CULTIVATION MANAGEMENT ON THE DORRIGO PLATEAU

CODE OF PRACTICE & GUIDELINES

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With the assistance of
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Clarence Valley Shire Council
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SECTION 1

1.0 THE CODE

Sound cultivation practices shall be used to maintain and enhance the soil health status of cultivation areas of the Dorrigo Plateau.

1.1. Introduction

The Dorrigo Plateau supports a number of cultivation based agriculture activities. In particular a high value potato industry. Unfortunately, viable production can often be offset by significant soil loss.

1.2. Aim

This Code of Practice aims to provide practices that can be used to maintain the soil health of cultivation lands upon the Dorrigo Plateau volcanic soils.

1.3. Application

This Code of Practice applies to the volcanic soils of the Dorrigo Plateau. The section **does not** apply to the red or grey granitic soils or metasediments found toward Bosterbrick and Tyringham. A qualified soil conservationist should be consulted in regard to management of these soils.

1.4. Provisions

Whilst approvals are not required to undertake cultivation on previously cultivated or exotic pasture lands, potential impacts from cultivation are still recognised by a number of legislation including:

- Soil Conservation Act 1938 (s.15a)
- Rivers and Foreshores Improvement act 1948 (s.22b) (soon to be transferred to the Water Management Regulations)
- Protection of the Environment Operations Act 1997 (ss.91, 96 & 120)
- Environmental Planning and Assessment Act 1979 (121b)
- Local Government Act 1993 (s.124).

This document is a living document and can be updated where justified. The document is also available for an annual review by the Dorrigo Potato Growers Group.

1.5. Standard of Works

The standard of works outlined in this section are the minimum requirement, or better, required to conform with the abovementioned legislation. All works must be carried out within these guidelines unless in accordance with a plan certified by a suitably qualified Soil Conservation Officer.

SECTION 2

2.0 DEFINITIONS

In this Code, unless the context or subject matter otherwise indicates or requires:

"Appropriate runoff disposal area" means a stable constructed or natural waterway, and/or a sediment trap and/or an environment where; erosion will not occur, degradation of the land surface covering will not occur, sediment will not leave the property or enter a stream, and where concentrated flow does not leave the property or enter a stream in a manner that would cause bed or bank instability.

"Cultivation" means disturbance, breaking down and exposure of the soil for cropping or pasture.

"Erosion and Sediment Control Measures" means those measures taken to minimise the potential for:

- erosion as a result of either ground disturbance, increase in runoff volume, velocity or concentration or any combination of these
- soil leaving a property or causing sedimentation to a watercourse or impacting infrastructure.

"Groundcover" means any type of herbaceous vegetation.

"Indigenous" means a species of vegetation, that existed in the State before European settlement.

"Land degradation" means damage of the physical shape or form of the land and/or any impact to the natural covering of the land.

"Native vegetation" means ***"indigenous"*** trees (including any sapling or shrub, or any scrub), understorey plants, groundcover (being any type of herbaceous vegetation), and plants occurring in a ***"wetland".***

"Natural Waterway or Drainage Depression" means any longitudinal depression deeper than 300 mm and subject to concentrated runoff.

"Safe disposal area" means an environment where; erosion will not occur, degradation of the land surface covering will not occur, sediment will not leave the property or enter a stream, and where concentrated flow does not leave the property or enter a stream in a manner that would cause bed or bank instability.

"Significant catchment" means contributing external area that can generate runoff volumes, velocities or concentrations capable of causing erosion to subject cultivated land.

"Wetland" means any shallow body of water (such as a marsh, billabong, swamp or sedgeland) that is inundated cyclically, intermittently or permanently with water, and vegetated with wetland plant communities.

"Vulnerable lands" (refer section 3.2)

SECTION 3

3.0 SOME LIMITING REGULATION ASSOCIATED WITH CULTIVATION

3.1. Native Vegetation

Paddock vegetation in the form of windbreaks reduces pasture and crop stress. Vegetation also provides habitat for native animals including pasture and crop pest predator species. Paddock vegetation can be strategically enhanced to assist farm viability.

Riparian vegetation protects creek banks from erosion. Riparian vegetation also assists stream water quality and provides for biodiversity. Where riparian vegetation is absent, re-establishment of indigenous vegetation is strongly encouraged.

In general, native vegetation cannot be cleared except:

- in accordance with a Development Consent or a Property Vegetation Plan" granted in accordance with the *Native Vegetation Act* 2003, **or**
- where the "land is excluded" from the Act, **or**
- where clearing is "permitted clearing", a "permitted activity" or "excluded clearing" under the Act,

and,

- and in accordance with a development consent from local Government where required

3.2. Woody Exotic Plants on Vulnerable Lands

Vulnerable Lands includes:

- *any land the surface of which generally has a slope greater than 18 degrees from the horizontal*
- *any land that is situated within, or within 20m of, the bed or bank of any part of a specified river or lake*
- *any land that is, in the opinion of the Minister, environmentally sensitive or affected or liable to be affected by soil erosion, saltation or land degradation, by order of Gazzette.*

In general, the removal of **Woody Exotic Plants on Vulnerable Lands** shall only be carried out in accordance with the provisions of the Native Vegetation Act 2003 (see above) and/or in accordance with the "Ministers Guideline for Clearing of Woody Exotic Plants on Vulnerable Lands".

3.3. Streams and Other Waterbodies (Rivers)

Poor management practices in or near streams and waterbodies have the potential to reduce stream bed and bank stability and water quality impacting both domestic users and aquatic ecosystems. The maintenance or reinstatement of riparian vegetation is vital to maintaining bank stability, biodiversity and water quality. Additional, thickly grassed "buffer zones" adjacent to riparian vegetation, can be effective in reducing the amount of sediment from cultivated paddocks reaching the stream or waterbody.

- In general, any "activity", within the bed and banks or within 40m of the top of the bank (other than routine agricultural management practices), of any stream or waterbody (eg. construction of stream crossings) requires approval under the Rivers and Foreshores Improvement act 1948 (s.22b) (soon to be transferred to the Water Management Regulations) (ref. DNR &/or Local Council).

SECTION 4

4.0 CONDITIONS FOR CULTIVATION

4.1. Slope

Ridge-tops and upper slopes will be less likely to erode than side and lower slope sections. The longer and/or steeper the slope, the higher the erosion risk. General guidelines are:

- *0 - 10% preferred slope range, lower erosion risk*
- *11 - 15% higher erosion risk*
- *16 - 20% very high erosion risk*
- *>20% should not be cultivated*

Condition(s) for Cultivation in relation to Slope

4.1.1 Cultivation shall not be carried out on any slope or slope section steeper than 20% unless in accordance with a plan certified by a suitably qualified soil conservationist.

4.1.2 Erosion and sediment control practices shall be incorporated on all cultivation land to the standards outlined in this Code of Practice

4.2. Natural Dry Watercourses and Drainage Depressions

Water will concentrate and flow where depressions in a cultivated paddock run down the slope. These depressions or drainage lines should be left well grassed to minimise the potential for erosion of the drainage line. Well grassed drainage lines/depressions may even be incorporated into the soil conservation strategy for the cultivation paddock by acting as natural waterways, collecting and transferring paddock runoff.

Condition(s) for Cultivation in relation to Natural Dry Watercourses/Drainage Depressions

4.2.1 Cultivation shall not occur in or along natural dry watercourses (gullies) or drainage depressions.

4.2.2 No disturbance is to occur to vegetation within natural dry watercourses or drainage depressions other than for the enhancement of erosion protection or for light periodic grazing or slashing.

4.3. Erosion and Sediment Control Measures

Land degradation and its effects on streams/waterbodies and adjoining properties is subject to the Soil Conservation Act 1938 (s.15a), the Protection of the Environment Act 1997 (s. 91, 96 & 120), the Local Government Act 1993 (s.124) and the Environmental Planning and Assessment Act 1979(s.121b).

The inclusion of "Erosion and Sediment Control measures" within the cultivation program can significantly reduce the potential for soil loss, maintaining soil health, hence crop production, and reducing its affect on receiving environments. This can be achieved by adoption of the following 6 principles (Table 4.1).

- *Manage External 'run-on' water*
- *Control the off-site movement of soil*
- *Manage in-paddock "runoff"*
- *Monitor and Maintain control measures*
- *Retain in-paddock soil*
- *Stabilise post cropped (harvested) land*

Conditions for Erosion and Sediment Control Measures

4.3.1 All control measures shall be installed in accordance with Section 6 – Soil conservation Works Construction Guidelines of this Code

4.3.2 Variation to the design of measures identified in Section 6 must be accompanied by a plan certified by a suitably qualified Soil Conservation Officer

4.4. Managing External "runon water"

The interception of external "clean runon" water can significantly reduce the amount of "runoff" flowing across the cultivated paddock thereby significantly reducing erosion and subsequent soil loss. The volume, velocity and concentration of "runon" water will determine the level of management needed.

There is therefore the need to look above the paddock to assess the upslope catchment size (the volume of runon), gradient (the potential velocity of runon) and any depressional areas, drainage lines, road culverts and mitre drains (concentration of runon).

Conditions for Managing External "runon water"

4.4.1 Major Soil Conservation Earthworks, "Peak or Rolloverbanks Diversion banks" (*see section 6.1.1*) shall be used to intercept and divert External "runon" water from entering cultivated land where the length of slope above the cultivated paddock is greater than:

- 100m on slopes between 0 & 5%
- 75m on slopes between 6 & 13%
- 50m on slopes greater than 13%, or
- in a concentrated form (eg. depressions, road mitre drains and/or culverts).

4.4.2 External "runon" water that is intercepted and diverted shall be released from the diversion bank to a "Safe disposal area".

4.5. Managing In-paddock Runoff Water

Depending on the length and grade of the cultivated paddock, rain falling on the cultivated paddock has still the potential to generate runoff and erosion. Keeping your soil in the paddock will again rely on reducing the velocity, concentration and volume of runoff across the paddock.

Conditions to Managing In-paddock Runoff Water

4.5.1 Major Soil Conservation Earthworks, "Peak or Rolloverbanks Diversion banks" (*see section 6.1.2*), shall be provided at regular intervals across all cultivated lands to intercept and divert incrop runoff to an "Appropriate runoff disposal area".

4.5.2 Major Soil Conservation Earthworks shall be provided and operational during all phases of the cultivation activity.

4.6. Managing intercepted in-paddock runoff

In paddock runoff will generally contain significant levels of suspended sediment. In paddock runoff diverted by peak or rollover diversion banks needs to be managed so as to avoid:

- *erosion at the disposal point*
- *sediment in runoff continuing onto and burying farm infrastructure or sensitive natural environments (eg. vegetation communities, waterbodies) and/or from leaving the property.*

Conditions for Managing intercepted in-paddock runoff

4.6.1 In-paddock runoff intercepted and diverted by peak and rollover diversion banks shall be directed to an "appropriate runoff disposal area".

4.7. Retaining Soil in the Paddock

Sediment control measures, located between peak and rollover diversion banks, can be used to further keep soil in the paddock. Success will be reliant on reducing the velocity and filtering of runoff. Recommended Sediment control measures include grass buffer strips, rip and ridging (Dammer/Dyker), standing straw barrier lines and filter fabric fencing.

Small diversion drains (using a rotary drain digger) can be effective during small storm events however, the abovementioned sediment control measures are considered more effective.

Conditions to Retain Soil in the Paddock

4.7.1 In-paddock sediment control measures shall be provided between all Peak and Rollover Diversion banks unless the spacings of banks has been reduced to:

- 120m or less between consecutive banks on slopes between 0 & 5%
- 80m or less between consecutive banks on slopes between 6 & 13%
- 40m or less between consecutive banks on slopes between stepper than 13%

4.7.2 In-paddock sediment control measures shall be provided and operational during all phases of the cultivation activity and where post harvest groundcover is less than 70%.

4.8. Managing off-paddock movement of soil

Given the incorporation of the above erosion control measures, soil laden runoff will still most likely leave the paddock. Two methods can be employed to reduce the amount of soil leaving the paddock. These are the capture and settlement by gravity of soil in runoff in ***sediment traps*** *and the capture and filtration of runoff by* ***sediment filters*** *(fabrics and grass/straw buffers).*

A sediment trap can be a large dam type excavation or a long thin bank/channel (sediment bank) across the length of the bottom of the paddock.

Sediment filters are less capable of handling expected runoff volumes than large sediment traps and should only be used on smaller, flatter cropping paddocks.

Conditions for Managing the off-paddock movement of Soil

4.8.1 Sediment traps and/or fabric filters shall be provided at the bottom of the cultivation paddock where the potential exists for soil to enter a sensitive environment (eg. vegetation community, waterbody) or leave the property boundary.

4.8.2 A "buffer zone" of a minimum width of 20 m of thick grass groundcover shall be maintained between cultivated lands and any stream bank or property boundary. Appropriately designed sediment traps and filter fabrics may be incorporated within the buffer zone where they:

- do not involve clearing of **Any** vegetation on "Vulnerable lands" (NVC Act)
- do not involve clearing of **Native** vegetation on any stream (NVC Act)
- do not have the potential to destabilise the bed or bank of the stream, and
- are sited above the average expected storm flow level.

4.9. Post harvest stabilisation

Further erosion and sediment concerns will be removed by the prompt re-establishment of pasture post harvest. The cultivation paddock can be seeded either:

- ***immediately before harvest using for example a seed spreader with seed being incorporated into the soil by the harvesting operation***
- ***during harvest by incorporating a seed box on the harvester and again with seed being incorporated into the soil by the harvesting operation***
- ***or immediately after harvest using for example a seed spreader and with seed being incorporated into the soil by scarification.***

Conditions for Post Harvest Stabilisation

4.9.1 Stabilisation of post harvested cultivation land shall be carried out for each completed block or where harvesting has ceased for more than 7 days by either:

- Seeding with an appropriate cover or pasture crop within 7 days and promotion of strike (eg. scarification of soil, fertilising, irrigation and/or reseeding)

OR

- Immediate deep ripping of the block within 7 days on the contour maximum spacing of 2m and a minimum depth of 30cm

AND WITH

- Maintenance of existing, or incorporation of new, in-paddock sediment control filters such as grass strips, straw barriers etc.

4.10. Monitoring and Maintenance of works

Conditions for the Monitoring and Maintenance of works

4.10.1 All soil conservation works shall be inspected for damage after each rainfall runoff event and/or each farming phase

4.10.2 All soil conservation works shall be maintained including:

- repair of any damage
- removal of sediment when above 50% of the measures capacity

4.10.3 Temporary control measures shall not be removed until a minimum of 70% ground cover is achieved.

SECTION 5

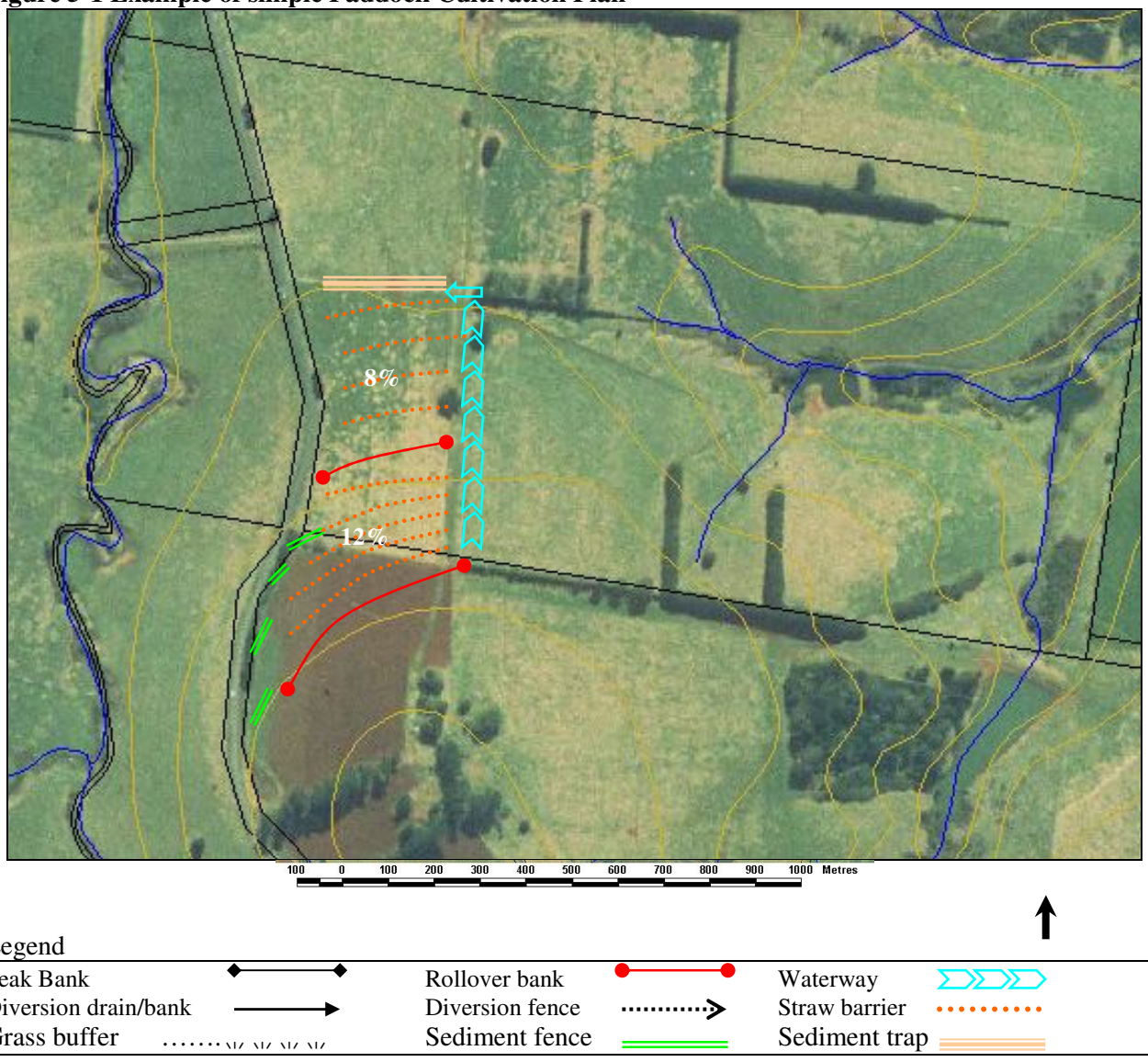
5.0 PLANNING GUIDELINES

5.1. Farm/Paddock planning

Whilst formal documentation is not required for cultivation, the development of a basic farm/paddock plan is strongly recommended. This can simply be a scaled drawing of soil conservation measures on a colour aerial photograph that has been overlain with contours and drainage lines. The ideal plan will include:

- *a scale*
- *north direction*
- *existing streams and waterbodies (eg. dams)*
- *existing contours & slopes*
- *the proposed soil conservation earthworks*
- *the location of paddocks and fencing*
- *the location of access roading*
- *legend*

Figure 5-1 Example of simple Paddock Cultivation Plan



SECTION 6

6.0 SOIL CONSERVATION WORKS CONSTRUCTION GUIDELINES

6.1. Managing external "runon" and internal "runoff" Water

Major Soil Conservation Works for cultivated lands are generally designed to cater for an expected 1 in 10 year average recurrent storm interval. Peak and Rollover Diversion banks are used to both manage external "runon" and internal "runoff" Water.

6.1.1. Peak Diversion Banks

Peak Diversion Banks are used to divert external run-on water and are not generally used in-crop as machinery cannot function over them. Where Peak Diversion Banks are used in-crop, inter-bank spacings are the same as for rollover banks (refer to section 6.1.2).

The design of Peak Diversion Banks include:

- channel longitudinal grade around 1-2%
- a maximum length of 1000 m
- minimum channel width 3m
- compacted bank height minimum 60cm
- batter grades variable (generally 1[v]:2-3[h])
- have a level sill spreader
- areas subject to runoff flows immediately seeded with a suitable permanent grass species and/or an appropriate covercrop seed species

Cross-sectional design detail of peak diversion bank

Figure 6-1 Cross-sectional design detail of peak diversion bank

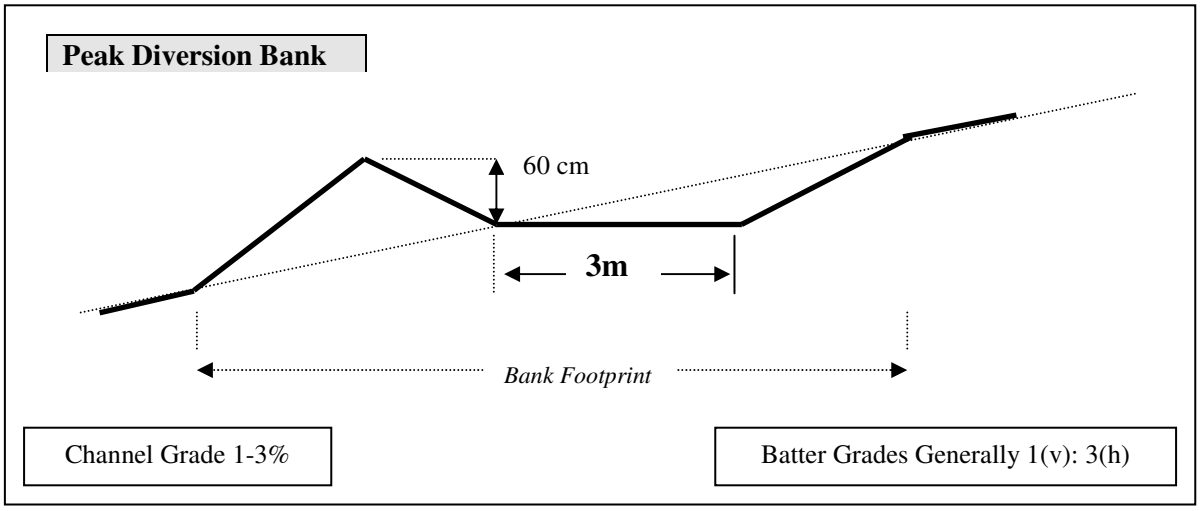


Figure 6-2 Photograph of typical peak diversion bank

Table 6-1 Construction Cost For 150m Of Peak Diversion Bank Using A D6 Bulldozer As At 2005

12% slope & topsoil not stripped		**12% slope & topsoil completely stripped & respread**	
footprint	6.0m	***footprint***	6.0m
non plant zone	6.0m	***non plant zone***	6.0m
No. of pushes	2.0	***No. of pushes***	3
time	4hrs	***time***	6hrs
length	150m	***length***	150m
Cost/metre	$ 4.00/m	***cost/metre***	$6.00/m

6.1.2 Rollover Diversion Banks

Rollover Diversion Banks are wider and flatter than peak diversion banks. Rollover Diversion Banks should only be used where it is desired that machinery continually cross the bank. Rollover banks can generally only be constructed on slopes up to **15%** giving batter slopes around 1(verticle):8(horizontal).

The design of Rollover Diversion Banks include:

- a channel longitudinal grade of 1-2%
- for a channel longitudinal grade of 1% a maximum length in any one direction of 320m
- for a channel longitudinal grade of 2% a maximum length in any one direction of 640m
- a minimum bank height (h) of 35 cm
- a minimum channel width (w) of 3m but this will vary (increase) with increasing slope
- a level sill spreader
- areas subject to runoff flows immediately seeded with a suitable permanent grass species and/or an appropriate covercrop seed species, and

For both Rollover and Peak Diversion banks:

Where additional in-crop controls (see section 6.3) ARE used:

- a maximum spacing of 200m between consecutive banks on slopes between 0 - 5%
- a maximum spacing of 150m between consecutive banks on slopes between 6 – 13%
- a maximum spacing of 100m between consecutive banks on slopes steeper than 13-20%

Where additional in-crop controls ARE NOT used, reduced to:

- a maximum spacing of 120m between consecutive banks on slopes between 0 & 5%
- a maximum spacing of 80m between consecutive banks on slopes between 6 & 13%
- a maximum spacing of 40m between consecutive banks on slopes between stepper than 13-20%

Figure 6-3 Cross-sectional design detail of a Rollover Diversion bank

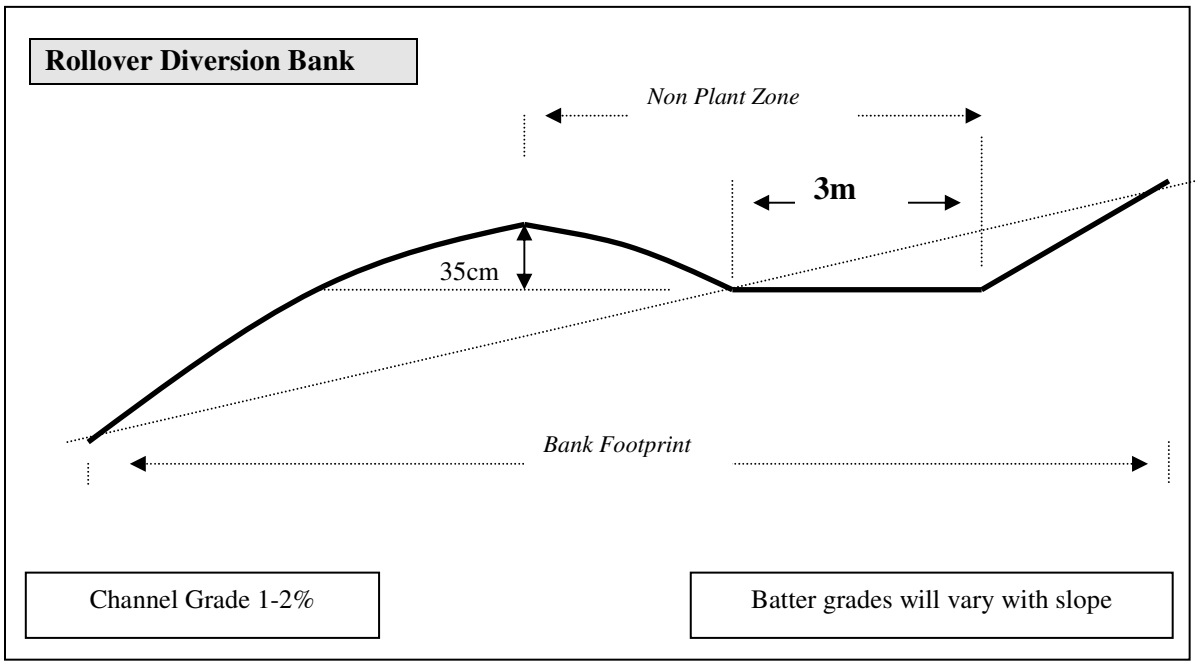


Figure 6-4 Photograph of rollover diversion bank

Table 6-2 Estimated Construction Cost For 150m Of Rollover Diversion Bank Using A D5 Bulldozer As At 2005

8% slope & topsoil not stripped		**12% slope & topsoil completely stripped & respread**	
footprint	34m	***footprint***	42m
non plant zone	15m	***non plant zone***	20m
No. of pushes	4	***No. of pushes***	4-5
time	6hrs	***time***	8.5hrs
length	150m	***length***	150m
Cost/metre	$5.00/m	***cost/metre***	$7.00/m

6.2. Managing Intercepted "Runon" and "Runoff" Water

"External runon" and "in-paddock runoff" water intercepted and diverted by peak and rollover diversion banks needs to be directed to "appropriate disposal areas" at the bank outlets.

"Clean" runoff conveyed by Natural or Constructed waterways can be released directly from the waterway but to a disposal area where erosion does not occur and it does not leave the property in a concentrated form. ***"Unclean"*** runoff conveyed by Natural or Constructed waterways must be released through a suitable sediment retention measure (see section.6.4 - controlling off-site movement of sediment).

6.2.1 Natural and constructed Waterways

Where "stable disposal areas" are not available at the sides of the paddock or where the paddock exceeds 150m in width, Natural or Constructed waterways are used to safely convey water further down or to the bottom of the paddock where a "stable disposal area". They must have a sufficient water carrying capacity and groundcover vegetation to ensure that the surface of the waterway does not erode. The major consideration for either waterway is an appropriate release area for the water it is conveying.

Natural Waterways are simply grassed drainage depressions. Natural waterways must be stable enough to safely carry expected flows.

Figure 6-5 Illustration of Natural Waterway

Constructed Waterways will need to be built where natural waterways are absent or in the wrong position (ie. >150m apart). Constructed waterways can be built by either:

- excavating a channel, or
- by leaving a grassed section between two parallel downslope small banks pushed up from the outside. In this way the channel is already grassed and not disturbed however gaps will need to be left at required intervals to let water from diversion banks to enter.

Waterways are generally designed to cater for a 1 in 10 year rainfall event. The design of Constructed waterways includes:

- a flat base of a minimum width of three metres
- a minimum depth of 25-30cm
- side batters of 3:1 or flatter grade to allow water from diversion banks to spill into the waterway without eroding it.
- topsoil saved and replacement after construction to ensure successful revegetation.
- prompt vegetative stabilisation all exposed soil surfaces associated with waterways

Constructed waterways should be grassed immediately and before use (ie. having water directed into them by the Diversion Banks) to avoid erosion of the waterway.

Figure 6-6 Design detail of a Constructed Waterway

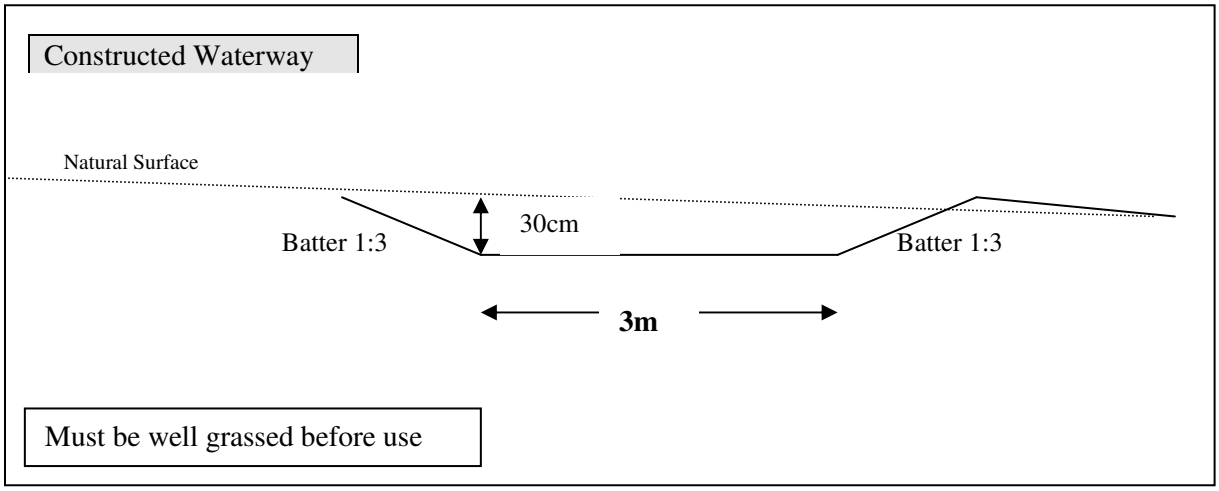


Table 6-3 Estimated Construction Cost For 150m Of Constructed Waterway Using A D7 Size Bulldozer As At 2005

Topsoil not stripped		**Topsoil completely stripped & respread**	
footprint	5.0m	***footprint***	5.0m
non plant zone	all	***non plant zone***	all
No. of pushes	2	***No. of pushes***	3
time	3hrs	***time***	4hrs
length	150m	***length***	150m
Cost/metre	$3.50/m	***cost/metre***	$4.60/m

Figure 6-7 Photograph of constructed waterway/irrigator run

Waterways constructed up and down the slope and parallel to one another can double as irrigator pathways (Figure 5.6). This technique means there are no barriers to irrigator travel and no erosion down irrigator wheel marks.

For dual purpose constructed waterways and irrigator runs spacing between each waterway/run will depend on the distance of irrigator throw which varies with individual irrigators and growers' requirements. For example an irrigator throw of 38 metres. Based on this distance irrigator runs were planned 76 metres apart with every second run a waterway. This means waterways were 152 metres apart. They also provide permanent boom spray markers.

6.3. Retaining Soil in the Paddock

Minor in-crop runoff Sediment Filtration controls include grass buffer strips, rip/ridging (Dammer/Dyker) sediment fencing and Straw barriers. . These not only reduce the velocity of runoff, but have the added advantage of catching and retaining sediment in the paddock.

Fabric fencing is generally not recommended for sediment filtration in the cultivation paddock situation as their maintenance requirements are considered too high.

6.3.1 Straw Filter Barriers

Straw Filter barriers can be used both during cropping and post harvest to slow runoff and retain sediment. The straw line must be thickly and evenly spread across the paddock with no gaps.

The design of Straw Filter Barriers include:

- being placed on the contour. If placed at an angle they will divert runoff more than they will filter it. If they have low sections that dip along the contour these will fill and overtop or bust and create greater erosion
- being correctly keyed into the ground to avoid undermining by runoff (ie. to manufacturers specifications or at least 100mm deep)
- straw extending above the ground surface a minimum of 100mm

In 2005 installation of straw mulch rows were estimated to cost $80 per Ha on 10% slope to install.

Figure 6-8 Photograph of Straw Filter Barrier being installed by Straw/Ripper Mulcher

6.3.2 Grass Buffers

Grass buffers can be used both during cropping and post harvest to slow runoff and retain sediment. They are simply strips left uncultivated at no actual cost.

The design of grass buffers include:

- location across the contour
- maximum spacings of 50m
- a minimum width of 3m
- a thick prostrate grass species (eg. Kikuyu)

Grass strips are simply left during the cultivation of the paddock.

Figure 6-9 Photograph of typical in paddock Grass Buffering

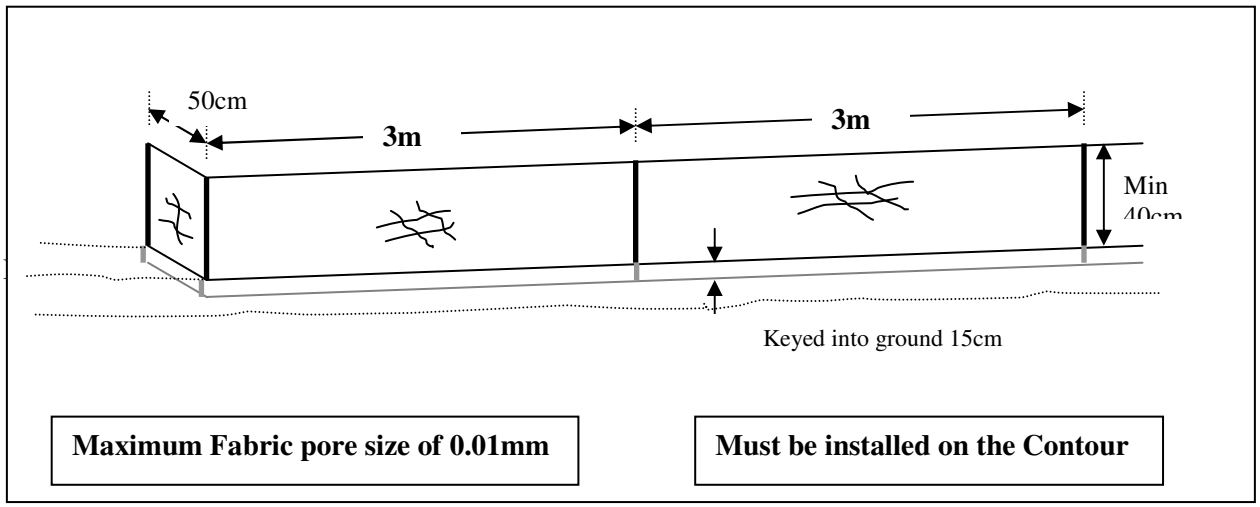
6.3.3 Sediment Filter Fabric Fencing

Sediment Filter Fabric can be used both during cropping and post harvest to slow runoff and retain sediment. The cost of implementation and maintenance generally make them impractical.

The design of sediment filter fencing includes:

- installation along the contour
- maximum spacings of 50m
- correct keying into the ground to avoid undermining by runoff (ie. to manufacturers specifications or at least 100mm deep)
- supported by stakes every 3m

Figure 6-10 Design for installation of Fabric Filter Fencing



As the use of filter fencing has not been identified in cultivation on the Plateau, Illustration and costs are not available at this time.

6.3.4 Dammer/Dyker (Rip - Paddle Wheel)

A 'dammer dyker' basin tillage implement can be mounted on the same 3-point linkage tool frame behind hillers and rippers. After planting potatoes, three 'soil friendly' operations can be achieved with one pass of the tractor. The rippers break compaction pans under the wheel ruts, soil is "hilled" and small ponds made by the basin tillage reduce runoff. The result is improved infiltration of water along the wheel ruts and a saving in machinery operation cost and time.

Figure 6-11 Photograph of typical in-paddock Dammer/Dyker

In 2005 installation of Dammer/Dyker was estimated to cost $65.00 per Ha on slopes up to 10% to install and up to $100.00 per Ha on steeper slopes.

6.4. Managing the Off-Paddock Movement of Soil

Measures for the control of the off-paddock movement of soil can include sediment dams and Sediment Filter Fabric fencing.

6.4.1 Sediment dams

Sediment dams can be either:

- a level (not diversion) "peak bank" with it's ends blocked off at an appropriate height across the bottom of the paddock for the paddocks entire width.
- an excavated dam with a water storage capacity of 250 cubic meters (10m x 25m x 1m deep) per hectare of contributing catchment

Both types of sediment dams must have:

- a stable area for bywash/overflow
- establishment of grass on external batter surfaces

Figure 6-12 Photograph of Sediment Trap Bank below cultivation

The cost of sediment trap banks will be similar to the cost for Peak Banks.

6.4.2 Sediment Filter Fabric Fencing

Sediment Filter Fabric fencing (refer to section x) is only to be used on slopes of up to 5%.

6.4.3 Grass Buffers

Grass buffers (refer to section x) are also encouraged to compliment sediment dams and filter fabric fencing at the lower end of the paddock. The design of off-paddock soil retention grass buffers include:

- can only be used on slopes up to 5%
- a minimum width of 20m
- a thick prostrate grass species (eg. Kikuyu)

Figure 6-13 Photograph of grassed buffer below cultivation

Re-establishment of riparian vegetation will also maintain stream stability and ecosystems

SECTION 7

7.0 OPERATING PRACTICES FOR SOIL HEALTH

Extracts from: ColClarke B, 1993- Dorrigo Potato Lands - Potato Growers' Handbook for Erosion Control - DIPNR. **(Refer to document for more comprehensive detail)**

7.1. Maintain soil structure and Soil Fertility

Avoid unnecessary compaction and trafficking. Keep off wet paddocks wherever possible. Compacted wheel tracks left by machinery will shed stormwater and create erosion. Remove compaction with a rigid tyne implement as soon as possible after planting. Harvesting is particularly devastating on soil structure because harvesters and trucks compact the often wet soil. Design your cropping layout so as to minimise harvesting traffic and utilise designated tracks for trucks and trailers. Provision should also be made for removal of soil from tyres - a tyre bath/pond or corrugated ramp should achieve the required results.

7.2. Reduce number and type of tillage operations

Excessive cultivation will break down soil structure, leading to compaction and soil erosion. Soil organic matter not only contains nutrients required by plants, but also binds soil particles together to form larger aggregates that give soil its structure. The problem is of course, that each cultivation encourages decomposition of organic matter and breaks up the bonding responsible for soil aggregates so each cultivation further breaks down the soil structure.

After rainfall and run-off, soil settles and is less susceptible to erosion. Each subsequent cultivation disturbs the soil and detaches soil particles. With rain, those detached soil particles are likely to combine with the water and wash into a watercourse.

Reducing the number of cultivation operations will benefit soil structure and reduce soil erosion. Consider using herbicides (or ideally natural protection/practices) for weed control in the growing crop in preference to scuffling with machinery. Consider using herbicides to reduce tillage operations in ground preparation for autumn potatoes. (***See full document for information on herbicide use***).

Machines that 'hill and plant' in one operation will reduce the number of soil workings and allow soil to settle and develop a ground cover of grass and weeds. Decaying weeds will provide mulch on the ground to provide protection against rain and storm run-off.

Less pulverising and deeper working machinery, such as mouldboard ploughs, can increase seedbed depth and reduce the number of cultivations and hence physical damage to soil structure. Avoid unnecessarily fine seedbeds caused by overworking and harrowing when pasture follows potatoes.

7.3. Use cover crops and green 'manure' crops

Quick-growing cover crops will increase infiltration, decrease run-off (and associated soil and fertiliser loss) and protect the bare ground against rainfall impact.

Immediately after harvest, deep-rip bare ground across the slope and establish protective ground cover. Deep-ripping and cover crops should be regarded as part of the harvesting schedule (particularly for spring potatoes) because the bare, broken-up post-harvest ground coincides with peak rainfall activity, Jan/Feb.

Green manure crops planted in summer and autumn (Dorrigo) have the potential to maintain organic matter levels in (potato) paddocks under conditions of continuous cultivation. This in turn should result in maintenance of soil structure, conservation of nutrients, less erosion and better (potato) crops. High organic matter levels will mean less 'clods' for mechanical harvesters to contend with. (***See full document for suggested timing, species and sowing rates***).

7.4. Paddock Cultivation Cycles

Crop rotation and ley phases increase organic matter and improving soil structure, enable a healthy and diverse soil biota and reduce soil pathogens.

General Time line for the cultivation activities in Potato crops on the Dorrigo Plateau

	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June
Early Spring crop	Commence cultivation	Cultivation	Plant from 2nd week	No cult	Cultivation and top dressing	No cult	Harvest from 15th Dec/sow cover crop	Harvest/ sow cover crop		Cultivation and sow pasture	Cultivation and sow pasture		
Late Spring crop			Commence cultivation	Cult	Plant	No cult	Cultivation and top dressing	No cult	Harvest/ sow pasture	Harvest/sow pasture	Harvest/sow pasture		
Autumn Crop							Cultivate	Cultivate/ Plant	Plant	Cult and top dressing late March/early April	Cult and top dressing late March/early April		Harvest -Paddock may lay bare until pasture or cover crop sowing in Summer

Note. Double cropping can occur with two crops grown in a 12 month period. That is a Spring crop can follow an Autumn crop or an Autumn crop can follow an Early Spring crop.

The inter row area has no cover until approx 2 weeks after the cultivation and top dressing operation. This cover is thick until approximately 2 weeks prior to harvest when it will be either sprayed off, mulched or frosted.

Appendix 1 - Potato Growers comments on the "Code of Practice and Guidelines - Final Draft" and NRCMA responses, 14th Sept 05.

COMMENT	*RESPONSE*
1. The design of the diversion banks should be to have a flat base in the channel rather than curved so the water is less likely to cut a groove in the channel.	Some farmers prefer a curved base to enable machinery to cross over more easily. Both are acceptable and grooves are likely to occur in both after high flow events unless grass is established.
2. The Code should include outlying districts such as Tyringham, Ebor etc and should cover all soil types in this area.	1. The priority landscape upon which the Dorrigo Land Management project is based is Volcanic 2. Incorporating such information would detract from the simplistic nature of the document. Controls are likely to be much the same on these soils however it is considered better to double check. Provision is made in section 1.3 – Application, *(ie. A qualified soil conservationist should be consulted in regard to management of these soils)*
3. Diversion banks should be no greater than 1% grade	The recommended grades are between 1-2%. Some farmers prefer the 2% grade to reduce the potential maintenance costs associated with removing sediment from the channel to maintain it's design capacity. The Bare earth channels (as designed in the COP) are capable of conveying runoff safely at 2%. The purpose of the channels is not to trap sediment (although trapping sediment at any stage is desirable) but to transfer runoff to appropriate sediment traps.
4. Soils on leased paddocks which are cropped on a much less frequent basis should be subject to lesser control measures due to them having better structure and higher organic matter.	Cultivation on any paddock/soil will result in very high soil erodibility potential regardless of it's pre cultivation condition. The controls outlined are the minimum standard required already. We should be thinking about doing even more where we can (eg. wider buffer strips near streams, closer bank spacings to minimise erosion)
5. Bank spacings should be measured to suit individual paddocks and not be on a set minimum spacing.	Bank spacings are designed based on slope. They are set on maximum permissible spacing. Allowance is made however, Refer to 4.3.2 *(ie. Variation to the design of measures identified in Section 6 must be accompanied by a plan certified by a suitably qualified Soil Conservation Officer).*
6. The document should be reviewed on a regular basis and not taken as "law" at this stage.	Noted and added to section 1.4 *(ie. This document is a living document and can be updated where justified. The document is also available for an annual review by the Dorrigo Potato Growers Group*). This is not a legal document. It is a Code of Practice. It is the local industries agreed way of managing cultivation land. However implementation of these standards can be seen as due diligence in the eyes of local compliance.
7. Bank spacings should be increased on gentle slopes to allow for more efficient use of large harvesting machinery.	There has been much debate over bank spacings. Theory would suggest that the proposed spacings are already above the recommendation. Discussions with farmers also indicate that at least 150m bank spacings are required to operate efficiently. Lower slopes already allow 200m spacings.