Queensland Soil and Land Resource Survey Information Guideline

VEG/2018/4460

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Queensland Government

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Version History

Version	Date	Comments
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2.00	22/02/2021	Document updated to include information for additional assessment purposes under the *State Development Public Works Organisation Act 1971.*

Approval

Position	Name	Date
Director	Peter Lazzarini	20 April 2021

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1 Purpose

This guideline outlines clear and consistent procedures for the collection of soil and land resource information for an agricultural land suitability assessment, to support a development application for clearing regulated vegetation for a coordinated project for agriculture (State Development Assessment Provisions - State Code 16: Native Vegetation Clearing). It will also assist proponents in collecting soil and land resource information for other assessment, regulatory or monitoring purposes (e.g. approvals for major infrastructure, and mineral resource projects under the *State Development Public Works Organisation Act 1971* (SDPWO Act 1971).

This guideline is complementary to other guidelines for the collection, evaluation and interpretation of soil and land resource information.

This guideline is an update of the *Guideline for co-ordinated projects involving clearing for agriculture (land suitability requirement)* VEG/2018/4460 (DNRME 2018).

2 Rationale

The collection and interpretation of soil and land resource information is required to assess the variability of soils and landscapes, and to demonstrate how this variation affects land use (e.g. agricultural suitability), land management and land degradation risks.

The Queensland Government may require the collection of soil and land resource data to support sound decision making under the SDAP State Code 16: Native Vegetation Clearing. SDAP State Code 16: Native vegetation clearing includes Performance Outcomes to avoid land degradation such as soil erosion, salinity and acid sulfate soils. In addition, applicants for coordinated projects involving agriculture must demonstrate that the land is suitable for the proposed crop(s) (and irrigation if applicable) having regard to topography, climate and soil attributes.

Such assessment processes provide long-term beneficial outcomes for stakeholders with interests in land, water and vegetation use by providing a pathway for sound evidence-based decisions, including risk-based approaches for managing natural resources. Time and money spent conducting high quality soil surveys at the beginning of a development approval process will enable proponents to avoid long term land degradation and ensure that their developments achieve natural resource management outcomes.

Following these guidelines will ensure that applications include relevant and sufficient information to enable assessment and minimises the need for the Department of Resources to seek further information from the applicant. This will expedite assessment and enable the approval process to be streamlined.

2.1 Land degradation and water quality

Land degradation covered in this guideline includes soil erosion, rising water tables, the expression of salinity, mass movement by gravity of soil or rock, stream bank instability and a process that results in declining water quality (*Vegetation Management Act 1999*).

Where the use of water for irrigation is proposed for major infrastructure projects, there is potential to mobilise soil and groundwater salt stores in rising water tables, degrade land and increase saline baseflow to streams. Potential pathways of salt movement include deep drainage, lateral flow and salt wash off. Nutrients and pesticides can also be transported off-site via these pathways, impacting on water quality. Soil structure may also be damaged by the application of saline water or water with chemical composition that does not suit the soil. Potential impacts may occur both on-site and off-site.

All soils are subject to erosion, but the natural rate of erosive soil loss broadly equates to the rate of soil formation (DNRME 2020). Activities such as clearing of vegetation, over-grazing, some horticultural activities and major infrastructure development can increase the exposure of the soil surface to rainfall, runoff or wind, by the reduction of protective ground cover. This poses a risk to land degradation if there is soil loss through erosive run-off from these landscapes. Fine sediment export from gully erosion has been shown to have a detrimental impact on water quality in the Great Barrier Reef lagoon (Brodie *et al.* 2013).

3 Related documents

Soil and land resource information that is collected and stored in the Queensland Government's Soil and Land Information (SALI) database is available to proponents to support land suitability assessments for new irrigation projects and infrastructure projects. This includes:

- state-wide datasets such as the state-wide agricultural land class (ALC) layer, the strategic cropping land (SCL) trigger map, the Natural Resources Inventory, and the Agricultural Land Audit
- site data, land suitability data, land systems mapping, salinity data for salinity risk assessments, gully erosion site characterisation information, acid sulfate soils data, soil carbon data that is available for the Land Restoration Fund, erosion modelling data, soil attribute data (eg soil permeability, soil drainage, surface pH, Australian Soil Classification etc) available as a series of spatial products

The soil and land resource data that is stored in the SALI database is accessible through multiple Queensland Government platforms.

The general principles and guidelines for soil survey, land suitability assessment and land degradation studies are contained within a variety of state and national standards. The following documents complement these guidelines and provide further information in relation to best practice and standards to follow.

3.1 Soil survey guidelines and handbooks

The methodology and principles of soil survey recommended for Queensland landscapes are documented in:

- *Australian Soil and Land Survey Field Handbook* (3rd edn), National Committee on Soil and Terrain, 2009– commonly referred to as the 'field handbook' or 'Yellow Book'.
- *Guidelines for Surveying Soil and Land Resources,* McKenzie *et al.* 2008 – commonly referred to as the 'Blue Book'.
- *Soil Physical Measurement and Interpretation for Land Evaluation*, McKenzie *et al.* 2002 – commonly referred to as the 'Brown Book'.

- *Soil Chemical Methods- Australasia*, Rayment & Lyons, 2011 – commonly referred to as the 'Green Book'.
- *Australian Soil Classification – Third Edition,* Isbell and National Committee on Soil and Terrain, 2021.
- *Guidelines for Soil Survey along Linear Features*, Soil Science Australia 2015 (or later edition).
- *Queensland Land Resource Assessment Guidelines, Volume 1: Soil and Land Resource Assessment*, Department of Environment and Science & Department of Resources 2021.
- *Queensland Land Resource Assessment Guidelines, Volume 2, Field Tests*, Department of Environment and Science & Department of Natural Resources Mines and Energy 2020.

3.2 Agricultural land evaluation

The procedures for agricultural land evaluation in Queensland are contained in the following guidelines:

- *Guidelines for Agricultural Land Evaluation in Queensland (2nd edn),* Department of Science, Information Technology and Innovation & Department of Natural Resources and Mines 2015.
- *Regional Suitability Frameworks for Queensland,* Department of Natural Resources and Mines & Department of Science, Information Technology, Innovation and the Arts, 2013.

3.3 Land degradation studies

Guidance on assessing land degradation risks associated with salinity, soil erosion and acid sulfate soils is available from the following sources:

- *Salinity Risk Assessment Guidelines for Queensland*, Department of Resources in press.
- *Soil Conservation Guidelines for Queensland*, Department of Science, Information Technology and Innovation, 2015.
- *Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines*, Dear *et al*. 2014.
- Further acid sulfate soil guidance for Queensland

3.4 Related regulatory guidelines

Related regulatory guidelines include:

- *State Development Assessment Provisions: State Code 16: Native Vegetation Clearing*, The State of Queensland, July 2019.
- *Regional Planning Interests Act Guideline 08/14, how to demonstrate that land in the strategic cropping area does not meet the criteria for strategic cropping land,* DILGP 2015.

Note: The *Regional Planning Interests (RPI) Act Guideline 08/14* includes requirements for the collection of soil information for specific regulatory purposes under the RPI Act 2014. These requirements are specific to the RPI Act 014 and should not be confused with the requirements of this guideline. The RPI Act Guideline 08/14 includes additional complementary information on assessing slope, gilgai and pedotransfer functions such as plant available water capacity etc.

4 Qualified personnel

In the interests of achieving sound-evidence based decision making, the engagement of qualified persons with relevant competencies, experience and technical knowledge will help ensure that the information that is collected is of an appropriate standard and contains sufficient detail to allow the application to be assessed in a timely and cost-effective manner.

It is recommended that a soil survey and agricultural land suitability assessment be completed by a suitably skilled and experienced soil and land resource scientist. A suitably skilled and experienced soil and land resource scientist should:

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), and
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).

A Certified Professional Soil Scientist (CPSS) with demonstrated experience in soil survey and land suitability will meet these criteria. If a CPSS is not engaged, the proponent should ensure the consultants engaged can demonstrate that they meet these criteria.

Note that geotechnical workers are typically not trained as soil surveyors and use different standards for description of soil.

5 Common issues/questions

The following issues / questions frequently arise when the collection of soil and land resource information is required for planning, assessment, management or regulatory purposes associated with natural resource management or infrastructure projects:

- Should I talk to a Department of Resources Land Resource Officer?
- Is there existing soil information?
- What scale of soil survey is required?
- How many soil sites should be described and where should they be located?
- How much information is required for each site?
- Which analytical methods are required?
- How should soils be classified?
- How should agricultural land suitability be determined?
- Is the irrigation method suitable and sustainable within that particular landscape?
- How do I assess land degradation such as salinity, erosion and acid sulfate soils?

This guideline has been formulated to address these issues and questions.

5.1 Discussions with Department of Resources officers

It is recommended that proponents discuss issues such as existing data, scale, collection of site data, analytical requirements, land suitability and irrigation suitability/sustainability with a Department of Resources Land Resource Officer prior to the commencement of any fieldwork. This will help ensure that sufficient information is collected, and to appropriate standards.

Where the clearing of regulated vegetation is being considered, it is strongly recommended that applicants participate in a pre-lodgement meeting involving a Department of Resources Land Resource Officer and a Department of Resources Natural Resource Management Officer prior to lodging an application.

Proponents for a coordinated project are advised to contact the Office of Coordinator General for a pre-lodgement meeting as early as possible in their project development.

5.2 Existing soil and land resource information

Existing soil and land resource information can be used to support development applications and other assessment processes covered by this guideline.

Different types and scales of land resource mapping data exist in Queensland. At the broadest scale is the Atlas of Australian Soils (Northcote *et al*. 1960–68). Broad scale land systems or land resource area (LRA) mapping (1:250 000 to 1:500 000) exists for nearly all parts of Queensland. Land systems represent recurring combinations of geology, soils, landform and vegetation.

Similarly, LRA mapping used in Land Management Manuals groups soils, vegetation and landforms that are associated with common geological units. This mapping and the associated manuals give a broad overview of the agricultural resources of a region, mapping broad land types and describing the major soils. Despite the broad scale, the value of land systems and LRA data should not be under-estimated, and considerable information is held in the descriptions of the map units (component land units and soils).

LRA and land systems mapping can be used to determine if certain soil types of interest are likely to be present in a particular area. Many land systems publications have associated land capability assessments. Land capability (Rosser *et al*. 1974) is an assessment of broad agricultural land use potential (e.g. cropping and pasture). This was revised in 1997 (QDPI 1997). Other broad scale government datasets may be available across Queensland (e.g. compiled by CSIRO). This information is not suitable for property scale planning.

In some areas of Queensland, more detailed land resource assessment has been undertaken (1:100 000 scale or finer). Older assessments (pre-1985) are typically only soil surveys, with a limited set of attribute data associated with each polygon—often just the soil type. These surveys are often referred to as mapcode-based mapping.

Modern surveys use the concept of unique mapping areas (UMAs) where each map unit or polygon has a unique identifier. In such mapping, for each UMA (or individual polygon), one or more soil types are described, along with detailed attributes or features of the soil and landscape. This data is the basis for agricultural land suitability assessment, which is described in the *Guidelines for Agricultural Land Evaluation in Queensland* (DSITI & DNRM 2015). The process utilises the concept of limitations, based on reductions in crop productivity or potential environmental impacts, to assign five suitability classes (refer to Attachment B). Some limitations apply across all land uses (e.g. soil depth), while others may only affect certain land uses (e.g. certain nutrient limitations).

Site data collected by various government organisations (primarily Department of Resources, the Department of Environment and Science (DES), CSIRO and their predecessors) is available across the state. More than 100 000 soil profile descriptions are publicly available on the Queensland Globe, with nearly 1.5 million laboratory results for 167 000 different samples. This data is stored in the Soil and Land Information (SALI) database. Refer to Queensland soils website for information about mapping and site data, Queensland open data portal, the Queensland Spatial Catalogue and the Queensland Globe. This includes a step-by-step guide to accessing soil information from the Globe.

An extensive collection of information on Queensland soils exist as published land resource survey technical reports. Titles can be searched and are available for download from the Land Queensland Library Catalogue and the Queensland Publications Portal. For any enquiries, email soils@qld.gov.au.

In many situations the soil information (e.g. site and UMA data) held in the Queensland Government SALI database, and information within published technical reports (e.g. Land Management Manuals and land resource survey reports) may be used to supplement applicant collected data. It is recommended to discuss these options with a Department of Resources Land Resource Officer early on in any collection process.

5.2.1 Land suitability for clearing regulated vegetation

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 may be required (including the collection of new soil and landform site data, evaluated against new crop(s) and limitations). In Queensland, the most important limitations are those that relate to erosion, use of machinery (slope), wetness and soil moisture availability. Some of this information will need to be considered in conjunction with water allocations. Additional information about reporting requirements for the soil and land suitability assessment for clearing regulated vegetation are included in Attachments A, B and C.

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

- the data being originally collected for a purpose other than property scale land suitability assessment
- insufficient collection of soil attribute data
- incomplete laboratory analysis, or
- the soil attribute data has been described inconsistently with the current preferred or acceptable standards (e.g. *The Australian Soil and Land Survey Field Handbook,* NCST 2009).
- Additional information will need to be collected if the following circumstances apply:

- the existing published land suitability report did not include an assessment of the proposed crop(s)
- the existing published land suitability report shows all, or part of the proposed area is unsuitable for the proposed crop(s)
- evidence that the existing mapping showing the extent of suitable and unsuitable land may be incorrect
- evidence that an attribute (a physical or chemical property) of the soil or land, which makes the area currently unsuitable, is incorrect, and/or
- 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 Department of Resources (contact the Department of Resources VegHub on 135 834) before commencing further detailed assessments.

5.3 Desktop assessments

Prior to the collection of any soil and land resource information, a review should be undertaken of all existing data. This, combined with pedological principles, should be used to formulate a hypothesis regarding soils and landscapes likely to be encountered in the study area. Such a desktop assessment aims to:

- identify UMAs 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 area subject to the application including areas of potential off-site impact, particularly if irrigation is proposed
- pinpoint any obvious or critical data gaps, and
- identify the required site intensity and scale.

Desktop assessment also includes tasks such as analysis of terrain, using derivatives of digital elevation models (DEMs) and analysis of surficial features using geophysical data such as airborne radiometrics to assess the landscape. The use of these is well established in soil surveys, but as with all remotely sensed data, care must be taken to establish sufficient calibration and estimates of uncertainty and error. While analysis of remotely sensed data can provide a quick interpretation of landscapes and be useful for the derivation of key attributes such as slope, stereo-interpretation of aerial photographs remains a highly efficient and effective method for detailed land resource mapping, and a useful method for defining linework (UMA/polygon boundaries). Refer to QImagery for digital aerial photos, that can be used for aerial photo interpretation. Linework should be captured digitally and geo-rectified.

Once all of the information from the desktop assessment has been collated and analysed, sites for field observations will need to be selected, and the validity of the landscape concepts (i.e. the relationships between soil types, landform and geology) will need to be confirmed in the field. Considerable time can be devoted to the analysis of site selection. Survey effort may need to be focused to the areas of the landscape that contain the most complex soils and landforms, to areas where there is obvious land degradation, and to areas with any obvious data gaps.

The national SITES schema (Jacquier *et al*. 2012) is recommended as a template for designing a soil site database structure.

5.4 The question of scale

Scale can be confusing in soil surveys due to terminology sometimes being used inappropriately. Appropriate survey methods and scale will yield not only baseline data, which may also be used for evaluation and monitoring purposes, but data that supports different aspects of land use and land management—not just agricultural uses. The scale required will vary from project to project and should be clearly communicated and clarified with the involvement of Department of Resources Land Resource Officers during the project design stage. The scale of a feasibility study will generally be less detailed (e.g. 1:100 000), with more detailed investigation (e.g. 1:10 000) required if or when the project progresses. Regardless of the scale, the line work should be precise in relation to obvious surface features (e.g. alluvium versus hard rock), particularly where high-resolution imagery is available.

5.4.1 The clearing of regulated vegetation and scale

For a land suitability assessment that involves the clearing of regulated vegetation, the 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 complexity is not high, and there is good understanding of the soils and landscapes. At scales of 1:50 000 or broader, insufficient information is collected to allow for 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). Alluvial landscapes are generally complex and will require at least 1:10 000 scale investigation.

Applicants proposing to use survey or mapping scales broader than 1:25 000 will need to discuss this with a Department of Resources Land Resource Officer at a pre-lodgement meeting prior to commencing the work.

5.4.2 Minimum polygon size

The minimum size of a polygonal feature that can be delineated on a hardcopy map is fixed irrespective of scale. For a uniform feature it is a roughly circular shape with diameter of 5 mm. For an elongate feature, it is approximately 3 mm by 9 mm. When scale is considered, these dimensions translate to a minimum mappable area (Reid 1988).

5.4.3 Site locations and density

In general, soil observations should be distributed in a manner that represents all of the soil and landscape characteristics that are being assessed. Observations located on the polygon boundary of a soil UMA should be avoided unless their purpose is to specifically characterise transition zones, or the UMA boundary. The location of soil observations within a UMA for assessments of strategic cropping land, acid sulfate soils and linear infrastructure are contained in separate guidelines.

Historical standards (Schoknecht *et al.* 2008) suggest a rule of thumb of one site per cm^2 of map printed at the published map scale. Table 1 is an updated modification of these standards that presents recommended observation densities at different cartographic scales for conventional land resource surveys in landscapes of moderate complexity. The recommended range for ground observation density is between 'B' (low density) and 'C' (higher density). 'A' is the minimum density that should be used only with compelling justification.

For a highly uniform landscape, where there is a good understanding of the soils, such as the Black Vertosol landscapes on the Eastern Darling Downs or the Julia Downs in the Gulf of Carpentaria, the 'B' lower density of observations would be required (e.g. 8 observations per 100 ha for 1:25 000 scale). For a highly complicated landscape, such as the alluvial floodplains of the Burdekin River, the 'C' higher density of observations would be required (e.g. 100 observations per 100 ha for 1:10 000 scale).

Depending on the purpose and scale, every mapped UMA/polygon should contain at least one detailed site description—depending on the purpose, there may be a requirement or need for more than one. Overall site density should approximate the theoretical requirement for the intended scale unless clear evidence/justification can be provided for deviation from this.

Not all sites need to be described in detail (see section 6.8). Mapping observations (Class IV, as described in Schocknecht *et al*. 2008) in uniform landscapes that are used to define mapping boundaries are acceptable, providing the minimum data such as location, landform, soil surface features, photographs and some notes are recorded. A soil profile may still need to be exposed to confirm the soil type and soil attributes. Laboratory analysis of soils will often be required for at least one site in each UMA.

Table 1: Site density for different survey scales (modified from DES & Resources 2021)

Cartographic scale	Area (ha) per 1 cm² of map	Area per observation *Area (cm²) of published map per observation (all scales)* *4* A (min)	 *2* B (low)	 *1* C (high)	No. of observations per unit area *No. observations per 1 cm² of published map (all scales)* *0.25* A (min)	 *0.5* B (low)	 *1* C (high)
		Area (ha) per observation			*Observations per 100 ha (1 km²)*		
1:2500	0.0625	0.25	0.125	0.0625	400	800	1600
1:5000	0.25	1	0.5	0.25	100	200	400
1:10 000	1	4	2	1	25	50	100
1:25 000	6.25	25	12.5	6.25	4	8	16
1:50 000	25	100	50	25	1	2	4
1:100 000	100	400	200	100	0.25	0.5	1

Note: Where land suitability is being determined for the clearing of regulated vegetation, site density will be required to conform with a property scale investigation. See section 6.4.1.

5.5 Soil observation classes

Schoknecht *et al*. 2008 described four classes of observation that are used when mapping, including:

- detailed soil profile description (Class I)
- deep borings (Class II)
- analysed sites (Class III)
- brief mapping observations (Class IV).

These observation classes have been expanded for use in Queensland, as shown in Table 2. Depending on the purpose of the soil survey and the complexity of the landscape, a combination of these four classes of observations will be required. All soil observations should be positioned in locations that best represent the soil and landscapes being assessed. Laboratory analysis is expensive and should be carefully selected.

Where existing knowledge is significant and there is high quality existing site data (e.g. available on the Queensland Globe), those existing sites may be incorporated into the site intensity calculations for the detailed and analytical sites.

For linear infrastructure, site intensity and soil observation types should be guided by the *Guidelines for Soil Survey along Linear Features* (Soil Science Australia 2015), or later edition.

5.5.1 Information required for each site

The following provides an example of the type of standard information and data that should be collected for each observation class. All sites must be located using GPS. Coordinate position should preferably be obtained through averaging over a period of five to ten minutes, the longer the better. Map Grid of Australia (MGA) is the recommended projection system using the GDA2020 datum, which is now the standard geodetic datum for Australia. Alternatively, the GDA94 datum

(MGA94) may be used which will result in an approx. 1.8 m offset. Collection method, date, datum and projection details need to be recorded. Long-term monitoring sites must be physically marked, pegged or located to an accuracy of less than 1 m using accurate surveying methods (e.g. Real-time kinematic positioning).

Table 2: Classes of observations for high intensity survey (modified from DILGP 2015, and DES & Resources 2021)

Observation class after **(**Schoknecht *et al*. 2008)[1]	**Method of observation**	**Description**	**When is it required?**	**Type of data**	**% of observations for high intensity survey**
Class I Detailed soil profile description with no laboratory analysis	Preferred options are soil pit or undisturbed soil core. Soils are described to minimum of 1.5 m, or an impermeable layer such as bedrock.	Detailed soil profile morphology and site descriptions to characterise the main soil and landscapes.	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. All 'typical' soil types require a minimum of one detailed soil profile description, and most will require more, depending on the size of the investigation.	Profile description, field tests	Greater than 50%
Class II b Deep borings	Deep (>2 m) core (preferred) or auger boring with limited or non-standard laboratory analysis	Deep borings examine the substrate and regolith below the normal depth of soil description. They are important when subsolum and substrate properties influence land use. Deep borings allow consideration of factors such as impermeable or permeable 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.	Essential if irrigation is proposed, particularly to assess the off-site impacts associated with deep drainage, water logging and salinity.	Profile description, field tests, laboratory analysis	Up to 25%

[1] For more information on observation classes, refer to *Queensland Land Resource Assessment Guidelines, Volume 1* (DES & Resources 2021)

Class III a **Class III b** Analysed sites	Any method that obtains relatively undisturbed soil samples (e.g. cores) with accurate depth increments. Profiles with limited or non-standard laboratory analysis (Class III a), or standard laboratory analysis[2] (Class III b).	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. Mechanical and hand augers less preferred. Existing vertical exposures need to be cut back before samples are taken. See Attachment C.	These are used to evaluate sites and unique map areas and to characterise off site impacts. Each 'typical' soil requires at least one analysed site. Soils which pose a higher risk, based on the proposed activity (e.g. cultivation above 3% slopes), will justify a higher intensity of survey, and more diagnostic Class III b sampling (e.g. particle size distribution, cations etc.) rather than the minimum suite of analytes (Class III a).	Profile description, field tests, laboratory analysis	Greater than 10%
Class IV a **Class IV b** Brief mapping observations	Brief mapping observations where some or all the soil profile is observed. Soil morphological data may (Class IV a) or may not (Class IV b) be collected.	Less detailed soil profile inspections of sufficient depth and/or sufficient detail to allocate the site to a specific soil type and unique map area or mapping unit. Description of salient soil features for soil classification, suitability assessment, surface soil assessment etc.	Used to accurately delineate the location of the boundaries of unique map areas or to ascertain the degree of variability within a map unit. Full profile exposure will provide the most useful information.	Brief profile description (Class IV a) or brief mapping observation (Class IV b)	Less than 20%

[2] Refer to section 5.5.4 for a list of 'standard' laboratory analytes

Table 3: Minimum data for site observations (modified from DES & Resources 2021)

Attributes	Attributes by observation class (▲ = required, ☼ = recommended, blank = optional)			Reference
	Full site description (Class I, II, III) (detailed, deep, analysed)	Brief mapping observations (Class IV)		
		(a): Some soil morphological data	(b): No soil morphological data	
Location				
Datum/projection, coordinates, method, accuracy	▲	▲	▲	YB p7–11, BB Ch16 p246–251
General				
Described by	▲	▲	▲	YB p13
Date (time optional)	▲	▲	▲	YB p13
Site type	▲	▲	▲	YB p13
Observation class	▲	▲	▲	
Observation method	▲	▲	▲	BB Ch16 p252, YB p147–148
Reason for lower investigation depth	☼			
Project	▲	▲	▲	
Site ID	▲	▲	▲	
Geology: unit, map sheet, year	▲	☼	☼	BB Ch4
SPC/Taxonomic unit	▲	▲	▲	BB Ch19
Australian Soil Classification	▲	☼ (Suborder)	☼ (Order)	ASC, BB Ch19, YB p225–227
Photos: profile, landscape, field sheet	▲	☼	☼	BB Ch16 p256–257
Landform				
Landform: element, pattern, RMS	▲	▲	☼	YB p15–55
Slope: method, % slope, slope class, MT	▲	☼	☼	YB p18–26
Site/land surface				
Land use	▲	▲	☼	
Disturbance	▲	▲	▲	YB p128
Microrelief	▲	▲	▲	YB p129–133
Erosion	▲	▲	▲	YB p133–138
Surface coarse fragments	▲	▲	▲	YB p139–143

Attributes	Attributes by observation class (▲ = required, ☼ = recommended, blank = optional)			Reference
	Full site description (Class I, II, III) (detailed, deep, analysed)	Brief mapping observations (Class IV)		
		(a): Some soil morphological data	(b): No soil morphological data	
Rock outcrop	▲	▲	▲	YB p143–144
Surface condition	▲	▲	▲	YB p189–191
Runoff	▲	☼		YB p144–145
Vegetation	▲	☼	☼	YB p73–125
Permeability	▲	☼		YB p200–202
Drainage	▲	☼		YB p202–204
Depth to free water	▲			
Soil profile				
Horizon notation	▲	☼		YB p148–159
Horizon depths	▲	☼		YB p156
Horizon boundaries	▲	☼		YB p199–200
Soil matrix colour	▲	☼	☼ IV a	YB p159
Mottles	▲	☼		YB p159–161
Field texture	▲	☼	☼IV a	YB p161–169
Coarse fragments	▲			YB p170–171
Structure	▲	☼		YB p171–181
Cutans (required if slickensides are present)	☼ / ▲			YB p182–183
Segregations	▲	☼		YB p195–198
Strength (SWS and consistence)	▲			YB p186–187
Depth to R horizon, strongly cemented pan	▲	☼		YB p156–159
Pans	▲			YB p192–195
Permeability and drainage (by horizon)	☼			YB p200–204
Sample depths, number	▲ (sampled sites)			BB Ch17 p265
Substrate				YB p205–224
Type of observation	▲			
Confidence	☼			
Depth	▲	☼		
Lithological type	▲	☼		

Attributes	Attributes by observation class (▲ = required, ☼ = recommended, blank = optional)			Reference
	Full site description (Class I, II, III) (detailed, deep, analysed)	Brief mapping observations (Class IV)		
		(a): Some soil morphological data	(b): No soil morphological data	
Grain size, texture, structure, mineral composition, strength, alteration, distance	☼			
Field tests				Vol 2
pH: method, value	▲	☼	☼ IV a	
Dispersion/slaking class (sandy clay loam or heavier)	☼	☼	☼IV a	
Electrical conductivity: method, value	☼			
Effervescence of fine earth ($CaCO_3$) or segregations (Mn)	☼			

Note:

- 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 - Third edition (Isbell & NCST in press).
- Vol 2: *Volume 2: Field tests* (DES & DNRME 2020).

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

- nature of the general environs and soil surface at the site
- 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 included in Figure 1, and a sample field sheet is included as Attachment A6-1.

The observation method will be by either or a combination of (in order of reliability): excavation/pit, relatively undisturbed core or hand auger. Existing vertical exposures can be used however the face will need to be cut back to expose fresh soil. Vertical exposures in drainage lines should be avoided, unless they are representative of a broader landscape unit. Post hole diggers (or other mechanical augers) are not acceptable or reliable due to contamination of the soil profile horizons and are not considered to be a hand auger. Pits or cores are preferred to manually or mechanically augered holes, as a more accurate representation of horizon depths is obtained and soil features such as structure are preserved for inspection. Any deviations from the above should be discussed with Department of Resources (contact the VegHub on 135 834). Photographic evidence of soil exposure should always be provided.

5.5.2 Detailed sites – Class I observations

Figure 1 is 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: Soilsac Site: 15

Location:
GDA94 zone 56, 300 000 mE
7 000 000 mN
Described by: Prof Steve Jones AO
Date: 15-Jan-2021

Site description

Geology: Qa – alluvium
Landform Pattern: Flood plain
Element: Plain
Permeability: Slowly permeable
Microrelief: Zero or none
Drainage: Moderately well-drained
Slope: 1.5%
Rock outcrops: No bedrock
Surface coarse fragments: Nil
Surface condition: Periodic cracking
Disturbance: Cultivated

ASC classification: Haplic, Epipedal, Black Vertosol

Profile morphology

Horizon	Depth (m)	Description
A1	0.0 to 0.10	Very dark brown (10YR 2/2) moist; no mottles; light medium clay; no coarse fragments; moderate 5-10mm; angular blocky structure; no segregations; moist, firm strength; few faint slickensides; pH 6; abrupt change to
B21	0.10 to 0.80	Black (10YR 2/1) moist; no mottles; silty medium heavy clay; no coarse fragments; moderate 2-5mm lenticular structure; no segregations; moist, weak strength; common distinct slickensides; moderately permeable; moderately well-drained; pH 7; diffuse change to
B22	0.80 to 1.5	Very dark greyish brown (10YR 3/2) moist; no mottles; medium clay; no coarse fragments; strong 10-20mm subangular blocky structure or moderate 2-5mm lenticular structure; no segregations; moist, weak strength; common distinct slickensides; moderately permeable; moderately well-drained; pH 8; clear change to:
D1	1.5 to 1.7	Dark brown (10YR 3/3) moist; few 2-10%, <5mm faint orange mottles; silty medium clay; no coarse fragments; moderate 5-10mm subangular blocky structure; no segregations; moderately moist, firm strength; slowly permeable; moderately well-drained; pH 8. .

Figure 1: Example of a detailed site description

Traditionally, soil profile descriptions have been to depths of 1.5–1.8 m. For modern surveys, soil descriptions often need to be deeper – particularly when irrigation is planned. This is due to the importance of characterising the unsaturated zone (of which the soil profile is the upper part). In the case of hillslope soils, an attempt should made to describe all sites to bedrock (C or R horizon), where soil depth is <1.5 m. In hillslope areas where soil depth is >1.5 m, where possible, a sufficient number of sites should be dug to bedrock. For alluvial areas, where depth to bedrock may be up to 100 m, there is an overlap with regolith/groundwater/unsaturated zone investigations.

5.5.3 Deep borings – Class II observations

A subset (~25%) of soil profiles should be drilled to a depth of at least 2 m (or 3 m where irrigation on the floodplain is proposed). Integration with regolith/ groundwater studies is essential to provide sufficient characterisation of the unsaturated zone. While soils data that is collected in deep borings during geotechnical investigations is complementary to the information that is collected in a soil survey, it can be difficult to use this data due to the difference in intent and standards used (Soil Science Australia 2015).

5.5.4 Analysed sites – Class III observations

Guidance for soil sampling provided in the *Guidelines for Surveying Soil and Land Resources* (McKenzie *et al*. 2008) 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 0.3 m, the maximum sampling interval should be 0.3 m. These recommendations should be followed when sampling analysed sites for a land resource survey and land suitability determination.

Many guidelines are available regarding general methods of sample collection, often from companies providing an analytical service. Baker and Eldershaw (1993) also provide some useful advice.

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

- which soil attributes and limitations the analyses are assessing, 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; 1.4–1.5 m and 1.7–1.8 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 soil horizon.
- Irrespective of whether sampling is horizon or depth interval based, the following should apply:
- all samples should be taken within single soil horizons (i.e. depth interval samples should not cross significant soil horizon boundaries for example an A2e/B2 boundary in a texture contrast soil)
- sufficient sample must be collected for analysis (> 300 g)—this may require coring of more than one bore hole and combining samples of the same depth interval from 2 or 3 holes, all within 0.2 m of each other
- samples from the soil profile should not be bulked between sites
- surface fertility samples (0–0.1 m) are traditionally taken from a bulk sample (6–9 points) around the site
- no sample interval should exceed 0.3 m

- samples should be from a described site (and include all required soil attributes from Table 2).

Before submitting soil samples, it is important to check that the laboratory is accredited and/ or holds certification for all the required tests. All samples and analytes should be analysed at a National Association of Testing Authorities (NATA) accredited or Australasian Soil and Plant Analysis Council (ASPAC) accredited laboratory.

Methods for soil chemical and physical attributes are described in Rayment & Lyons (2011) and McKenzie et al. (2002) respectively. The casual observer will note that there are many different methods for measuring some attributes (e.g. phosphorus, hydraulic conductivity). There are many reasons for this, including the evolution of methods and apparatus, fundamental changes in understanding and operational efficiency in laboratories.

In many instances, the specific method chosen e.g. exchangeable cations, is determined by one or more other attributes of the soil (e.g. pH) which must be determined prior to selecting the method. There are also instances where no single method is perfect, and the level of uncertainty associated with any method is high. For all methods, estimates of error and uncertainty must be included in reports.

When salinity is present in the landscape, laboratory methods must not be based on estimates. For example, chloride content must be measured via laboratory analysis and not estimated from electrical conductivity.

Sample collection

Field tests for pH and EC may be necessary to determine the exact location of critical horizon boundaries in some soils, in particular pH inversion Vertosols.

Samples may be collected using plastic bags (or other containers) the choice of which is not critical, unless moisture is being assessed. More importantly, cross-contamination between samples should be prevented, and steps should be taken to ensure the integrity of sample identification (e.g. using waterproof labels). Samples should not be taken from atypical areas (e.g. stock camps, dam sites, within 10 to 20 m from current/old fence lines, headlands, paddock corners, dung/urine patches or other significantly disturbed areas). If the sampling intensity differs from Table 1, sampling methodology and justification should be documented to enable scale and accuracy assessment. Additional care needs to be taken with samples and sampling intervals in specific situations including, but not limited to:

- Not allowing bagged samples to “cook” in the sun—this is particularly relevant for analytes such as nitrate.
- Altering sample increments to suit specific test requirements, for example, keeping sample increments contiguous and narrow (e.g. every 0.1 m) when undertaking chloride balance analysis.
- Avoiding field contamination of samples—in particular ensuring that oil lubricants are not used with hydraulic tube samplers when sampling for carbon.
- Storing and transporting samples appropriately.

Laboratory analysis

As discussed above, all analysis should be undertaken by accredited laboratories. Standard analytes include:

- pH, EC, Cl (all on 1:5 soil water suspension)
- exchangeable cations, CEC, ECEC, ESP (calculated)
- particle size analysis (clay, silt, fine sand, coarse sand)
- air dry moisture content (ADMC), moisture characteristic (1/3, 15 bar)
- fertility suite (macro and micronutrients)
- organic carbon, total nitrogen, available phosphorus (down the profile)
- phosphorus buffering index and Colwell P
- for strongly acid soils with pH <5.5, exchangeable aluminium and exchange acidity.
- Other analyses might include:
- hydraulic conductivity (if irrigation is proposed)
- bulk density (if irrigation is proposed)
- sulfate (in gypseous soils)
- free iron content.

Some of these analytes are primarily required for agronomic assessment (e.g. the fertility suite), while others are necessary for both salinity and agronomic purposes (e.g. Cl). Many of these analyses are conducted only in a laboratory, while others involve measurements from both the field and the laboratory. In instances where good profile descriptions and correlation to other relevant research and assessments has been proven, or there is existing site/analytical data from other sources (e.g. within Queensland SALI database and visible through the Queensland Globe), the number of analyses undertaken may be reduced.

For further information on laboratories for soil analyses, refer to Attachment C.

Bulk density and PAWC

Plant available water capacity (PAWC) and bulk density are required for many calculations and models. PAWC may be estimated (e.g. for initial crop/water balance modelling) using the methodology for assessing soil water storage in the *Regional Planning Interests Act 08/14 Guideline How to demonstrate that land in the strategic cropping area does not meet the criteria for strategic cropping land (DILGP 2015)*. This entails the use of a soil texture look up table and the PAWCER pedotransfer function developed by Littleboy (1997). PAWCER is the more reliable of the two and relies on laboratory derived values for the percentage of clay and percentage of sand in each layer of the soil. It also requires an analysis to derive the soil's gravimetric water content at a pressure deficit of 1.5 MPa. Refer to section A1.8 of DILGP (2015) for further information. Alternatively, more accurate and reliable determinations of soil water may be chosen, however the acceptability of these methods, particularly in respect to non-rigid (shrink/swell) soils may not be acceptable to assessing agencies.

Bulk density for shrink/swell soils should be derived at drained upper limit (DUL). The dimension of a core (5, 7.5 or 10 cm) is less critical than the moisture content at which the bulk density samples are obtained. DUL and bulk density measurements can be derived from the same wet-up site.

5.5.5 Mapping observations – Class IV observations

Brief mapping observations (sometimes called check sites) are used where some or all the soil profile is observed. Class IV(a) sites are where some or all the soil profile is observed and at least some soil morphological data is recorded e.g. soil texture. Class IV(b) sites are where investigation is limited to visual inspection only and no morphological data is recorded.

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.), surface 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 more landscape complexity is identified after soil exposure, the soil profile should be described in detail. This check site would then become a Class I observation.

The attributes that confirm a check site belongs to a particular soil type or UMA must be recorded for each check site and confirmed with photographic evidence.

For a high intensity survey, check sites should comprise less than 20% of all observations.

5.6 Grouping site data

Site data should be grouped or organised into similar soil types, preferably based on similar landform and/or parent material, as displayed on most Queensland Government soil maps. This allows correlation with other mapping, as described below. Where appropriate, soil types may be grouped into soil management units, but the basis of such grouping must be clearly demonstrated.

5.6.1 Soil classification

Soil classification serves many purposes, the primary of which is as a communication tool. Soils should be classified using the *Australian Soil Classification* (ASC – Third Edition, Isbell & NCST in press) to at least the Subgroup level. Classification using additional schemes can be useful, but they should not be used in place of the ASC.

5.6.2 Soil correlation to existing mapping/SPCs (where available)

Correlation of both sites and UMA/polygon data with existing published soil data should be undertaken when published data is available. The correlation process is part of demonstrating a critical understanding of the attributes of a soil or map unit, and the way in which it relates to others. Appropriate correlation and classification also substantially increase the likelihood of being able to use data from previous studies on similar soil types/landscapes (e.g. PAWC, crop model parameter files in salinity risk assessment).

6 Suitability of the proposed irrigation method

A variety of irrigation methods are commonly used in Queensland landscapes, including surface, spray and micro-irrigation systems. The focus on suitability of the proposed irrigation practices is generally on:

- restricting the use of irrigation with poor water quality
- ensuring improved water use efficiency through a good understanding of soil types, crop water use and soil moisture status
- irrigating to crop demands avoiding deep drainage and surface runoff (to reduce onsite and offsite impacts such as secondary salinity and nutrient/sediment export).

6.1 Irrigation methodology

Depending on the specifics of the irrigation methodology and the nature of the soils and landscapes, not all irrigation practices are sustainable in all landscapes. Therefore it is appropriate to condition a development approval for the crop type and irrigation method that was proposed and assessed during the application process. Development conditions can have an enduring effect. Where a significant change of crop type or irrigation method is desired, additional information may be required to support a request for an amended development approval.

Surface irrigation methods (furrow, flood, border-check, contour bay) are typically used on broad acre cropping systems such as sugarcane, cotton, rice, or intensive pasture production. While these methods are relatively cheap in equipment costs, they are labour intensive and establishment and ongoing maintenance costs can be high. A high level of associated planning and development costs are involved, particularly related to earthworks and land levelling. Distribution and other water management infrastructure (e.g. head ditches, tailwater management) are typical of this form of irrigation but are not normally associated with other methods. They also have the lowest efficiencies of all the methods due to evaporative, deep drainage and outflow losses of the water being applied. There is a high risk of the development of secondary or irrigation-induced salinisation of the landscape associated with these types of irrigation. These irrigation methods are most suitable for clay textured soils with slow permeability (e.g. Black Vertosols on level or very low slopes).

Overhead spray types of irrigation (centre pivot, lateral move, solid-set, water winch or cannons) can be used on the wide range of landforms and soil types on which annual row or field crops are typically grown. This form of irrigation is typically more efficient than surface irrigation. Application efficiencies as high as 95% can be achieved with centre-pivot or lateral move travelling irrigators. These low-pressure overhead application systems, with emitters spraying relatively small droplets, tend to be affected by strong winds. High running costs associated with pumping can be an issue, and these systems are limited in terms of the area that can be irrigated at the one time. This irrigation method is suitable for most soil types with an adequate soil depth for cropping, with limits typically set by the maximum slope suitable for annual cultivation and safe machinery operation.

Micro-irrigation systems are widely used on annual and perennial horticultural crops, and include mini-sprinkler, micro-spray, drip and trickle. Agronomic or crop husbandry considerations, along with water availability and capital costs generally determine the type of miro-irrigation employed. Micro-irrigation is advantageous where water supplies are limited. Micro-irrigation systems can be used where other methods are impractical or unsuitable, allowing for closer control of water application that can achieve high yields under intensive management. However, high establishment costs, as well as high running and maintenance costs, are typical of this form of irrigation. Water quality can be a particular issue with these systems. For example, algae or high calcium levels in the water can lead to blockages, significantly increasing maintenance and repair costs.

Justification including scientific evidence will be required to confirm the suitability of the proposed irrigation method. This will include well-considered strategies relating to the design and development of water supply and application systems, irrigation block design and layout, irrigation scheduling and application efficiencies, drainage and runoff management and control measures, and monitoring. Hydraulic conductivity throughout the profile is a particularly important consideration for the choice of irrigation method and particularly important if needing to demonstrate furrow irrigation is suitable for the site.

7 Land degradation risks

An assessment of the variability of soil and land resource information can be used to identify how this variation affects land degradation risks such as salinity, soil erosion and acid sulfate soils.

7.1 Salinity

The risk associated with applying additional water and associated salts to soils and landscapes have been documented by Shaw and Yule (1978) and SalCon (1997). These risks include:

- soil structural decline and physical instability (leading to surface sealing and crusting, and reduced infiltration and drainage, aeration, macro porosity and permeability)
- changes in soil chemistry including leaching of nutrients
- watertable rise, potentially leading to soil waterlogging, shallow watertables and salinisation of soils
- on-site and off-site degradation of soil/land and surface/ground waters (e.g. erosion, silting, nutrient/pesticide runoff, salinisation)
- poor crop growth, reduced crop yield and permanently compromised agricultural productivity.

Land degradation risks can be broadly split into direct risks/effects (e.g. change in soil physical/chemical properties) and indirect risks (e.g. groundwater recharge). Direct risks occur in short timeframes or at the point of water application, whereas indirect risks occur over long timeframes or off-site. Given that these risks threaten the viability of sustainable long-term irrigation systems, it is essential that they are understood before beginning any irrigation scheme.

Prior to the development of any new irrigated lands, appropriate investigations are necessary to ensure that both short-term and long-term risk and the agronomic viability of the enterprise are assessed. This has been normal practice in the development of many irrigation areas in Queensland. This is particularly the case for greenfield development areas. Pre-existing land use does not reduce the need for such investigations in fact; the opposite is often the case. In existing cropping areas, the argument that the land has been safely cropped for years, and thus has no salinity risk is false as the time lag between land use change and the expression of salinity problems is generally measured in decades.

7.1.1 Salinity risk assessment

The current salinity risk assessment method in Queensland is that described by Department of Resources (in press). A risk assessment pathway is described in Figure 2. In summary, to predict, manage and mitigate irrigation salinity risk, a risk assessment must deal with each of the following:

- The water balance – how significantly is it changed? does it consider rainfall seasonality and episodicity of events; and crop water use? —the aim is not to cause excessive deep drainage compared with baseline conditions.
- The salt balance – does the water applied maintain appropriate physical and chemical conditions in the soil and aquifers e.g. hydraulic conductivity, salinity?
- The unsaturated zone – does the application of the irrigation water create a landscape in which a salinity impact will emerge within 100 years of the commencement of irrigation?

The salinity risk assessment framework presented is based on the following key salinity risk assessment principles for irrigation:

- use of appropriately detailed site-specific data
- use of appropriately skilled professionals to conduct assessments
- appropriate treatment/amendment of water to be used for irrigation
- appropriate irrigation method/regime
- the unsaturated zone must not be filled in 100 years from commencement of the irrigation activity
- existing groundwater resources (used for consumptive purposes) are not detrimentally impacted
- appropriate ongoing monitoring and analysis of soil, water and crop parameters
- adaptive management.
- The salinity risk assessment must ensure:
- no worsening of the salinity levels of the soil and surface or ground water because of changes in the hydrology of the subject land, and
- no increase in the incidence of waterlogging.

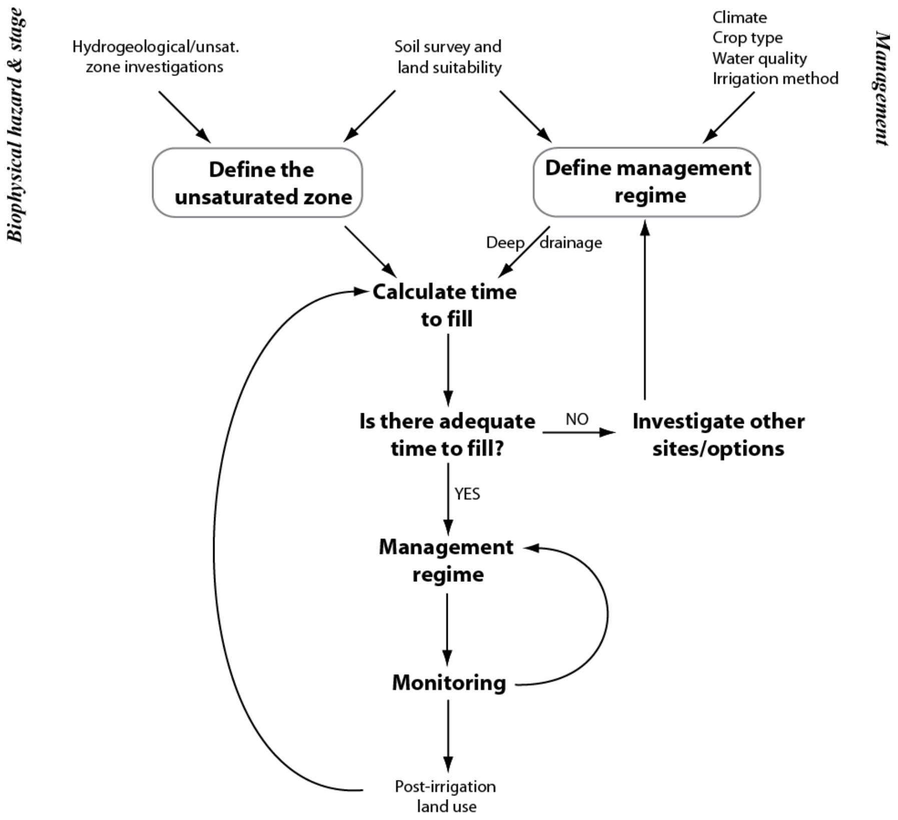

Figure 2: ***Salinity risk assessment process (Department of Resources in press)***

See Attachment D for information on requirements to assess the Water Balance component of the Salinity risk assessment.

7.2 Soil erosion

Land degradation in the form of soil erosion reduces the productive capacity of the land; and soil losses from erosion may be considerable if preventative measures are not taken (DSITI 2015). Activities such as clearing of vegetation, over-grazing, or conventional tillage where there is little to no crop cover or stubble retention, can increase the exposure of the soil surface to rainfall, runoff or wind, due to the reduction in ground cover. In addition, if runoff is not adequately controlled, the risk of land degradation due to water erosion will then be increased. The erodibility of a soil is influenced by a variety of factors including particle size distribution, soil structure and cohesiveness. While subsoils are generally more erodible than surface soils, once the surface soils are lost, the rate of soil loss will accelerate, which can result in significant land management issues (e.g. gully erosion, and reduced crop and pasture growth) (DNRME 2020).

See Attachment E for information on requirements for an erosion and sediment control plan.

7.3 Acid sulfate soils

Acid sulfate soils (ASS) are soils or sediments containing iron sulfides. When they are exposed to oxygen, the iron sulfides oxidise, releasing sulfuric acid and soluble iron into the environment. Within ASS affected areas of Queensland, there is an overall objective to protect the natural and built environment, and human health from potential adverse impacts of acid sulfate soils by:

- identifying areas with high probability of containing ASS

- providing preference to land uses that will avoid, or where avoidance is not practicable, minimise the disturbance of ASS
- including requirements for managing the disturbance of ASS to avoid or prevent the mobilisation and release of acid, iron and other contaminants.

While appropriate planning and development controls can minimise the risks to the environment, avoiding the disturbance of ASS is always the preferred strategy. Where avoidance is not possible, at all times the acid sulfate soils must be adequately investigated to determine whether the impacts can be managed to prevent the release of acid, soluble iron and other contaminants to the surrounding environment. This is done via an ASS Risk Assessment. For guidance on ASS investigations, laboratory methods, dewatering and management, refer to the Queensland Government soils website.

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9 Legislation

This guideline is relevant to and can support assessment under the following legislation:

- *State Development Public Works Organisation Act 1971 (SDPWO Act 1971)*
- *Planning Act 2016*
- *Vegetation Management Act 1999*
- *Water Act 2000*
- *Land Act 1994*
- *Soil Conservation Act 1986*
- *Environmental Protection Act 2004.*

Attachment A: Land suitability report

A land suitability report to support a development application for clearing regulated vegetation for a coordinated project for agriculture (SDAP code 16) must be completed in accordance with the *Guidelines for Agricultural Land Evaluation in Queensland 2015* (available at Land Queensland Library) and should 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 and irrigation method(s) used—these need to be specified and will be linked to the conditions of a development approval in relation to the clearing of regulated vegetation
    d. Management practices for growing and harvesting the crop(s) to ensure limitations are considered when determining land suitability
    e. Describe how the irrigation method used will ensure suitability and sustainability of the irrigation practice with minimal impacts on water quality and land degradation (including soil salinity and soil structural decline)
3. Use land suitability classes as detailed in Table A2-1
4. 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 GPS coordinates of all sites and the applicable spatial datum
        ii. soil profile descriptions (see Figure 1 in section 6.8.2)
    b. Soil map at a scale that is appropriate for the assessment (e.g. property scale) with a description of each soil type and limitations for each of the unique mapping areas. This may include information collated 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), disturbance and microrelief of each site sampled
    e. Description of each soil horizon at each site, including the minimum standards specified in Table 3 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 the 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 assess the impacts of different agricultural land uses (e.g. crops), soil types, irrigation practices and climate on deep drainage, water logging and off-site impacts from salinity. Software packages such as 'HowLeaky', 'APSMI' and SALF can be useful (see Attachment D)
j. All digital copies of spatial data (e.g. ArcGIS shapefiles, layer package, feature class/geodatabase) used for assessment including unique map areas, final suitability results, and LiDAR digital elevation model in raster format (if available, preferably in ArcGIS)
k. 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 A2-2)—consistent with the limitations described in the *Queensland Agricultural Land Evaluation Guidelines* (DSITI & DNRM 2015)
l. The limitation values and suitability subclasses rules for the land management options must be included
m. Source of land evaluation rules (e.g. from Regional land suitability frameworks for Queensland, specific land resource project etc.). Any deviation from the existing published frameworks will require justification

5. 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)) and irrigation method(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
6. Attachments
    a. Laboratory results from an accredited laboratory (e.g. NATA, ASPAC)

Attachment B: Agricultural land suitability in Queensland

Agricultural land evaluation involves determining the potential of land for alternative, and possible competing forms of land use and identifying management requirements for sustainable use. Methodology for the determination of agricultural land suitability is described in *Guidelines for agricultural land evaluation in Queensland* (DSITI & DNRM 2015), and follows the definitions listed in Table A2-1. Table A2-2 provides an example of suitability derivation for a UMA for three land uses and five limitations.

The first three classes of land (classes 1 to 3) are considered **suitable** for the specified land use, as the benefits obtained from that land use in the long-term should outweigh the inputs required to initiate and maintain production. Class 3 land may be as productive as class 1 or 2 land; however increased inputs (e.g. fertiliser, land preparation and maintenance operations) would generally be required. It is not uncommon to find in a land resource survey that there is no land assessed as suitability class 1 for a particular land use.

Class 4 land is considered **currently unsuitable** for the specified land use, due to the severity of one or a number of limiting factors. It is implied that the inputs required to achieve and maintain production outweigh the benefits of production in the long-term. This land may be upgraded to a suitable class if future agronomic, edaphic or engineering studies show it to be economically viable and environmentally sustainable. Changes in climate, economic conditions, or technology may alter the level of management inputs required to achieve satisfactory long-term productivity.

Class 5 land is considered **unsuitable** for the specified land use, as it has limitations that alone or in aggregate are so severe that the benefits would not justify the inputs required to initiate and maintain sustainable production in the long term. Such land is unlikely to ever be suitable for the specified land use.

Table A2-1: Land suitability classes

Class	Suitability	Limitations	Description
1	Suitable	Negligible	Highly productive land requiring only simple management practices to maintain economic production.
2	Suitable	Minor	Limitations that either constrain production, or require more than the simple management practices of Class 1 land to maintain economic production.
3	Suitable	Moderate	Limitations that either further constrain production, or require more than those management practices of Class 2 land to maintain economic production.
4	Unsuitable	Severe	Currently unsuitable land. The limitations are so severe that the sustainable use of the land in the proposed manner is precluded. In some circumstances, the limitations may be surmountable with changes to knowledge, economics or technology.
5	Unsuitable	Extreme	Land with extreme limitations that preclude any possibility of successful sustained use of the land in the proposed manner.

Table A2-2: 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.

The land evaluation schemes must follow the rules specified in the *Regional Suitability Frameworks for Queensland* (DNRM & DSITI 2013). Any deviation from the rules must be justified. For further information on suitability frameworks, contact soil.enquiry@qld.gov.au

Attachment C: Laboratories for soil analysis

Under normal circumstances the laboratories performing the analysis of soil samples 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 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 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.

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 accompanying report.

All descriptions should be made on a standard field sheet (Attachment F provides an example) using coding provided in the National Committee on Soil and Terrain (2009).

Attachment D: The water balance

Water balance modelling will be required to assess the deep drainage from proposed land uses and the consequences of that deep drainage e.g. salinity risk. Water balance modelling requires a detailed understanding of the proposed agronomic system, including:

- calculations of the amount and frequency of irrigation events
- climatic data
- soil attributes such as effective rooting depth and plant available water capacity
- run-off and deep drainage
- recycle pits (tailwater capture and recycling)
- irrigation system design and management

Software packages such as 'HowLeaky' and 'APSIM' can be useful to assess the impacts of different land uses, soil types, management practices and climate on hydrology and water quality. Water balance models built in spreadsheets are discouraged. The impacts of water quality should also be assessed when marginal/poor quality irrigation water is used. This can be achieved through models such as SALF – salinity modelling tool.

The following must be provided with any report:

- input data files and associated details (which rainfall station was used, source of evapotranspiration data, soil parameters)
- model assumptions
- assessment of water quality impacts
- documentation of an appropriate time step and how long the model was run
- key outputs of the model
- scenarios used (pre- and post- development)
- detailed management practices relevant to reducing the risks associated with deep drainage should be supplied and modelled where possible.

Attachment E: Erosion and sediment control guideline

A5.1 Introduction

An Erosion and Sediment Control Plan (ESCP) addressing Soil Erosion and Sediment Control should be prepared by a Certified Professional in Erosion and Sediment Control (CPESC) and developed in accordance with the International Erosion Control Association's '*Best Practice Erosion and Sediment Control'* document (IECA 2008).

The ESCP must aim to achieve:

- no worsening of the existing levels of soil loss from the land within or downslope of the subject land
- no increased risk of erosion, or other land degradation, on land or in waterways downslope of the subject land
- no net increase in the sediment load leaving the development area and entering waterways and/or watercourses.

An ESCP needs to adequately address the potential for, and management of, erosive soil loss and sediment movement and deposition in the context of on-site and off-site impacts for the construction and operational stages of development. In some scenarios, post development erosion potential will be relatively static once the runoff and sediment control measures have been stabilised. For land uses within an agricultural system, there may be seasonal changes affecting a range of risks contributing to erosion and sediment control potential.

A5.2 Design guidelines and further reading

Unless otherwise advised, design criteria, performance standards and design calculations used in the ESCP need to be consistent with those provided in the following guideline or standard publications:

'*Soil conservation guidelines for Queensland*', DSITI 2015

'*Best Practice Erosion and Sediment Control*', IECA 2008

'*Australian Rainfall and Runoff*', Geoscience Australia 2016

Additional guidance can also be sought from the following publications:

'Erosion and Sediment Control Plans for Rural Development' Department of Land Resource Management, Northern Territory Government (2019)

'*Guideline: Stormwater and environmentally relevant activities*', DEHP 2014

'*Principles of construction site erosion and sediment control*', Catchments & Creeks 2012

'*Introductory erosion and sediment control guidelines for Queensland councils*', LGAQ 2006

'*Environmental best management practice guidelines: Erosion and sediment control*', Civil Contractors Federation Queensland 2011

'*Managing Urban Stormwater: Soils and Construction*', Landcom, 2004

'*Soil conservation through sediment trapping: a review'* Mekonnen *et. al. 2014 Land Degrad. Develop. 26: 544-556.*

A5.3 ESCP management principles

The primary requirements of an ESCP include the following practices:

- **Erosion control** - minimising the extent and duration of soil disturbance, including promptly stabilising disturbed soils, and maximising protective groundcover – by use of both natural and artificial material as necessary.
- **Drainage control** - control water movement on to and, within the site (including managing the discharge rates, flow velocities and discharge points). This may include the diversion and management of 'clean water' away from the site.
- **Sediment control** - maximise sediment retention on site.

A defined **maintenance** and rehabilitation program, post-development.

The ESCP also needs to provide for the following principles:

- Integration of the erosion and sediment control measures on-site during the construction and operational phases.
- Timing operations to avoid high-risk weather events to minimise erosion risk.
- An ESCP that may be satisfactorily amended if the implemented works fail to achieve the objectives of the ESCP.
- All permanent and temporary ESCP measures to be maintained so that they meet design capacities at all times.
- The ESCP's performance to be monitored, modified if necessary, to meet required performance standard.

The ESCP must be tailored to the specifics of the development (e.g. land clearing, cropping activities, major infrastructure etc). The plan can be presented as a series of plans and diagrams, showing the development site with the location of all temporary and permanent erosion controls. The plans do not always need to be unnecessarily complicated (e.g. Level 1 ESCP would be appropriate for a simple landscape and farming/land clearing operation where the risk of erosion is low). For more extensive soil disturbances and/or more sensitive landscapes, a more comprehensive assessment of the erosion risk will be required. This can entail an estimation of soil loss using the revised universal soil loss equation of RUSLE for pre- and post-development conditions. The factors (e.g. C-factor, R-Factor, P-Factor etc) used for soil loss modelling must be described, and sources documented in the assessment. For example, there is published data available for R-Factor and K- Factor available from QSPATIAL. Published data for C-Factor, M-Factor and P-Factor are available within erosion research literature (e.g. FAO 1992, Rosewell 1997, Silburn 2011; Kuok *et.al.* 2013).

A5.4 Level 1 and 2 ESCPs

This guideline proposes a 2-tier system of ESCPs, where the level of detail required should change, depending on the risk and scale of activities. For example:

- Where post-development soil loss rates are assessed as low, a level 1 ESCP should be undertaken, where an acceptable level of erosion control can be guaranteed using well-recognised and proven management practices and control measures.
- A comprehensive and detailed level 2 ESCP should be provided where visible signs of erosive soil loss are already present (e.g. gully, tunnel, rill or streambank erosion), and the proposed development should provide for rehabilitation of these areas. Where land degradation is likely to result from development and risks are not appropriately managed, the development application is unlikely to be recommended for approval.
- Where post-development soil loss rates are likely to be high, a level 2 comprehensive ESCP is recommended, to demonstrate an acceptable level of performance, in terms of both minimising land degradation and other environmental impacts. For a Level 2 ESCP, there will be a requirement to maximise sediment retention on site. Detailed design calculations, drawings and plans and a suitable monitoring program should be provided to confirm the performance of the plan. This outcome will likely require the use of a sedimentation system able to provide an acceptable level of settling of the sediment entrained in runoff. The suggested performance requirements for that sedimentation system are given in Table A5-1. By themselves, vegetated filter strips, are unlikely to meet the performance requirements, but can be used for secondary treatment of runoff discharged from sedimentation systems.

A Level 2 ESCP may be recommended where land suitability has been assessed for the clearing of regulated vegetation under the SDPWO Act 1971.

A5-5 Measures for Level 1 ESCP

A Level 1 ESCP should identify homogenous management units on the proposed site, with the identification and delineation of those units based on attributes relevant to the evaluation of erosive soil loss (e.g. soil characteristics, landforms, terrain slopes, slope lengths etc).

The Level 1 ESCP should include a suitably scaled site plan or map covering the area proposed for development, and any adjoining areas that might be impacted (e.g. vegetated buffers). The plan should include:

- elevation contours covering the proposed development and its environs
- watercourses, retained vegetation, protected and ‘no go areas’
- any discharge points for water-conveying structures

- details of any stabilisation and revegetation of disturbed areas outside of those to be disturbed (e.g. vegetated waterways, grassed swales etc)
- any design calculations (including performance criteria) that are sufficient to allow the ESCP to be evaluated for likely efficacy in controlling erosive soil loss, and
- nominated suitable performance criteria.

A Level 1 ESCP should focus on three parts—drainage, sediment and erosion control. The description of the control measures should include:

- Drainage control - the plan should include detailed measures to manage the potential volume and velocity of surface water flows, and incorporate measures to avoid or limit the formation of concentrated flows. This may also include contour banks and waterways.
- Sediment control - these plans should include a description and design of simple vegetative sediment control (e.g. grass strips, tree buffers, riparian vegetation, grassed waterways) established along contours, at the edge of paddocks, or along streams. These sediment trapping measures can be designed to reduce overland flow velocity, filter and enhance sediment capture on site, before being discharged into waterways and streams (see Mekonnen *et al.* 2014).
- Erosion control - field/paddock layout should be designed to limit erosion (e.g. row direction, row length). Further agronomic practices and mechanisms to aid surface stabilisation (e.g. minimum or zero tillage, trash retention, controlled traffic, mulching, re-grassing etc) and staging soil disturbance activities can also be discussed.

The performance of a Level 1 ESCP should be monitored by adopting the relevant best management practice principles listed in Section A5-3. Details of likely maintenance and monitoring requirements, and responsibility for the ESCP, system maintenance, monitoring, performance evaluation and remediation of any identified deficiencies will need to be documented. Timing of operations is important, particularly where there is a defined wet season.

A5-6 Measures for Level 2 ESCP

The Level 2 ESCP should address the control of erosion and sediment movement associated with activities that will disturb the soil on site (e.g. the clearing of the vegetation or cropping activities). The ESCP must include:

- a suitably detailed description of the existing environment
- description of activities on the development site that will disturb the soil, with an emphasis on limiting activities during the wet season
- erosion hazard and risk assessment
- a detailed description of the proposed erosion, drainage and sediment control measures applicable during the construction and operational phases
- a timeline of proposed works, including any site rehabilitation and re-vegetation
- details of the proposed performance monitoring program and ESCP review process
- plans and drawings.

Description of the existing environment

The description of the existing environment should include the following:

- climatic conditions (both long term and those likely to be experienced during and immediately after the proposed clearing operations), including Intensity-Frequency-Duration data tables for the site
- site topography (slope gradients and lengths)
- soil types, characteristics and attributes
- site hydrology and drainage
- existing vegetation (including any protected flora and fauna), or declared weeds under the *Biosecurity Act 2014,* and
- any existing soil erosion or other land degradation.

If the area to be disturbed exceeds 2 ha in a sub-region of a coastal bioregion (as defined in the *Glossary of Terms* in the State Development Assessment Provisions (SDAP)) or 10 ha elsewhere, then for each of the soil types identified above, at a minimum, the following soil analytical tests should be undertaken on a representative topsoil (A horizon) and a subsoil (B horizon) as follows:

- particle size distribution (AS1289 – 3.6.1)
- electrical conductivity and pH of 1:5 soil water mixture (method 3A1 and method 4A1, respectively, in Rayment & Lyons 2011)
- soil organic carbon percentage (most appropriate method for determining cation exchange capacity described in Table 15.2 in Rayment & Lyons 2011)
- exchangeable sodium percentage, and
- emerson dispersion test (AS1289 – 3.8.1).

Each soil type should be described (see section 6.8.2) and characterised to Australian Soil Classification sub-order level. Where the same soil type is identified as occurring across the site, topsoil and subsoil samples should be taken and tested at two different sites in the area it is proposed to develop (i.e. 2 x 2 samples to be tested).

Description of the activities that will disturb the soil

The description of the proposed development (e.g. land clearing, cropping activities etc) and future use of the land should include:

- the nature or method, staging and timing of any proposed land clearing
- the proposed post-development land use, and
- the physical extents and characteristics of the area that will be disturbed during or in association with the proposed development.

A suitably detailed site plan should include:

- disturbance areas
- natural land slopes and orientations and/or elevation contours
- the extents of identified soil types and vegetation communities, and
- natural drainage lines and watercourses (including all first or higher order streams identified in regulated watercourse mapping).

Erosion hazard and risk assessment

The erosion hazard and risk assessment should include the following elements:

- spatial and temporal assessment of the erosion hazards associated with the proposed development site

- risk assessment complementing the hazard assessment (if required), including a clear linkage between the assessed risk, the required control measures and design criteria to be applied to mitigate the risks
- erosion risk map including zones differentiating the areas associated with different erosion risks, and
- the areas where soil disturbance is to be avoided, that is those areas shown as to be not suitable for the intended land use.

Attachment 1 outlines elements that can increase the level of risk due to soil erosion. Larger disturbances may opt to model soil loss using RUSLE for each homogenous management unit on site.

Proposed measures during construction and operation phases

The description of the erosion and sediment control measures must cover all phases of soil disturbing activities and the subsequent land use undertaken on the disturbed area. The description of the control measures should include:

- The performance criteria, such as design storm frequencies and durations, exceedance probabilities, recurrence intervals, maximum design velocities, maximum design discharges, flow path roughness, bed slopes, settling velocities, analyte concentrations and other quantitative standards applicable to the various elements of the system design.
- Engineering design calculations and suitably detailed design drawings for all permanent and temporary drainage, erosion and sediment control measures, including:
  - 'clean' water diversion banks
  - runoff control ('contour') banks
  - waterways and drains
  - any sedimentation systems (vegetative and structural) providing for the temporary or permanent impoundment, reduction in velocity and sediment capture of runoff water
  - outlet structures, weirs and spillways
  - culverts, causeways and drains
  - energy dissipation structures
  - nominated discharge point hydrographs
  - construction materials used in any structures
- Details of any chemicals or ameliorants that might be applied to stabilise soil or to flocculate suspended particulates in any runoff, as well as applicable dosing or application rates.
- A suitably detailed site plan showing the locations of:
  - all the structures – both temporary and permanent – identified above
  - any soil stockpiles – either temporary or permanent
  - the nominated discharge points for runoff from the site
- The nature and form of any revegetation, rehabilitation or re-stabilisation.
- Details and the scheduling for:
  - limiting the extent and duration of soil exposure, so that land disturbance is confined to areas of manageable size, allowing the works to be implemented for each stage,
  - major earthmoving and land disturbance activities to occur during the dry season – particularly in areas of extreme rainfall erosivity
  - the removal of any temporary erosion and sediment control measures, and
  - the undertaking of any proposed revegetation, rehabilitation or re-stabilisation measures.

- Details of how the above measures address the identified hazards and risks, and how those measures align with the elements of the ESCP.

Performance monitoring program

The description of the proposed monitoring program should include the following:

- timing or frequency and sites at which monitoring data and samples will be collected
- pro forma checklists and forms to be used in the monitoring process
- proposed chemical and physical analyses proposed to be undertaken on any samples collected (including references to a recognised standard methods publication)
- consistency with any industry BMPs
- the nature of the accreditation held by any chemical or physical analysis laboratory undertaking the specified tests
- the way in which monitoring data is to be used to determine the effectiveness of the ESCP, with reference to the metrics and measures that are to be used establishing the success or shortcomings of the ESCP, and
- the process by which the ESCP might be revised and modified to reflect any identified deficiencies.

Table A5-1: Performance requirements for Level 2 ESCPs

Element	Requirement
Design intensity-frequency-duration rainfall data	Derived as per the methodology in '*Australian Rainfall and Runoff*' (IFD data for any site in Australia is available from the Bureau of Meteorology website at: http://www.bom.gov.au/water/designRainfalls/ifd-arr87/index.shtml)
Drain and waterway peak flow	Peak discharge in a 10-year ARI design storm with a duration equivalent to the time of concentration of the contributing catchment. In more high-risk catchments, the peak discharge may need to be designed for a 20-year ARI or 50-year, depending on the level of potential impact of sedimentation of any associated vulnerable features.
Drain and waterway freeboard	0.15 m (post-setting)
Sedimentation system peak flow	Peak discharge in a 10-year ARI design storm with a duration equivalent to the time of concentration of the contributing catchment. The design storm will need to match that chosen for the drain/waterway segment.
Sedimentation system geometry	• Length to width ratio ≥3: 1 • Sediment storage zone equivalent to 50% of the upper settling volume • Freeboard = 0.9 m (post-settling) • Settling velocity as determined using Stokes' Law • Surface area as per Technical Note B2 (page B.13) in Appendix B of '*Best Practice Erosion and Sediment Control*' (IECA, 2008)
Sedimentation system sediment storage capacity	Equivalent and in addition to the design capacity of the settling volume
Spillway and discharge chute peak flow	Peak discharge in a 50-year ARI design storm with a duration equivalent to the time of concentration of the contributing catchment

Plans and drawings

All drawings and plans for Level 1 and Level 2 ESCPs should be drawn to scale. They should identify the applicable scale and incorporate a suitable title block and legend. All plans should show a north point and the spatial datum (horizontal and vertical) applicable to the plan.

A5.6 Monitoring

Level 1 ESCP

Adopt the monitoring requirements for the soil health or soil erosion standards in industry best management practice programs (e.g. grazing BMP, cotton BMP etc).

Level 2 ESCP

The applicant will need to provide auditable details of a monitoring program that will demonstrate that the ESCP is meeting the relevant performance criteria.

A5.7 Collection of information

Suitably qualified and experienced person
The applicant should consider engaging a soil conservationist, skilled environmental engineer, soil scientist, environmental scientist or similar who has undertaken formal training or has demonstrated experience directly relevant to erosion and sediment control. It is recommended that the engaged person have professional affiliation with an organisation such as the International Erosion Control Association, Soil Science Australia, or Engineers Australia, and have the requisite technical knowledge and skills to be a Certified Professional in Erosion and sediment control (CPESC). If a CPESC is not engaged, the proponent should ensure the consultants engaged can demonstrate that they meet these criteria. Such affiliations are neither a fundamental requirement nor an absolute guarantee that the prepared ESCP will be acceptable to the Office of the Coordinator-General and/or Assessment Managers.

Attachment 1: Erosion hazards

Hazard assessment factors	Points	Score
Average slope of the whole site prior to development·		
Slope < 3%·	0	
Equal to or more than 3% but < 5%·	1	
Equal to or more than 5% but < 10%·	2	
Equal to or more than 10% but < 15%·	3	
Equal to or more than 15%	4	
Surface soil characteristics		
Sandy soil/gravel	0	
Coarse sandy loams and soils with high organic matter	1	
Moderate to strongly structured clay loams and clay soils	1	
Fine sandy clay loams to fine sandy light clay	2	
Clay loams and clay soils with weak to massive structure	2	
Silty loam to silty light clay	3	
Anticipated duration of site disturbance[3]		
< 3 months	2	
≥ 3 months but < 6 months	4	
≥ 6 months	5	
Anticipated rainfall erosivity[4] risk during site disturbance[5]		
Low rainfall erosivity e.g. <1200 MJ mm/ha hr yr	0	
Medium rainfall erosivity e.g. 1200–2500 MJ mm/ha hr yr	1	
High rainfall erosivity e.g.2500–5000 MJ mm/ha hr yr	2	
Very high rainfall erosivity e.g.5000–10 000 MJ mm/ha hr yr	3	
Extreme rainfall erosivity e.g. >10 000 MJ mm/ha hr yr	4	
Sediment control down-slope of the soil disturbance		
Score 1 point if there are ***no*** purpose-built, operational and well-maintained sediment traps (e.g. sediment basin) to catch sediment before it enters a water body, watercourse or wetland.	1	
Extent of site disturbance·		
Score 2 points if the development requires reshaping of the ground surface (e.g. excavation, land levelling or cut and fill works) of more than 1 m depth or fill	2	
TOTAL SCORE		
If total score ≥10, the development has an elevated risk		

[3] This represents the time span over which the disturbed area will have <30% ground cover

[4] Modified from Lu *et al*. 2001

[5] In Queensland, rainfall erosivity generally peaks during the summer period from December to February

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Attachment F: Templates for submitting data

The templates on the following pages have been devised to assist consultants who may be required or requested to submit data to the Queensland Government for regulatory or monitoring purposes, where the data may be stored in Queensland Government Corporate Databases (such as SALI).

Note: soil data that is collected for assessment of suitability of agriculture under the SDAP State Code 16: Native Vegetation Clearing is not required to be submitted to the Department of Resources using these templates.

It is recommended that soil and landscape data including: full profile observations, deep borings, analytical and check sites, and; digital copies of spatial data (e.g. ArcGIS shapefiles, feature class/geodatabase) used for assessment including UMAs, suitability rules and results, be collected and presented using the following templates, adhering to the procedures documented in this Guideline.

At all times, it is preferable to discuss the proposed fieldwork program with a Department of Resources Land Resource Officer prior to the commencement of fieldwork. This officer will be able to coordinate and receive any data.

Contact with a Department of Resources Land Resource Officer, and where relevant, any data and information submission from A6.1, A6.2 and A6.3 should be provided by email to soil.enquiry@qld.gov.au.

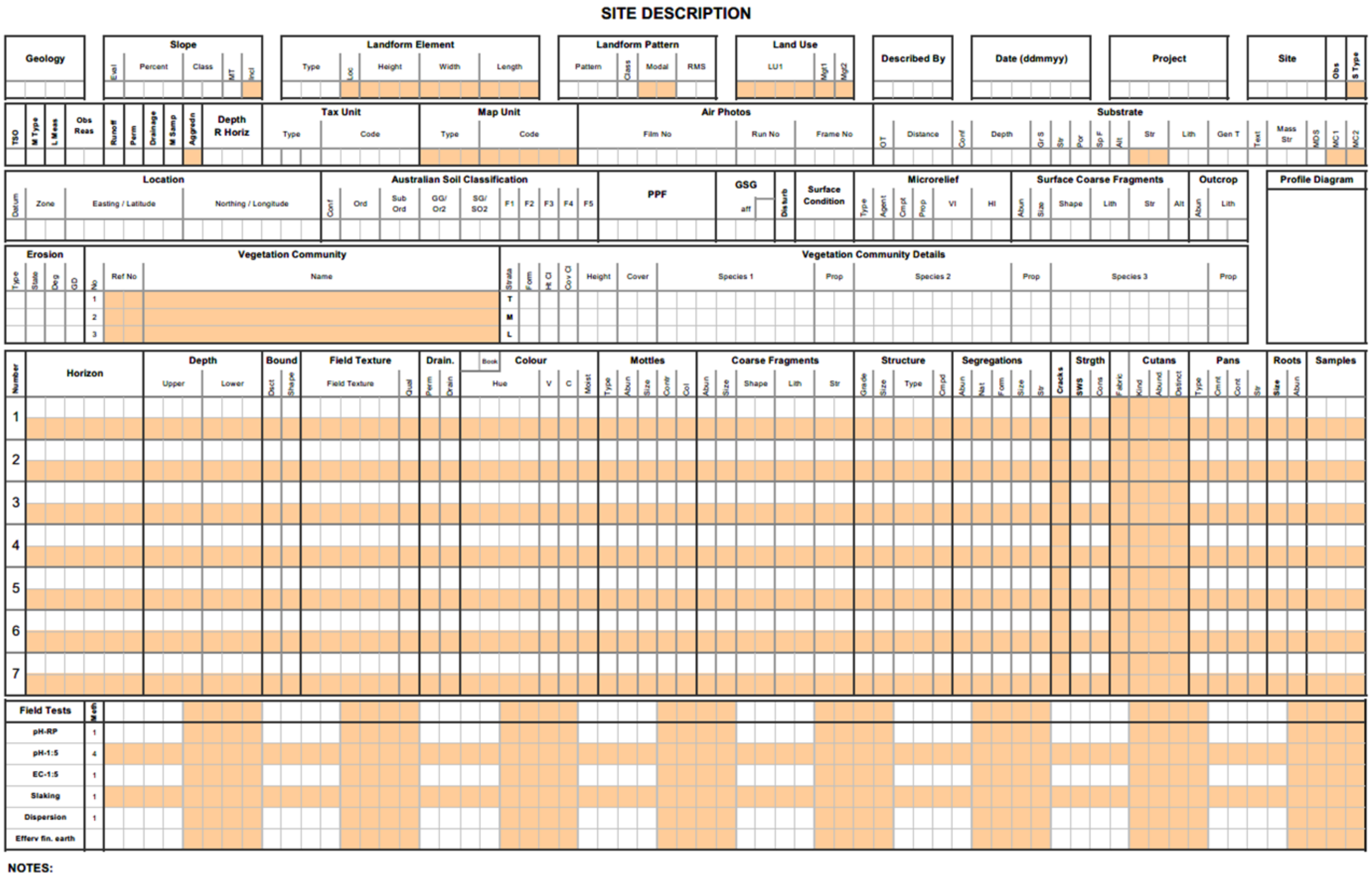
A6.1 Queensland Government sample field sheet

When soil and land resource information is submitted to the Queensland Government, including in support of a development application, the information should be included on a field sheet (see Figure A6.1 on the following page), and the following should be adhered to when applicable:

- The field sheet should describe what was observed at the time of the field inspection, not what was necessarily anticipated or expected to occur.
- The field sheet should be typed if possible. Alternatively, handwritten field sheets will be acceptable provided the information is clearly legible.
- The field sheets must be filled in using the relevant codes (or full decode) from the *Australian Soil and Land Survey Field Handbook* (NCST 2009) – commonly referred to as the "Yellow Book". For example:
  - texture recorded as a light clay has the code LC
  - structure recorded as strong 2-5 mm polyhedral has the code S2PO
  - coarse fragments recorded as 2-10% cobbles with subangular sandstone has the code 2 4 S SA etc.
- Diagrams of the soil profile or surrounding landscape should be included on the back of the field sheet, along with any specific notes that may be of use back in the office.
- All soil attributes that have been assessed should have an entry recorded, even if the attribute is absent e.g. zero mottles should be recorded as 0.

The data should be emailed to Department of Resources. Please compress the file before emailing. For larger files (>5 Mb), contact soil.enquiry@qld.gov for further advice.

The following example of the Queensland Government field sheet is available as Excel spreadsheet from soil.enquiry@qld.gov.au


SITE DESCRIPTION

Geology | Slope: Eval, Percent, Class, MT, Incl | Landform Element: Type, Loc, Height, Width, Length | Landform Pattern: Pattern, Class, Modal, RMS | Land Use: LU1, Mgt1, Mgt2 | Described By | Date (ddmmyy) | Project | Site | Obs | S Type

TSO | M Type | L Meas | Obs Reas | Runoff | Perm | Drainage | M Samp | Aggredn | Depth R Horiz | Tax Unit: Type, Code | Map Unit: Type, Code | Air Photos: Film No, Run No, Frame No | Substrate: OT, Distance, Conf, Depth, Gr S, Str, Por, Sp F, Alt, Str, Lith, Gen T, Text, Mass Str, MDS, MC1, MC2

Location: Datum, Zone, Easting / Latitude, Northing / Longitude | Australian Soil Classification: Conf, Ord, Sub Ord, GG/ Or2, SG/ SO2, F1, F2, F3, F4, F5 | PPF | GSG: aff | Disturb | Surface Condition | Microrelief: Type, Agent, Cmpt, Grad, Prop, VI, HI | Surface Coarse Fragments: Abun, Size, Shape, Lith, Str, Alt | Outcrop: Abun, Lith | Profile Diagram

Erosion: Type, State, Deg, GD | Vegetation Community: No, Ref No, Name (1, 2, 3) | Vegetation Community Details: Strata (T, M, L), Form, Ht Cl, Cov Cl, Height, Cover, Species 1, Prop, Species 2, Prop, Species 3, Prop

Number | Horizon | Depth: Upper, Lower | Bound: Dist, Shape | Field Texture: Field Texture, Qual | Drain.: Perm, Drain | Book | Colour: Hue, V, C, Moist | Mottles: Type, Abun, Size, Contr, Col | Coarse Fragments: Abun, Size, Shape, Lith, Str | Structure: Grade, Size, Type, Cmpd | Segregations: Abun, Nat, Form, Size, Str | Cracks | Strgth: SWS, Cons | Fabric | Cutans: Kind, Abund, Distinct | Pans: Type, Cmnt, Cont, Str | Roots: Size, Abun | Samples

1
2
3
4
5
6
7

Field Tests | Meth
pH-RP | 1
pH-1:5 | 4
EC-1:5 | 1
Slaking | 1
Dispersion | 1
Efferv fin. earth |

NOTES:

Figure A6.1: Example of a field sheet, available from soil.enquiry@qld.gov.au

SITE DESCRIPTION SHEET - NOTES

Project	Site	Obs

Type	Site Notes

Type	Observation Notes

Type	Horizon Notes

Other Notes

A6.2 Analytical spreadsheets

When analytical data is to be submitted to the Queensland Government the information should be in the format of Table A6.2 (see the following page), and the following should be adhered to when applicable:

- Ensure that the laboratory is NATA and/or ASPAC accredited and holds certification for all the required tests.
- The analytical results should be provided using the relevant codes from the *Soil Chemical Methods Australasia* (Rayment & Lyons 2011) – commonly referred to as the 'Green Book'. For example: pH1:5 in water has the code 4A1.
- The minimum set of analytes and acceptable methods should be discussed with Department of Resources Land Resource Officers before the samples are submitted for laboratory analysis. For example at times, the minimum data suite of analytes will include pH, EC, Cl, particle size, air dry moisture content, -15 Bar water content, dispersion ratio, exchangeable cations, CEC, total organic C, total N, Colwell P and phosphorus buffer index (PBI) for the standard depths 0–0.1 m, 0.2–0.3 m, 0.5–0.6 m, 0.8–0.9 m, 1.1–1.2 m; 1.4-1.5 m and 1.7-1.8 m.
- At other times, depending on the purpose, bulk density may be required, or a reduced number of analytes will be acceptable.
- Results must be accompanied by method statements that include units, uncertainty, PQL and the reporting basis (40°C or 105° C)
- Certified laboratory reports must be provided.
- It is strongly recommended that results be provided in .xls or .csv format.

The data should be emailed to a Department of Resources Land Resource Officer. Compress the file before emailing. For larger files (>5 Mb), contact soil.enquiry@qld.gov for further advice.

The following examples (Table A6.2 and A6.3 on the following page) are available as Excel spreadsheets from soil.enquiry@qld.gov.au

Table A6-2 Analytical Results

		Method code	4A1	3A1	5A2
		Method description	pH of 1:5 soil/water suspension	EC of 1:5 soil/water suspension	Cl of 1:5 soil/water suspension
		Component/ Analyte	pH	EC	Cl
		Units	-	dS/m	mg/kg
Site ID	**Sample Number**	**Depth (m)**			
1a	1	B 0.00-0.10			
1a	2	0.00-0.10			
1a	3	0.20-0.30			

Table A6-3 Analytical Methods

Method Description	**Code from Rayment & Lyons**	**Analyte**	**Uncertainty ±%**	**Min practical Quantitation Limit**	**Unit**	**Reporting Basis**
pH of 1:5 soil/water suspension	4A1	pH	5	0.100	-	Oven dry (48 hours at 40°C)
Soil: pH EC Aqueous (1:5)	3A1	EC	10	0.010	dS/m	Oven dry (48 hours at 40°C)
Soil: Cl NO3-N Aqueous (1:5)	5A2	Cl	10	20.000	mg/kg	Oven dry (48 hours at 40°C)

A6.3 Spatial data – observations and polygon

When digital copies of Unique Mapping Areas (UMAs) and site data is to be submitted to the Queensland Government the following should be adhered to when applicable:

- Digital copies of spatial data (e.g. ArcGIS shapefiles, layer package, feature class within a geodatabase) used for assessment including unique map areas should be attributed with the land suitability results, soil types (e.g. Australian Soil Classification to sub-order, or Soil Profile Class with proportions of any minor soil specified).
- Coordinates of all the observation sites (e.g. full profiles, deep borings, analytical sites and check sites) should be provided (preferably as an ArcGIS shapefile, layer package or feature class within a geodatabase).
- Topology and geometry checks must be performed to ensure no overlapping polygons and no gaps and to ensure the polygon geometry fits with the intended scale and accuracy – note this can apply to a feature classes within a geodatabase.
- Map Grid of Australia (MGA) is the recommended projection system using the GDA2020 datum, which is now the standard geodetic datum for Australia. Alternatively, the GDA94 datum (MGA94) may be used which will result in an approx. 1.8m offset. Collection method, date and projection details need to be recorded.
- Appropriate metadata should be included. The current Department of Resources spatial metadata standard is ISO 19139.
- Scale and observation density must be specified within metadata.
- Land suitability rules should be provided in an excel spreadsheet if there is any deviation from the rules of the *Regional Land Suitability Frameworks for Queensland* (DNRM & DSITI 2015).

The data should be emailed to a Department of Resources Land Resource Officer. Compress the file before emailing. For larger files (>5 Mb), contact soil.enquiry@qld.gov for further advice.

10 Review

This guideline shall be reviewed within two years from the effective date of the approval.

11 Keywords

VEG/2018/4460; land resource information; land suitability; agricultural land evaluation; salinity risk assessment; soil erosion; qualified personnel; clearing regulated vegetation; scale; site density; irrigation methodology; templates for submitting data