3. LAND MANAGEMENT GUIDELINES

3.1 Management of land characteristics that influence land use

The land characteristics used in capability rating tables have been selected because of the limitations they impose on the use of the land. This section explains why these features are important and how an improved level of management can reduce or even overcome the limitation. The information outlined has been extracted from the Rowe *et. al* (1980) and Charman and Murphy (1991).

Soil texture

Soil texture is largely determined by the proportions of different-sized soil particles which make up the soil. Topsoils with well-graded textures have a relatively even distribution of particle sizes from clay through to sand, and tend to be better able to support agricultural and pastoral activities than either very sandy or very clayey soils. They are better able to withstand cultivation and stock trampling and are more resistant to soil erosion.

Soil texture is closely related to available water-holding capacity. The fine sandy loam - silty clay loam soils have more available water than sands or clays, and so can maintain plant growth for longer periods after wetting. Texture is also an important determinant in soil infiltration and internal drainage, with sandier soils tending to have greater infiltration rates and better internal drainage.

Soils with fine texture (the clay soils) tend to be more suitable for grazing than for agriculture. Except where they are composed of well-structured or self-mulching clays, they may be very difficult to cultivate in either the wet or dry states. On the other hand, soils with coarse texture (the sands) are very unstable and easily eroded, and may need the protection of a vegetative cover over the dry season.

Some of the limitations imposed by soil texture can be reduced or overcome by special treatments such as the addition of stabilising chemicals, incorporating organic matter or simply by importing better quality topsoil if the area and volume of soil required is not excessive.

Boulders and rock outcrop

Boulders and rock outcrop provide physical obstacles to excavation, cultivation and plant growth, and so inhibit land uses involving these activities. It may be possible to remove isolated rock outcrops by blasting, but for extensive uses, such as cropping and grazing, boulders and rock outcrop are a permanent limitation. Additional costs may be involved with the increased management required to maintain pasture growth or reduce storm water runoff from rocky areas.

Depth to hard rock

Soil depth, along with soil texture are important co-factors in governing soil water-holding capacity. Soil depth also determines the extent of root penetration and controls the available store of plant nutrients. A moderate depth of soil (0.75 m or more) is needed for arable agriculture whereas shallow soils are only capable of being used for growing pastures. Very shallow soils are inherently more susceptible to erosion and require the protection of a permanent undisturbed cover of vegetation.

The limitations to engineering activities such as road works, building foundations and other shallow excavation work, may be overcome by blasting, but bed-rock at shallow depths is a permanent limitation to the construction of farm dams.

Depth of topsoil

Topsoil is not favoured as a construction material because of its low bearing capacity and the greater the depth, the greater the cost of removing and stockpiling it. Many excavation permits now require the topsoil to be re-spread on construction sites to facilitate revegetation and this can be done successfully provided the compacted surface is broken up prior to the topsoil being returned.

Depth to watertable (seasonal, perched, permanent)

The presence of a watertable close to the surface causes problems for both agricultural and engineering land uses. Saturated soils have a low bearing capacity so, for uses dependent on a stable foundation (e.g. building foundations, roads), a high watertable is undesirable.

High watertables restrict the percolation of additional water from rainfall, irrigation or the effluent from septic tanks through the soil profile, whereas a fluctuating watertable is likely to cause leaching of the more mobile plant nutrients, or the concentration of iron compounds which immobilise nutrients such as phosphorus. Poor aeration in the zone of saturation will restrict root growth. Trafficability can be adversely affected and in the case of effluent disposal public health aspects may be of concern. High watertables may also restrict the depth of excavation for farm dams and quarries, even the shallow excavations for sand and gravel deposits.

Watertables can be lowered by pumping or constructing artificial drains, however if the water is saline, disposal into the nearest stream may not be allowable.

Dispersible clays

Dispersion represents the spontaneous deflocculation of the clay fraction of a soil in water, whereas slaking is the breakdown of an aggregate into smaller aggregates. Dispersion and slaking are important characteristics of a soil because of their influence on the stability of the soil structure. Soils with a high degree of slaking or dispersion have a high erosion potential and any activity that exposes the topsoil or sub-soil to rainfall or running water increases the risk of erosion.

For a highly dispersible topsoil, when rain falls onto the unprotected surface the soil pores become blocked and reduce water infiltration, thus increasing runoff and the risk of erosion. Dispersible topsoils usually have poor physical characteristics, such as surface crusting, cloddiness, poor aeration and low emergence of plant seedlings. Maintenance of an effective pasture cover or litter layer reduces raindrop splash, dispersion and the associated surface sealing of topsoils.

The problems associated with a dispersible B horizon relate to gully and tunnel erosion and may be overcome by careful pasture management such as ensuring that the slopes and drainage depressions are well vegetated with plant species that have deep root systems and high water requirements. Road batters become a victim to slumping and erosion, with subsequent turbidity of runoff water and sedimentation in nearby water storages. As the dispersibility of the subsoil increases, so does the need to reduce batter slopes and establish a protective vegetative cover on the exposed soil.

Flooding

Flooding can be a problem on land with very low gradients and within confined drainage ways. Precise data is difficult to obtain on the frequency of flood events and the classes have been determined by observations of land form, catchment geometry and soil types which reflect recent sediment deposition.

A distinction should be made between fast flowing flood waters (flash floods) and flooding caused by a rise in water levels with little flow (inundation). The type and severity of impact caused by these two forms of flooding differ and different management may be required to reduce the hazard.

Floods are a threat to human safety, cause damage to property and are a general inconvenience. Thus, flood prone land should not be used for capital intensive uses, but should be retained for the more extensive land uses such as grazing, where stock can be moved to higher ground in times of increased hazard. In some areas the problem may be overcome by building levee banks or retarding basins. Some modification of flooding characteristics may be possible by special management aimed at delaying surface runoff. However, when dealing with large catchments, the problem is a long-term hazard and a permanent limitation.

Organic matter

Where soil materials are to be used as road fill or for earthen dams, the presence of organic matter reduces soil quality for these purposes. Soils containing even moderate amounts of organic matter are more compressible and less stable than inorganic soils. The presence of organic material in sand for concrete is also undesirable.

When used as a medium for plant growth, a high level of organic matter is most desirable as it produces better structure and chemical fertility, and the soils are good for intensive cropping. However, cultivation promotes rapid oxidation of organic matter and the condition of the topsoil will deteriorate if the organic matter is not replaced. Organic matter levels can be increased by sowing the area down to improved pastures for several years or by ploughing in green manure crops.

Permeability

Soils of low permeability have poor drainage through the profile. On sloping land, lateral flow may occur above an impervious layer thereby draining the water away from the site, but on relatively flat areas such soils can become waterlogged and inhibit plant growth or become too boggy for the use of agricultural machinery. Low permeability in soils also reduces the efficiency of effluent disposal systems, although this limitation can be overcome, if sufficient area is available, by increasing the length of absorption trench or by using plants to transpire water from the effluent disposal area. For earthen dam construction low permeability in the floor, the sides and the walls of the dam is most desirable. Conversely, an extremely permeable soil may have excessive leaching of plant nutrients or an inability to retain moisture for plant growth. Such a soil may drain too rapidly to purify the effluent from septic tanks thereby increasing the risk of polluting a groundwater system.

Plasticity Index

The plasticity index is a measure of the range of moisture content over which the soil is in the plastic state. A soil is most easily worked or is most readily deformed when in the plastic state. A low index indicates that the range is narrow, which is desirable where the stability of the material is important, such as in a road subgrade. But where the soil is to be cultivated, a higher plasticity index is desirable to enable working over a wider range of moisture contents.

Linear shrinkage (shrink-swell potential)

This relates to the capacity of clayey soil material to change in volume with changes in moisture content, and is dependant on the quantity and nature of the clay minerals present. The shrink-swell characteristics of a soil influence the capability of land for uses such as roads or buildings which require a stable substrate. Buildings and roads shift or crack in soils which undergo large changes in volume during periodic wetting and drying. Construction on soils with a high shrink-swell potential requires special techniques such as laying deeper-than usual foundations for roads or using a reinforced concrete slab rather than stumps or strip footings for buildings.

Site drainage

Site drainage is influenced by soil type, soil permeability, steepness of slope, slope shape, rainfall and position in the landscape. For most land uses it is important that water flows freely from the site, since poor site drainage can result in the land becoming waterlogged and boggy, inhibiting plant growth, damaging roads and buildings through subsidence, and reducing the capacity of the area to dispose of effluent.

Special works or higher levels of management may be necessary to overcome poor site drainage and this will add to the cost of development and production.

Slope

As the angle and length of slope increases so too does the erosion hazard. Lack of adequate ground cover, which usually occurs during the construction of dams, roads and buildings, or on land that is cultivated or overgrazed, accentuates the erosion hazard. Steeper slopes are more difficult and costly to use for agricultural, forestry or road-making activities, and impose limitations on the type of machinery which can be used.

Certain soil types become unstable in wet conditions and as the slope increases, the risk of mass movement increases particularly if large quantities of water are contained in the soil profile. Instability can occur on natural slopes under trees or pasture, road batters and earthen dam banks.

Effluent from septic tanks contains high levels of nutrients and bacterial organisms. If the absorption beds are situated on sloping land, then during wet periods when the soil profile may be saturated (from excessive rainfall and/or run-on from upslope), there is an increased risk of effluent being washed into the streams and water storages further down the catchment. With algal blooms now a common occurrence and water treatment costs increasing, the nutrient and bacterial levels in water storages must be minimised.

Soil reaction

The pH of the soil is a measure of its acidity or alkalinity and most plants have a pH range in which optimum growth can be expected. Soil acidification occurs as the topsoil loses its ability to maintain pH at a desirable level. With the long-term use of superphosphate and N-fixing legumes and the constant removal of grain, hay and/or animal products from the land, the topsoils in many areas have become more acid and aluminium toxicity; has caused a decline in plant vigour. Regular applications and incorporation of lime back into the topsoil is an expensive, but the only way of restoring the land to maximum productivity.

Stones and gravel

The stone and gravel content in a soil can restrict land use and plant growth in the following ways:

I. reducing the available water content and nutrient supply in the profile;
II. increasing the wear and tear on cultivating and excavating machinery;
III. increasing the cost of harvesting root and tuber crops, e.g. potatoes.

Little can be done to overcome this limitation, other than the continual removal of stones from an area as they appear on the land surface.