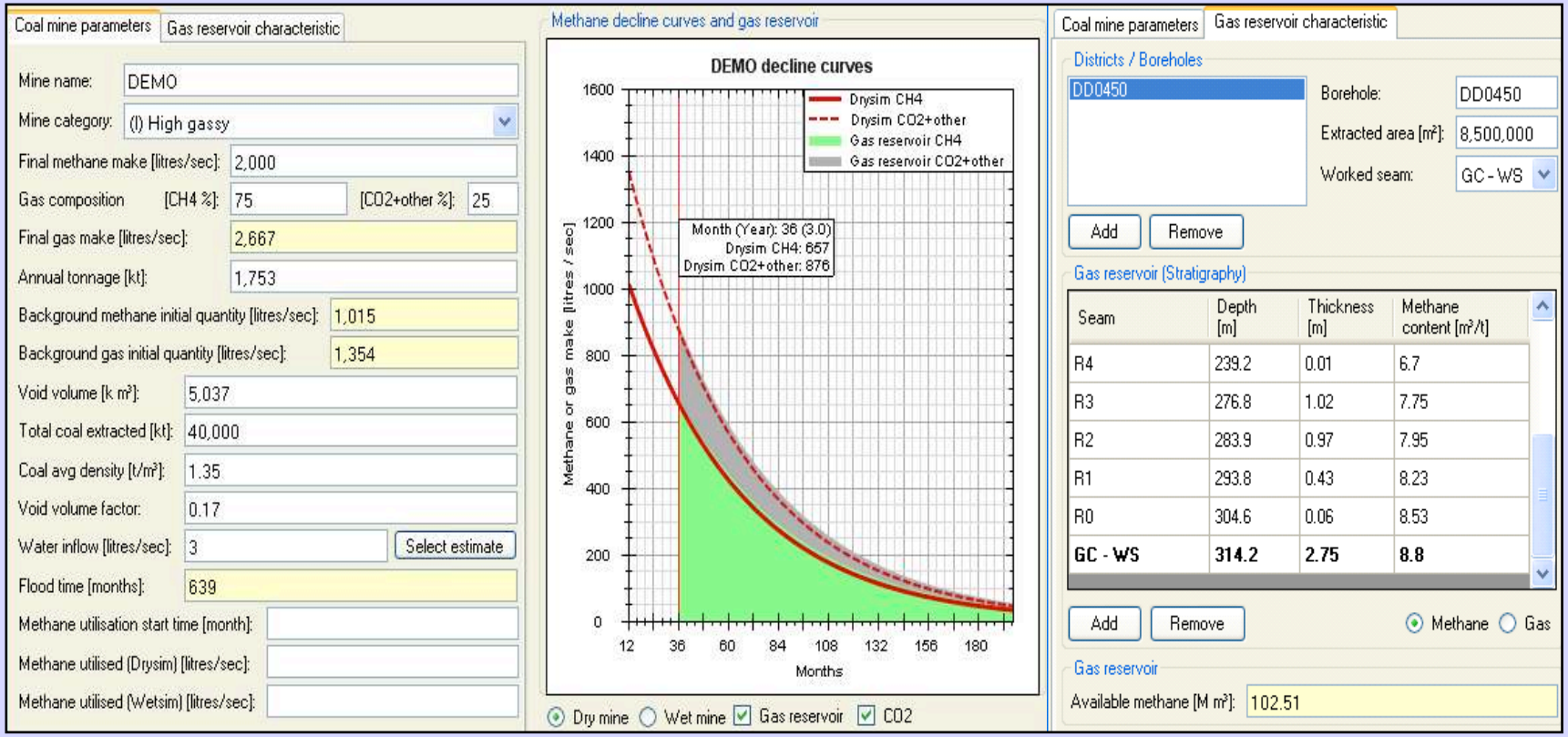
Where:
x - time (months)
a - quantity constant
b - decline constant

Category	Description	Coefficient a	Coefficient b
I	High gassy	a_{I}	b_{I}
II	Low gassy	a_{II}	b_{II}
III	Low permeability	a_{III}	b_{III}
IV	High permeability or shallow mine	a_{IV}	b_{IV}
V	Temporary closed	a_{V}	b_{V}
VI	Sealed district goaves	a_{VI}	b_{VI}
VII	Sealed longwall goaf	a_{VII}	b_{VII}
VIII	Room & pillar goaf	a_{VIII}	b_{VIII}


CMGGP flowchart
Start
- Enter the Mine name and select the Mine category
- Enter the Final Methane Make (one month before ceasing coal production)
- Enter the gas composition
- Enter the Annual Tonnage (last 5 year average)
Will the mine be flooded?
Yes
No
Do you have own calculated void volume?
Yes
No
Enter the Void Volume
Enter the following: Total Coal Extracted, Void Volume Factor, Coal Avg Density.
Enter measured water inflow data, or select estimation for NSW or QLD.
Will the mine utilise methane?
Yes
No
Enter utilisation start month and the quantity of methane utilised
Do you have gas reservoir data?
Yes
No
Is Coal Avg Density empty?
Yes
No
Enter the Coal Avg Density
Switch to "Gas reservoir characteristic"
Click the "Add" button in the Disctric/Borehole pane
- Enter the exploration borehole, longwall or district name
- Enter the longwall or district extracted surface area.
Do you have more gas reservoir (stratigraphy) data?
No
Yes
Select correct Worked seam
Click the "Add" button in the stratigraphy pane
Enter the coal seam's: Number or Name, Depth, Thickness. In Situ Gas Content or (Auto) (Worked seam gas content is compulsory)
Do you have more gas reservoir data?
Yes
No
End

CMGGP software

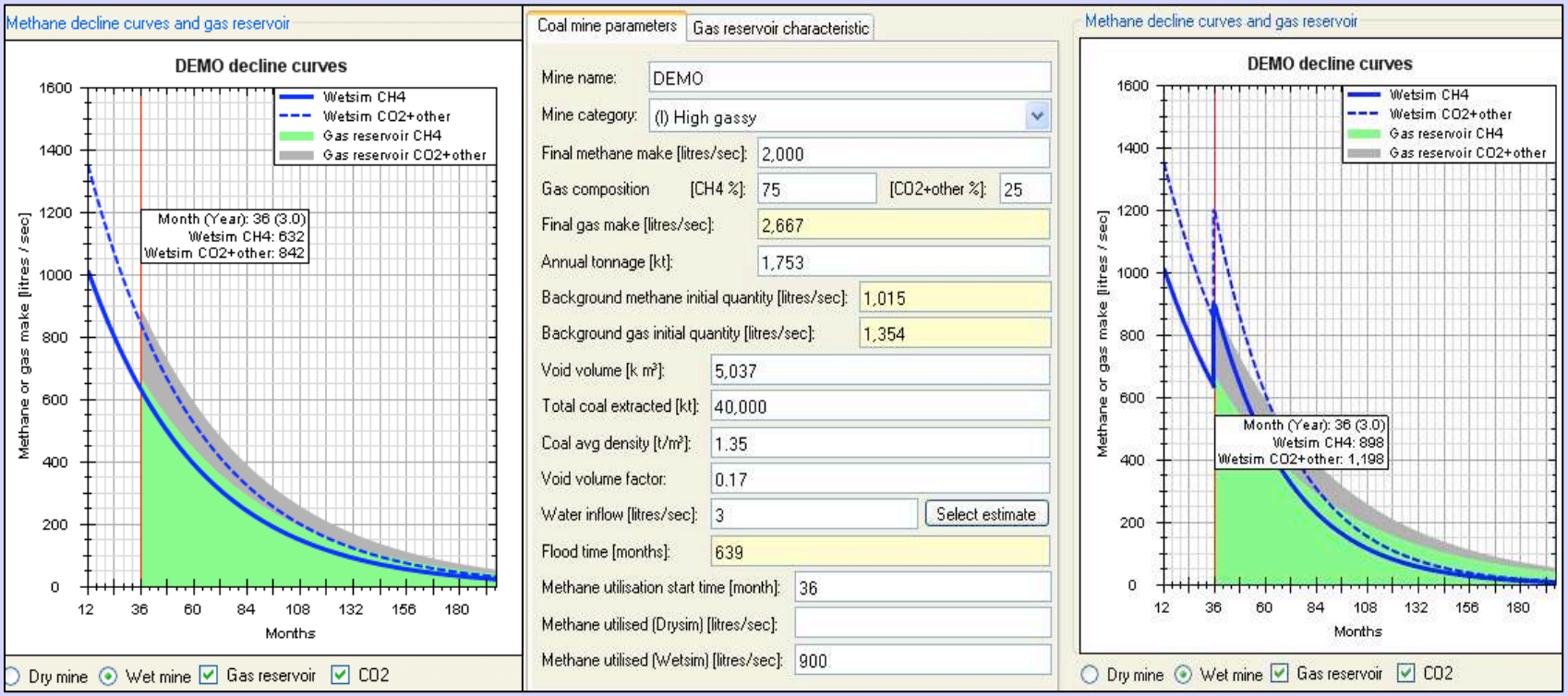
Dry mine inputs & outputs



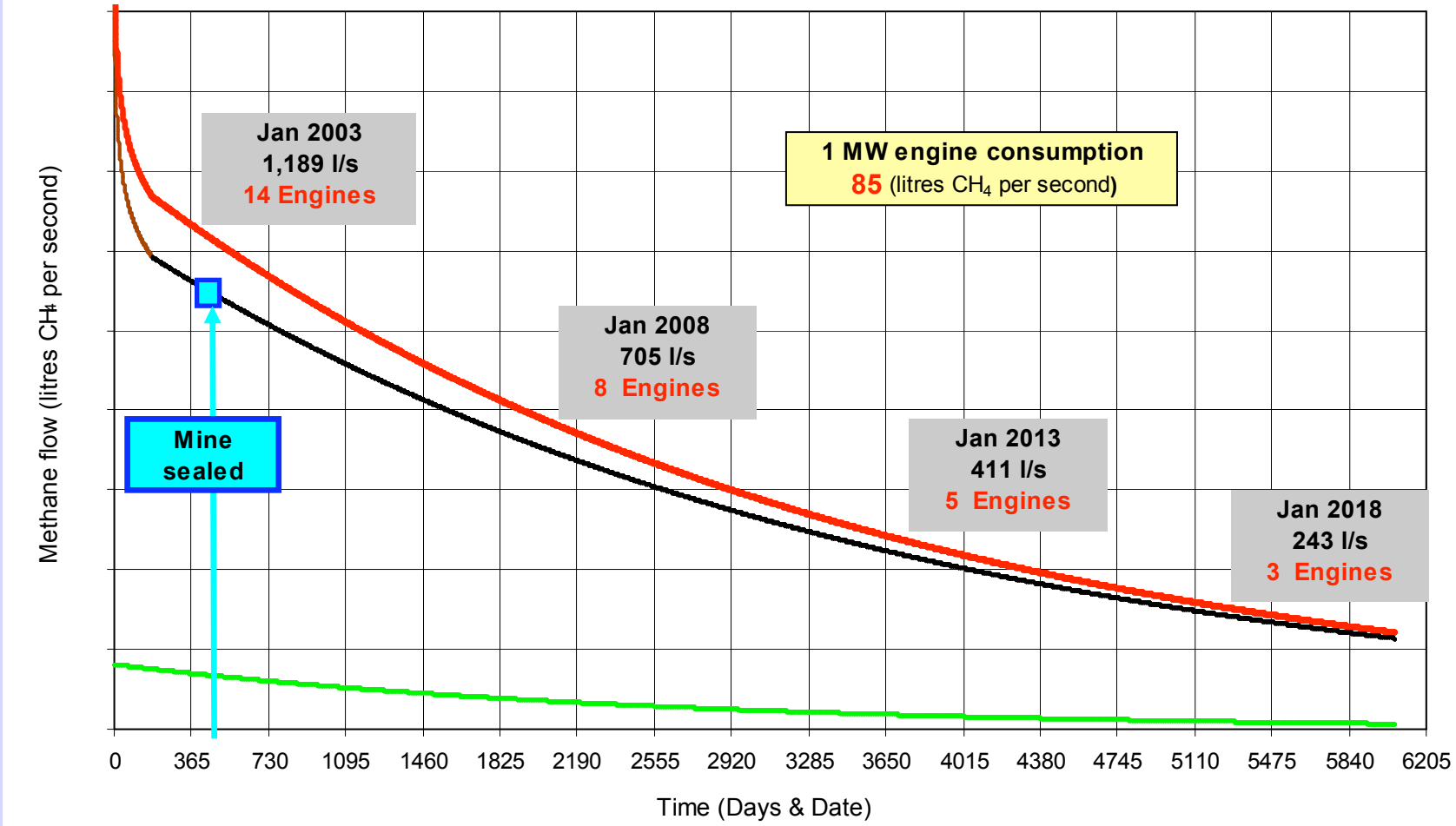
CMGGP software

Flooded mine inputs-outputs

Gas emission & methane utilisation curves



Coal mine gas emission projection for temporary closed mine pumping water



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