Guideline for co-ordinated projects involving clearing for agriculture (land suitability requirement)

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Further information

- Contact your nearest business centre
- Visit www.qld.gov.au (search for 'vegetation management')
- Call 135 VEG (135 834)

This publication has been compiled by Land Policy – Vegetation Management, Department of Natural Resources, Mines and Energy.

Approval

Position	Name	Date
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1 Purpose

This guideline has been prepared by the Department of Natural Resources, Mines and Energy (DNRME) to assist applicants to demonstrate land suitability for dryland or irrigated cropping when applying to clear regulated vegetation for a coordinated project involving agriculture.

Under the State Development Assessment Provisions (SDAP): State Code 16, applicants for coordinated projects involving agriculture must demonstrate that the land is suitable for the proposed crop(s) having regard to topography, climate and soil attributes (SDAP State Code 16- Performance Outcome 29). This guideline assists applicants to understand the types and standard of information required to demonstrate that land is suitable for a particular crop or crops.

2 Legislation

The legislation that is relevant to this guideline includes the:

- *State Development and Public Works Organisation Act 1971*
- *Planning Act 2016*
- *Vegetation Management Act 1999*

3 Related documents

- The State of Queensland, (July 2018). "*State Development Assessment Provisions: State Code 16: Native Vegetation Clearing."* (Published by the Department of State Development, Manufacturing, Infrastructure and Planning, Brisbane, Queensland).
- National Committee on Soil and Terrain, (2009). "*Australian soil and land survey handbook*." (3rd edn). (CSIRO Publishing: Melbourne, Victoria).
- McKenzie, NJ; Grundy, MJ; Webster, R; Ring-rose-Voase, AJ, (2008). "*Guidelines for surveying soil and land resources."*(CSIRO Publishing: Melbourne, Victoria).
- Department of Science, Information Technology and Innovation (DSITI), and Department of Natural Resources and Mines (DNRM), (2014). "*Guidelines for agricultural land evaluation in Queensland* (2nd edn). (Queensland Government (DSITI and DNRM), Brisbane, Queensland).
- Department of Natural Resources and Mines (DNRM) and Department of Science, Information Technology, Innovation and the Arts (DSITIA), (2014). "*Regional suitability frameworks for Queensland*." (Queensland Government (DNRM and DSITIA), Brisbane, Queensland).
- Department of Environment and Science, and Department of Natural Resources, Mines and Energy, (2018) "*Queensland soil assessment and data quality framework (Volume 1: Soil and land resource assessment." (Queensland Government, Brisbane, Queensland)* (Unpublished).
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4 Demonstrating land suitability

Land suitability is the evaluation of soil and land attributes for a specified land use (for example, rain-fed sorghum or drip irrigation grapes). To demonstrate land suitability, a land suitability assessment must be undertaken at an appropriate property level scale by an appropriately skilled and experienced soil and land resource scientist. A land suitability assessment may provide information that assists satisfying other performance outcomes under State Code 16, such as salinity, erosion and acid sulfate.

4.1 Land suitability assessment

A land suitability assessment that provides suitable information should be undertaken by an appropriately skilled and experienced soil and land resource scientist, in accordance with the following steps:

1. Undertake a desktop assessment
2. Undertake a reconnaissance survey
3. Undertake a detailed field survey (see Appendix 1)
4. Send samples to laboratory for analysis (see Appendix 3)
5. Prepare a report on Unique Mapping Areas (UMAs) and suitability assessment for the proposed crop(s) (see Appendix 2)
6. If the land is suitable for the proposed crop(s), prepare a response to the Performance Outcomes in the State Development Assessment Provisions: State Code 16- Native Vegetation Clearing.

4.2 Scale

The land suitability assessment, must be conducted at a property scale level. In general, property scale assessments will range from 1:5000 to 1:25 000 scale. If more than 10 000 hectares are proposed to be cleared, then up to 1:50 000 scale may be considered appropriate, if the soils and landscape are proven to not be complex. At scales of 1:50 000 or greater, insufficient information is collected to allow an adequate assessment of the land suitability to demonstrate compliance with the SDAP Performance Outcomes and the assessment of off-site impacts (including salinity, erosion and acid sulfate soils).

The survey and mapping scale chosen must suit the circumstance—the cropping proposed, its spatial extent, and most importantly, the complexity of the landform and soils. Chapter 14, and Table 14.1 of the *Guidelines for Surveying Soil and Land Resources* (McKenzie et al 2008) provides further information about scale. Applicants proposing to use survey or mapping scales greater than 1:25 000 will need to discuss this with a DNRME Land Resource Officer at a pre-lodgement meeting prior to commencing the work.

In some areas of Queensland, published land suitability data is available. Depending on the scale and currency of published data, a re-evaluation of part or all of the land, ranging from an assessment of a soil or land attribute at a single location, to a complete detailed study (including the collection of new soil and landform site data, evaluated against new crop(s) and limitations) may be required. All additional soil and landform site data, and the crop suitability evaluation, will need to be collected and compiled in accordance with the *Australian Soil and Land Survey Field Handbook* (NCST 2009), *Guidelines for Surveying Soil and Land Resources* (McKenzie et al 2008) and the *Queensland Guidelines for*

Agricultural Land Evaluation (DSITI & DNRM, 2015) at property scale. In Queensland, the most important limitations are those that relate to erosion, use of machinery (slope), wetness and soil water availability. Some of this information will need to be considered in conjunction with water allocations. Additional information about requirements for the soil and land suitability assessment are included in the Appendices.

4.3 Engage a suitably skilled and experienced soil and land resource scientist

The land suitability assessment must be undertaken by a person who has skills and experience in soil and land resource science. This person must:

(1) understand landscapes for the purpose of mapping and describing soils types, soil attributes and limitations
(2) be competent in the description of soils in accordance with the *Australian Soil and Land Survey Field Handbook* (NCST 2009) and mapping them at a property scale in accordance with the *Guidelines for Surveying Soil and Land Resources* (McKenzie et al. 2008)
(3) be competent in undertaking agricultural land suitability assessments considering key soil attributes and land limitations in accordance with the *Guidelines for Agricultural Land Evaluation in Queensland* (DSITI & DNRM 2015).

It is recommended that a Certified Professional Soil Scientist (CPSS) with a specialist competency in Australian soil survey is engaged. Engaging persons with proven competencies in soil and land resource science will help to ensure that the mapping and necessary agricultural land suitability assessment information is sufficient to allow the application to be assessed in a timely and cost-effective manner.

4.4 Desktop assessment

It is recommended that a desktop assessment of all available sources of relevant information should be undertaken prior to commencing further work such as a reconnaissance survey or an intensive field survey. The aims of the desktop assessment are to:

- identify unique map areas or map units and provide an indication of the soil type/s present in the area
- identify the survey area and the number and location of observation sites for further field investigation based on the likely number of soil types represented, the nature of those soils and their likely distribution across the area of interest. This may be larger than the land the subject of the application to include areas of potential off site impact, particularly if irrigation is proposed
- pinpoint any obvious or critical data gaps.

Suitable sources of information for the desktop assessment include:

- geology mapping and reports
- topographic mapping
- remote sensing data (e.g. land use mapping, digital elevation models, etc.)
- aerial photographs and satellite imagery
- existing soils and land resource reports, maps and associated information.

There is a substantial body of published soil and land resource reports and mapping that have been produced by various federal and state government agencies that are likely to be

relevant to land suitability assessments. This material comes in a range of scales and is generally freely available or available at minimal cost.

In many coastal areas, as well as some inland areas of Queensland, detailed mapping at a scale of 1:25 000 to 1:100 000 is available and may include soil attribute data. In the majority of inland areas only broadscale 'land system' or 'land resource area' mapping is available at scales of 1:250 000 or 1:500 000. Soil, land system and land resource mapping at all the above scales are often complemented by detailed reports.

The scales applicable to published maps normally need to be refined by a field survey covering the area of interest to an applicant. However, there are certain areas which have been subject to very intensive soil surveys by government agencies and those surveys could potentially yield information and data suitable for forming the sole or principal basis of an application.

Existing soils data, whether taken directly from government agency data bases or publications, or other privately collected data, may not fully satisfy the requirements for demonstrating the suitability of the land for the specific crops. This is frequently due to:

- the data being originally collected for a purpose other than property scale land suitability assessment; or
- insufficient soil attribute data was collected; or
- incomplete laboratory analysis; or
- the soil attribute data has been described inconsistently with the current preferred or acceptable standards (e.g. the Australian Soils and Land Survey Field Handbook).

Electronic copies of existing government soil reports and maps, and GIS spatial data for the associated mapping, can be accessed through the following Queensland Government websites:

- https://www.qld.gov.au/environment/library
- https://data.qld.gov.au/dataset/land-resource-areas-series

Additional information will need to be collected if the following circumstances apply:

1. The existing published land suitability report did not include an assessment of the proposed crop(s).
2. The existing published land suitability report shows all or part of the proposed area is unsuitable for the proposed crop(s).
3. You disagree with the existing mapping showing the extent of suitable and unsuitable land.
4. You believe that an attribute (a physical or chemical property) of the soil or land, which makes the area currently unsuitable, is incorrect.
5. The subject area is not part of an existing, appropriately scaled, land suitability study and no suitable soil or land suitability data has been published.

Justification including scientific evidence will need to be provided in situations where there are inconsistencies between your results and published land suitability reports. Applicants are encouraged to discuss all results of the desktop survey with DNRME (contact the VegHub on 135 834) before commencing further detailed assessments.

4.5 Reconnaissance survey

In some cases, a desktop assessment of available soil mapping and data might be sufficient to demonstrate compliance with the requirements for a land suitability assessment, depending on the scale of the published data, and complexity of the soil and landscape. Where more detail is required, a reconnaissance survey can be a cost effective step that complements the desktop assessment.

A land resource scientist with some basic equipment (e.g. a hand auger, corer or similar, and GPS), and the knowledge gained from the desktop assessment, should be able to quickly survey a parcel of land and, if necessary, review or refine the survey area for a subsequent, more detailed field survey.

Information gained in the reconnaissance survey can provide significant benefits in planning any subsequent, detailed field survey, including:

- providing guidance on the validity of the concepts developed (in the desktop assessment) on the likely distribution and nature of the survey area
- focusing resources to the areas of the landscape that contain the most complex soils and landforms
- allowing more accurate costing and budgeting for the field survey.

If done correctly, the information and data gained in the reconnaissance survey should potentially reduce the amount of information and data that needs to be collected in the subsequent, more detailed field survey.

4.6 Detailed field survey

The critical aspect of a field survey is the identification and characterisation of sufficient ‘observation sites’ to be examined, documented and evaluated.

There are four types of observation sites that can be used to map the unique map areas and determine land suitability, including:

- detailed soil profile description
- deep borings
- analysed sites
- check sites.

Table 1 Classes of observations

Observation type	Description	When is it required?
Detailed soil profile description	Detailed morphological and site descriptions to characterise the main soil and landforms, and the specific soil attributes required in land suitability assessments. Soils are described to minimum of 1.2 m or 1.5 m (if irrigation or deep rooted crops are proposed), or an impermeable layer such as bedrock.	Used to identify the different soil types and characterise the dominant soil in a unique mapping area, essential for characterising the soil attributes and limitations used in land suitability assessment.
Deep borings	Deep borings examine the material below the normal depth and are important when subsolum and substrate properties influence land use. Deep borings allows consideration of factors such as deep impermeable layers, salt accumulation, groundwater depth and salinity. Full soil profile morphology including pH and electrical conductivity, measured from the surface and at 0.3 m increments. Lower soil depth for these borings should be discussed with DNRME (contact the VegHub on 135 834) to ensure adequate assessment of deep drainage.	Essential if irrigation is proposed, particularly to assess the off-site impacts associated with deep drainage, water logging and salinity.
Analysed sites	Profiles where samples are taken for laboratory analysis. Sampling is usually conducted to characterise each 'typical soil' in the area being investigated, or to target selected soil attributes such as fertility, sodicity or salinity. Physical and chemical analyses are expensive and must be well targeted and clearly specified. Minimum required includes pH, EC, Cl, particle size distribution, air dry moisture content, dispersion ratio, cations, trace elements and fertility suite.	These are used to evaluate sites and unique map areas within the area to be cleared, to characterise off site impacts and to confirm field textures, soil permeability and field tests, which are required to assess limitations such as wetness, soil water availability and erosion. Each 'typical' soil requires at least one analysed site. More may be required for larger applications, particularly if irrigation is proposed (up to three analysed sites per unique map area if polygons exceed 10 ha).
Check sites	Check sites are brief observations to confirm mapping boundaries, soil type distributions or other	Used to accurately delineate the location of the boundaries of unique map areas or to

	characteristics being mapped in the survey area. They must be in sufficient detail to allocate the site to a specific soil type and unique map area or mapping unit.	ascertain the degree of variability within a map unit.

Note: Soil site density and mapping scale should be produced at the property scale and determined by the area to be cleared, crop type and complexity of the soils and landscape. Mapping scale needs to be discussed during prelodgement, for proposed scales coarser than 1:25 000.

Appendix 1 Minimum information required for each site

Information required for each site

The following provides an example of the type of standard information and data that should be collected for each detailed site, deep boring, analysed site and check site. This information should be included in a report supporting the application:

Table 2: Minimum data for land resource survey site observations (modified from DES & DNRME 2018)

Attributes	**Detailed soil profile description, deep borings and analysed sites**	**Check sites**	**Reference in *Australian Soil and Land Survey Field Handbook***	
Location				
Datum/projection, coordinates, method, accuracy	▲	▲	YB p7-11, BB Ch16 p246-251	605 900 mE 7 380 000 mN, Zone 55S, UTM WGS84 or -23.687366°, 148.038652°, GDA94
General				
Unique, meaningful site identification code				D/08 for site 8 in project XYZ
Described by	▲	▲	YB p13	
Date (time optional)	▲	▲	YB p13	
Site type	▲	▲	YB p13	
Observation class	▲	▲		
Observation method	▲	▲	BB* Ch16 p252, YB p147-148	Soil pit, auger, pit
Reason for lower investigation depth	▲			Auger refusal due to bedrock
Geology: unit, map sheet, year	▲	☼	BB Ch4	
Australian Soil Classification	▲	☼ (Sub order)	ASC, BB Ch19, YB p225-227	Haplic Mesotrophic Red Dermosol
Photos: profile, landscape, fieldsheet	▲	☼	BB Ch16 p256-257	

Attributes	Detailed soil profile description, deep borings and analysed sites	Check sites	Reference in *Australian Soil and Land Survey Field Handbook*	
Landform				
Landform: element, pattern, RMS	▲	▲	YB p15-55	Levee on Floodplain, Level Plain
Slope: method, % slope, slope class, MT	▲	☼	YB p18-26	
Site/land surface				
Land use	▲	▲		
Disturbance	▲	▲	YB p128	Cultivated; rainfed
Microrelief	▲	▲	YB p 129-133	Including element sampled
Erosion	▲	▲	YB p133-138	
Surface coarse fragments	▲	▲	YB p139-143	
Rock outcrop	▲	▲	YB p143-144	
Surface condition	▲	▲	YB p189-191	Hardsetting
Runoff	▲		YB p144-145	
Vegetation associations	▲	☼	YB p 73-125	
Permeability	▲		YB p200-202	
Drainage	▲		YB p202-204	
Depth to free water	▲			
Soil profile				
Horizon notation	▲	☼	YB p148-159	A1, A2
Horizon depths	▲	☼	YB p156	
Horizon boundaries	▲	☼	YB p199-200	Clear, Diffuse
Soil matrix colour	▲	☼	YB p159	10YR32
Mottles	▲	☼	YB p159-161	<2%, 1-15mm, prominent, orange
Field texture	▲	☼	YB p161-169	Sandy clay loam
Coarse fragments	▲		YB p170-171	2_10%, 20-60mm, subangular, quartz
Structure	▲	☼	YB p171-181	moderate, <2mm, subangular blocky

Attributes	Detailed soil profile description, deep borings and analysed sites	Check sites	Reference in *Australian Soil and Land Survey Field Handbook*	
Cutans (slickensides)	☼			
Segregations	▲	☼	YB p195-198	10-20% calcareous concretions, 2-6mm
Depth to R horizon, strongly cemented pan	▲	☼	YB p156-159	
Pans	▲			
Permeability and drainage (horizon)	☼			
Sample depths, number	▲ (sampled sites)		BB Ch17 p265	
Substrate			YB p205-224	
Type of observation	▲			
Confidence	▲			
Depth	▲	☼		
Lithological type	▲	☼		
Grain size, texture, structure, mineral composition, strength, alteration, distance	☼			
Field tests				
pH: method, value (surface 0.1m and for each horizon or every 0.3m)	▲	☼	YB p198, GB* p46	
Electrical conductivity (surface 0.1m and for each horizon or every 0.3 m)	▲			
Dispersion/slaking class (sandy clay loam or heavier)	☼	☼		
Effervescence of fine earth ($CaCO_3$) or segregations (Mn)	☼			

Note:

- ▲ means mandatory information.
- ☼ means optional information.
- YB refers to the "Yellow Book", *Australian Soil and Land Survey Field Handbook* (NCST, 2009).
- BB refers to the "Blue Book", *Guidelines for Surveying Soil and Land Resources* (McKenzie et al 2008).
- ASC refers to the *Australian Soils Classification* (CSIRO, 2016).
- GB refers to the *Soil Chemical Methods– Australasia* (Rayment and Lyons, 2011).

At least two clearly labelled photographs are required for each site showing:

- the nature of the general environs and soil surface at the site
- the attributes of the exposed soil profile, including a scalar reference (that is clearly visible on the photograph), such as a tape, surveying staff or calibrated sample tray.

An example of suitable photographs is include in Figure 1, and a sample field sheet is included as Figure 2.

The soil profile shall be described (dug or exposed) to a minimum depth of 1.2 m, or 1.5 m if irrigation is proposed, or to a shallower depth if refusal by hardpan or bedrock.

Exposure will be by either or a combination of (in order of reliability) – excavation/pit, relatively undisturbed core, jarret hand auger as used in soil survey. Post hole diggers are not acceptable or reliable due to contamination of the soil profile horizons, and are not considered to be a jarret hand auger. Any deviations from the above should be discussed with DNRME (contact the VegHub on 135 834).

Detailed sites

Figure 1: An example of the level of detail required for a detailed site using basic format, and the required level of detail for site and soil descriptions as well as the use of photographs to support those descriptions

Project: CAPEVILLE	Site: 13
Location: GDA 94 zone 56, 300 000 mE 7 000 000 mN **Described by**: Bill Smith **Date:** 17-Jan-18	
Site description	
Geology: Rte – sandstone **Landform Pattern**: low hills **Element**: hillslope **Permeability:** slowly permeable **Microrelief**: zero or none **Drainage:** moderately well drained **Slope:** 7 % **Rock outcrops:** no bedrock exposed **Surface coarse fragments:** less 2%, 20-60 mm subrounded sandstone **Surface condition:** hard setting **Disturbances:** extensively cleared	

ASC classification:	Brown Chromosol	
Profile morphology		
Horizon	Depth (m)	Description
A1	0.0 to 0.005	Very dark grey (10YR3/1) moist; clay loam; very few <2% rounded sandstone small pebbles 2-6 mm; subangular blocky moderate 2-5 mm structure; no segregations; clear change to.
B1	0.06 to 0.18	Brown (10YR4/3) moist; medium clay; very few <2% rounded sandstone small pebbles 2-6 mm; sub-angular blocky moderate 2-5 mm structure;no segregations; clear change to.
B21	0.18 to 0.45	Dark yellowish brown (10YR4/6) moist; medium clay ; very few <2% sub-rounded sandstone small pebbles 2-6 mm ferruginised;lenticular moderate 2-5 mm structure; very few <2% fine <2-6 mm ferromanganiferous nodules; gradual change to.
B22k	0.45 to 1.2	Brownish yellow (10YR6/6) moist; very few <2% fine <5 mm faint orange (7.5YR6/6) mottles; medium clay; very few <2% sub-rounded sandstone small pebbles 2-6 mm ferruginised; lenticular strong 5-10 mm structure; very few <2% medium 2-6 mm ferromanganiferous nodules; many <20-50% medium calcerous nodules; few prominent slickensides; clear change to.

BCk	1.2 to 1.3	Yellowish brown (10YR 5/6/4) moist; coarse sandy light medium clay; massive structure; very few <2% fine ferromanganiferous nodules.

Analysed sites

Guidance for soil sampling provided in the *Guidelines for Surveying Soil and Land Resources* suggests that for the purposes of a general soil survey, the maximum sampling interval should be
0.1 m in the upper 0.3 m of the soil profile. Likewise below that depth the maximum sampling interval should be 0.3 m. These generic recommendations are required when sampling analysed sites for a land suitability determination.

When deciding on a suitable sampling regime, applicants need to also consider:

- which limitations and soil attributes the analyses are verifying, and what analytical tests are involved
- whether sampling is of individual soil horizons (e.g. A1 horizon, A2 horizon, B2 horizon, etc.) or based on standardised profile depth intervals (e.g. 0–0.1 m, 0.2–0.3 m, 0.5–0.6 m, 0.8–0.9 m, 1.1–1.2 m; and 1.4-1.5 m for deep rooted crops and irrigated assessments)
- if the soils are uniform, gradational or texture contrast soils, and if the horizon boundaries are gradual or diffuse
- the risks of the size of a sample interval diluting material from a narrow layer of soil.

Irrespective of whether sampling is horizon or depth interval based, all samples should be taken within single soil horizons (i.e. depth interval samples should not cross major soil horizon boundaries).

All samples are to be analysed at a National Association of Testing Authorities (NATA) accredited or Australasian Soil and Plant Analysis Council (ASPAC) accredited laboratory. Before submitting soil samples, it is important to check that the laboratory is accredited and/ or holds certification for all of the required tests. When salinity is present in the landscape, laboratory methods must not be based on estimates. For example, chloride must be measured via laboratory analysis and not estimated from electrical conductivity. See Appendix 3 for further information.

The same site and soil profile information must be provided for each analysed site as set out in Figure 1.

Check sites

Where the defining attributes of the characteristic soil in a map unit can be readily identified by obvious superficial features (e.g. surface soil colour, surface soil texture, surface condition, presence of gilgai, etc.), check sites can provide a quick and reliable means of identifying the areal extent of the unique mapping area (i.e. map unit).

Alternatively, depending on the complexity of the landscape, a determination of whether the check site is within a homogenous unit or not, may require exposure of part or all of the soil profile. If necessary, the check site may need to become an additional detailed site. In these

alternate circumstances, provided the number of detailed sites is increased accordingly, there may be no need to have observation sites that are designated as check sites.

The attributes that confirm a check site belongs to a particular soil type or unique map area must be recorded for each check site, along with the unique identification (e.g. C16 for check site 16). The GPS coordinates of the check site and the applicable spatial datum (e.g. 605 900 mE 7 380 000 mN, Zone 55S, UTM WGS84) must also be recorded and submitted, along with a shapefile with the relevant information. Simply submitting a site identification and some location coordinates for a check site, without any evidence of the confirmatory site or soil attributes observed, is insufficient information to demonstrate land suitability. Accordingly the nature of the confirmatory evidence obtained at check sites needs also to be stated (e.g. self-mulching, surface cracking, black clay surface soil).

Figure 2: Sample field sheet

Site #		Slope		Permeability		Erosion	
Desc. by		Element		Drainage		Surface Corse Fragments	
Date							
Datum		Pattern		Microrelief		Rock Outcrop	
Zone							
Easting/Lat		Northing / Long					
Notes :							

Horizon Name	Depth	Texture	Moisture Status	Colour	Mottles	Coarse Frags	Segregations	Structure	Test Depth	pH	EC	Sample Depth

Landscape drawings are commonly completed on the reverse of the field sheet.

Appendix 2 Land suitability report

Your land suitability report must be completed in accordance with the *Guidelines for Agricultural Land Evaluation in Queensland* (available at Guidelines for Agricultural Land Evaluation in Queensland) and must include all of the following:

1. Signed statement by a person who has qualifications and experience in soil and land resource science confirming that the land is suitable for the proposed crop(s)
    a. Qualifications and experience in soil and land resource science
    b. Statement of land suitability for the proposed crops
2. Site location, description and proposed activity, including all of the following:
    a. Lot number and registered plan number
    b. Current site plan with scale bar, showing north, lot on plan boundaries and location of soil sampling sites (including GPS coordinates and the applicable spatial datum coordinates of detailed sites, deep borings, analysed sites, and check sites)
    c. Proposed crop(s) to be grown
    d. Management practices for growing and harvesting the crop(s) to ensure limitations are considered when determining land suitability i.e. irrigation method
3. Assessment and findings, including all of the following:
    a. Assessment methodology in accordance with the required standards (*Guidelines for Agricultural Land Evaluation in Qld*; *Australian Soil and Land Survey Field Handbook*), including:
        i. the location of all sites
        ii. soil profile descriptions (see Appendix 1)
    b. Soil map at property scale with a description of each soil type and limitations for each of the unique mapping areas. This may include collated information from published land resource/ land suitability studies used in the assessment (including a discussion of each limitation used in that particular land suitability assessment)
    c. Description of the proposed crop(s) requirements in terms of climate and seasonal variability, linked to the climatic and seasonal conditions at the site location
    d. Description of the landscape element, landscape pattern, slope, drainage, permeability, surface rockiness (abundance, size, and lithology), rock outcrop (abundance and lithology) and microrelief of each site sampled
    e. Description of each soil horizon at each site, including the minimum standards specified in Table A1.1 of this guideline (e.g soil texture, colour, structure, coarse fragments, segregations, field pH, upper/lower depths of horizons etc)
    f. Data on the pH and Electrical Conductivity at each site at 0.3 m increments to at least 1.5 m depth unless bedrock is encountered beforehand
    g. Photographic evidence of the general environs and soil surface at each site, and the attributes of each exposed soil profile to thye required depth.
    h. Links or correlation between the sites sampled to the soil unique map areas and how the soil attributes relate to the limitations and overall land suitability

i. For irrigated cropping, a daily water balance model to make an assessment of deep drainage, water logging and off-site impacts from salinity
j. Findings and reasons for the findings
k. All digital copies of spatial data (e.g. ArcGIS shapefiles) used for assessment including unique map areas, final suitability results, and LiDAR digital elevation model in raster format (if available, preferably in ArcGIS)
l. All digital copies of excel spreadsheet listing each unique mapping area, soil types, limitation categories used, suitability subclasses for each different land use, and the overall suitability class (see example in Table 2)
m. The limitation values and suitability subclasses rules for the land management options must also be included
n. Source of land evaluation rules (e.g. from regional suitability framework, specific land resource project etc)

4. Conclusions and recommendations including all of the following:
    a. Statement that the subject land is/is not suitable for the identified land use (crop(s))
    b. Identification of any limitations and constraints on the use of the site where applicable
    c. Where limitations exist, describe the land management strategies to overcome the limitations
    d. Land suitability mapping
5. Attachments
    a. Laboratory results from an accredited laboratory (e.g. NATA, ASPAC)

Table 2: Example of UMA suitability derivation for three land uses and five limitations (modified from DSITI & DNRM 2015)

UMA 1	Limitation categories/ values	Suitability subclasses for different land uses		
		Sugarcane	Peanuts	Banana (irrigated)
	M4 (soil water availability)	2	3	1
	R3 (rockiness)	3	5	2
	W3 (wetness)	3	3	3
	E2 (water erosion)	2	3	2
	Ts3 (slope)	4	3	3
Overall suitability class		**4**	**5**	**3**

Note: These suitability subclasses are examples only and are not to be taken as prescriptive. The limitation category/ value will need to be defined in the report.

Appendix 3 Laboratories for soil analysis

Under normal circumstances the laboratories performing the analysis of soil samples required to determine whether land suitability will need to:

- comply with the Australian Standard (AS) AS ISO/IEC 17025-2005: General requirements for the competence of testing and calibration laboratories
- have the technical expertise for the specific analytical methods.

Accreditation provided by the National Association of Testing Authorities (NATA) can provide evidence of compliance to this standard.

Preferably, analytical laboratories should also participate in Australasian Soil and Plant Analysis Council (ASPAC) proficiency trials, and maintain certification for the relevant methods. The ASPAC website (www.aspac-australasia.com.au) lists participating laboratories.

In the cases of both NATA and ASPAC, the respective accreditation or certification is for specific analytical tests or methodologies (e.g. method 15C1 in Rayment & Lyons, 2011), and is not a generic accreditation for all analyses undertaken at a laboratory. Therefore before submitting soil samples for analysis, it is important to check that the laboratory is accredited and/or holds certification for all of the required tests.

While the use of sample handling and preservation focused quality assurance measures, such as chain-of-custody documentation, analysis of field and trip blanks, spiked and duplicate samples, is not to be discouraged, if site selection and sample collection are not of a suitable quality, post sampling quality assurance measures are of no value and will not overcome sampling or procedural deficiencies.

Where analytical testing of soil samples is undertaken outside of an accredited facility, the agency assessing a verification application might require evidence that:

- the equipment used has been calibrated or recalibrated by the equipment supplier, or another entity with suitable expertise, and that the calibration is current
- the calibration of the equipment is routinely checked when the equipment is operating
- a recognised analytical methodology has been followed
- a documented set of suitable quality assurance procedures is in place to cover all aspects of the testing, from sample receipt to the provision of the results
- the persons undertaking the tests have the competencies necessary to prepare the samples, operate the testing equipment, record the results, and identify quality assurance non-conformities and any anomalous results.

Irrespective of the accreditation or certification held by a laboratory, copies of all analysis certificates provided by the analytical laboratories or other providers must be submitted as part of the Land Suitability Report.