Particulates and Health

Dr Craig Dalton,

Public Health Physician

Hunter New England Population Health

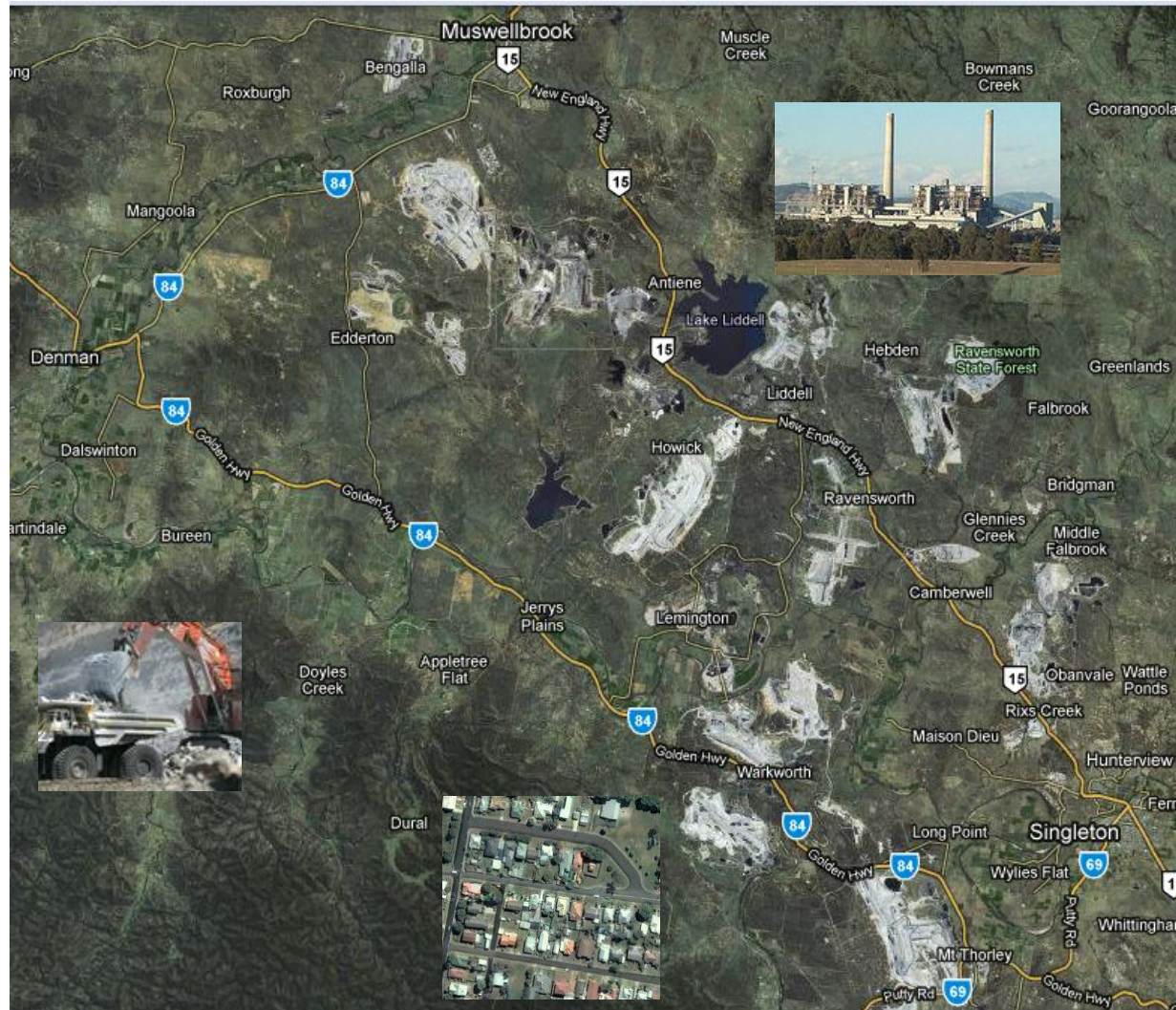Craig.dalton 'at' hnehealth.nsw.gov.au

Presentation Overview

- What are particulates?

- What are their health effects?

- What we do/don't know about particulates in the Hunter

- Health studies in the Hunter

  - Hospital data for Hunter New England

  - General Practice data (BEACH Report)

- Future studies

Hunter Valley Mining & Power

Particulates (PM10, PM2.5)

PM_{10} and $PM_{2.5}$ refer to particles with mean diameter of less than 10 and 2.5 microns, respectively.

$PM_{2.5}$ average 70% of PM_{10} by weight, but there are many more $PM_{2.5}$ particles in number

$PM_{2.5}$ are more hazardous to health, especially those produced by burning coal and petroleum

Health
Hunter New England
Local Health Network

Health effects of particulates

Numerous scientific studies have linked particle pollution exposure to a variety of problems, including:

- increased respiratory symptoms, such as irritation of the airways, coughing, or difficulty breathing, for example;
- decreased lung function;
- aggravated asthma;
- development of chronic bronchitis;
- irregular heartbeat;
- lung cancer;
- nonfatal heart attacks; and
- premature deaths (esp. in people with heart or lung disease).

HUMAN HAIR
50-70 μm
(microns) in diameter

PM2.5
Combustion particles, organic
compounds, metals, etc.
< 2.5 μm *(microns)* in diameter

PM10
Dust, pollen, mold, etc.
<10 μm *(microns)* in diameter

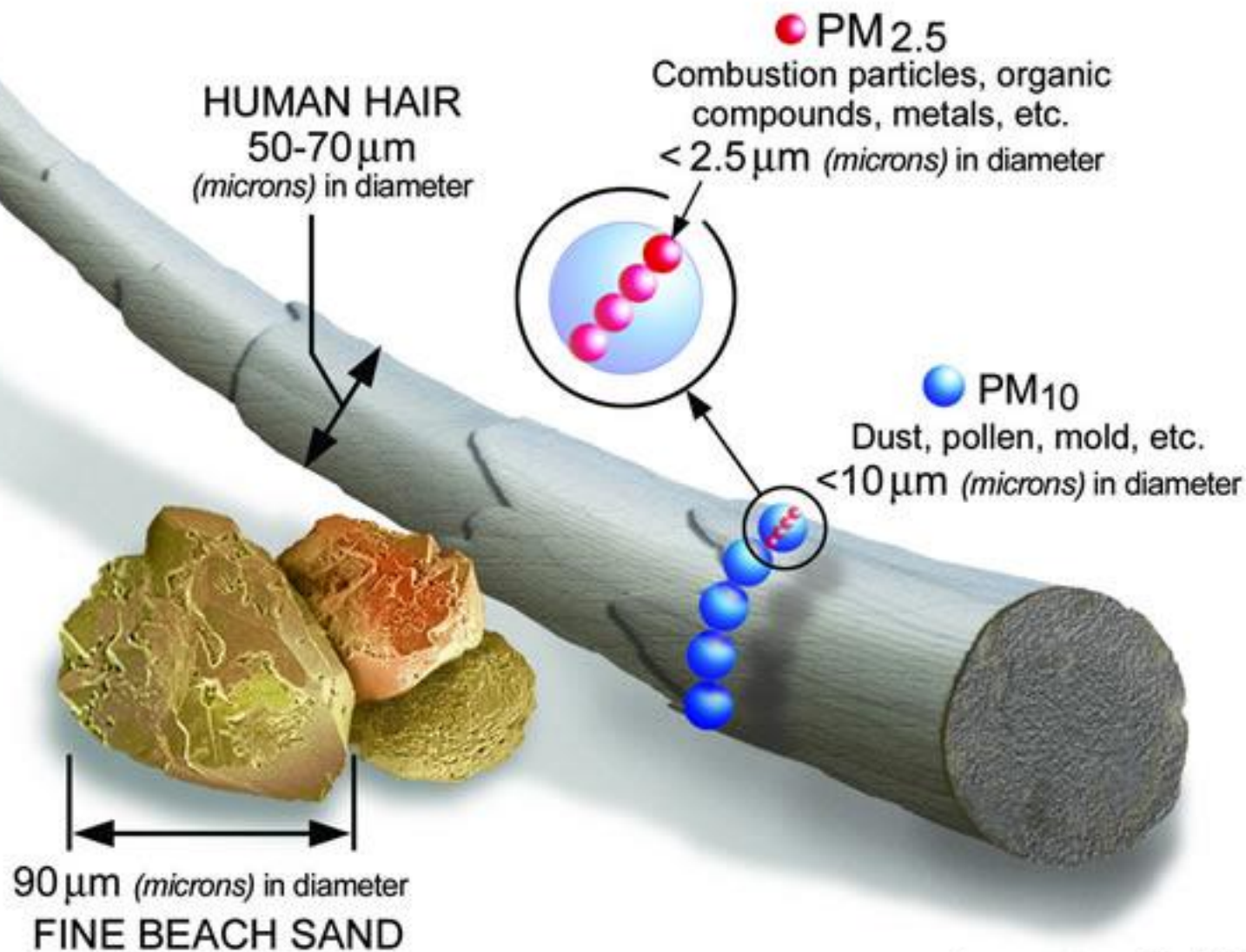90 μm *(microns)* in diameter
FINE BEACH SAND

Image courtesy of the U.S. EPA

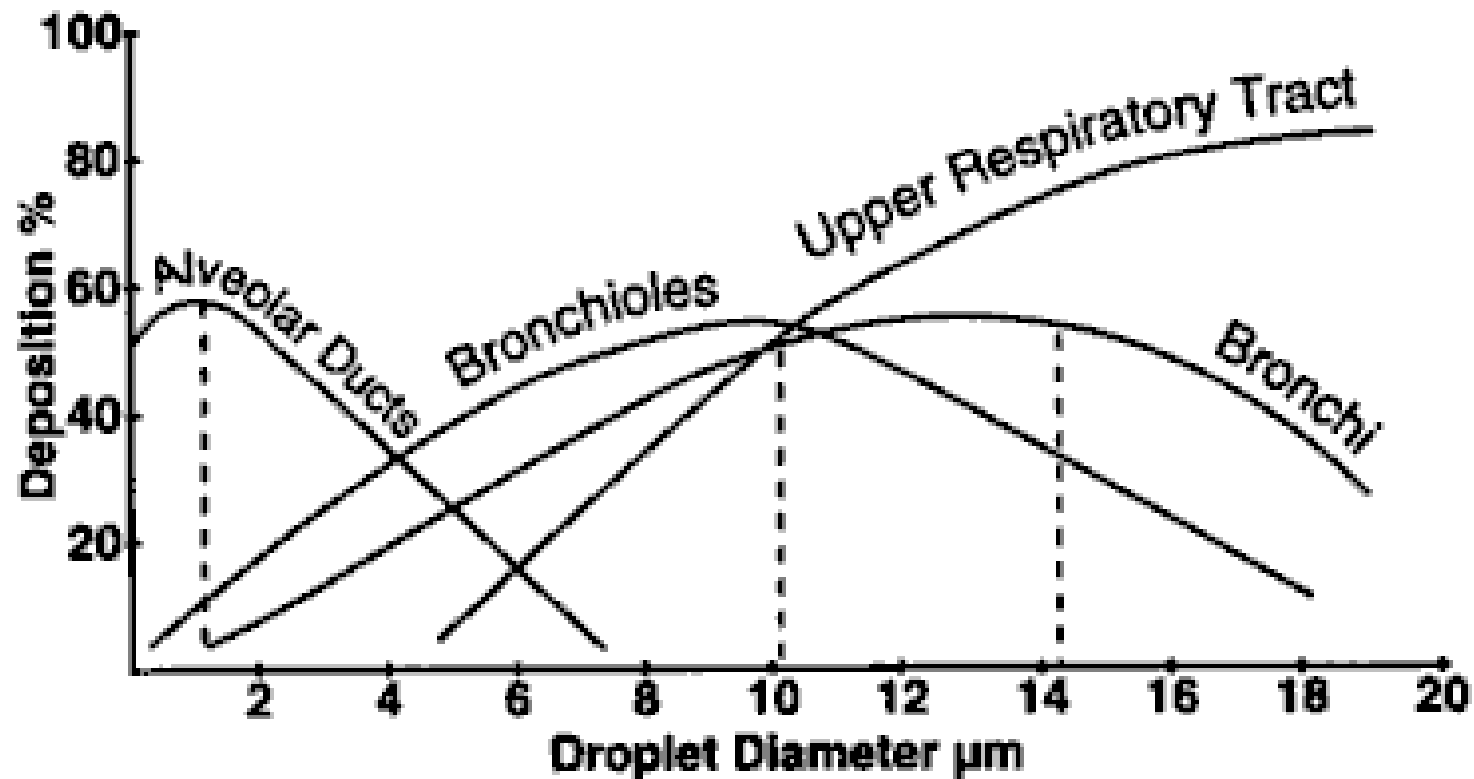# Diesel particle – a cocktail of substances...
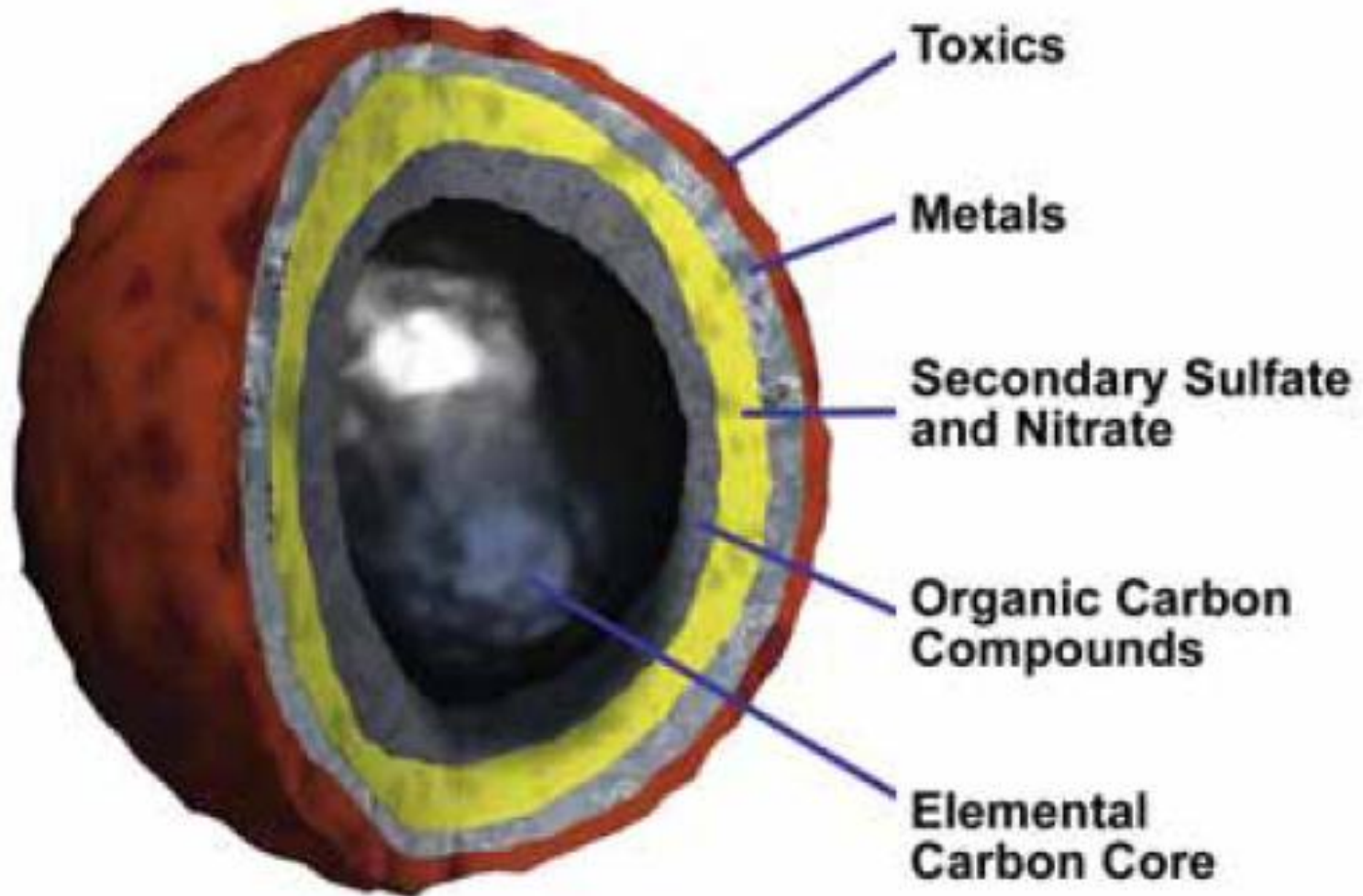
Particle size

Nasopharynx — 7 Microns & above

Mouth

4.7 - 7 Microns

Trachea

3.3 - 4.7 Microns

Lungs

2.1 - 3.3 Microns

Bronchial Tree

1.1 - 2.1 Microns

0.65 - 1.1 Microns

Diaphragm
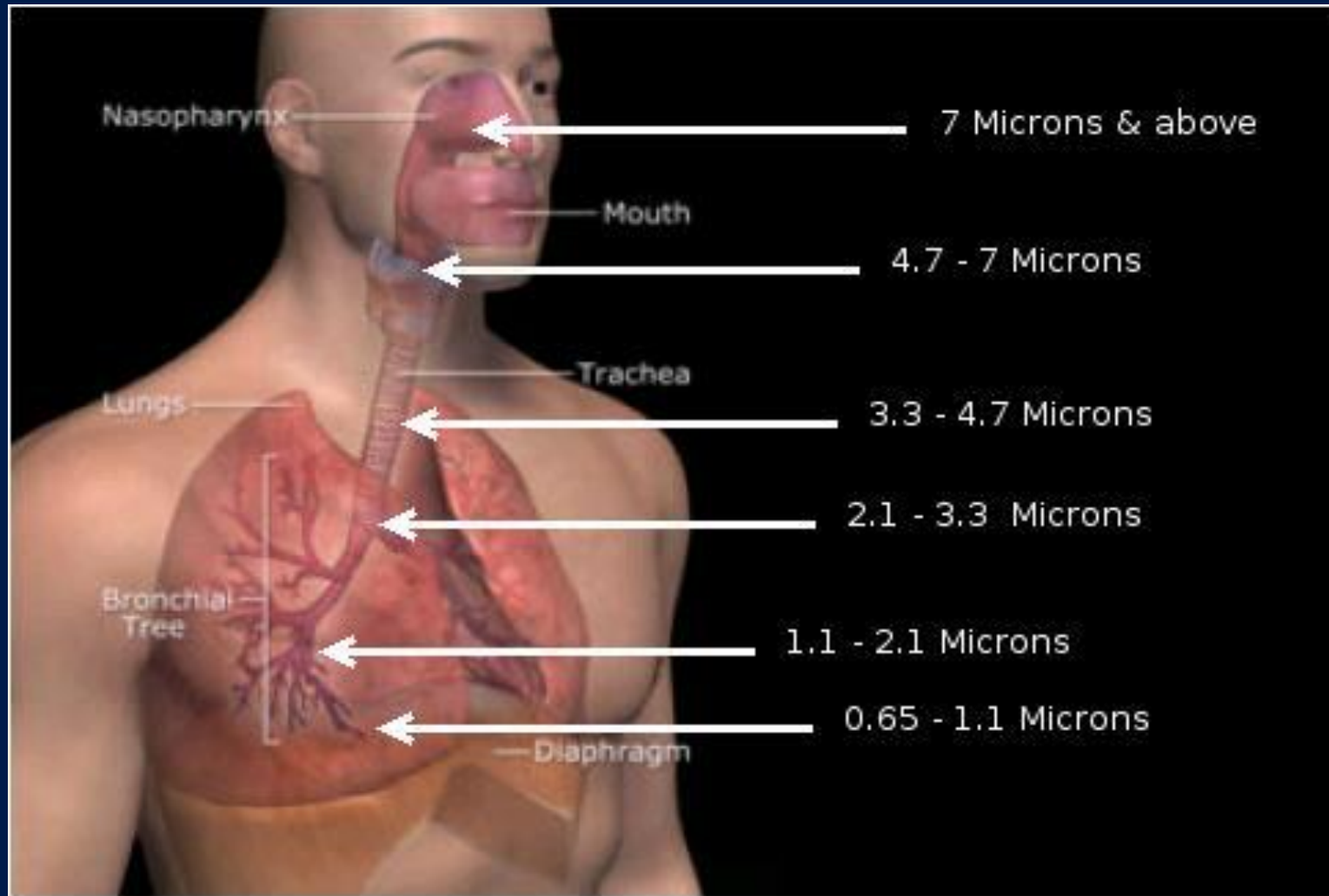
Figure 1-I. Droplet Size and Penetration of Respiratory Passages

Figure 2.1 Selected pollutants, their average residence times in the atmosphere and maximum extent of their impact

Maximum scale of the problem

global: CO_2 CH_4 N_2O SF_6 HFCs PFCs HCFCs CFCs

CO

Tropospheric ozone

regional: SO_4^{2-} NO_3^- NH_4^+ $PM_{2.5}$

local: SO_2 NO_2 NO NH_3 PM_{10}

hours — days — weeks — months — years — centuries

Residence time in the atmosphere

Source: EEA, 1995, Center for Airborne Organics, 1997.
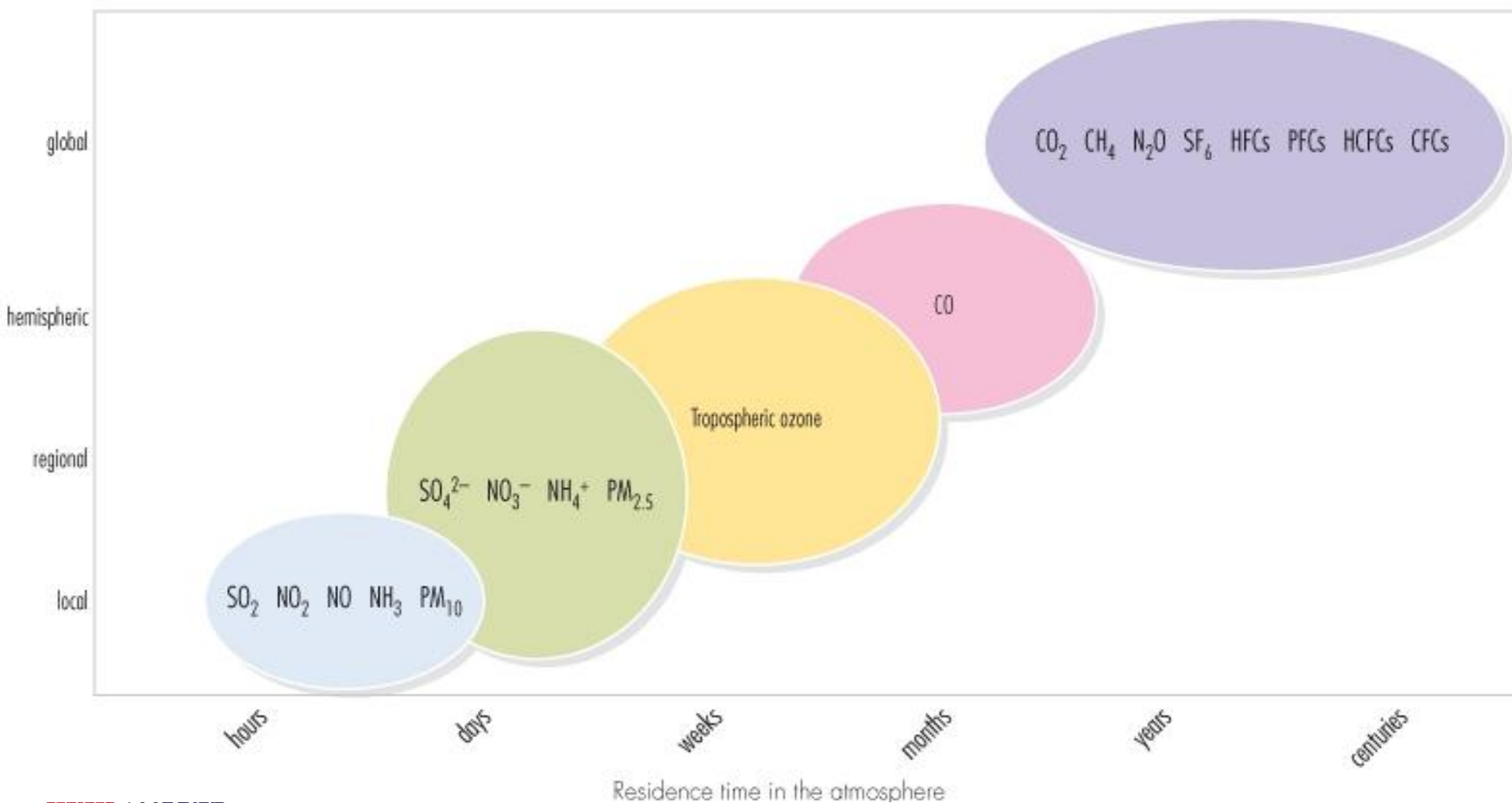
Airborne particle size distribution in a diesel-equipped mine
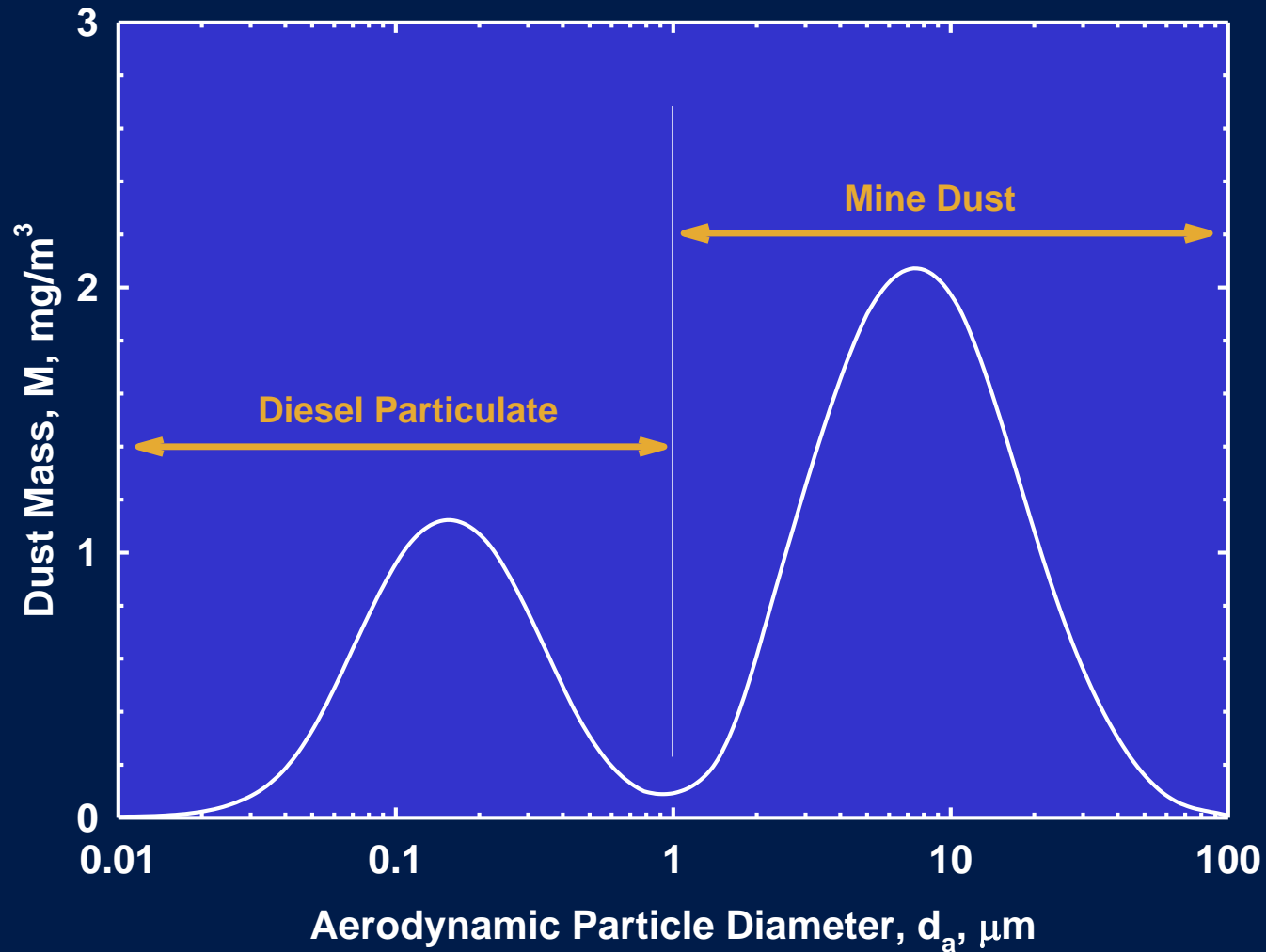
Source: Airmet Scientific

Annual Particulates and Mortality in Six Cities

Dockery et al., NEJM 1993:329:1753-9

Y-axis: relative risk of death (1, 1.1, 1.2, 1.3)

X-axis: PM2.5 (ug/m^3) (5, 15, 25, 35)

NSW GOVERNMENT Health
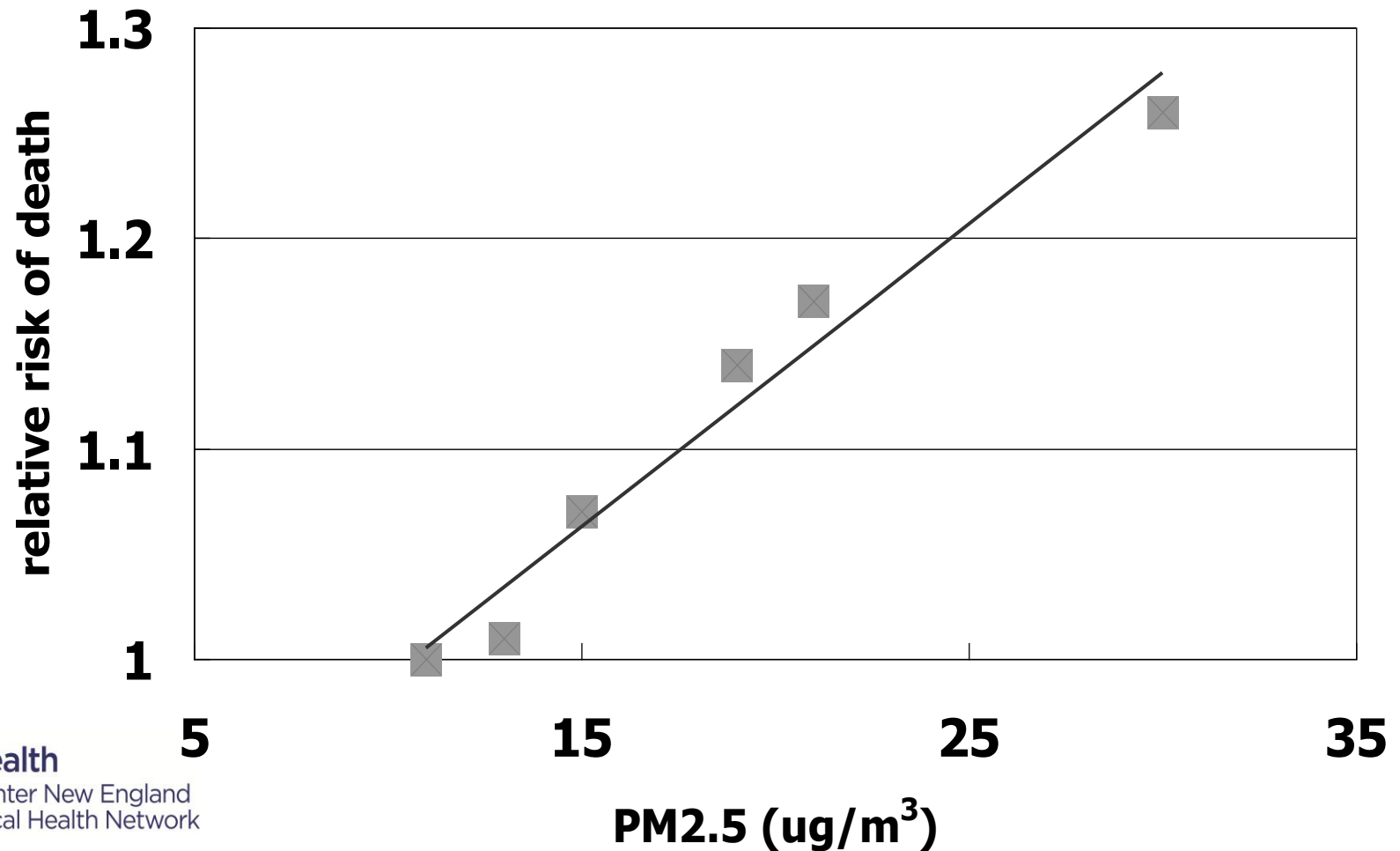Hunter New England Local Health Network

From Respiratory and cardiovascular diseases and cancer among residents in the Hunter New England Area Health Service P 65

Concentration response function (for 10 µg/m3 increase in particulates) Relative risk (95% confidence interval)

	PM$_{10}$	PM$_{2.5}$
Deaths		
Long-term deaths** (age 30+ years)		1.06 (1.02-1.11) (Pope et al, 2002)
Hospitalisations		
Cardiovascular disease (age 15-64 years)		1.0141 (1.0074-1.0208) (Moolgavkar 2000)
Cardiovascular disease (age 65+ years)		1.0159 (1.0092-1.0227) (Moolgavkar 2003)
All respiratory disease (all ages)	1.008 (1.0048-1.0112) (World Health Organization 2000)	

** annual average PM2.5

'Clean' Lung
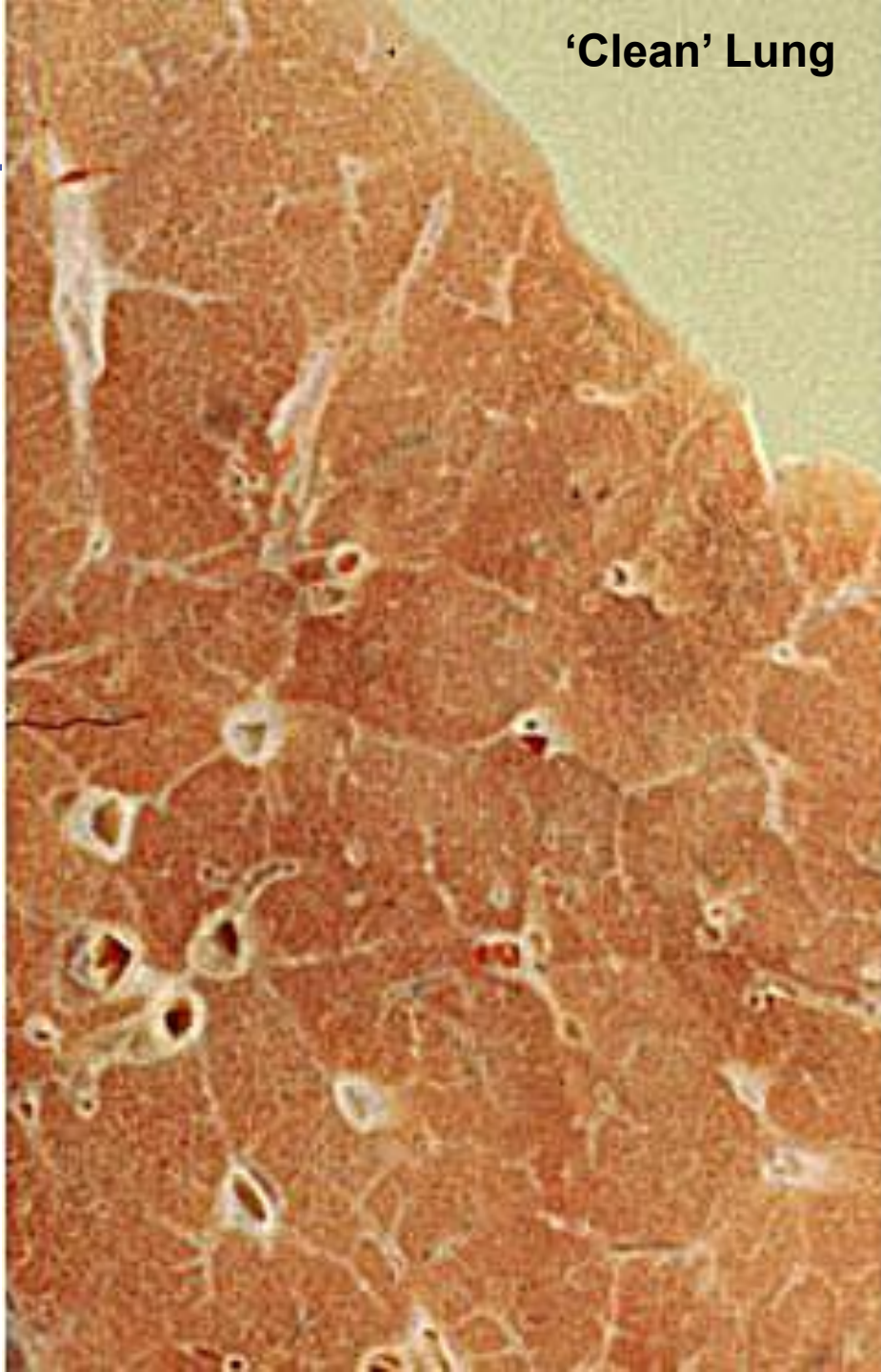
'City' Lung
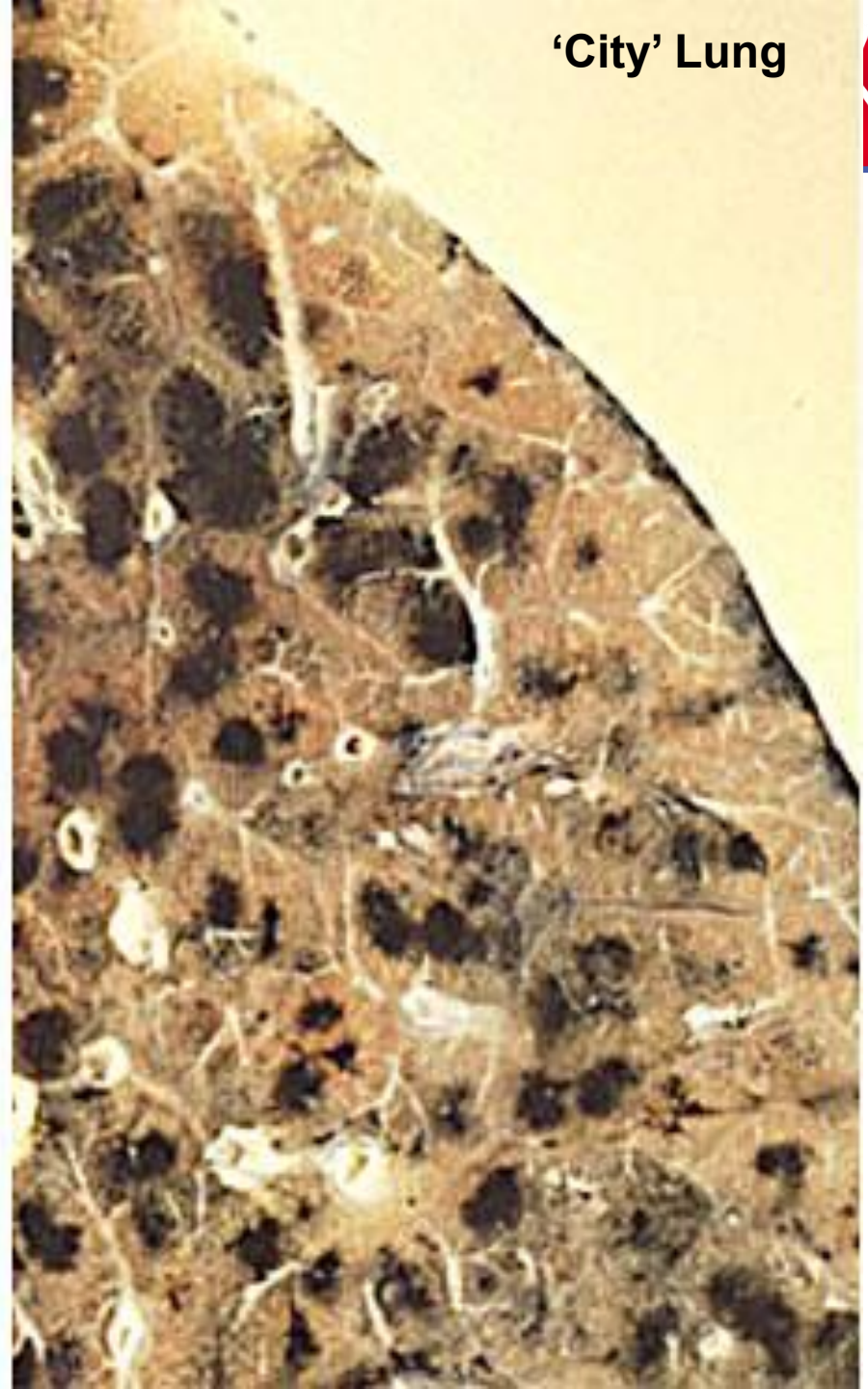
Mechanism of PM2.5 induction of vascular inflammation

Conklin, D. J. Circ Res 2011;108:644-647

Circulation Research

Cascade of Triggers Culminating in Acute Myocardial Infarction

Coronary thrombosis and acute myocardial infarction

Focal atherosclerotic plaque formation

Inflamed vulnerable plaque

Rupture of vulnerable plaque

Erosion of vulnerable plaque without inflammation
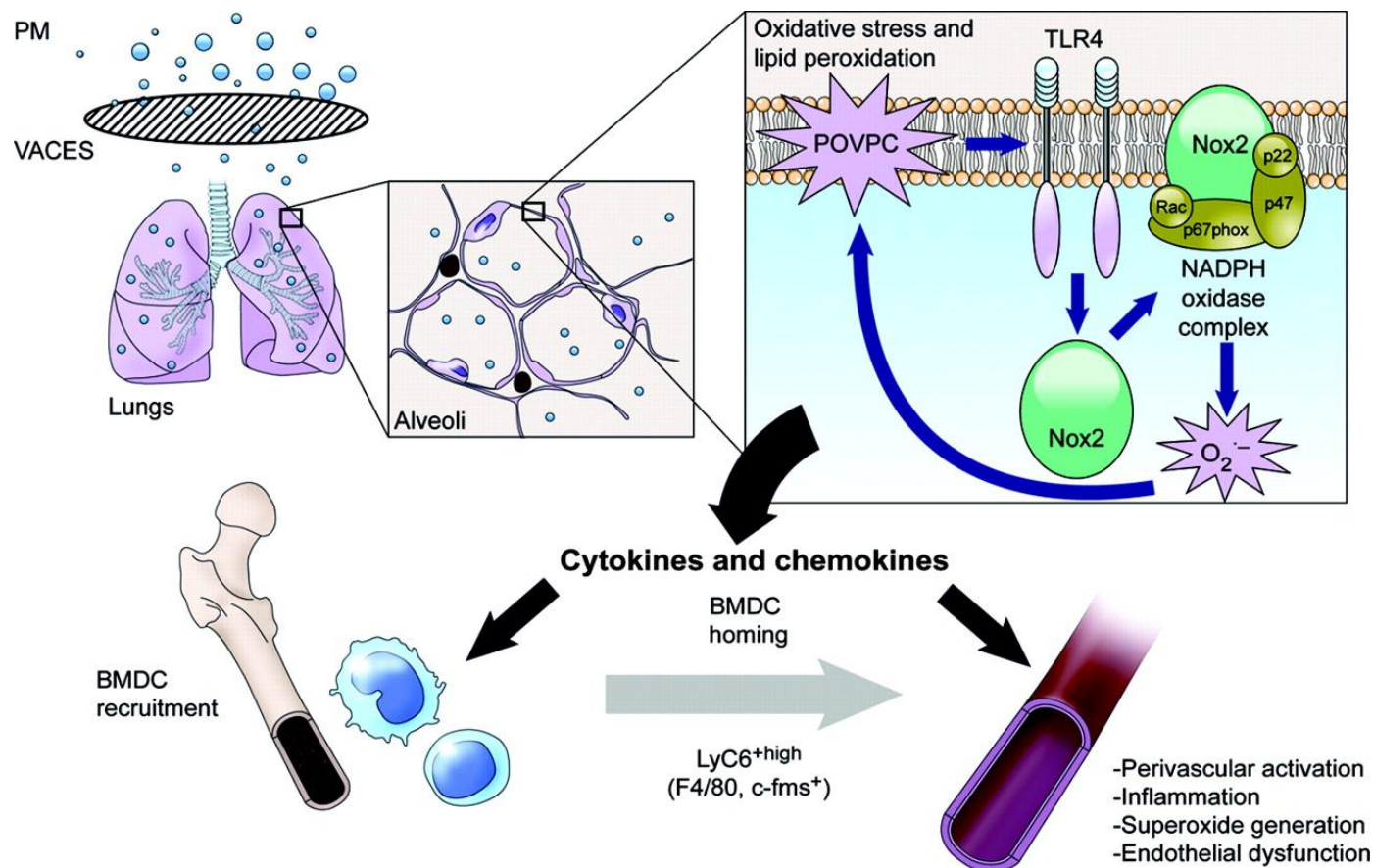
Triggers leading to atherosclerosis:
Risk factors for CAD
Local hemodynamic factors (shear stress)

Triggers probably leading to focal inflammation:
Local hemodynamic factors
Local vascular-remodeling response to plaque formation
Exacerbation by systemic inflammation

Triggers leading to plaque disruption:
Increased sympathetic stimulation
Increased physical or emotional stress
Increased local or systemic inflammation
Increased vasoconstriction

Air-pollution triggers predisposing to thrombosis:
- **Inc. coagulability**
- **Inc. inflammation**
- **Inc. viscosity**
- **Inc. vasoconstriction**

- Titled *Compendium of Upper Hunter Ambient Air Quality Monitoring Data.* Data obtained through industry reporting for period 2005 to 2009

- Data obtained from individual mine monitors in the Hunter Valley

- Report accompanied the NSW Health report

- http://www.environment.nsw.gov.au/aqms/upperhunterreview.htm

Table 2-1   Ambient Air Quality NEPM Standards and Goals

Pollutant	Averaging period	Maximum concentration	Goal within 10 years maximum allowable exceedences
Nitrogen dioxide	1 hour 1 year	0.12 ppm 0.03 ppm	1 day a year none
Sulfur dioxide	1 hour 1 day 1 year	0.20 ppm 0.08 ppm 0.02 ppm	1 day a year 1 day a year none
Particles as PM_{10}	1 day	50 µg/m^3	5 days a year
Particles as $PM_{2.5}$	1 day 1 year	25 µg/m^3 8 µg/m^3	Goal is to gather sufficient data nationally to facilitate a review of the Advisory Reporting Standards.

Upper Hunter Ambient Air Quality Monitoring – PM$_{10}$ – 2009
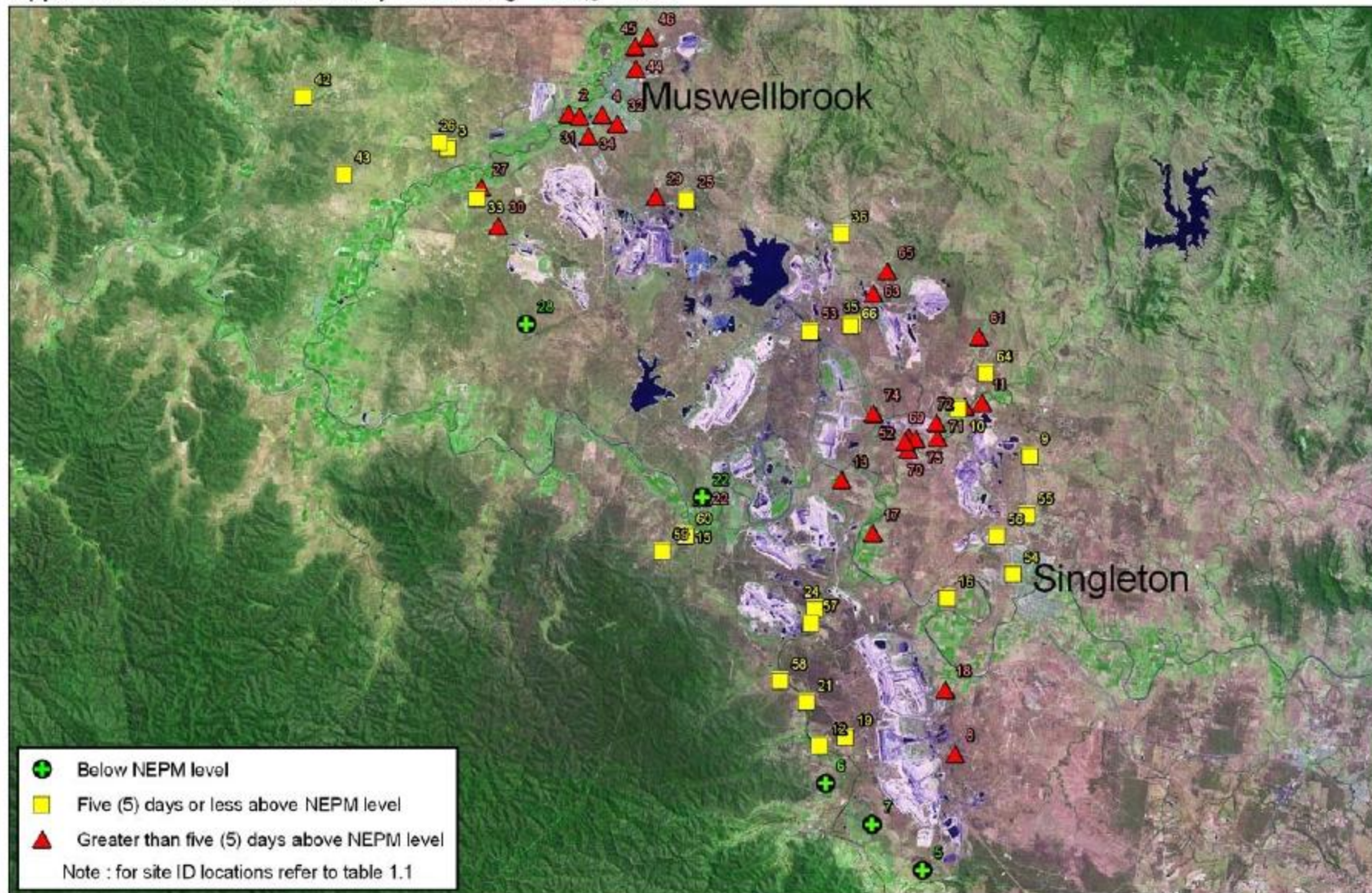
Some high PM10 results....

Table 3-88   24 Hour Average PM$_{10}$ – Site ID 61_PM10_AM-22

Year	Percent Data Coverage	Concentration (µg/m³)						Number of Days Above NEPM Level
		1st Highest	2nd Highest	3rd Highest	4th Highest	5th Highest	6th Highest	
2005	26%[#]	49.1	47.1	40.6	40.6	37.4	35.2	0
2006	95%	67.5	56.3	54.2	53	53	52.5	7
2007	98%	94.1	81.8	78.1	75.7	67.9	65.2	18
2008	95%	100.7	95.6	81.3	72.2	71.1	63.3	24
2009	90%	2171.7	360.6	215.5	194.7	143	137.9	34

[#]   Data record starts or stops mid-year. Refer to dates in Table 1.1

Table 3-89   24 Hour Average PM$_{10}$ – Site ID 62_PM10_AM-22

Year	Percent Data Coverage	Concentration (µg/m³)						Number of Days Above NEPM Level
		1st Highest	2nd Highest	3rd Highest	4th Highest	5th Highest	6th Highest	
2005	16%[#]	41.8	41.7	35.0	34.8	32.5	31.2	0
2006	87%	88.2	81.2	77.5	66.1	62.4	61.9	13
2007	100%	81.8	73.1	69.3	62.3	59.8	59.6	16
2008	97%	135.7	84.6	83.1	75.4	69.1	65.7	13
2009	99%	2134.4	336	200.8	176	113	109.5	27

[#]   Data record starts or stops mid-year. Refer to dates in Table 1.1

Table 3-1   24 Hour Average PM$_{2.5}$ – Site ID 1_PM2.5_AM-18

Year	Percent Data Coverage	Concentration (µg/m^3)						Number of Days Above NEPM Level
		1st Highest	2nd Highest	3rd Highest	4th Highest	5th Highest	6th Highest	
2005	95%	17.9	16.1	15.3	12.1	11.4	11.0	0
2006	82%	28.0	18.1	14.2	13.0	12.6	12.5	1
2007	86%	19.3	14.7	14.5	12.4	12.2	11.2	0
2008	85%	11.8	10.3	9.9	9.8	9.6	9.6	0
2009	95%	380.1	41.4	25.4	22.0	19.4	13.3	3

* This is an Advisory Reporting Standard. The goal is to gather sufficient data nationally to facilitate a review of the Advisory Reporting Standards as part of the review of this Measure scheduled to commence in 2005.

Table 3-2   Annual Average PM$_{2.5}$ – Site ID 1_PM2.5_AM-18

Year	Percent Data Coverage	Concentration (µg/m^3)
2005	95%	6.1
2006	82%	6.4
2007	86%	6.3
2008	85%	5.1
2009	95%	10.3 > 8

* This is an Advisory Reporting Standard. The goal is to gather sufficient data nationally to facilitate a review of the Advisory Reporting Standards as part of the review of this Measure scheduled to commence in 2005.

Online Air Quality Monitoring

	VERY GOOD	GOOD	FAIR	POOR	VERY POOR	HAZARDOUS

Pollutants		Ozone O3	Ozone O3	Nitrogen dioxide NO2	Visibility NEPH	Carbon monoxide CO	Sulfur dioxide SO2	Particles PM10	Particles PM2.5
Averaging Periods		1-hour average	rolling 4-hour average	1-hour average	1-hour average	rolling 8-hour average	1-hour average	rolling 24-hour average	rolling 24-hour average
Sydney East	Randwick	0.4	1.4	1.9	0.11		0.0	11.0	
	Rozelle	0.1	0.5	2.6	0.21	0.3		10.3	
	Lindfield	0.0	0.4	2.1	0.43		0.1	8.1	
	Chullora	0.1	0.3	2.7	0.32	0.4	0.2	16.7	
	Earlwood	0.2	0.5	1.9	0.28			9.4	1.7
Sydney North-west	Richmond	0.7	0.8	0.8	0.07		0.0	7.1	
	St Marys	0.3	0.7	1.1	0.24			9.0	
	Vineyard								
	Prospect	0.0	0.2	2.8	0.38	0.5		12.2	
Sydney South-west	Bargo	0.3	0.4	1.0	0.76		0.0	8.9	
	Bringelly			1.4	0.44			9.1	
	Liverpool	0.1	0.2	2.1	0.46	0.4		10.7	1.7

Upper Hunter - Muswellbrook	Muswellbrook							25.6	9.3
Upper Hunter - Singleton	Singleton							13.0	4.5
	Malson Dleu							18.6	

Gaps indicate that an instrument was not online for that period OR an

South-west Slopes	Albury	11.6	
	Wagga Wagga	16.5	
Upper Hunter - Muswellbrook	Muswellbrook	25.6	9.3
Upper Hunter - Singleton	Singleton	13.0	4.5
	Malson Dleu	18.6	

UH AQM station - Muswellbrook PM10 and PM2.5 - 24 hour average.
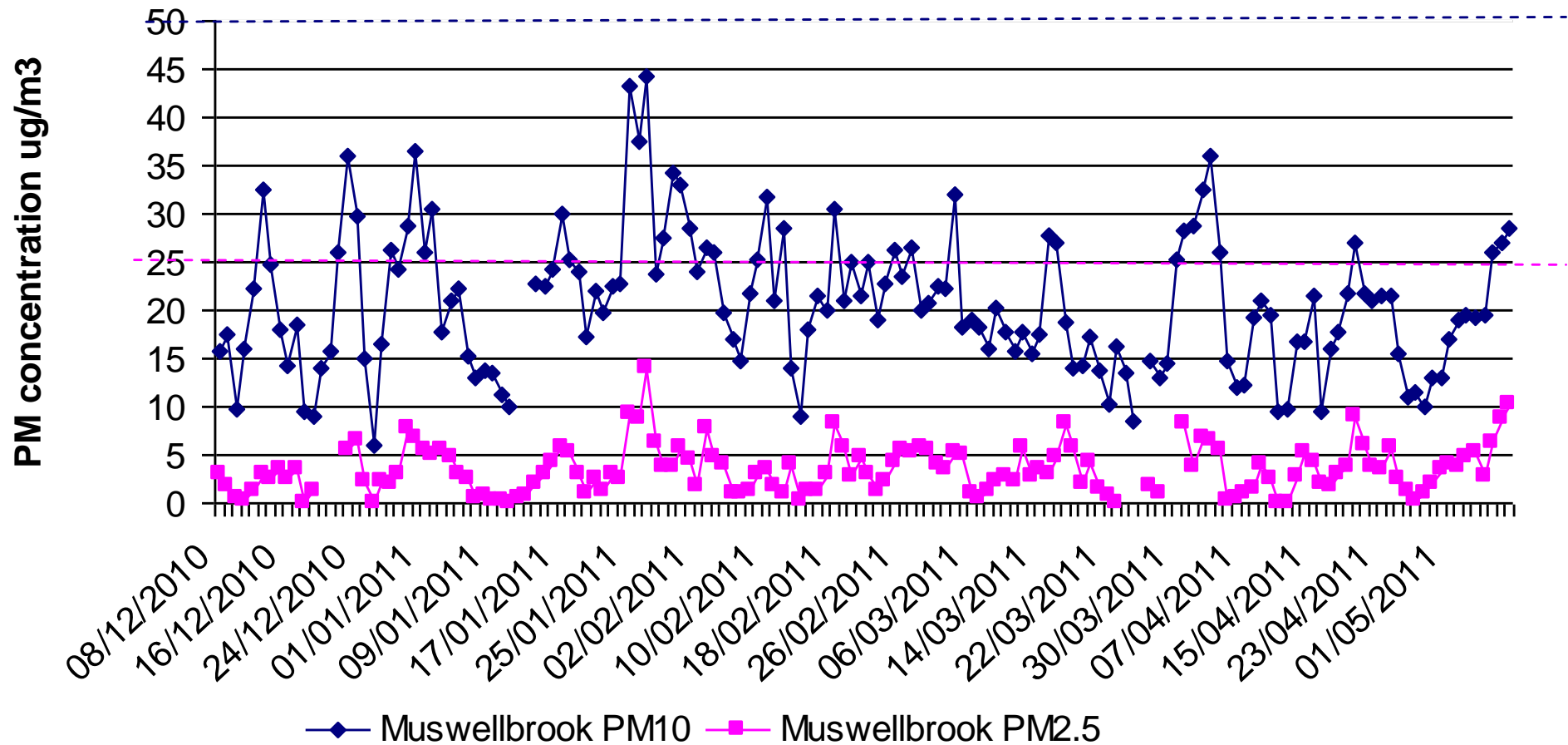
UH AQM station - Singleton PM 10 and PM 2.5 - 24 hour average.

Source of particulates
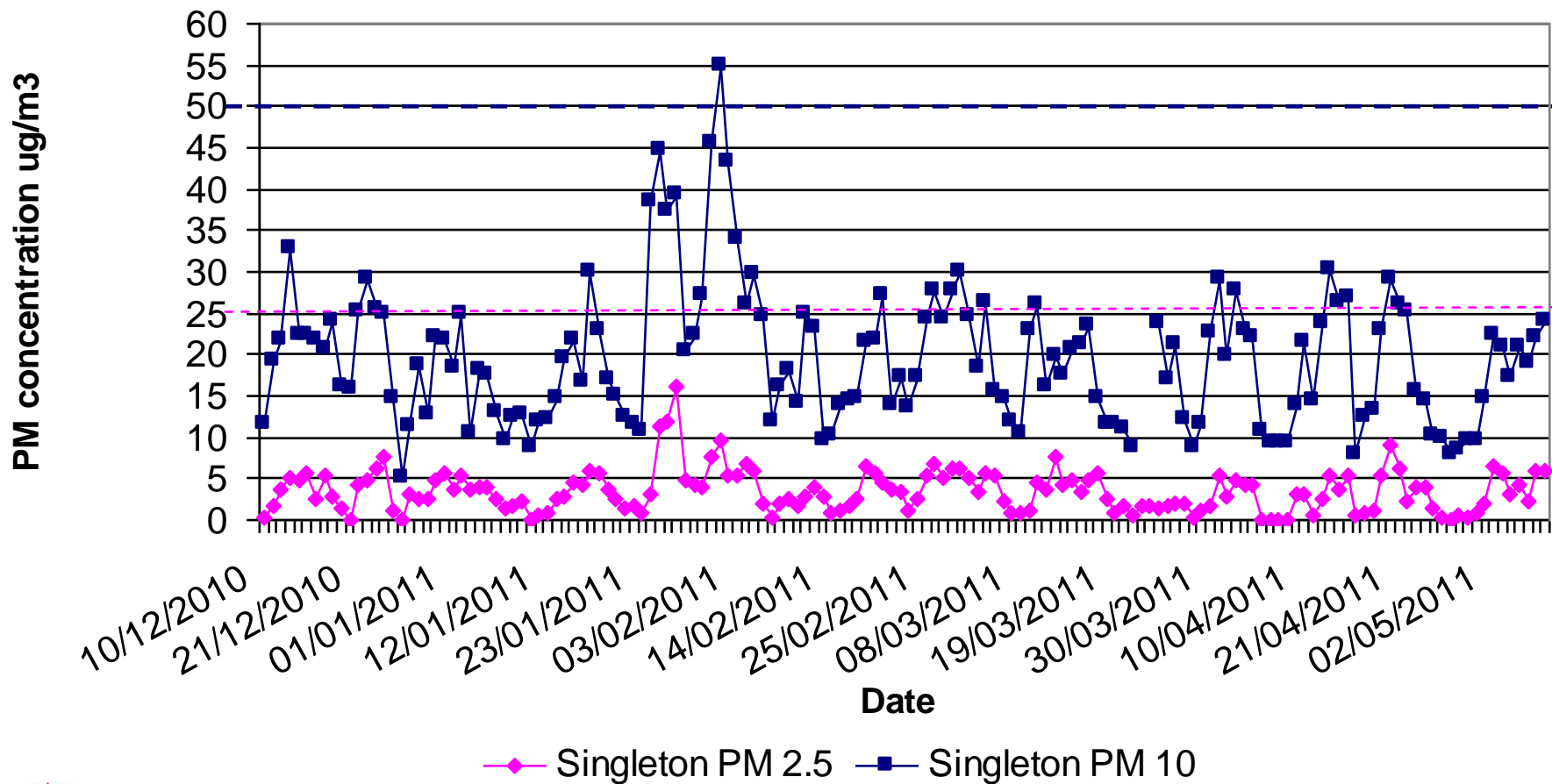
- Camberwell Cumulative Impact Review:

   "The review found that coal mining contributed 85% of PM10 <u>emissions</u> and 70% of all PM2.5 <u>emissions</u> from within the Singleton local government area.."

NSW Expert Advisory Committee on Air Quality

- Chief Health Officer Dr Kerry Chant convened an independent Expert Advisory Committee on Air Quality for State of NSW

- Purpose is to consider investigations and published records in relation to air quality matters across the State

- Membership consists of:
  - Professor Bruce Armstrong (Cancer Epidemiologist)
  - Professor Guy Marks (Respiratory Medicine)
  - Dr Alison Jones (Toxicologist)
  - Dr Michael Hensley (Respiratory Medicine)
  - Mark Hibberd (CSIRO Air Modeller)
- Regular meetings (4-6 weeks)

- Review of proposed air quality monitoring network sites and sampling
- Review of health reports:
  - Hospital data
  - General Practice data
- Review of community concerns including:
  - Rainwater tank quality
  - Biosolids application in mine rehabilitation
  - Mine blasting and NO_x
  - Power station emissions
- Future health study

Health
Hunter New England
Local Health Network

- Focus on:
  - diseases and causes of death potentially associated with air pollution
    - Emergency Department visits
    - Hospital admissions
    - Mortality
    - Cancer
  - Hunter New England residents compared within Area and with other parts of NSW
  - examined variation in health in HNEAHS in relation to coal mining & coal-fired electrical power generation

http://www.health.nsw.gov.au/pubs/2010/pdf/HNE_Respi_Cardio_Disease.pdf

- Findings:

Geographical regions in HNEAHS most affected by coal mining and power generation have higher rates:

- Emergency Department attendance for asthma
- hospital admissions for respiratory conditions (Upper Hunter)
- hospital admissions for cardiovascular disease
- death from all causes and cardiovascular disease (Lower Hunter)

Health
Hunter New England
Local Health Network

NSW GOVERNMENT

Emergency department presentations for respiratory illness and asthma

- The rates of presentation for all respiratory illnesses in Muswellbrook and Singleton postcodes ranked below those of Tamworth, Gunnedah and Cessnock in all age groups
- Muswellbrook area has high rates for emergency department presentation for asthma, but not the highest (Tamworth and Gunnedah) in Hunter New England Area Health Service (HNEAHS)
- Singleton also ranks highly for rates of emergency department presentations for asthma in those aged 15-64 years
- Muswellbrook and Singleton are equally highly ranked for rates of emergency department presentations for conditions unrelated to air pollution.

Problems with these data

- Emergency department diagnoses are recorded by busy emergency department staff and not by trained hospital information managers or coders.

- The HNEAHS uses a
different computer program from the rest of the state for its emergency department patient management database.

- These factors may lead to variation in the coding of emergency department diagnoses within the state

Figure 7. Rates of asthma hospital separation by local government area in Hunter New England Health Area Health Service and NSW, 2004 – 2009
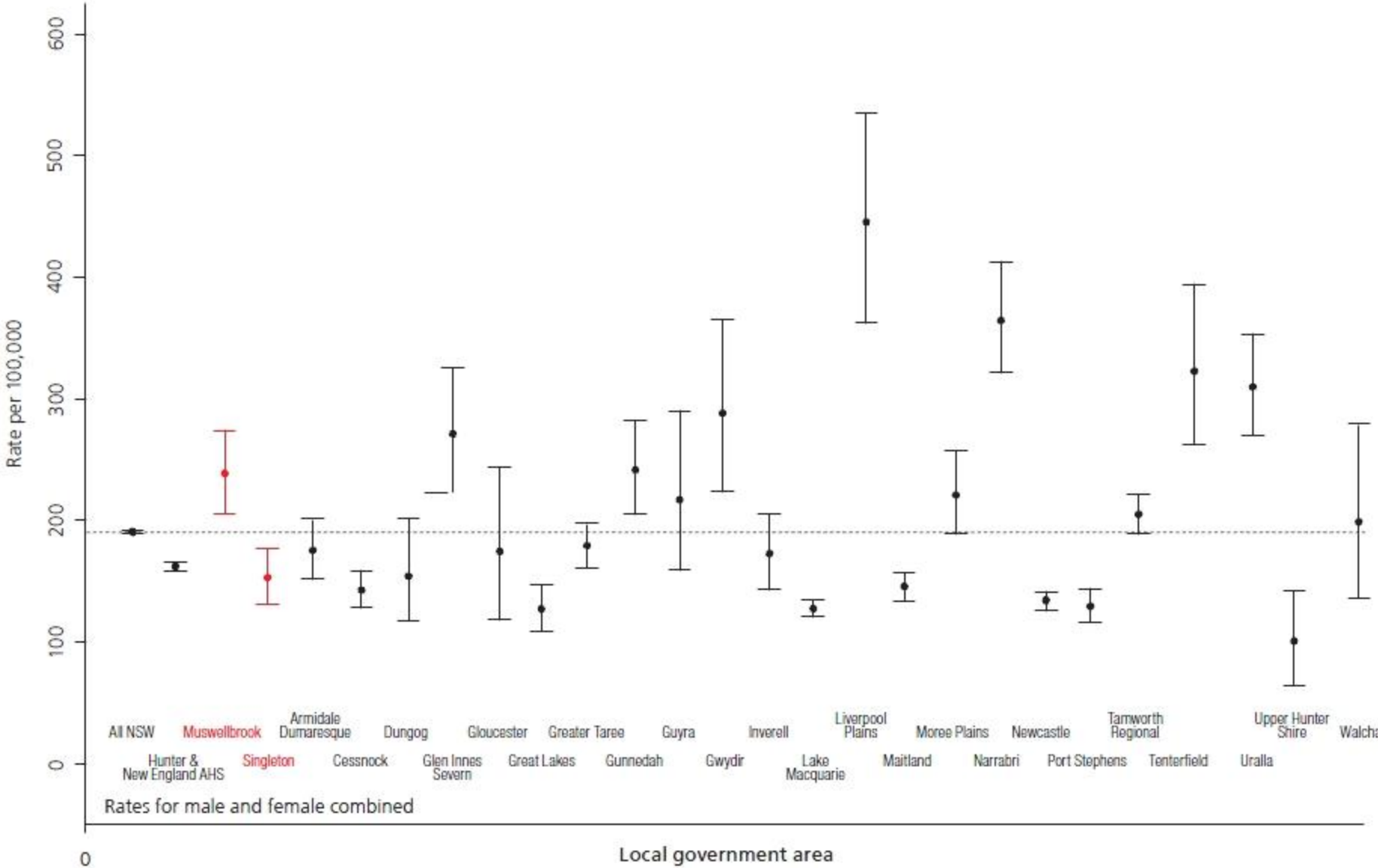
Close up former slide – respiratory hospitalisations
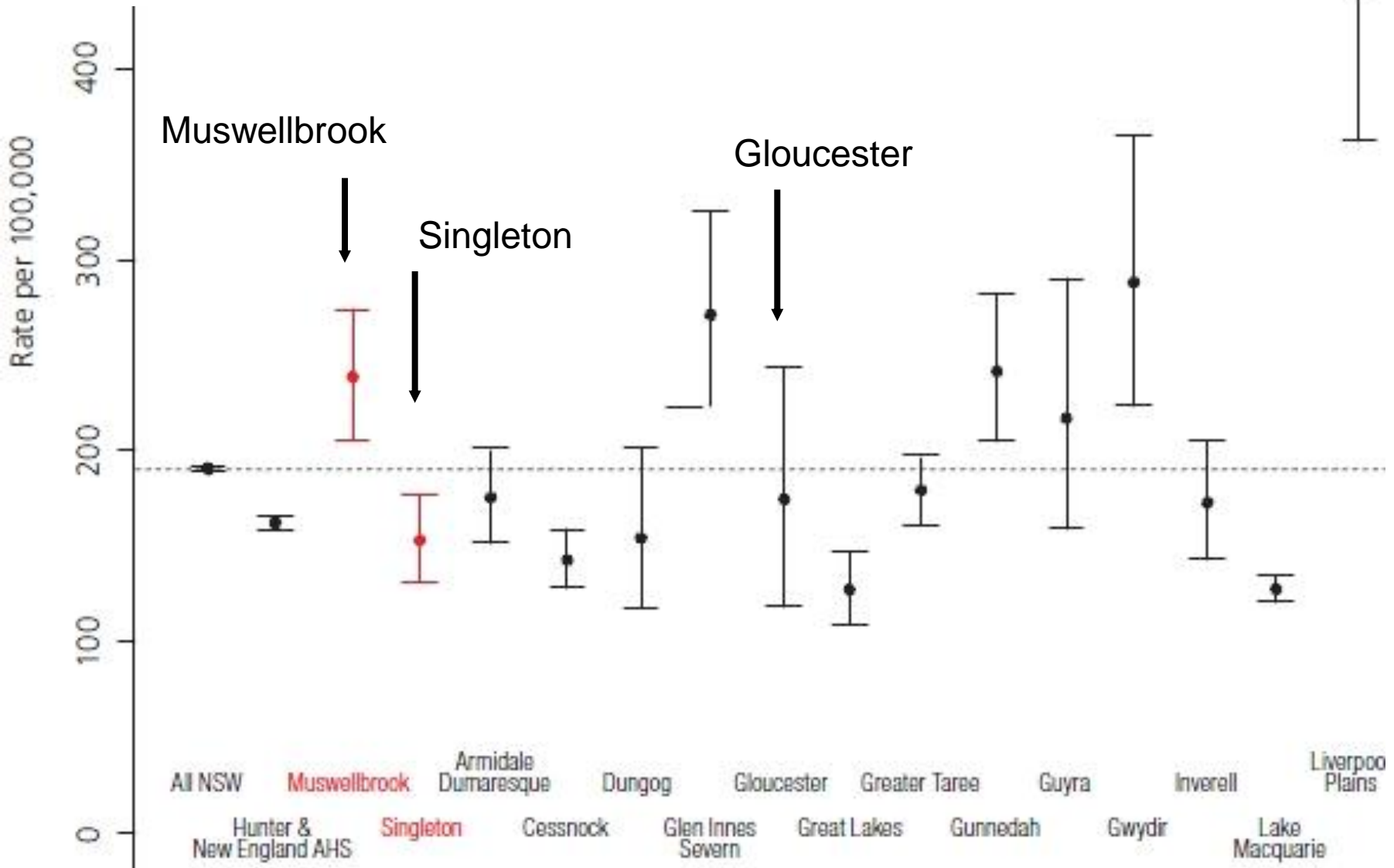
Figure 17. Parent/carer-reported current asthma rates for children (≤ 15 years of age) by Hunter New England Area Health Service clusters in Hunter New England Area Health Service and NSW, 2006-2008
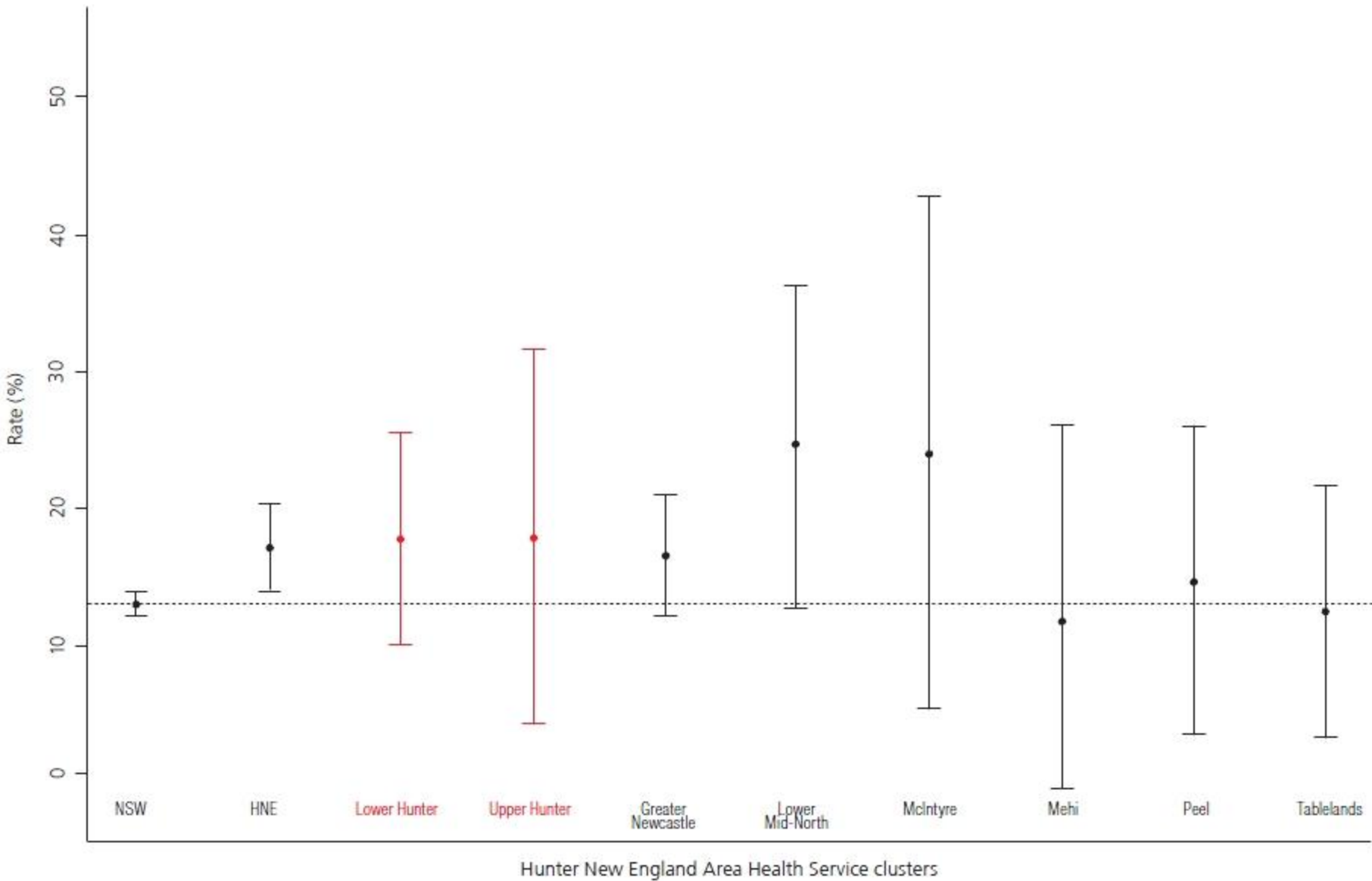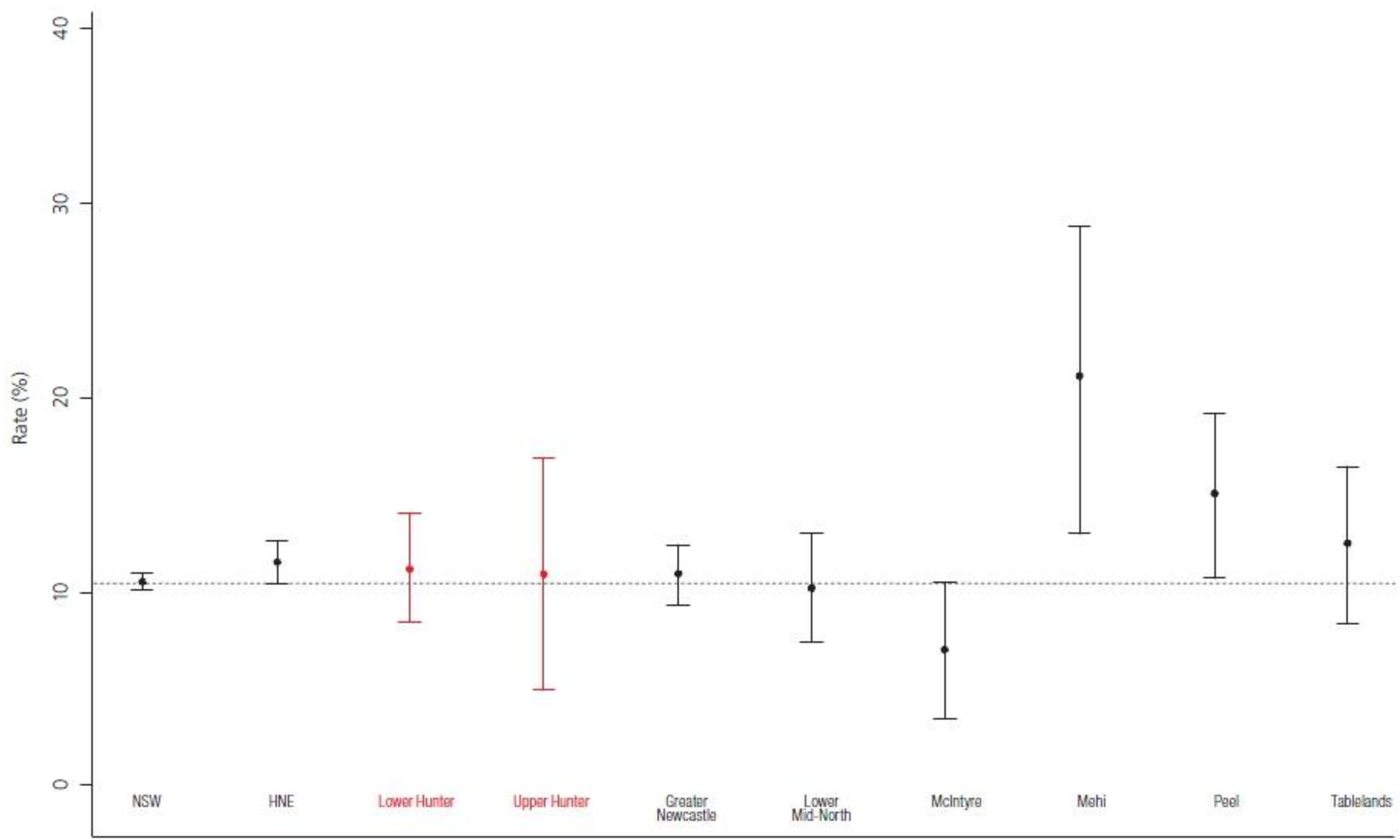
Figure 18. Self-reported current asthma rates for adults (> 15 years of age) by Hunter New England Area Health Service clusters in Hunter New England Area Health Service and NSW, 2006-2008
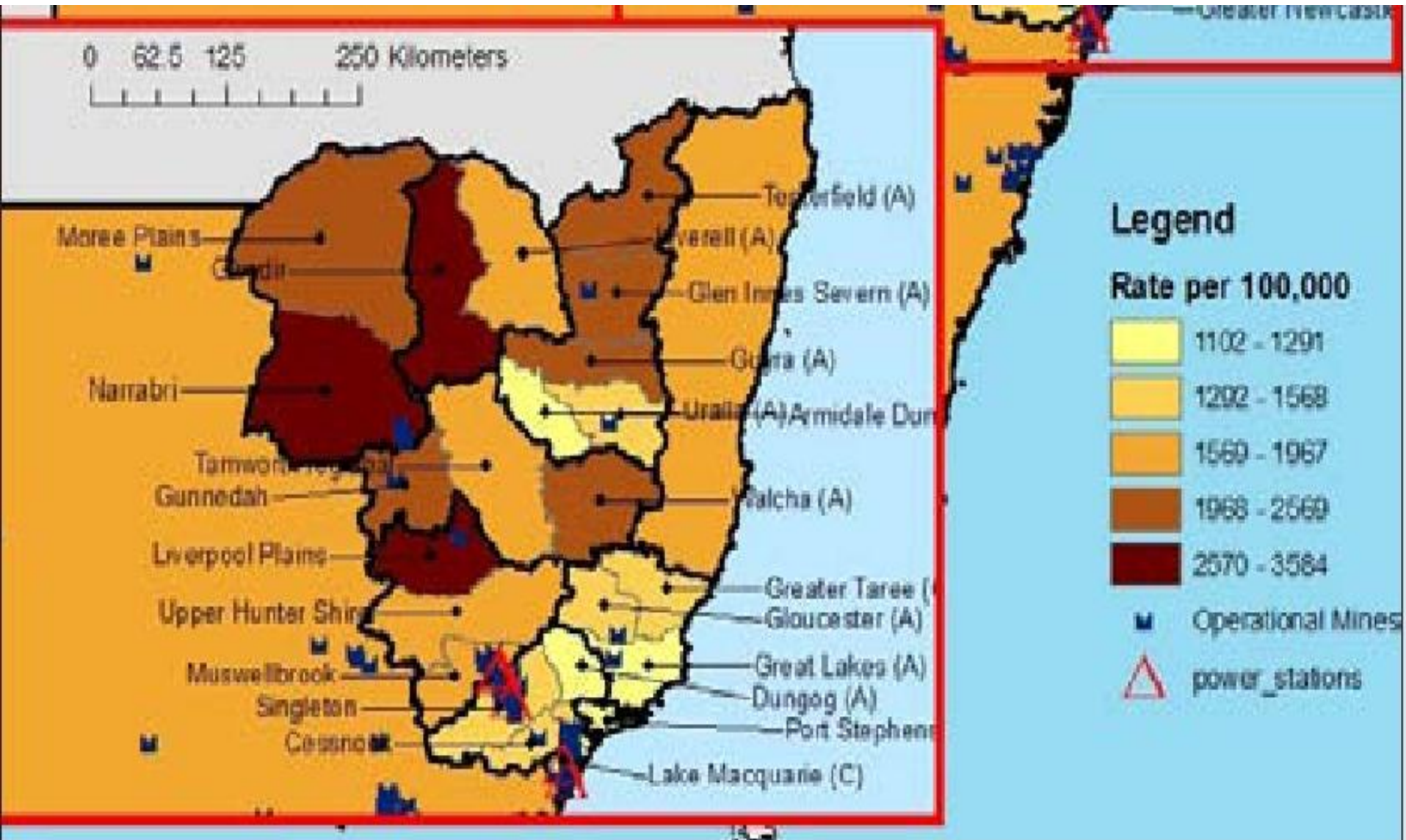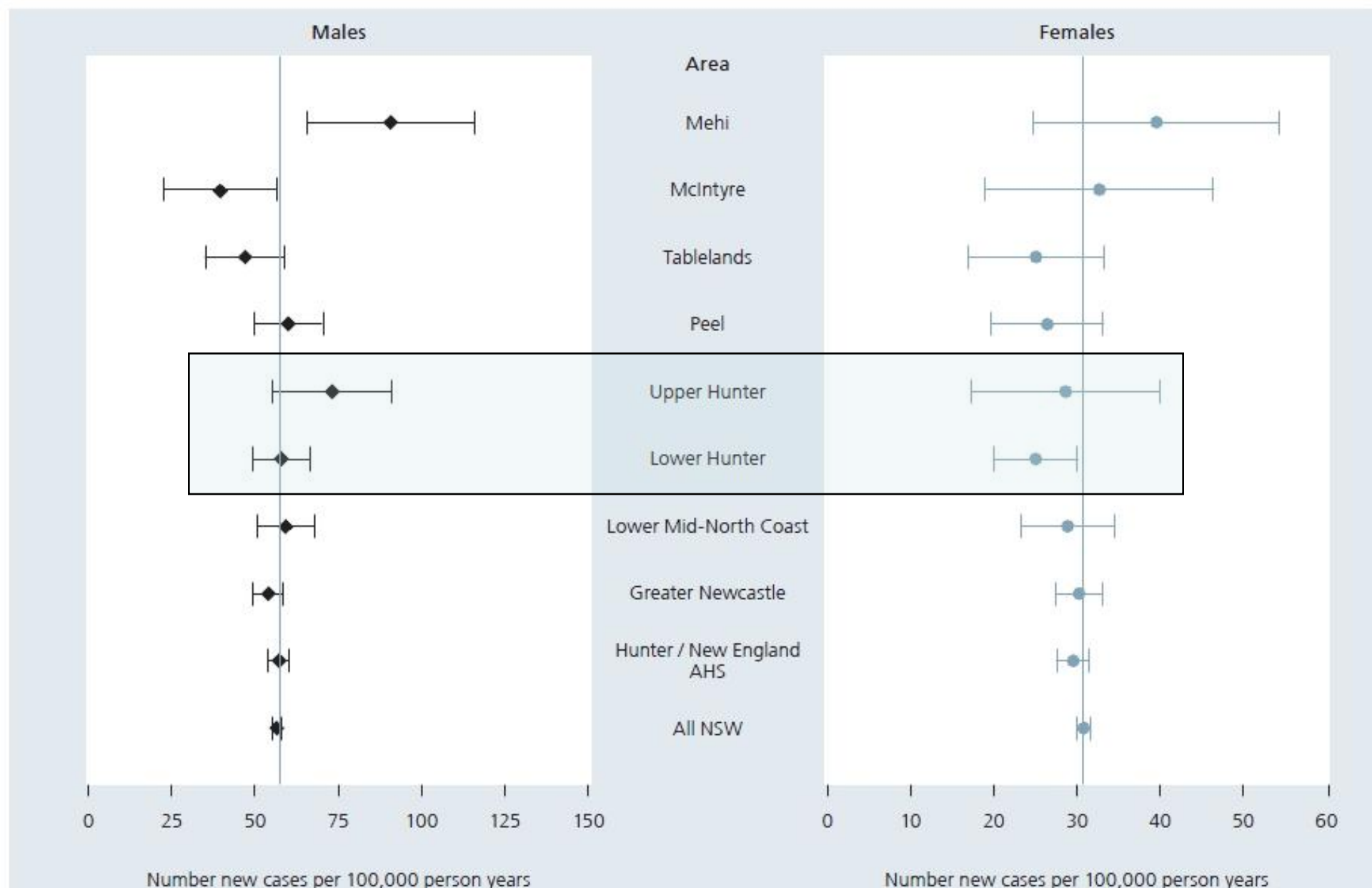
Figure 37 Number of new cases of lung cancer by NSW, Hunter New England Area Health Service and Hunter New England Area Health Service clusters and sex, 2004-2008

General Practice (BEACH) Report

- Bettering the Evaluation and Care of Health

- General Practice consultation data

- Collects 100 consecutive consultations for 1000 GPs across Australia each year

- This analysis compared residents in Singleton, Muswellbrook and Denman with the rest of non-metropolitan NSW for the period 1998 to 2010

- Data available for 3448 problems managed by 18 different GPs working in 7 Practices

- Data adjusted for age, sex, season and Health Care Card status

- http://www.health.nsw.gov.au/pubs/2010/pdf/beach_report.pdf

General Practice (BEACH) Report

- NSW Expert Advisory Committee Conclusion:

- **These BEACH data suggests that conditions presenting to and medications prescribed by GPs in the Upper Hunter region are similar to those in the rest of non-metropolitan NSW.**

- There are early indications that **asthma <u>may</u> be a more important issue in the Upper Hunter region.**

- With all findings from this and other studies considered together, **further study of the health effects of the mining industry and other exposures in Singleton, Muswellbrook and Denman should focus particularly on asthma and other respiratory disease.**

Camberwell Village

- Independent review Cumulative Impacts Coal Mining

Mine impact study begins

By Rachel Oldknow

THE cumulative impacts of mining on Camberwell study has begun with a meeting at Glennies Creek Hall on Tuesday night.

Residents from Camberwell and nearby Falbrook packed the meeting with representatives from the NSW Department of Planning and independent experts ready to gather their information.

The meeting was an opportunity for residents to raise their concerns about the noise, dust and possible water contamination from nearby mines face-to-face with Department representatives.

NSW Department of Planning (DOP) major development assessment director David Kitto chaired the meeting.

Mr Kitto said Tuesday night's meeting was to provide residents with background information regarding the study as well as introducing the experts that would be involved.

"There will be two to three months of study by experts and we are hoping to get a final report by the end of June early July this year," Mr Kitto said.

A panel of five experts, three from Department of Planning and two independents, spent most of the night talking with residents about their concerns.

Independent experts John Wassermann from Wilkinson Murray, an acoustics and air specialist, and Yvonne Scorgie from Environ, air quality and carbon consultant, will be undertaking the cumulative impact study.

The experts are required to consider and recommend appropriate measures to minimise and mitigate any identified

impacts from mining operations.

Mr Kitto said the study would look at existing impacts of coal mining at Camberwell taking into consideration the concentration of existing mines and future proposals.

"The first issue is to get a current look at the existing situation and existing impacts and anything the Department can do to minimise and improve performance of mines," Mr Kitto said.

"The second issue is looking towards the future in regards to existing and additional operations and how that will impact Camberwell," he said.

The Department of Planning also invited residents to make submissions on what issues they believe should be adopted into the review's terms of reference.

The current terms of reference will take into consideration noise and dust impacts and the

potential contamination of drinking water in Camberwell village and its surrounds due to mining activities.

Submissions need to be lodged to the Department by April 17.

The Department of Planning commissioned the study after years of lobbying by Camberwell residents.

COMMUNITY INTERACTION: Yvonne Scorgie from Environ chats with local residents Brian Cherry and Graeme Cheetham during Tuesday night's meeting at Glennies Creek Hall.

HOUSE CALL: Camberwell resident Wendy Bowman meets with representatives involved in the cumulative health study including (from left) Nicholas Hall, Department of Planning, Yvonne Scorgie from Environ, Jeff Parnell, Department of Planning and John Wassermann from Wilkinson and Murray.

dents.

The Department announced the study would be undertaken late last year while simultaneously announcing that the Glennies Creek open cut mine had been approved.

NSW Minewatch president and Camberwell resident, Wendy Bowman said

she was pleased the study had finally begun.

The consultants also visited five properties on Wednesday to take a closer look at their individual concerns facing residents.

Residents said they appreciated the opportunity to have their concerns listened to.

Camberwell Cumulative Impacts

- Department of Planning released reports 13/7/10 & media release http://www.planning.nsw.gov.au/PlanningSystem/Independentplanningassessmentandreviewpanels/tabid/70/language/en-US/Default.aspx#camberwell

- PM 10 daily standard regularly exceeded.

- Low level lead in water tanks not associated with mining.

NSW Health
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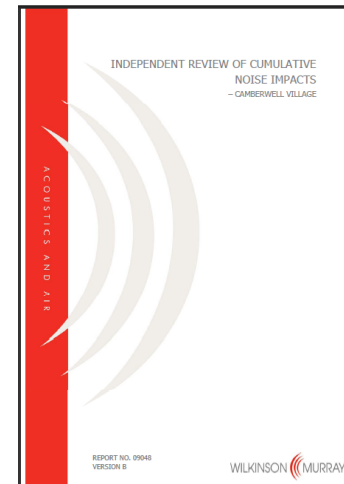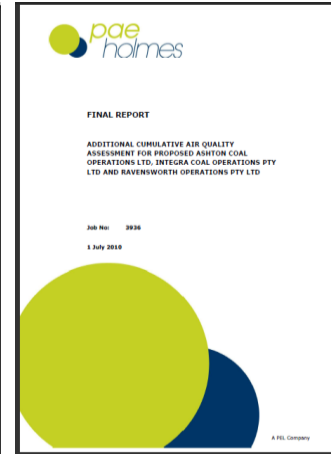
Additional Health Concerns

- Power station emissions – composition of particulates
- Mine blasting and NO_X

Future - what kind of health study?

- Epidemiological
  - Examines relationship between local pollution levels and local health effects in the valley
  - Could take 5 to 10 years or more and might miss "small" health impacts
  - Would provide locally relevant data

- Monitoring/Risk assessment
  - Uses pollution standards from studies overseas to predict (and prevent) local health effects
  - Assumes overseas pollution and health studies are relevant to the Hunter.

Health
Hunter New England
Local Health Network

Summary

- Well established international literature linking respiratory, cardiovascular and some cancers to air quality
- Hunter Valley is unique environment with intensive mining, power generation and population bases in close proximity
- Extensive review of existing health and environmental monitoring data been conducted
- Upper Hunter Air Quality Monitoring Network is growing
- Further studies required to assess health impact

Health
Hunter New England
Local Health Network

Best kind of health study is one in which..

..the local citizens become epidemiologists and the epidemiologists become local citizens…

Health
Hunter New England
Local Health Network

Thank you

Thank you.

Hunter New England Population Health is a unit of the Hunter New England Local Health District.

Supported by funding from NSW Health through the Hunter Medical Research Institute.

Developed in partnership with the University of Newcastle.