SUBMISSION TO THE SENATE COMMITTEE INQUIRY INTO THE IMPACTS OF MINING IN THE MURRAY DARLING BASIN

Submitted by the Australian Society of Soil Science Inc. (ASSSI)

September 2009

The Australian Society of Soil Science Inc. (ASSSI) welcomes the opportunity to make a submission to the Senate Committee Inquiry on the Impacts of Mining in the Murray Darling Basin and is available for follow-up consultation should the Senate consider this necessary.

Two objectives in our society's strategic plan (attached) make it imperative that we respond to this senate inquiry:

- Objective 1.4 Promote the importance of soil and enhance the profile of soil science in Australia by engaging with key government and industry sectors. (1.4.2) Ensure formal society response to government policy documents and discussion papers relevant to soil science.
- Objective 2.1 Enhance expertise in soil science by accrediting Certified Professional Soil Scientists (CPSS).

The ASSSI is the peak body for soil scientists in Australia. It is a not-for-profit organisation with a membership in excess of 700. The ASSSI is a federated entity, with a Federal Council and seven Branches – New South Wales, Victoria, Queensland, South Australia, Western Australia, Tasmania and Riverina. Only the Executive Officer, who maintains a "Federal Office", is salaried (0.6 FTE).

Members are engaged in soil research, extension and policy across the full range of soil management activities and throughout Australia. Members are in universities (as students and staff), in regional, state and federal government agencies, are employed in many consultancy firms or run their own businesses. Many members have contributed significantly to the current knowledge of rehabilitation of mined land in Australia. There are also a significant proportion of members who have retired from their jobs but continue to give a lifetime of service, actively participating in the ASSSI as well as giving support to soils projects and practitioners.

Members may also attain accreditation as 'Certified Professional Soil Scientists' (CPSS). The purpose of the CPSS accreditation scheme is to ensure that clients requiring competent soil science advice, execution of soil-related research, data interpretation and soil management can identify bona fide experts.

All ASSSI members are also members of the International Union of Soil Sciences (IUSS) which is made up of 65 national societies representing approximately 40 000 soil scientists from around the world. On behalf of the IUSS, ASSSI is organising the 19th World Congress of Soil Science to be held in Brisbane in 2010 when the management of Australian soil resources will receive global attention.

Objectives of this submission

The objectives of this submission by ASSSI are to draw to the attention of the Senate Committee:

1. the high value of the Darling Downs of Queensland and Liverpool Plains of New South Wales for Australian Agriculture,
2. the reasons for the high capacity for food and fibre production of the cracking clay soils (Vertosols) on the Darling Downs of Queensland (QLD) and the Liverpool Plains of New South Wales (NSW),
3. the scarcity of other areas in QLD or NSW that have the combination of soils, favourable rainfall and groundwater to enable these high levels of production,
4. the potential impacts on this production capacity if these areas were to be mined,
5. the paucity of research or demonstration of successful rehabilitation of cracking clay soils following gross disturbance, and
6. the need for a rigorous decision-making process where the competing uses of agriculture and mining exist.

Distribution of highly productive cracking clay soils (Vertosols)

Vertosols are shrink-swell (cracking) clay soils having a clay percentage of ≥ 35 % throughout the entire soil depth (profile). They have long been known as Black Earths and Grey, Brown and Red Clays. The soils occur throughout Australia, with large areas occurring in arid and semi-arid regions (Appendix 1). They generally occur on gently undulating plains and are developed on alluvial clayey sediments, sedimentary rocks and basic volcanic rocks, particularly basalt (McKenzie et al. 2004).

On the Darling Downs of QLD and the Liverpool Plains of NSW, Vertosols are the dominant soil types, with the Black Earths making up a substantial proportion of this group (Appendix 1). The distribution of the soils on the Darling Downs is documented in the Central Darling Downs Land Resource Areas Map (Maher et al. 1998) and the South Eastern Darling Downs Land Resources Areas Map (Biggs, 2003). The publications by Banks (1994) and Banks (2001) cover the distribution of the soils on the Liverpool Plains.

Appendix 1 shows that the Vertosols of the Darling Downs and Liverpool Plains occur in regions with favourable rainfall (600-800 mm/a) for the growth of crops, particularly grains.

Productivity of the Vertosols of the Darling Downs and Liverpool Plains

The Vertosols of the Darling Downs and Liverpool Plains are amongst the most productive in Australia in terms of crop production, with the most fertile soil type in this group being the deep Black Earths. Satellite photographs of the two regions (Appendix 2) illustrate the intensity of cropping on these soils compared with surrounding areas. Reference to Appendix 3 shows that the yields for a wide range of crops in the Gunnedah district in the Liverpool Plains areas exceed both the State and National averages. Similar data shows the high productivity of the Darling Downs relative to other grain growing areas of the State (www.abs.gov.au), with this area being one of the nation's main areas for the production of Australian prime hard (APH) wheat.

Both summer and winter crops are grown in the areas in question and include, but are not limited to, sorghum, sunflower, maize, chickpeas, soybeans, canola, wheat, oats, barley, mung bean and cotton. Additionally, in the areas such as the Felton Valley on the Darling Downs, high value vegetable production (cabbage, cauliflower, broccoli, lettuce, potatoes and capsicum) occurs.

The reasons for the outstanding productivity of the clay soils in these two areas are their (1) inherent chemical fertility, (2) high capacity to hold water after rain or irrigation (high plant available water capacity), (3) location in a zone providing good natural rainfall (600-800 mm/a) and (4) access to good quality groundwater for irrigation. There are few other areas in QLD and NSW which have this combination of resources.

The excellent chemical fertility of the soils is related to their high cation exchange capacity (or negative charge density) which enables the soils to hold important positively charged plant nutrients such as calcium, magnesium and potassium against leaching. The high plant available water capacity (which enables winter crops to be grown on the Darling Downs using the water from summer rains held in the soil) is a result of both the high clay content and the particular clay mineralogy of the soils. Well documented descriptions of the properties of the soils in the areas in question are provided in handbooks produced by government departments in QLD (e.g. Harris et al. 1999) and in NSW (e.g. Banks 1994, 2001) and in the CSIRO publication by McKenzie et al. (2004).

As stated earlier, the coincidence of the chemically and physically fertile Vertosols with good quality underground water for irrigation in both the Darling Downs and Liverpool Plains contributes to the unique role these areas play in food production. In the recent Geoscience Australia report by English et al. (2007), reference is made to the fact that "Groundwater is an important source of water for crop irrigation, stock and domestic water supplies in the rich eastern Darling Downs agricultural region." and that "Irrigation water is largely sourced from basalt aquifers and from a range of depths, shallow to 110 m.". This report reviews the existing literature relevant to understanding groundwater flow processes in the eastern part of the Condamine River catchment. Documentation of the quantity and quality of groundwater supplies used for irrigating crops on the Liverpool Plains can be found in the publications by Broughton (1994), Timms (1997) and Timms et al. (2002).

The importance of these regions from both a national and a global perspective cannot be over emphasised. Food security, for feeding not only Australia, but also other countries through valuable export of primary produce, should be high priority for governments. Globally, the area of land capable of food production (arable land) per capita is decreasing, resulting in an increased demand for agricultural land (FAO, http://atlas.aaas.org/pdf/75-78.pdf). This decrease in arable land has resulted both from an increase in population and degradation and abandonment of agricultural land. Indeed, one third of all arable land has been lost within the last 40 years, and 80% of global agricultural land suffers moderate to severe erosion (Pimentel et al. 1995; Faeth and Crosson 1994; Pimentel and Pimentel 2003).

Location of soil/water resources in relation to coal and petroleum resources

Companies have applied for exploration permits for coal and petroleum over much of the Darling Downs, with many permits for coal being granted in the central and eastern sections and for petroleum in the western areas (www.dme.qld.gov.au) (Appendix 4). The Liverpool Plains overlie the Gunnedah Coal Basin (NSW DPI, 2008), and several major companies have been given exploration permits for coal over this area (www.dpi.nsw.gov.au/minerals).

Potential impacts of mining on the Darling Downs and Liverpool Plains

The potential impacts of mining on the cropping soils of the Darling Downs and Liverpool Plains and surrounds would be associated with (1) reduction in the yield potential of the reinstated soil, (2) loss or reduction of underground water supplies and (3) dust impacts on surrounding crops.

Reduction in yield potential of reinstated soil

The Australian mining industry has developed the technology to successfully rehabilitate diverse landscapes back to native vegetation or grazing, particularly in the case of mining of bauxite and mineral sands. Rehabilitation of land mined for coal by open-cut methods in QLD and NSW has involved, in almost all cases, establishment of pastures for grazing or of native ecosystems on land that was capable only of supporting grazing or forestry (Mulligan, 1996). To the knowledge of the ASSSI, nowhere in Australia have Vertosol soils, supporting prime agriculture, been reinstated for cropping after mining.

The most successful global examples of reinstatement of prime agricultural land after open-cut coal mining are those associated with Germany (Wuertz 1986; Häge 1996) and black coal mining in the Midwest of the USA (Dunker and Barnhisel 2000). In both countries, however, the soils reinstated to cropping have not been Vertosols, being much lower in clay content (<35 %) than the soils of the Darling Downs and Liverpool Plains. Clay contents of some Vertosols (Black Earths) on the Darling Downs can exceed 70 % in the subsoil (McKenzie et al. 2004).

If the community, industry and government believe that mining should proceed in the Darling Downs and Liverpool Plains, but that the land should be returned to its original productivity following mining, then experience from both Germany and the USA shows clearly that the entire depth of the soils need to be conserved and replaced (particularly to retain the plant available water capacity). In the Vertosols of the Darling Downs and Liverpool Plains, which are commonly 1.0 – 2.0 m deep, the chemical and physical properties change with depth, viz. increase in clay and salt content and the proportion of sodium ions balancing the soils negative charge (commonly called the exchangeable sodium percentage or ESP). Once the ESP of a soil exceeds around 6 %, it will disperse, become erodible and set hard when dry (ESP values in the subsoils of Vertosols commonly exceed 6 % with values reaching at least 20 % (McKenzie et al. 2004)).

Given the change in chemical and physical properties of the Vertosols with depth, in order to return the soil close to its original state (and cropping potential), the entire soil profile would have to be cut into layers of the order of 25-30 cm which would have to be stockpiled separately and then replaced, in order, after mining. Mixing of the soil profile would result in depression of crop yields due to the increased salinity and ESP in the upper layers. Additionally, the stockpiling of soil, which would be necessitated because of the restraints of the mining process, would result in organic matter breakdown in the surface layer and in the dispersion and erosion of the subsoil layers.

Notwithstanding these effects, the major limitation to reinstatement of these clay soils would be the compaction of the soil that would occur during the stripping, stockpiling and replacement processes. In the USA, the major limitation to achieving pre-mining crop yields on the medium clay soils in the Midwest has been compaction which results in poor root growth (Dunker and Barnhisel 2000). Research on trying to achieve original production on the Midwest soils has been in progress for over 20 years, with the latest efforts focussing on breeding of crop varieties that can better tolerate water stress (which occurs with reduced root growth). The extent of compaction and resultant impacts on growth would be expected to be more severe with the higher clay content Vertosols.

Loss or reduction of underground water supplies

Open-cut coal mining of the cropped area will destroy underlying shallow aquifers. Mining of surrounding intake areas could also reduce available water supplies. As referred to previously, the uniqueness of the Darling Downs and Liverpool Plains areas is the quality of the soils and the location with good natural rainfall for grain crops. Additionally, both areas have the benefit of access to good quality underground water for irrigation which can provide insurance in times of drought. In the USA, there is now little mining in "alluvial valley floors" because of the stringent conditions placed on mining in such areas (see the website of the US Office of Surface Mining Reclamation and Enforcement, www.osmr.gov).

Dust impacts on surrounding crops

Australian mines are generally very effective at controlling dust on haul roads to improve safety and health issues. However, it is very difficult to control the movement of dust from piles of overburden that result from coal mining. There is the potential for dust deposition on nearby crops to reduce quality particularly where horticulture crops are grown (e.g. Felton Valley of the Darling Downs where a wide range of vegetables are produced).

Strategic planning in land use

The ASSSI congratulates the Senate in undertaking this inquiry that hopefully will lead to improved land use planning where there are competing uses from two industries which contribute much of Australia's wealth.

The ASSSI recognizes the importance of forward planning in the efficient utilisation of soil and mineral resources and trusts that governments, in making decisions on land use, will consider the cumulative impacts that may occur in prime agricultural land with the sequential development of one mine after another. Whereas one mine may not reduce the cropping potential of a region substantially, ongoing development, as a result of precedents set, could lead to the loss of productive capacity over large areas (see for example the paper by Briggs and Whan 2009).

To the knowledge of the ASSSI, no field research has been undertaken to show the feasibility of reinstating prime agricultural land based on Vertosols on the Darling Downs or the Liverpool Plains. Given the productivity of these areas and the potential detrimental effects that may occur during reinstatement, it is imperative that research should be conducted to demonstrate whether it is even feasible to reinstate these landscapes, prior to any decision being made regarding mining.

Conclusions

The ASSSI recognises the importance of both mining and agriculture to the Australian economy.

In this submission the organisation documents-

- the reasons for the high productive capacity of the Darling Downs of Queensland and the Liverpool Plains of NSW; and
- the potential impacts on this capacity if these areas were to be mined.

The high cropping productivity of the areas is due to-

- the physical and chemical properties of the cracking clay soils (Vertosols);
- the location of the regions which provides good natural rainfall for grain production; and
- access to good quality underground water for irrigation which can enhance yields and provide security in times of drought.

Potential impacts on productivity, if these areas were mined, would be associated with-

- a reduction in the crop yield potential of the replaced soil;
- loss or reduction in the underground water resources; and
- reduction in crop quality through aerial deposition of dust.

The major limitations to reinstatement of these soils would be-

- the increasing salinity, dispersion and crusting of the soils if mixed; and
- the potential compaction that could occur during the stripping, stockpiling and replacement process.

Finally, the ASSSI is of the view that no mining should proceed before the completion of research to demonstrate if the reinstatement of these productive landscapes is feasible.

References

Australian Bureau of Statistics (accessed 2009) Agricultural commodities, Australia, cat. no. 7121.

Australian Bureau of Statistics, Canberra (www.abs.gov.au).

Banks, R G (1994). Soil Landscapes of the Curlewis 1:100 000 Sheet Map. Department of Conservation and Land Management: Sydney.

Banks, R G (2001). Soil Landscapes of the Tamworth 1:100 000 Sheet Report. Department of Conservation and Land Management: Sydney.

Biggs A J W (2003). South Eastern Darling Downs Resource Areas. Department of Natural Resources: Brisbane.

Briggs H S and Whan I F (2009). Recognising the inherent value of rural lands. *Agricultural Science* 1, 21-26.

Broughton A (1994). Mooki River Catchment Hydrogeological Investigation and Dryland Salinity Studies. Department of Water Resources report T594.026, Vol. 1 and 2, NSW Department of Water Resources: Sydney.

Dunker R E and Barnhisel R I (2000). Cropland reclamation. In R I Barnhisel, RG Darmody and WL Daniels (Eds.) Reclamation of Drastically Disturbed Lands. pp 323-369. American Society of Agronomy Inc.: Madison, Wisconsin, USA.

English P M, Lewis S J, Dyall A, Sandow, J and Coram J E (2007). 3D Groundwater Model Pilot Project for the Condamine Alliance, Queensland. Feasibility Report. Geosciences Australia: Canberra.

Faeth P and Crosson P (1994). Building the case for sustainable agriculture-policy lessons from India, Chile, and the Philippines. *Environment* 36, 16-20.

Häge K (1996). Recultivation in the Lusatian mining region – targets and prospects. *Water, Air and Soil Pollution* 91: 43-57.

Harris P S, Biggs A J W and Stone B J (Eds.) (1999). Central Darling Downs Land Management Manual. Queensland Department of Natural Resources: Brisbane.

Maher J M, Harris P S, and Briggs A J W (1998). Central Darling Downs Land Resource Ares, Queensland Department of Natural Resources: Brisbane.

McKenzie N, Jaquier D, Isabell R and Brown K (2004). Australian Soils and Landscapes. An Illustrated Compendium. CSIRO Publishing: Melbourne.

Mulligan D R (Ed.) (1996). Environmental Management in the Australian Minerals and Energy Industries. Principles and Practices. University of New South Wales Press: Sydney.

New South Wales Department of Primary Industries (NSW DPI) (2008). New South Wales Coal Industry Profile New South Wales Government: Sydney.

Pimentel D, Harvey C, Resosudarmo P, Sinclair K, Kurz D, McNair M, Crist S, Shpritz L, Fitton L, Saffouri R and Blair R (1995). Environmental and economic costs of soil erosion and conservation benefits. *Science* 267,1117-1123.

Pimentel D and Pimentel M (2003). World population, food, natural resources, and survival. *World Futures* 59, 145-167.

Timms W (1997). Liverpool Plains Water Quality Project 1996/7. Report on Groundwater Quality. New South Wales Department of Land and Water Conservation: Sydney.

Timms W, Acworth R I and Berhane D (2001). Shallow groundwater dynamics in the Narrabri Formation on the Liverpool Plains of New South Wales. *Australian Journal of Soil Research* 39: 203-218.

Wuertz W (1986). Methods and successes in agricultural and forest reclamation in German lignite mines. In C L Carlsen and J H Swisher (Ed.) Innovative Approaches to Mined Land Reclamation. pp. 173-186. Southern Illinois University Press: Carbondale.

Appendices

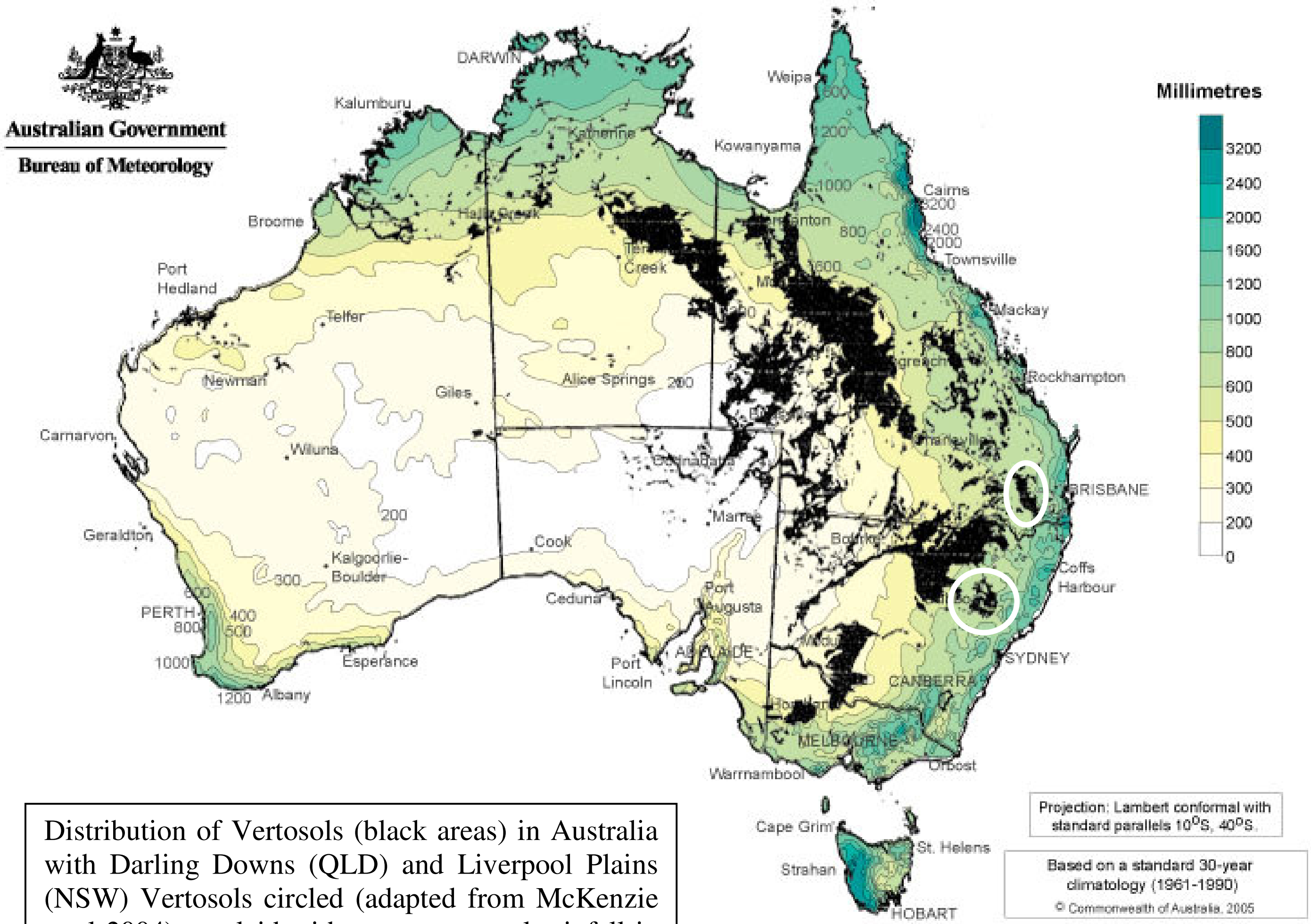
Appendix 1. Distribution of Vertosols in Australia with the Darling Downs (QLD) and Liverpool Plains (NSW) Vertosols circled (adapted from McKenzie et al. 2004) and average annual rainfall from 1961-1990 (http://www.bom.gov.au/jsp/ncc/climate_averages/rainfall/index.jsp).

Appendix 2. Satellite photographs of Darling Downs and surrounding areas (Appendix 2a) and Liverpool plains and surrounding areas (Appendix 2b), showing the intensity of cropping on the Vertosols (Google Maps).

Appendix 3. Gunnedah district (Liverpool plains) average crop yields.

Appendix 4. Location of exploration permits for coal (Appendix 4a) and petroleum (Appendix 4b) on the Darling Downs (Queensland Murray Darling Committee, www.qmdc.org.au).

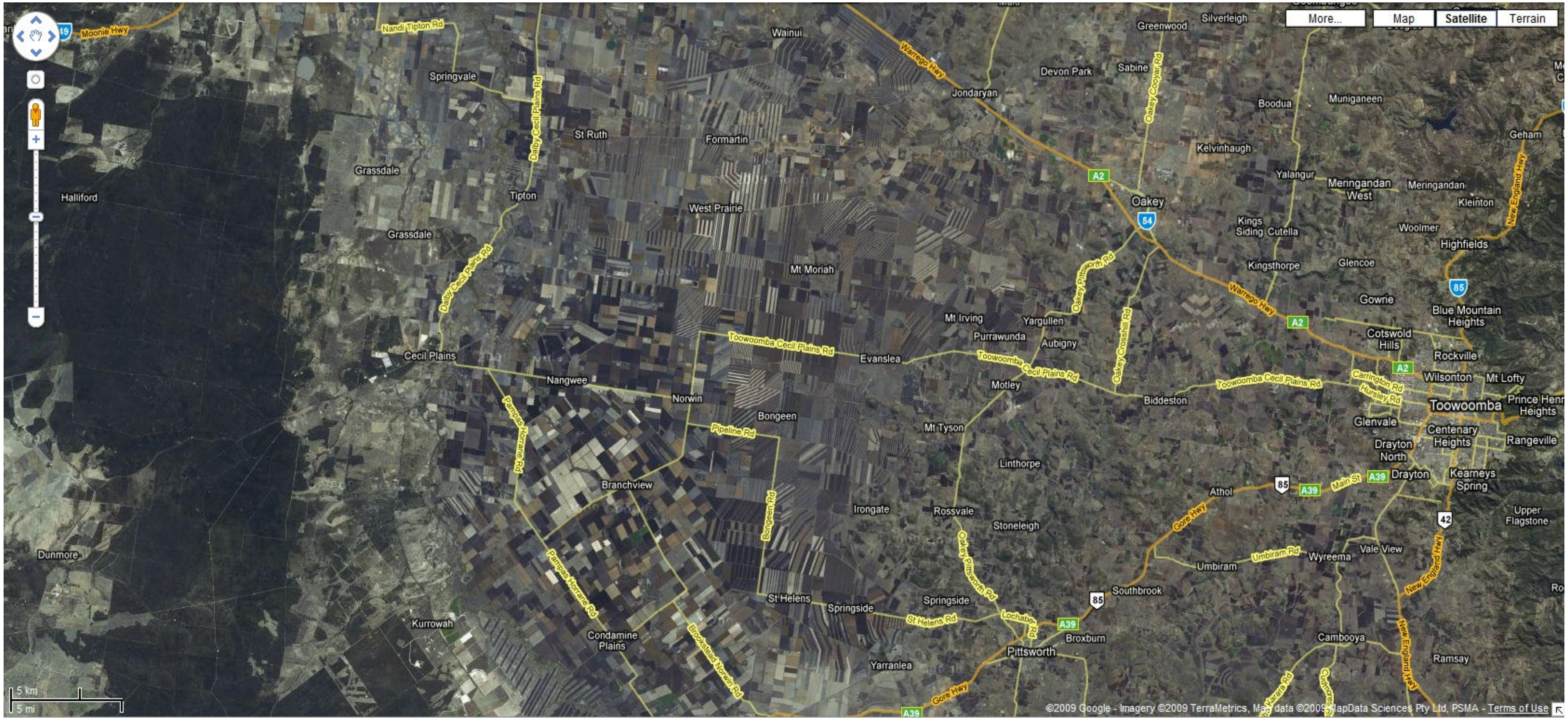
Appendix 1



Distribution of Vertosols (black areas) in Australia with Darling Downs (QLD) and Liverpool Plains (NSW) Vertosols circled (adapted from McKenzie et al 2004) overlaid with average annual rainfall in millimetres (www.bom.gov.au).

Appendix 2

Appendix 2a. Darling Downs



Appendix 2b. Liverpool Plains

Appendix 3

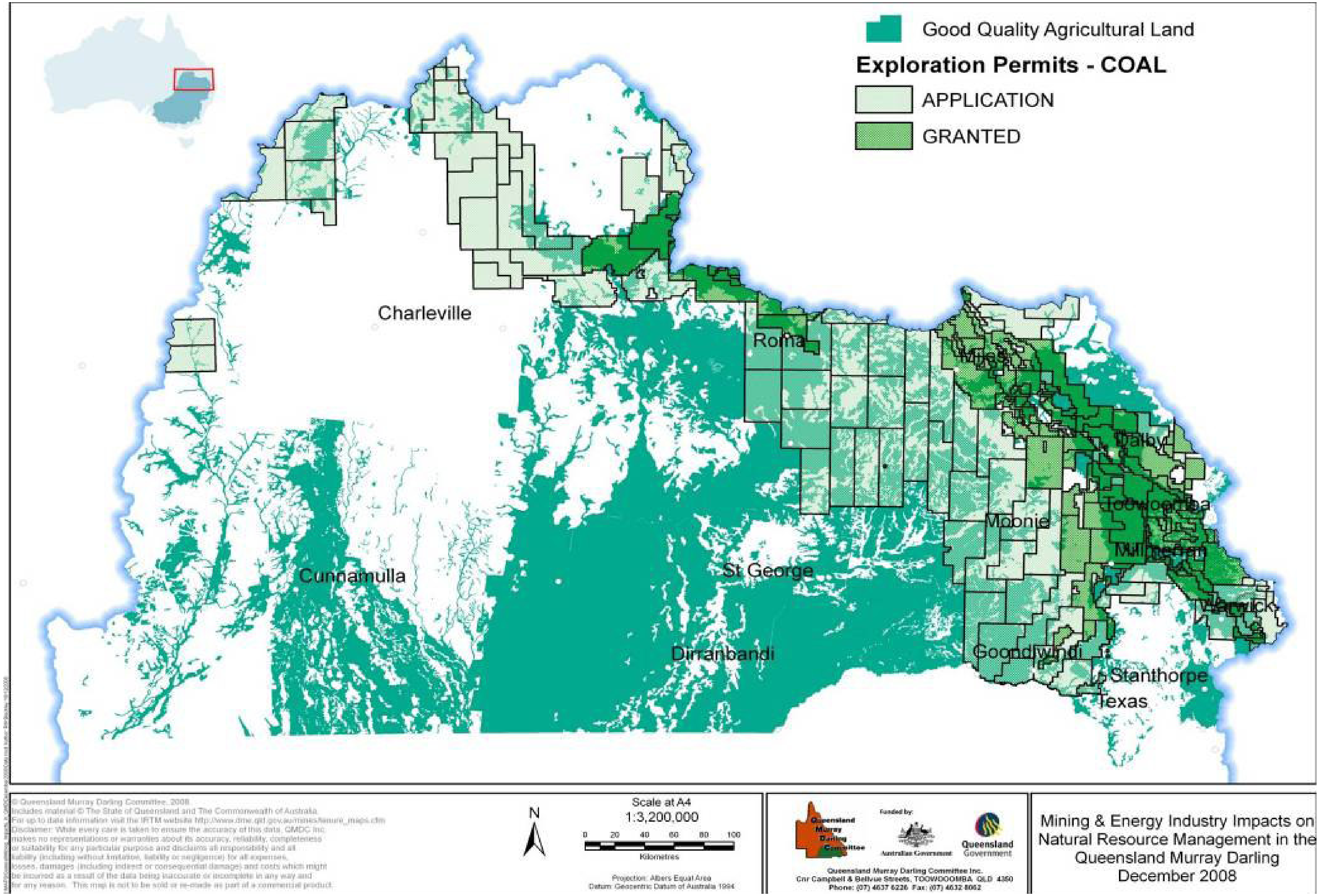
Gunnedah district (Liverpool Plains) average crop yields compared to New South Wales and Australian averages. (Source: Australian Bureau of Statistics; www.abs.gov.au)

Crop	Average Gunnedah yield (t/ha)*	Average NSW yield (t/ha)*	Average Australian yield (t/ha)**
Wheat	2.56	1.92	1.69
Oats	1.78	1.55	1.57
Barley	2.45	1.88	1.79
Sorghum	3.80	3.20	2.67
Canola	1.63	1.36	1.20
Faba bean	1.76	1.80	
Maize	7.83	7.94	
Mungbean	0.79	0.86	
Sunflower early	1.54	1.32	
Sunflower Late	1.50	1.41	
Chickpea	1.15	1.27	
Soybean	2.17	2.25	

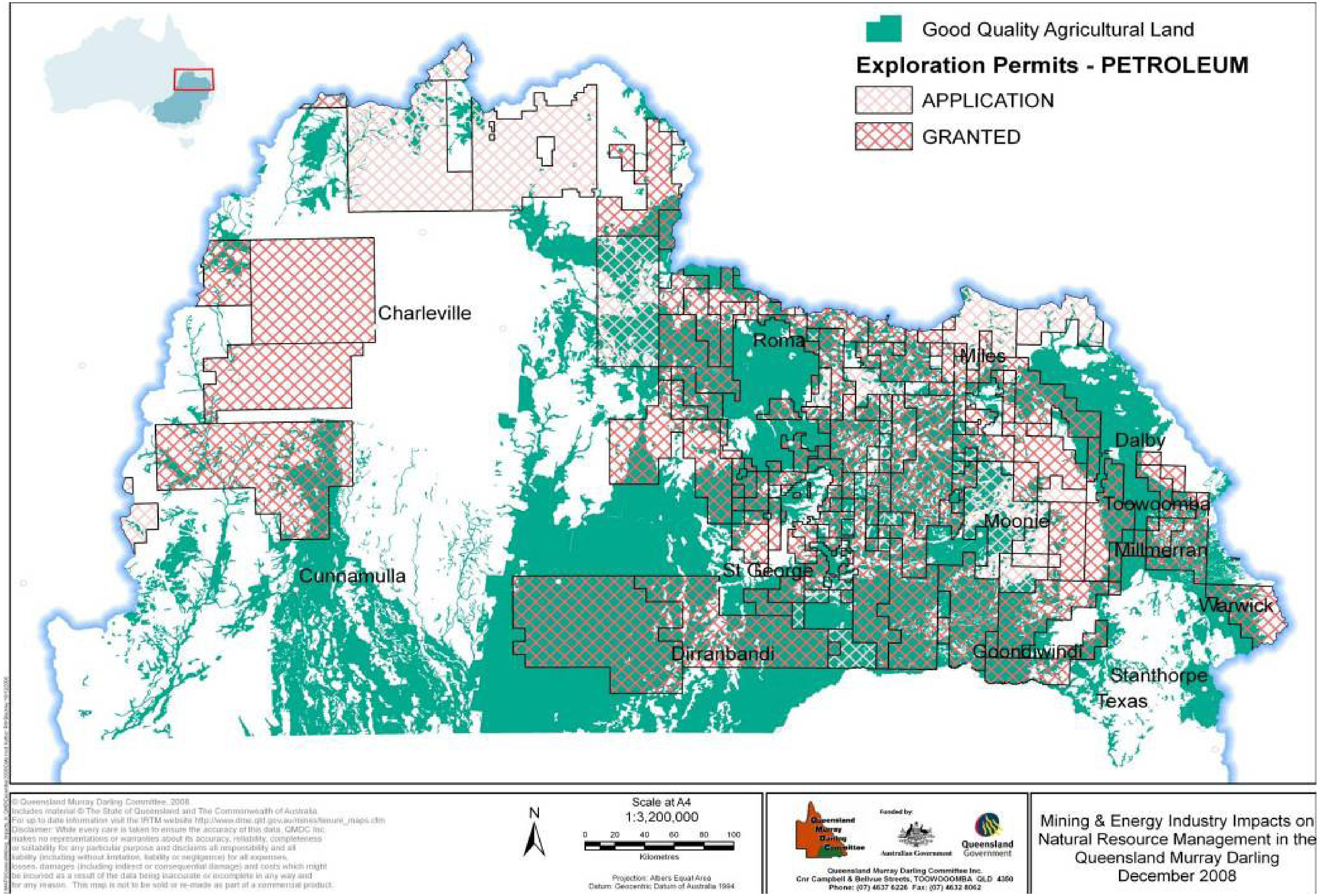
*Averages calculated from 1993-2008 inclusive.
**Averages calculated from 1996-2008 inclusive.

Appendix 4

Appendix 4a.



Appendix 4b.



Good Quality Agricultural Land
Exploration Permits - PETROLEUM
APPLICATION
GRANTED
Charleville
Roma
Miles
Dalby
Toowoomba
Moonie
Millmerran
St George
Cunnamulla
Warwick
Dirranbandi
Goondiwindi
Stanthorpe
Texas
© Queensland Murray Darling Committee, 2008
Includes material © The State of Queensland and The Commonwealth of Australia
Disclaimer: While every care is taken to ensure the accuracy of this data, QMDC Inc
makes no representations or warranties about its accuracy, reliability, completeness
or suitability for any particular purpose and disclaims all responsibility and all
liability (including without limitation, liability in negligence) for all expenses,
losses, damages (including indirect or consequential damage) and costs which might
be incurred as a result of the data being inaccurate or incomplete in any way and
for any reason. This map is not to be sold or re-made as part of a commercial product.
N
Scale at A4
1:3,200,000
0 20 40 60 80 100
Kilometres
Projection: Albers Equal Area
Datum: Geocentric Datum of Australia 1994
Funded by:
Australian Government
Queensland Government
Queensland Murray Darling Committee Inc.
Cnr Campbell & Bellvue Streets, TOOWOOMBA QLD 4350
Phone: (07) 4637 6226 Fax: (07) 4632 8062
Mining & Energy Industry Impacts on
Natural Resource Management in the
Queensland Murray Darling
December 2008