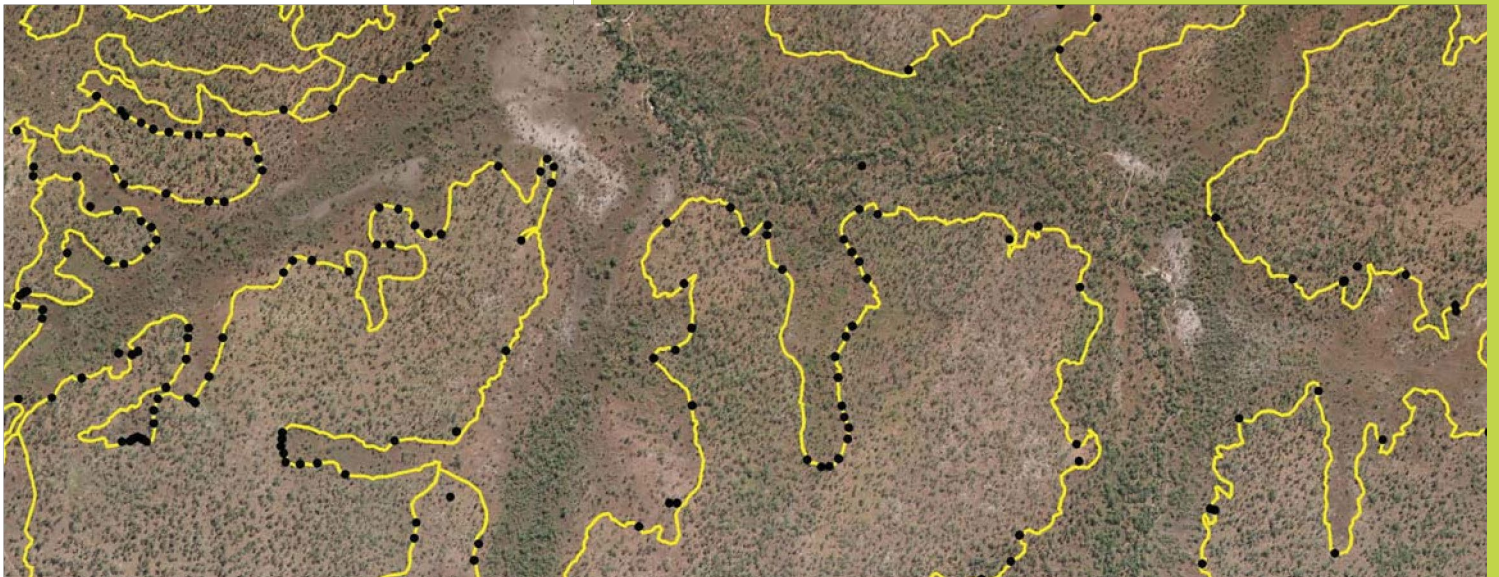




Northern
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Northern Territory Land Suitability Guidelines



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Front Cover Image

The extent of constrained land accurately delineated from field inspection over a parcel of land in the Darwin rural area.

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Executive Summary

The Northern Territory (NT) Land Suitability Guidelines apply internationally recognised land suitability classes to seven categories of land suitability in the NT. The guidelines outline the information required to address the term ‘unconstrained land’ in Section 6.3 of the NT Planning Scheme 2020.

The guidelines provide developers and consultants with information on what the NT Government expects in relation to land suitability information for general developments. In doing so, the land suitability guidelines can assist in streamlining the development assessment process.

Land suitability (FAO, 1976) promotes land uses that utilise land for its most suitable economic use while also reducing potential environmental and social risks. It does not necessarily prevent a land use from occurring, but in most situations indicates that additional inputs in terms of costs, design, planning and ongoing management could be required in order to adequately address social, economic and environmental risks.

The NT guidelines address seven important land suitability categories. They are:

1. Drainage
2. On-site Wastewater Management
3. Erosion Risk
4. Soil Salinity
5. Acid Sulfate Soils
6. Storm Tide Flooding
7. Riverine Flooding

The seven land suitability categories adopt nationally recognised guidelines for terminology. For each land suitability category, the guidelines provide:

- (i) a definition of terminology;
- (ii) the importance of managing the issue for economic, health, social and/or environmental benefits; and
- (iii) a definition of what is deemed to be potentially constrained under the NT Planning Scheme.

1 Defining Land Suitability

The land and water resources of an area, including flooding information, should be one of the first considerations when identifying potential development of a parcel of land. The accurate and appropriate delineation of the relevant land resources and potential flood levels ultimately provides the proponent with the information required to plan and implement a development.

Land suitability is the fitness of a given area for a land utilisation type (or land use), or the degree to which it satisfies the land user. It is generally presented as a class or rating.

Land evaluation is the process of estimating the potential of land for alternative kinds of land use so that the consequences of change can be predicted.

(FAO, 1976)

Where a landscape characteristic does not meet the requirements for a particular land use, it constitutes a potential limitation or 'constraint'. Constraints are commonly rated to express the degree of severity to which they may impair land use.

Internationally recognised suitability classes outlined by the United Nations Food and Agriculture Organization (FAO) can be adapted and applied at both a regional and local scale. Adapted FAO (1976) suitability classes, as cited in Van Gool (2008), are presented in Table 1.

Suitability Classes	Description
Class S1 Highly Suitable	Land having no significant limitations to sustained application for a given land use or only minor limitations. Nil to minor negative economic, environmental, health and/or social outcomes.
Class S2 Moderately Suitable	Land having limitations which in aggregate are moderately severe for sustained application of a given land use. Appreciably inferior to S1 land. Potential negative economic, environmental, health and/or social outcomes if not adequately managed.
Class S3 Marginally Suitable	Land having limitations which in aggregate are severe for sustained application of a given use. Moderate to high risk of negative economic, environmental, health and/or social outcomes if not adequately managed.
Class S4 Not Suitable	Land having limitations which may be insurmountable. Limitations are so severe as to preclude successful sustained use of the land. Very high risk of negative economic, environmental and/or social outcomes if not managed.
Class S5 Not Suitable	Land having limitations which appear so severe as to preclude any possibilities of successful sustained use of the land in the given manner. Almost certain risk of significant negative economic, environmental and/or social outcomes.

Table 1: Adapted Land Suitability Classes based on FAO (1976)

2 Land Suitability and the NT Planning Scheme

These guidelines are a referenced document of the NT Planning Scheme (the Scheme). Clause 6.3 (Subdivision of Rural and Unzoned Land) of the Scheme refers to the identification and extent of 'unconstrained' and 'constrained' land. For the purposes of the Scheme, 'constrained' land is land that contains characteristics that do not accommodate the requirements of the proposed land use.

The Suitability Classes in Table 1 are applied to the 'unconstrained' and 'constrained' land terms used in the Scheme. Suitability Classes 1-2 are considered to be generally 'unconstrained' whereas Suitability Classes 3-5 are considered to varying degrees 'constrained'. Where a Suitability Class is determined to be 3-5 it may:

- (i) prevent development; or
- (ii) if not necessarily preventing the land use, identify that additional inputs in terms of costs, design, planning and ongoing management may be required by the proponent. Some cases may involve significantly higher economic, social and environmental risks to the public.

3 Applying the Land Suitability Guidelines

Applications subject to clause 6.3.3 (Site Characteristics of Subdivisions for lots of 1 ha or Greater in Zones RL, R, H and Unzoned Land) must include a land suitability assessment to demonstrate that the proposal is consistent with these guidelines. The development assessment process, in accordance with the *Planning Act*, is detailed at <http://www.lands.nt.gov.au/planning/onestopshop>.

Detailed land suitability assessments will generally require the collection of new field-verified information. Land unit information published at various scales across the NT is a useful guide for planning but the scale and subsequent accuracy of this information is generally not sufficient for lots in peri-urban planning. The requirement under the scheme for peri-urban areas to contain at least 1ha of suitable or unconstrained land adjacent to public access, implies that the information provided by a proponent needs to be collected at a very detailed scale, be field verified, clearly presented and of sufficient accuracy so the consent authority has a very high level of confidence that the land is suitable for the proposed use.

Table 2, found at the end of this document, applies the land suitability framework to the seven important land suitability categories. In some situations there may be a requirement for specific additional land suitability categories not included in Table 2 to be investigated.

The presence and importance of some land suitability categories in Table 2 are often regionalised. Issues such as flooding and drainage are generally more prevalent in the Top End whereas salinity is generally restricted to drier climatic regions. A similar statement could also be made with regard to on-site wastewater systems for developments which will be connected to reticulated sewerage. For any one development, not all seven land suitability issues will be relevant and therefore may not be required to be addressed in detail.

There can also be significant overlap between the seven land suitability categories. Flooding, drainage and the suitability of soils for on-site wastewater management (when related to soil drainage or flooding) are all generally associated with the length and depth of potential inundation, and the impacts inundation could have on private and public infrastructure, and public and environmental health. Assessments undertaken to address the extent of poorly and very poorly drained land across a proposed subdivision may at the same time address flooding and also the suitability of the soils for on-site wastewater management.

A number of NT Government Departments have significant expertise in the seven land suitability categories. These departments can be contacted for advice on the guidelines and/or advice on specific developments.

4 Common Land Suitability Categories in the Northern Territory

4.1 Drainage

“Drainage is a useful term to summarise local soil wetness conditions; that is, it provides a statement about soil and site drainage likely to occur in most years. It is affected by a number of attributes, both internal and external, that may act separately or together. Internal attributes include soil structure texture, porosity, hydraulic conductivity, and water-holding capacity, while external attributes are source and quality of water, evapotranspiration, gradient and length of slope, and position in the landscape” (McDonald and Isbell, 2009).

Drainage is an environmental, health, social and cultural issue for a number of land uses. For example, traditional absorption based septic systems require well-drained locations to operate successfully throughout the year, especially during monsoonal periods. Development and disturbance of poorly drained landscapes also has health implications with increased occurrence of soil borne diseases such as melioidosis (*Burkholderia pseudomallei*) (Kaestli et al., 2012). Cultural and social limitations may include occupants having to live and undertake day to day activities whilst the soil and land is saturated, inundated or ‘muddy’ for a significant period, often sometime after the cessation of the wet season. There may be significant overlap in the types of suitability issues associated with land subject to either drainage or flooding constraints despite significant differences in the definition of the two. It can also represent for some land uses, a substantial additional financial cost to development.

Under the NT Planning Scheme, land evaluated as being imperfectly to very poorly drained (Suitability Classes 3-5 in Table 2) is considered constrained for a number of land uses that involve human occupation.

The seasonality, amount and intensity of rainfall are also an important consideration.

Landscapes typically constrained by drainage include intertidal areas, coastal floodplains, wetlands, swamps, lakes, drainage depressions, alluvial plains, lowland plains, levees and margins of these areas where subsurface water moves to lower positions within the landscape.

Land potentially constrained by drainage in the NT is defined as:

Areas that are wet or (saturated) either at, above or close to the land surface for a period of weeks to months typically during the wet season but potentially extending into the dry season as a result of rainfall, landscape function and/or position or soil hydrology factors.

4.2 On-site Wastewater Management

On-site wastewater systems are for the bacterial, biological, chemical or physical treatment of sewage, and include all tanks, trenches, beds, sewers, drains, pipes, fittings, appliances and land used in connection with the system.

The key performance objectives for on-site wastewater systems are to protect public health, maintain and enhance the quality of the environment and community amenity, and protect resources in unsewered developments.

The majority of on-site wastewater systems in areas such as the Darwin rural area comprise septic tanks with absorption trenches or beds. It is essential in an area with high annual rainfall, light textured, highly permeable soils and poorly drained soils that septic tanks are constructed on suitable land. For on-site wastewater systems to operate properly they require adequate soil landscape properties relating to surrounding drainage, clay content, gravel content, soil depth, and rockiness.

If a soil landscape cannot absorb waste water during all weather conditions, potentially contaminated wastewater is released into the landscape potentially impacting soil, ground water and streams. Consequently, this may pose a significant risk to public health and the environment.

The Department of Health has developed *Guidelines for Land Capability Assessment for Onsite Wastewater Management* to explain the process of undertaking a land capability assessment for on-site wastewater management for unsewered development proposals. The guidelines apply to the entire NT and describe the level of detail required for investigations and reporting, for a range of different development scenarios. This document is supported by a series of risk maps for on-site wastewater management, however the extent of mapping is limited to the Darwin rural area.

Land constrained for on-site wastewater management is defined as:

Soil landscapes that have one or more of the following characteristics:

- slopes greater than 5%;
- are imperfectly to very poorly drained;
- contain minimal clay (20%) at depth;
- shallow soils (<0.5m);
- contain extensive exposed rock (>10%); or
- greater than 25% gravel.

4.3 Erosion Risk

Erosion risk is the intrinsic susceptibility of a parcel of land to the prevailing agents of erosion. It is dependent on a combination of climate, landform and soil factors (Houghton & Charman, 1986).

The effects of erosion are economic, social and environmental. Erosion can be significantly accelerated in the wet dry tropics of northern Australia when the landscape is altered. The removal of vegetation and exposure to intense rainfall can cause severe erosion. Accelerated erosion can be mitigated against through erosion and sediment control practices, but in some landscapes mitigation may be difficult unless significant and sometimes costly engineering structures are appropriately designed and built. Not controlling soil erosion has implications for the water quality of streams, wetlands and tidal environments, ultimately affecting aquatic and marine ecosystems. Additionally, unmanaged soil erosion and sedimentation may impact adjoining property, infrastructure, roads and drainage systems.

Some soils are inherently highly erodible (Suitability Classes 3-5 in Table 1) due to physical and chemical properties of the soil (ie. loose sands & sodic soils). Others soils are at high erosion risk due to their position in the landscape (ie. land with significant slope and areas where runoff is concentrated such as drainage areas). Erosion risk is also dependant on the intensity of the proposed land use.

Soil-landscapes in the NT are generally a moderate to high or very high erosion risk due to the sandy nature of the landscapes and the intense rainfall.

Land constrained by an erosion risk is defined as:

Soil landscapes that have a moderate to very high erosion risk (Suitability Classes 3-5).

4.4 Soil Salinity

Soil salinity refers to the accumulation of water soluble salts. These are mainly sodium, but also potassium, calcium and magnesium, which may be chlorides, sulfates or carbonates (Hazelton & Murphy, 2007).

Soil salinity is an issue generally restricted to low rainfall areas. Upland soils in the wet dry tropics have generally been leached of salts over many thousands of years or weathering and intense rainfall. Soil salinity can be exacerbated by changes in the water balance (ie removal of native vegetation and intensification of land uses such as increased irrigation).

The effects of not identifying and managing this risk are economic, environmental and social. Public and private infrastructure such as housing can be severely degraded or destroyed over time. The environmental effects may include the impact increased salt concentrations have on aquatic ecosystems and water quality. Scalded landscapes are also aesthetically undesirable.

Land constrained by soil salinity is defined as:

Landscapes that have very high soil salinity (>4dS/m ECe) or could be at extremely high salinity risk (>4dS/m ECe) as a result of the proposed development (Suitability Classes 3-5 in Table 1). The level of salinity could be at a level where housing and associated infrastructure including public utilities could be damaged or degraded over time.

4.5 Acid Sulfate Soils

Acid sulfate soils are naturally occurring sediments and soils containing iron sulfides (principally pyrite) and/or their precursors, or are affected by the oxidation products of sulfides (Sullivan et al., 2011). The exposure of sulfides to oxygen by drainage or excavation leads to the generation of sulfuric acid.

The effects of not managing acid sulfate soils can result in serious long term economic, environmental, cultural and social impacts. These include adverse changes to soils and water quality, deterioration of ecosystems, and local and regional loss of biodiversity.

Economic impacts can result in substantial costs to replace public and private infrastructure, especially concrete infrastructure. The impact on water quality, and aquatic and marine ecosystems from a range of acidic compounds including heavy metals may also be severe. The environmental impacts are long term, costly and very difficult to remediate.

Acid sulfate soils, both sulfidic and sulfuric are known to occur in intertidal and coastal floodplains in the Darwin region and most other parts of the NT coastline. Information published by the NT Government (Hill and Edmeades, 2008) indicate that the Darwin region has some of the most potentially toxic acid sulfate soils in Australia.

Land constrained by acid sulfate soils is defined as:

Soils where greater than 0.02% oxidisable sulfur is present (Suitability Classes 3-5 in Table 1) as indicated by NATA accredited soil testing results, undertaken according to nationally recognised methods and recognised in a standard test (ie Chromium Reducible Sulfur or SPOCAS), and collected at appropriate depth and density, preferably in accordance with the published Queensland sampling guidelines (Ahern et al., 1998). The level of risk is dependent on both the level of oxidisable sulfur and volumes of soil disturbed.

4.6 Storm Tide Flooding

Flooding caused by temporary sea-level rises associated with storm surges is restricted to coastal areas.

Storm surges occur when sea levels are raised due to the combined effects of the lowering of atmospheric pressure and wave run-up due to onshore winds during cyclones. Storm tide in terms of ocean water level comprises the combined effects of astronomical tide plus storm surge plus wave set up. Storm tide mapping is progressively being completed to identify potential land development constraints for major coastal population centres in the NT.

Land constrained by risk of storm tide flooding is defined as:

Coastal areas at elevations below the Primary (100 year Annual Recurrence Interval (ARI) Storm Tide inundation extent.

4.7 Riverine Flooding

This flooding is associated with the depth and extent of inundation caused when rivers rise above their banks. Floodplain modelling and mapping is progressively being completed to identify land potentially constrained by this type of flooding for areas where there is greatest risk to human life and/or infrastructure.

Land constrained by risk of riverine flooding is defined as:

Land that is below the 1% Annual Exceedence Probability (AEP) flood level.

Suitability Classes	Description	Drainage ⁺	On-site Wastewater Management		Erosion Risk	Soil Salinity	Acid Sulfate Soils	Storm Tide Flooding	Riverine Flooding
			Risk Category**	Equivalent Criteria**					
Class S1 Highly Suitable	Land having no significant limitations to sustained application of a given land use, or only minor limitations. Nil to minor negative economic, environmental, health and/or social outcomes	Rapidly to Well	Low	Well drained soils with >35% clay at depth, deep soils >1.0 m, surface gravel <10%, slopes < 5%	No runoff occurs	<2 ECe dS/m or no potential to be >4dS/m	Not Present	Secondary Storm Tide (1000 year ARI) inundation risk for entire land parcel – Nil Risk not applicable	<0.5% AEP risk of river floodplain flooding for entire land parcel – Risk not applicable
Class S2 Moderately Suitable	Land having limitations which in aggregate are moderately severe for sustained application of a given land use. Appreciably inferior to S1 land. Potential negative economic, environmental, health and/or social outcomes if not adequately managed.	Moderately Well	Medium	Moderately well drained soils with >20% clay at depth, moderately deep soils 0.5-1.0 m, surface gravel 25-50%, slopes 5-10%	<0.75% slope	2-4 ECe dS/m or no potential to be >4dS/m	Oxidisable Sulfur >0.02% but very low and <50 tonnes to be disturbed*	Primary Storm Tide (100 year ARI) inundation risk for entire land parcel – Nil No Risk	<1% AEP risk of river floodplain flooding for entire land parcel – No Risk
Class S3 Marginally Suitable	Land having limitations which in aggregate are severe for sustained application of a given use. Moderate to high risk of negative economic, environmental, health and/or social outcomes if not adequately managed.	Imperfectly	High	Imperfectly drained soils with >15% clay at depth, shallow soils 0.25 -0.5 m, surface gravel >50%, slopes >10%	0.75-5% slope, Development will require practice erosion and sediment control involving engineered works. On-going land management required	Soil salinity >4dS/m or potential to be >4dS/m	Oxidisable Sulfur >0.02%, <100 tonnes to be disturbed*	Primary Storm Tide (100 year ARI) inundation risk for part of land parcel – Low Risk	≥1% AEP risk of river floodplain flooding on part of the land parcel other than floodway – Low risk and mitigated.
Class S4 Not Suitable	Land having limitations which may be insurmountable. Limitations are so severe as to preclude successful sustained use of the land in the given manner. Very high risk of negative economic, environmental and/or social outcomes if not managed.	Poor –to Very Poor	High	Poor to very poorly drained or inundated. On-site wastewater systems will not operate during periods of inundation	>5% slope, Development will require considerable best practice erosion and sediment control involving a significant level of engineered works. High level of on-going land management essential	Soil salinity >8dS/m or potential to be >8dS/m	Oxidisable Sulfur >0.02%, >200 tonnes to be disturbed*	Primary Storm Tide (100 year ARI) inundation risk for entire land parcel including occupied area and emergency exit route - Medium Risk and mitigated	≥1% AEP risk of river floodplain flooding for entire land parcel other than floodway – Medium risk and mitigated.
Class S5 Not Suitable [#]	Land having limitations which appear so severe as to preclude any possibilities of successful sustained use of the land in the given manner. Almost certain risk of significant negative economic, environmental and/or social outcomes.	To be determined on assessment of specific cases	Not Suitable for on-site wastewater management		To be determined on assessment of specific cases. Environmental, social, health or economic risks are considered too high.	To be determined on assessment of specific cases. Environmental, social, health or economic risks are considered too high.	To be determined on assessment of specific cases. Environmental, social, health or economic risks are considered too high.	Primary Storm Tide (100 year ARI) inundation risk for entire land parcel and the storm tide level is 2m or more above ground level – Very high risk and mitigation not feasible.	≥1% AEP risk of river floodplain flooding on entire land parcel and is covered by floodway extent – Very high risk and mitigation not feasible.

Potentially constrained land under the NT Planning Scheme

Table 2: NT Land Suitability Classes based on FAO (1976) in Van Gool et al (2008)

*Land Suitability classes for acid sulfate soils is based on Table 3 in *Guidelines for Sampling and Analysis of lowland Acid Sulfate Soils in Queensland 1998* (Ahern, Ahern and Powell, 1998). Table 3 in Ahern, Ahern and Powell (1998) should be referenced for exact treatment categories.

Class 5 (Not Suitable) can sometimes only be assessed for specific cases

**Refer to the DoH *Guidelines for Land Capability Assessment for On-site Wastewater Management* for more information about these risk categories including the level of detail required for investigation and reporting of land capability assessment.

+ As defined in the *Australian Soil and Land Survey Field Handbook*.

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