SoilFutures Consulting Pty Ltd

Review of Interim protocol for site verification and mapping of Biophysical Strategic Agricultural Land

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The findings and opinions in this report are based on research undertaken by Robert Banks (BSc Hons, Certified Professional Soil Scientist, Dip Bus, Adjunct Research Fellow UQ) of SoilFutures Consulting Pty Ltd, independent consultants, and do not purport to be those of the client.

Table of Contents

Executive Summary

This review has been prepared in response to the growing concern of the clients of SoilFutures Consulting Pty Ltd about the increase in coal and coal seam gas (CSG) activities in northern and western NSW. There appears to be a supposition that landholders would be willing to undertake extensive and expensive surveys of their own land to determine the possible extent of Biophysical Strategic Agricultural Lands (BSAL) on their own properties as a means of defending the possibility of coal and CSG exploration and development on their properties.

The review demonstrates that some of the assumptions regarding soil types are not relevant for all soil types and shows that self mulching Vertosols which form much of NW NSW cropping belt tend to be exceptions to the rules applied in the protocols. In addition to Vertosols, other soil types such as the Red Ferrosols of the Alstonville Plateau (NE NSW) are discussed as not meeting some requirements for BSAL. Both of the soils are considered the most productive soils in NSW and are highly sought after for their productive capacity.

An example costing to determine a reasonable cost for the determination of BSAL and Non BSAL lands is given for PEL 470 in the Bellata-Gurley region of Northern NSW. The costing clearly demonstrates that cost considerations are beyond the reach of most landholders in the cereal cropping belt.

This review has been prepared by Robert Banks BSc Hons, Certified Professional Soil Scientist (CPSS), Dip Bus, and Adjunct Research Fellow of the University of Queensland. Robert Banks has worked in soil and groundwater research and soil survey in the Liverpool Plains, across Australia and overseas for 14 years with the Soil Conservation Service of NSW and its successor organisations, and has been a practicing private soil consultant since 2004. His expertise is in the fields of Geomorphology, Remote Sensing, plant ecology, soil and landscape description and analysis, soil and groundwater salinity studies; and he has significant experience in connecting hydrogeological and surface processes.

1. Introduction

1.1 Background

This review has been prepared in response to concerns raised by clients of SoilFutures Consulting Pty Ltd regarding Biophysical Strategic Agricultural Land (BSAL) determinations and coal and coal seam gas (CSG) activities which they perceive are a threat to their agricultural activities, their soil and water supplies and to the social and economic fabric of their regions.

This review covers an assessment of the methodology offered in the NSW Government Interim Protocol for site verification and mapping of Biophysical Strategic Agricultural Land (NSW Govt., April 2013) as well as considering some of the practical implications of landholders going to the length of their own assessment made.

1.2 Methodology

The review was carried out by reading relevant sections of the Interim Protocol and the relevant appendices and commenting stepwise on issues arising within the document.

In addition to examination of the document, Petroleum Exploration License No. 470 (PEL 470) has been used as an example PEL to calculate a costing for the collection of the relevant information to make a determination on BSAL extent. PEl470 is located in the Bellata Gurley district of northern NSW. This costing will be indicative of the types of costs involved should landholders wish to undertake their own BSAL inventory.

2. Stepwise Review of relevant sections of the Interim Protocol

P1. State significant petroleum development that requires a new petroleum production lease,
- *State significant petroleum exploration activity,*

The use of the word State significant is interesting. Generally a State Significant Development (SSD) is declared following the exploration phase with CSG, yet this document refers to BSAL being recognised in the exploration phase. The reviewer is left trying to guess which CSG or mining activity will not be State significant. If there is such a thing as non-state significant development of this nature, does that mean that BSAL considerations are not required? If this is the case then could smaller (non-State significant) CSG activities escape scrutiny and therefore potentially go unregulated in terms of potential impacts?

P1. "excluding any associated development, such as linear infrastructure, outside the area of a proposed mining or production lease."

This is a puzzling statement, in that the activities relating to the development of infrastructure to support a mining operation may have an equal impact on BSAL lands. For instance, SoilFutures (2011) raises the issue of high pressure gas pipeline infrastructure on landscapes dominated by Vertosols (Cracking Clay soils). Generally Vertosol soils shrink and swell so significantly that inclusion of gas pipeline infrastructure is considered an unnecessary risk by many international standards.

P1 "The Gateway process is an upfront, rigorous and independent assessment of the potential impacts of a project on agricultural land and water resources (including BSAL) before a development application can be lodged."

There is no real reference to what the gateway process actually is if land qualifies as BSAL.

P1. "Maps accompanying the 2013 Mining SEPP amendment show BSAL at a regional scale. Due to the regional scale of the maps, it is important that appropriate processes are in place to provide for verification that particular sites are in fact BSAL."

The reviewer of this document is also author of several soil landscape maps and reports (Banks 1995, 1998, 2001) as well as the Reconnaissance Soil Landscape Map of the Namoi Catchment (Namoi CMA, 2009) and a contributing author to the Soil Landscapes of the Liverpool Plains (OEH, 2012). With this experience it is possible to comment on the precision of soil landscape mapping.

Soil landscape maps are very good sources of general information about soil distributions in a region; however they are limited in detail by scale as well as issues of on ground precision. The Soil Landscapes of the Curlewis 1:100 000 sheet map (Banks 1995) for example has mapping errors within it and as much as 220 km^2 of land within the map is inaccurately mapped. This is a reflection of the types of technology that were used in the preparation of the map as much as the limitations of the process of soil landscape mapping. The Soil Landscapes of the Blackville 1:100 000 Sheet (Banks 1998) has an on ground precision of approximately 95%.

The BSAL maps available for the Hunter and Northern Slopes and Plains areas of NSW are entirely based on Soil Landscape maps, and there is no serious attempt to describe the limitations of both the underlying data and the method by which BSAL was determined. The mapping should therefore be used as a guide only, and not be taken at face value in many instances.

P 2. "BSAL is able to be used sustainably for intensive purposes such as cultivation. Such land is inherently fertile and generally lacks significant biophysical constraints."

This aspect of the protocol is unfortunate. It shows a lack of understanding of grazing systems to catchments as well as the NSW economy. In the ten years running up to the year 2001, grazing was responsible for 51% of the Liverpool Plains income, and yet only 49% of the cleared lands in the Liverpool Plains are grazed. What BSAL does in this instance is isolate high value grazing lands from consideration for the "gateway process", as well as ignoring the connectedness of lands and aquifers in catchments like the Liverpool Plains and greater Gunnedah Basin.

P3. "Access to the project area will define the level of investigation that the proponent can undertake. If the proponent has access to the land then the BSAL verification requirements for on-site soils assessment as described in sections 6 and 9 should be met. If the proponent does not have access then the proponent should develop a model of soils distribution guided by sections 6 and 9.6 based on landscape characteristics using the information listed below."

This statement is confusing. One has to guess that the "proponent" is a developer. In addition to this, it appears that there may be two standards for determining BSAL; one is

supported by data, and the other is supported by a desktop study. This does not allow BSAL assessments to be compared if they are side by side and using different methods.

P3." • soils assessment of nearby accessible sites of similar landscape."

This does not allow for onsite investigation to the standards quoted later in the document. Soil assessment for BSAL should be done onsite, as soil variations on another site may lead to false conclusions regarding the actual site of the BSAL assessment.

P 5 "gilgai" as a soil and landscape verification criteria.

The presence of Gilgai is generally not a limitation to cultivation and development of no-till agriculture. Gilgai is "surface microrelief associated with soils containing shrink-swell clays…….Gilgai consist of mounds and depressions showing varying degrees of order, sometimes separated by a subplanar or slightly undulating surface (NCST, 2009). Gilgai are common phenomena in Vertosols (highly swelling clay soils) of NW NSW and western NSW. NCST (2009) recognises 6 types of gilgai. They are discussed below in terms of limitations to cropping operations:

1. Crabhole, normal, linear, lattice and contour gilgai – regardless of the height of the gilgai, or the depth of the mounds, these gilgai present no limitation to agriculture and are very slow to reform under no-till agriculture;

2 Melonhole Gilgai – This type of gilgai is typically associated with Brigalow lands, and can be up to 3 m deep and cause significant sorting of subsoil and topsoil material as they move slowly over time. They can be filled and ploughed out, but re-form over time and generally create a very patchy crop bed in a farming system.

For this reason, only Melonhole gilgai **only** should be considered as a potential limitation to the declaration of BSAL land.

P. 5 "The minimum area for BSAL is 20 hectares."

Although the size limitation seems reasonable for broad acre farming lands of NSW (ie the cereal cropping belt), there are many farms which have pockets of BSAL smaller than this on the Alstonville Plateau on the north coast of NSW and in the Sydney Basin that are used for intensive vegetable production, cut flowers or horticulture. These farms and are highly intensive and profitable, often employing several people. The size limitation on BSAL lands should be considered.

Page 6, level 10 in Figure 2. "Does the pH range from 5 - 8.9 if measured in water or 4.5 - 8.1 if measured in calcium chloride within the upper most 600 mm of the soil profile?

The lower pH limits seem reasonable for most cropping activities. Unfortunately the higher ranges do not generally limit crop growth for Vertosols. Soils with surface pH's of as high as 11 (in water) have been recorded in the Liverpool Plains and the wider Gunnedah Basin, yet there is no decline in productivity or toxic effects on plants as a result. This is, in part, due to the fact that most soil testing techniques for plant nutrients and trace elements have been developed in the United States on very young prairie soils which generally have moderate pH levels. These tests tend to fail at high pH and give misleading results. The high pH

limitation should be removed in the case of self-mulching, high clay, and high Cation Exchange Capacity (CEC) Vertosols.

P 6, level 10 in Figure 2. "Is effective rooting depth to a chemical barrier greater than or equal to 75 mm?"

This is clearly a typo and should read 750 mm, not 75 mm.

P7. 6.4. Gilgai (Step 4 in Figure 2)
Gilgai microrelief is a natural soil feature of mounds and depressions commonly associated with cracking clays or Vertosols. Although gilgai microrelief can be ameliorated, gilgais will typically reform if deeper than 500 mm.
If the average depth of gilgai depressions is deeper than 500 mm, and if the depressions occupy more than 50 per cent of a mapped area of gilgai, then the area is not BSAL.

Uneven surfaces interfere with cultivation, drainage and irrigation and may have elevated salinity and sodicity levels. Gilgai is a feature that is simple to identify.

The presence or absence of Gilgai has been discussed above. This section should be removed from consideration for BSAL, or modified so that it specifically refers to Melonhole Gilgai only as per NCST (2009). Also note typo. Gilgai is both plural and singular.

P 8. BSAL soils range from acidic to alkaline soil conditions within the range of 5.0 -8.9 when measured in water or 4.5 – 8.1 when measured in calcium chloride, within the uppermost 600 mm of the soil profile.

The upper limit for pH should be removed or an exception to this rule be made for Vertosols with high Cation Exchange Capacity and high clay content.

P8. BSAL soils have a level of soil salinity where electrical conductivity in a saturated extract (ECe) is less than or equal to 4 dSm/m or if gypsum is present, chlorides are less than 800mg/kg. This applies to the uppermost 600 mm of the soil profile.

This section is interesting. One should be aware that for every rule, there are exceptions and the freedom to include these exceptions is excluded from the BSAL process. Experience with Lettuce in the southern midlands of Tasmania shows that the effects of salinity can be offset to some degree. Lettuce is a very salt intolerant crop, however is grown very successfully with saline waters in Tasmania, where the effects of dissolved salts in irrigation waters is to offset sodicity and the lettuce plants appear to grow unaffected by the salinity of the soil which is up to 8dS/m, which is considered moderately saline (Hazelton and Murphy, 2007)

P 8. 6.11. Non-site criteria: minimum area
BSAL soils must have a contiguous area of greater or equal to 20 Ha.
The minimum area refers to the extent of the biophysical resource not the lot or holding size.
This is the minimum area considered necessary to commercially produce a high value agricultural crop.

As discussed above, there are many intensive vegetable farms in NSW, some with as little as 2 Ha in size that are successful commercial operations. The size limit needs to be dropped or to be made to apply only in regions suitable for broad acre crops such as cereals.

P 9. "exchangeable cations and cation exchange capacity (for deriving exchangeable sodium percentage (ESP) and the Ca:Mg ratio)."

The Ca:Mg ratio has been shown to have limited application in many broad acre cropping applications in NSW. AS discussed above, many soil tests that are used in Australia, have been developed in soils that are nothing like Australian soils. This is particularly so with Vertosols of the northern cropping belt of NSW.

P10. Each spatial dataset shall form a separate feature class within an ESRI file geodatabase, or as individual ESRI shapefiles if geodatabases are not supported by the user's GIS. All feature classes and shapefiles should use GDA94 geographic (latitude/longitude) coordinates. Wherever possible, each feature class shall be accompanied by a layer (LYR) file defining the symbology used in the final maps. All spatial data should be accompanied by metadata statements compliant with the ISO 19115 standard. Proponents can use the ANZMet Lite tool which is available for free download from the Office of Spatial Data Management at http://spatial.gov.au. Other maps and imagery may be prepared of the survey area including Light Detection And Ranging (LIDAR), electromagnetic, radiometric, satellite or geophysical imagery. They may highlight minor landscape variations that are associated with soil distribution patterns.

These specifications are standard for NSW government; however much of the publically available digital base map data for NSW is still in AMG 66 (an older map datum). This makes it difficult or expensive for consultants who are presumably going to do the work, to produce a reasonable map in GDA 94 (the most up to date datum for Australian map products). The NSW Government has the capacity to change the Datum which they view the information in as they require.

P10. or remotely sensed data data sets such as radiometrics or electromagnetic survey are encouraged.

Aside from the obvious typo here where the word "data" appears twice, this type of information can be very expensive to obtain. Although radiometrics and electromagnetic induction surveys are detailed and useful tools in land resource survey, they have limitations and in some instances can be misleading.

P11. Sites should be described 'as found' in the field. For example, areas that have been levelled or stone-picked should be described against the BSAL criteria in their current state. This includes those areas of gilgai that have been levelled for cultivation.

There is a typo here with the word "leveled". This is an important statement to people considering whether land is BSAL or not. **Apparently it implies that BSAL land can be created by rock picking land or leveling**. Either land should qualify as BSAL or not, therefore the presence of surface stones which may be rock picked, or uneven lands which can be leveled for agriculture should not be a limitation.

P11. "Areas that do not comply with BSAL due to obvious surface features such as slope, gilgai microrelief or surface coarse fragments may be excluded from further survey but appropriate exclusion sites (see section 9.4.1) should be recorded."

This statement clearly contradicts the paragraph immediately above it which implies that BSAL land can be made through rock picking or leveling.

P11. Exclusion areas. "Excluded areas should have at least two sites (exclusion sites) per polygon to demonstrate that the polygon does not contain BSAL. If the excluded area is based on slope determined by LIDAR, sites are unnecessary but the relevant methodology must be clearly explained."

This section is confusing. If an applicant considers land not to be BSAL, then much what is described here is redundant, as it is accepted not to be BSAL. If a property has, for example, 150 polygons, or areas of land which are not BSAL, then this would require 300 observations with photographs just to conclude that the area is not BSAL.

P21. For the purposes of this criterion, only unattached surface rock fragments with an average maximum dimension larger than 60mm and presence of outcropping bedrock need be recorded as the average density within a 10 m radius surrounding the site. Where there are multiple size ranges of coarse fragments, the total abundance of fragments greater than 60 mm in diameter must be measured.

As discussed above, BSAL land can apparently be created by rock picking surface rocks, so is this section actually relevant?

P 21 - 23. Gilgai microrelief

The key attributes of gilgai microrelief in the context of BSAL are the depth (vertical interval) of the gilgai depressions and the areal extent of depressions within a particular area of gilgai. If the average depth of gilgai depressions is deeper than 500 mm, and if the depressions occupy more than 50 per cent of a mapped area of gilgai, then the area is not BSAL……

As discussed above, the use of Gilgai for excluding lands from BSAL is flawed, and should either be removed or specifically refer to giant Melonhole gilgai only as a limitation. Once again, it has already been stated that BSAL land can be created by rock picking and leveling, so most gilgai will not be a limitation to agricultural development.

P23. Ideally, saturated hydraulic conductivity (Ks) should be measured to determine internal drainage rates (permeability) which will affect soil drainage. McDonald and Isbell (2009) have relevant saturated hydraulic conductivity figures for very slowly permeable (Ks range <5 mm/day) and slowly permeable (Ks range 5-50 mm/day) for soil layers. Less permeable soils will generally contribute to poorer drainage and saturation. The terms 'very poorly drained' and 'poorly drained' are defined in McDonald and Isbell (2009).

Hydraulic conductivity is **best estimated in the field** using field indicators as a guide (NCST, 2009). The measurement of hydraulic conductivity can be extremely time consuming and expensive. To give an example, many of the Vertosols in the Liverpool Plains have a sorptivity phase (the time that it takes a soil to saturate) of tens to hundreds of days. This would mean that to actually measure saturated hydraulic conductivity it would take tens to hundreds of days before the infiltration rate becomes a steady flow. Ringrose-Voase et al (2003) measured hydraulic conductivity of a small subset of soils in the Liverpool Plains in the 1990's. To do this with some measure of precision took the expenditure of many hundreds of thousands of dollars in time and equipment.

P24. Table 1. Summary of fertility rankings (adapted from Murphy et al. 2007).

The concept of fertility is a difficult one to assess and this table may well over simplify the process.

To take a soil type as an example, the Ferrosols (Isbell, 2002) or Krasnozems (Stace et al, 1968) are a good point in case. Red Ferrosols or Krasnozems are a relatively rare soil in Australia, as they are most commonly found in areas of rainfall >900 mm on basic rocks such as basalt. This soil dominates the highly productive Alstonville Plateau in north eastern NSW.

Appendix 2 Table 6 of the interim protocol lists all Ferrosols as having high inherent fertility. In direct contracts to this, the Food and Agriculture Organisation of the United Nations (FAO) lists *Ferralsols* (an international name for Ferrosols as being generally of low fertility and depleted in many trace elements for plant growth (FAO, 2006). This is true of Australian Ferrosols, the have very low available phosphorus and generally are highly acidic soils, however structurally they make good soils for cultivation of many different crops. They have fine aggregates or peds which have a good water holding capacity and yet drain relatively freely. Ferrosols are generally highly productive once their limitations have been corrected, with liming to increase pH, and with the addition of fertilisers.

P25. Within eastern and most of central NSW it is unlikely that soils containing significant natural gypsum will be present.

This statement is misleading. Many of the Vertosol soils of NW NSW, such as in the Liverpool Plains or Moree district have gypsum in them at some level. Perhaps this should be stated that gypsum can commonly be found in Vertosols of NSW's cropping districts.

P26. Table 4. Criteria for determining effective rooting depth

The criteria for sodic soils (Exchangeable Sodium Percentage or ESP) as having an ESP >15 is useful in many soils of NSW, however the Vertosols of the cropping belt tend to be the exception to this rule. Many types of subsoil Vertosols of the Liverpool Plains and other areas in the NW Slopes and Plains of NSW have ESP of up to 40. If the Cation Exchange Capacity (CEC) is high enough, and the soils have very high shrink swell potential, then sodicity generally has no significant effect on plant growth.

A field dispersion test would be a more useful as a guide to the impact of sodicity on subsoils. If soils become dispersed when wetted, then this is a limitation, if they don't, then sodicity is unlikely to be a limitation. This important exception to the rule needs to be put into the criteria for BSAL on Vertosols of the cropping zone of NSW.

The calcium magnesium ratio listed in Table 4, has been discussed above. It is useful in soils which have similar topsoil properties to northern American soils, however Ca:Mg ratio has limited application in many highly productive Vertosol soils in Australia.

P27. 9. Minimum area
BSAL must have a contiguous area equal to or exceeding 20Ha which meets the verification criteria.

As stated above, the minimum area limitation is faulty with respect to high value crop operations such as intensive vegetable growing, cut flower production or horticulture. This needs to be re-considered.

P 29. the activity is located in an area where no agricultural land uses exist such as in a well forested area;

Although the presence of a forest may preclude the presence of agriculture, it does not change the fact that lands may be BSAL. BSAL lands are supposed to be lands with high qualities for agriculture. Existing land use surely is not then a criterion for determining the risk of a proposed activity to that land.

P32. Appendix 4. Soil date cards – Should read "Soil Data Cards"

3. List of issues with Protocol

1. Grazing is not acknowledged as a relevant and profitable agricultural enterprise, despite its significant input to the economy of NSW as well as function in the landscape, of keeping non cropping lands stable and providing a water shed for surface and groundwaters.

2. The document has errors or typos which need to be corrected throughout.

3. Need for exceptions to rules. For example, the self-mulching Vertosols of the cropping belt of NSW can often have high pH and high sodicity (higher than the upper threshold values suggested as non BSAL lands), yet neither of these features is a significant limitation to cropping in areas such as the Liverpool Plains and much of the NW Slopes and Plains region of NSW. This needs to be seriously considered as an error, and doesn't take in available literature on the subject. Essentially if a Vertosol is self-mulching (has a fine surface structure that reforms naturally following disturbance), has high clay content (say >60%) and has a high cation exchange capacity (CEC) (for example >40 meq/100g), then high sodicity and pH do not generally have the predicted influence on these Vertosols that they would have on other soil types.

Perhaps in lieu of sodicity as an absolute measure, a field dispersion test such as an ASWAT score (reference) may be useful. That is to say that if the soil material disperses significantly, then there is a soil limitation which may affect the classification of a soil as BSAL.

4. The use of Gilgai height as a definitive for classification of BSAL. This has come from using the Queensland set of rules for the equivalent of BSAL (DERM, 2001, 2012). Many of the areas cleared for cultivation in Queensland have Melonhole gilgai which are often dense in the landscape and very deep (often 1m or more). Leveling and cultivation of this type of landscape leads to patchy development of cropping land and gilgai tend to reform over time.

The other main types of gilgai as described in NSCT do not generally propose a threat to development and operation cropping systems. For instance, approximately 40% of the Vertosol dominated farming landscapes of the Liverpool Plains which are mapped as BSAL by the NSW government once had gilgai of some sort on them. About 10% of this proportion had gilgai which would fail the classification for BSAL. The issue with this is that these soils are incredibly productive and that gilgai **do not reform** under current management on these soils.

5. The document states that lands that are not BSAL can be leveled or rock picked to become BSAL. Surely this insinuates that the land was BSAL in the first place, but was just rocky or needed leveling.

6. The fertility recommendations for BSAL are a bit arbitrary and inflexible. This is because fertility is more conceptual than many people realise. The example of Red Ferrosols (Isbell, 2002) or Krasnozems (Stace et al, 1968) is discussed above as most Ferrosols are of low to moderate fertility as natural soils, however they perform very well with ameliorants and have desirable water holding and drainage characteristics which make the one of the most sought after soil types in Australia.

7. The minimum area restriction of 20 Ha is not sensible and not based upon known land uses in NSW. Although 20 Ha is certainly of doubtful value under broad acre farming, 20 Ha or less of BSAL land can be extremely productive and profitable in terms of highly intensive vegetable growing systems or horticulture. Perhaps this limitation needs to be further refined, particularly in regions where landholdings have pockets of BSAL qualifying land which are able to be intensively used for high value crops such as vegetables, cut flowers or horticulture.

8. The presence of agriculture as a determinant for BSAL lands. The document appears to imply that forested lands may have limited value as BSAL lands. This is not the case. If the soil criteria are used to classify land as BSAL or not, then the current land use (ie under cropping, grazing, forested or otherwise) is immaterial.

9. Potential surface or groundwater processes and how a development proposal may impact on them are not mentioned in this review. Perhaps they are part of the "Gateway Process"?

10. The recommendation for expensive land resource survey on lands being mapped for BSAL at the bequest of a land holder is quite prohibitive, and may not be seen as an affordable option to landholders trying to defend their lands against what they might see as an unfair or incorrect declaration of their lands being BSAL or otherwise.

11. The concept of "State significant development" is not well defined and it seems that smaller (supposedly non – State significant) CSG or coal developments, may not be subjected to as rigorous scrutiny.

4. Example costing to determine the extent of BSAL in PEL 470

PEL 470 is a petroleum exploration license area in the Bellata Gurley area of N NSW, which SoilFutures has already done some investigation on, for the presence of BSAL lands, using available mapping only (SoilFutures, 2012). The mapping used is Reconnaissance soil Landscape mapping for the Border Rivers-Gwydir catchments. These maps have limitations as they do not have large amounts of supporting field soil profile data, nor do they have reasonable supporting laboratory data. The published BSAL maps available for PEL 470 are based entirely upon interpretation of this mapping.

Given that this area has existing BSAL maps of say 70% accuracy, it would be useful for either the proponent of coal seam gas (CSG) exploration and development, or the landholders

of the area to determine how much of the land qualifies as BSAL. This is done below as a hypothetical exercise and is costed according to the criteria listed in the interim protocol.

For the purpose of this exercise, the assumption has been made that the maps provided by Planning NSW are a relatively good representation of the relative areas of BSAL within PEL 470. It is assumed that the map created by a consultant following the protocol would have the same areas of BSAL and non BSAL.

It is assumed that the activity to be undertaken is CSG exploration and eventually mining, and that the exact localities of these activities is unknown as is frequently the case within a PEL until work is commenced. Therefore the whole PEL should be mapped for BSAL lands.

The area of the PEL is 74488 Ha

There are 13 BSAL soil landscapes in PEL 470 and these cover about 50 716 Ha.

There are 27 non-BSAL landscapes in PEL470, covering about 23 770 Ha, and taking up 142 mapped polygons (individual map areas).

For this costing, the following assumptions have been made:

- One soil profile described for each 20 Ha of proposed BSAL land
- For non-BSAL land there will be at least two measured and GPS located observations per non BSAL polygon;
- That a total of 12 soil profiles can be described as per the protocol in one working day;
- It is also assumed that 25 site observations can reasonably be achieved in one working day;
- That a backhoe or excavator costs an average of $1 000/day;
- That a qualified consulting soil scientist cost $900/day;
- That 7 days of development of a base map has been achieved;
- That at least 10 days of reporting is required once soil data cards are returned from SALIS (the OEH soil data base);
- That laboratory testing will be required for each soil profile to a depth of at least 900 mm;
- That each soil profile will produce 4 soil samples for testing based on one per 300 mm thickness of soil profile;
- That the Soil Conservation Laboratory at Scones price list of 2011 has not changed its prices in the past two year or so significantly and that this laboratory is of acceptable standard to do these tests.

A significant issue for the consultant and clients in this determination would be timing. It is likely that the laboratory timeframe from lodgement of samples to completion of samples would be 250 – 380 days, assuming that there were no other samples coming in to the laboratory for other jobs. This would come on top of 227 days of field work and mapping. The process would take at least two years to complete.

Should geophysical investigation with technologies such as ground Electromagnetic Induction (EM) surveys as recommended in the protocol, the price would increase by another 20 - 30%.

The above figures were used to prepare the costing as outlined below.

Activity	Cost per Unit	Units	Number of units	Cost
Preparation of Base map at 1:25 000 over 74888 Ha.	$900	Days	7	6300
Soil description and sampling of 2537 soil profiles as prescribed for 50716 Ha of BSAL	$900	Days	212	190800
Hire of excavator for 212 days	$1,000	days	212	212000
2 Observation at each of the 142 non-BSAL	$900	Days	8	7200
Laboratory Testing for pH, and EC1:5, and CEC using 2011 Scone pricelist as a guide for costing	$60	samples	10148	608880
Courier fee for samples		Once off fee for about 250 boxes of soil		15000
Vehicle Use	$80	days	220	17600
Preparation of Database/Spreadsheet and report describing baseline	$900	Days	10	9000
All Costs include GST			**Total**	**$1,066,780**

Red text indicates an estimate based on available figures.

5. Concluding Remarks

The Interim Protocol for Site verification and mapping of Biophysical Strategic Agricultural Land, has some merit, however, much of the protocol is inconsistent within itself, and has some assumptions about soils that do not apply across all soils in NSW.

Additionally, there are soil and landscape limitations which are not practical nor apply to all agricultural activities in NSW. The protocol excludes grazing as a viable and valuable economic activity in NSW and assumes that cropping is the only enterprise of value. Available figures for the value of grazing systems, both economically and ecologically do not match this assumption.

On reviewing this document in tandem with "State Environmental Planning Policy (Mining, Petroleum and Extractive Industries) Proposed amendment 2012 Under the Environmental Planning and Assessment Act 1979," it appears that the gateway process simply re-enforces

that the same environmental considerations need to be considered for non-BSAL lands. This raises the question of why does the state need the "Gateway Process?" Whether the review of an application occurs via a team of expert public servants with experience and appropriate qualifications in a region or a gateway panel, the result should be the same. It appears that no further measure of protection is afforded BSAL lands than that provided to non-BSAL lands.

In addition to issues raised with respect to the usability of the Protocol in determining BSAL lands, the cost imposed, particularly on landholders who wish to do their own verification of BSAL on their own lands is prohibitive. This is demonstrated in the costing given for PEL 470 where some holdings are in the range of 10 000 Ha. The time it would take to follow the protocol to the letter within PEL 470 leading up to a report on the determination of BSAL is approximately two years.

5. References

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