Environmental Protection Authority

Land

Environmental Factor Guideline

Landforms

The objective of the factor *Landforms* is:

To maintain the variety and integrity of distinctive physical landforms so that environmental values are protected.

Purpose

The purpose of this guideline is to communicate how the factor *Landforms* is considered by the Environmental Protection Authority (EPA) in the environmental impact assessment (EIA) process.

Specifically, the guideline:

- describes the factor *Landforms* and explains the associated objective
- describes EIA considerations for this factor
- discusses the environmental values of distinctive landforms, and their significance
- describes issues commonly encountered by the EPA during EIA of this factor
- identifies activities that can impact on distinctive landforms
- provides a summary of the type of information that may be required by the EPA to undertake EIA related to this factor.

What is a landform?

For the purpose of EIA, the EPA defines a landform as:

> *A distinctive, recognisable physical feature of the earth's surface having a characteristic shape produced by natural processes.*

A landform can be a small scale feature, such as a cliff or dune, or of larger scale, such as a dune field. The EPA considers the defining feature of a landform to be the combination of its geology (composition) and morphology (form).

Landforms are a component of the landscape. The EPA considers a landscape to be:

> *All the features of an area that can be seen in a single view, which distinguish one part of the earth's surface from another part. Landscapes can be either natural (largely unaffected by human activity) or human (created or significantly modified by human activity).*

Natural landscapes consist of a variety of landforms.

The environmental objective for for the factor *Landforms*

The EPA's environmental objective for the factor *Landforms* is: "To maintain the variety and integrity of distinctive physical landforms so that environmental values are protected."

This objective recognises that the geology and morphology of a landform can have value in their own right, as well as the important role unique or uncommon landforms often have in supporting environmental values such as threatened flora and fauna, ecosystems, or social and cultural values.

EPA guidance with respect to potential impacts on an environmental value which is supported by a landform, for example a threatened species, heritage or amenity, are dealt with in the relevant guidelines, including but not limited to *Flora and Vegetation, Terrestrial Fauna, Subterranean Fauna* and *Social Surroundings*.

Considerations for environmental impact assessment

Considerations for EIA for the factor *Landforms* might include:

- application of the mitigation hierarchy to avoid and minimise impacts to distinctive landforms, where possible
- the landform's environmental values which are potentially impacted, and their significance
- the scale of potential impacts to the landform and its environmental values
- the extent of impacts on the landform from previous activities or development
- the impact of the proposal on the stability and integrity of the landform
- the current state of knowledge of the environmental values supported by the landform

Environmental values supported by Landforms, and their significance

Environmental value is defined under the *Environmental Protection Act 1986* as a beneficial use, or an ecosystem health condition.

Landforms have numerous and varied environmental values which can include being a foundation for particular ecosystems, being sites of special scientific interest related to geology and geomorphology, and representing examples of important physical landscape processes. Landforms also embody social and cultural values. They can have strong historical and cultural associations and provide enjoyment through aesthetics or active use (e.g. tourism, climbing, hiking, etc.).

The focus of this factor and its associated objective is on the significance of the landform itself and the significance of the impacts on the landform. In considering these impacts, the EPA will focus on the significance of the removal or alteration of the landform's defining geology and morphology.

Where impacts to flora and vegetation or fauna supported by landforms are considered significant, the EPA will directly consider impacts through those factors.

The following considerations may be taken into account by the EPA in determining the significance of landforms:

- **Variety**
  The landform is a particularly good or important example of its type. The landform is not well represented over the local, regional or national scale or differs from other examples at these scales.
- **Integrity**
  The landform is intact, being largely complete or whole and in good condition.
- **Ecological importance**
  The landform has a distinctive or exclusive role in maintaining existing ecological and physical processes; for example, by providing a unique microclimate, source of water flow, or shade. The landform supports endemic or highly restricted plants or animals.
- **Scientific importance**
  The landform provides evidence of past ecological processes or is an important geomorphological or geological site. The landform is of recognised scientific interest as a reference site or an example of where important natural processes are operating.
- **Rarity**
  The landform is rare or relatively rare, being one of the few of its type at a national, regional or local level.
- **Social importance**
  The landform supports significant amenity, cultural or heritage values.

Issues

The following issues are matters that are commonly encountered by the EPA due to the nature of proposals that are referred to it. Background on these issues is provided here to help proponents and the community engage with EIA. This issues section will be updated from time to time to reflect new issues as they arise in referrals and EIA.

Banded Iron Formations

Banded iron formation (BIF) ranges in Western Australia form part of the Yilgarn Craton geological formation that covers the Midwest and Goldfields regions, and the Pilbara Craton that covers the Pilbara region. These ranges are amongst the oldest landforms on earth, deposited as chemical sediments at the bottom of the sea over two billion years ago, and later uplifted by tectonic processes. The hard, iron-rich rock is erosion resistant, leaving craggy hills and ridges isolated in predominately flat landscape.

BIF ranges are high points in the landscape, with their cooler, wetter conditions forming island-like refuges for plants and animals not found in the surrounding flat, dry plains. This includes species and communities that have highly restricted distribution and range endemics (species which only occur on one range). Being distinct features in an otherwise flat landscape, they also support a number of social and economic values including tourism.

The EPA recognises that there are significant biodiversity and mineral resource values in the banded ironstone ranges. It is not possible to reconstruct the structure of BIF ranges, once disturbed, which means that impacts from disturbance may be significant.

Dunes and dune fields

A dune is a mound or ridge of sedimentary particles, usually sand, formed by the action of either wind or water. Aeolian dunes may be found in coastal regions where sand accumulates at the back of a beach and in inland sand 'seas' of desert regions. Parabolic dunes are crescent-shaped isolated dunes which close downwind. Desert dunes range from less than a metre to 10m in height and occur in a variety of forms.

The Alkimos dune system north of Perth is considered to have national and world significance as an excellent example of parabolic dunes belonging to the Quindalup dune system, which developed around 10,000 years ago during the Holocene. The dunes are approximately two kilometres wide and extend four kilometres inland and provide amenity and geo-heritage values as well as supporting coastal vegetation, which provides stability for the dunes. Other important dunes occur along the coast of Western Australia.

Activities which can impact on dunes include coastal development and sand mining. These activities may bisect or remove important dune systems or cause disruption of sediment flow, and result in loss of environmental values supported by dune systems. These impacts are potentially significant in the context of increasing development pressure in coastal areas.

Caves and cave systems

Caves are natural cavities or systems of chambers beneath the surface of the earth. A cave system occurs where a group of caves is connected, or the same underground river or stream flows through the cave group. The largest caves and caverns in WA are formed mostly in limestone.

The Leeuwin Naturaliste Ridge in the South West Region contains over 150 limestone caves which have scientific and social value, as well as providing habitat for fauna and flora. A number of caves on the Leeuwin Naturaliste Ridge and in Yanchep National Park support dense growths of aquatic root mats in cave streams and pools which are recognised as Threatened Ecological Communities. Caves in the Pilbara region form habitat for the Pilbara Leaf Nosed Bat.

Surface activities such as changes to hydrology, removal of vegetation, pollution and land development can impact on caves, and are potentially significant if they will result in the loss of environmental values supported by caves or cave systems.

Impacts

Development activities that have the potential to impact on landforms include, but are not necessarily limited to:

- extraction of a mineral resource which forms part of the physical structure of the landform
- activities, such as blasting, which may alter the landform's structure or function (for example, blasting that collapses a cave's ceiling, creating an exposed cavern)
- activities where changing water flow causes erosion, changing the shape and structure of landform elements of a riverine system
- activities where removal of the downwind convex nose of a parabolic dune fragments the dune structure, resulting in loss of the parabolic shape.

Information required for EIA

Where *Landforms* has been identified as an environmental factor, the EPA may require the proponent to provide information or studies within the following broad topics:

- a description of the geology and morphology of the landform
- an analysis of whether the landform is robust and therefore less sensitive to damage or degradation from development activities, or whether it is easily disturbed or degraded
- an analysis of whether the landform is distinct at a local, regional or national level, or is well represented
- a comparison of the character and condition of the landform with others of the same type at the local, regional or national scale
- an analysis of the spatial extent of the landform likely to be impacted
- an assessment of the current integrity of the landform, the degree to which the landform has been disturbed, and the degree to which any previous disturbance has fragmented the landform
- an analysis of the environmental values supported by the landform, including how the proposal will affect the role of the landform in maintaining these values (e.g. surface water or groundwater flows, wind movement, precipitation, temperature, landscape connectivity, and soil composition/chemistry)
- identification of any significant scientific or evolutionary values associated with the landform, and an analysis of the extent to which these values will be impacted by the proposal (e.g. past ecological or biological processes, unusual or important geological or morphological sites)
- consideration of the cumulative impacts on the landform from historic and reasonably foreseeable future development.

Environmental Protection Authority 2016, *Environmental Factor Guideline: Landforms*, EPA, Western Australia.

This document is available in alternative formats upon request.

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