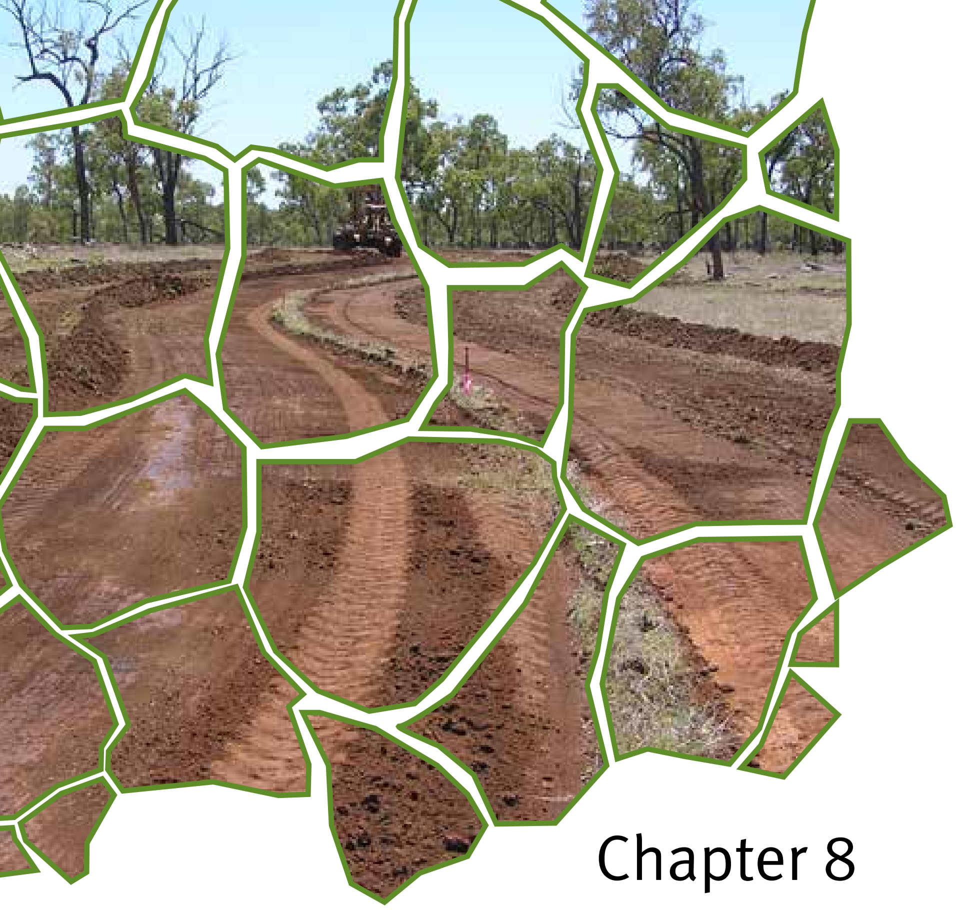


Chapter 8

Diversion banks

Key points

- Diversion banks are used to direct runoff around and away from areas where it could cause problems (such as cultivated paddocks) to areas where it can safely be disposed of, such as stable waterways or water storages.
- Diversion banks are usually designed for an average recurrence interval (ARI) of 20 years. Where the failure of a diversion bank would have serious consequences a higher standard, for example, an ARI of 50 years may be warranted.
- Diversion banks are usually constructed with a triangular cross-section. When designing diversion banks the same formula is used as for other waterways (incorporating channel slope and dimensions, rainfall, and catchment conditions), with the objective being to keep the average maximum velocity under the design conditions below a level that would cause erosion.
- Diversion bank channel and batters should be stabilised with vegetation as soon as possible after construction and kept permanently grassed thereafter.

Contents

Diversion banks should be constructed with a broad base wherever possible and revegetated quickly following construction to reduce erosion risk. Terry Creek Gully (Collinsville) reclamation project—this page October 2010, opposite page November 2011
Photos: Science Division © Queensland Government

Glossary

ARI (average recurrence interval): the average period in years between the occurrence of an event (usually a storm or a flood) of specified magnitude and an event of equal or greater magnitude.

Manning coefficient of roughness: a measure of resistance to flow in a channel; the more the resistance the higher the retardance. It is calculated using the Manning formula and has the symbol 'n'. Retardance is influenced by the physical roughness of the internal surface of the channel (e.g. the vegetation that lines it), channel cross-section, alignment, and obstructions.

wetted perimeter: the length of the boundary wetted by flow in a channel or pipe at a specified section, measured along a plane at right angles to the direction of flow.

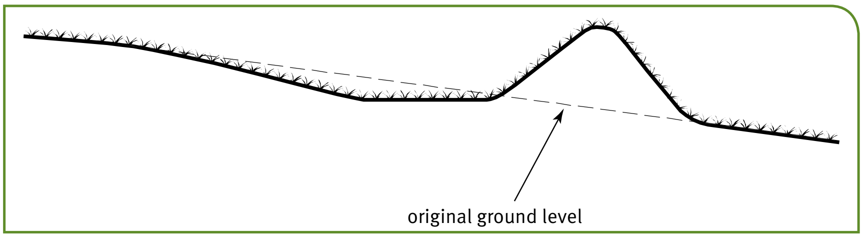
8.1 Introduction

Diversion banks divert runoff away from cultivation or buildings into stable waterways, natural depressions or water storages. They are usually constructed using a bulldozer to a height of at least one metre. Diversion banks are similar in many respects to perched waterways (refer to Chapter 9).

Diversion banks are typically used as follows:

- as the top interception bank in a paddock with contour banks
- in strategic locations within cultivated paddocks where they may be required to carry more runoff than a normal contour bank
- to divert runoff away from unstable areas (this option is only viable if there is a suitable disposal area for the runoff)
- to collect runoff from cross-road drainage points and direct it to a waterway
- to collect runoff from small constructed, or natural, waterways and divert it into a larger waterway.

Figure 8.1: Diversion bank cross-section



8.2 Diversion bank cross-sections

Diversion banks usually have a trapezoidal shape as shown in Figure 8.1. The excavated batter slope of trapezoidal diversion banks will increase as land slope increases and will be at risk from erosion until it is stabilised with vegetation.

On slopes greater than 2%, runoff will usually be contained entirely within the excavation. However, on slopes of less than 2%, diversion bank cross-sections may approximate a triangular shape where the upstream batter conforms to normal land slope. In such cases, the storage capacity of the structure will extend up-slope depending on the slope of the land.

8.3 Diversion bank gradients

There is considerable scope for varying the gradients of diversion banks provided they have grassed channels. When constructed as the top bank of a contour bank system, a gradient that is slightly steeper than contour bank gradient would normally be used. Most diversion banks above contour bank systems have gradients of around 0.5%. This means that the diversion bank tends to follow the same direction as the contour bank below it, resulting in a contour bay that is reasonably easy to work.

Because the channel of a diversion bank is grassed, gradients greater than 0.5% can be used. In horticultural situations it is common for diversion banks to have gradients from 1% to 3%. In such circumstances the diversion bank virtually becomes a perched waterway (see Chapter 9).

8.4 Stabilising diversion banks

It is desirable that the diversion bank channel and batters should be stabilised with vegetation as soon as possible after construction. Annual species such as millet (summer) or oats (winter) are suitable for providing rapid, temporary protection from erosion until perennial species become established. Species recommended for long-term stabilisation are listed in the appendices. Any pasture species suited to the local area can be used. If gradients exceed 0.5% and the diversion bank becomes a perched waterway then erosion-resistant species as recommended for waterways should be used.

8.5 Diversion bank freeboard and settlement

Refer to Chapter 6 section 6.5 for information about this topic.

8.6 Design approach for diversion banks

Equation 8.1

$$\frac{Q}{A} = V = \frac{R^{0.66} S^{0.5}}{n}$$

Where

Q = the discharge or hydraulic capacity of the channel (m^3/s)

A = cross-sectional area (m^2)

V = average velocity (m/s)

R = hydraulic radius (m)

S = channel slope (m/m)

n = Manning coefficient of roughness

As in the design of contour banks and waterways the the formula expressed in Equation 8.1 applies.

In estimating the design discharge, consideration should be given to the consequences of the diversion bank failing. A diversion bank would ordinarily be designed for an average recurrence interval (ARI) of 20 years; however, where the failure of a diversion bank would have serious consequences, its design should be to a higher standard, for example, an ARI of 50 years.

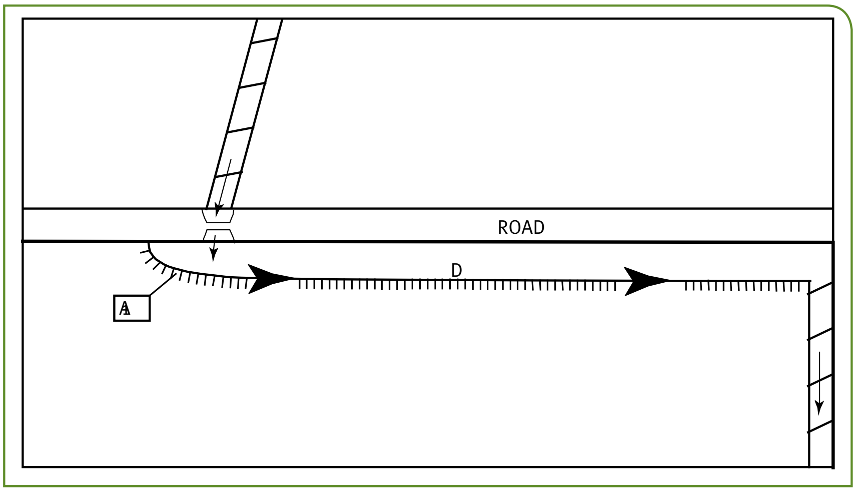
If the channel is grassed, then it is appropriate to apply the nVR relationship rather than using a fixed n value (refer to Chapter 6).

The approach to designing a diversion bank varies depending on the slope of the channel and whether it is grassed or cultivated. There are three possible scenarios:

- slopes greater than 2% with a grassed channel
- slopes less than 2% with a grassed channel
- bare, cultivated channel
- bare, consolidated channel.

Where a diversion bank intercepts runoff from a concentrated flow such as the discharge from a road culvert, additional capacity should be provided at the point of receival (design point A in Figure 8.2). As a general guide, in such situations the bank should be an additional 0.3 metres higher than along the rest of its length.

Figure 8.2: Diversion bank receiving runoff below a road culvert



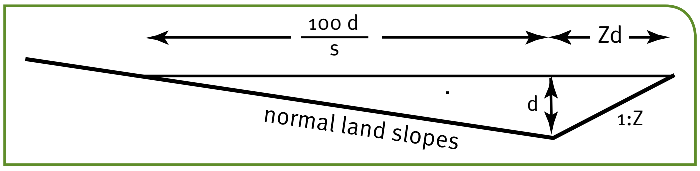
8.6.1 Slopes greater than 2%

Where land slopes exceed 2% and most of the runoff will be contained in the excavated channel of the diversion bank, the design of the diversion bank can be considered to be the same as that used for designing a waterway (see Chapter 9). As the slope of the bank batter and that of the excavated batter are likely to differ, an average of the two should be chosen for use in the design exercise.

8.6.2 Slopes less than 2%

Where land slopes are less than 2%, diversion bank cross-sections may be approximated to a triangular shape where the upstream batter conforms to normal land slope (Figure 8.3).

Figure 8.3: Diversion bank cross-section on a land slope below 2%



Equation 8.2

$$A = \frac{d^2(100/s + z)}{2}$$

Where

A = cross-sectional area (m²)
d = depth of flow (m)
s = land slope (%)
Z = horizontal width of bank batter (m)

Equation 8.3

P= d (100/s + z)

Where

A = cross-sectional area (m²)
P = wetted perimeter (m)
d = depth of flow (m)
s = land slope (%)
z = bank batter (1:Z) (V:H)

The formula used for the cross-section of such a channel is expressed in Equation 8.2.

The formula expressed in Equation 8.3 gives an adequate approximation of the wetted perimeter.

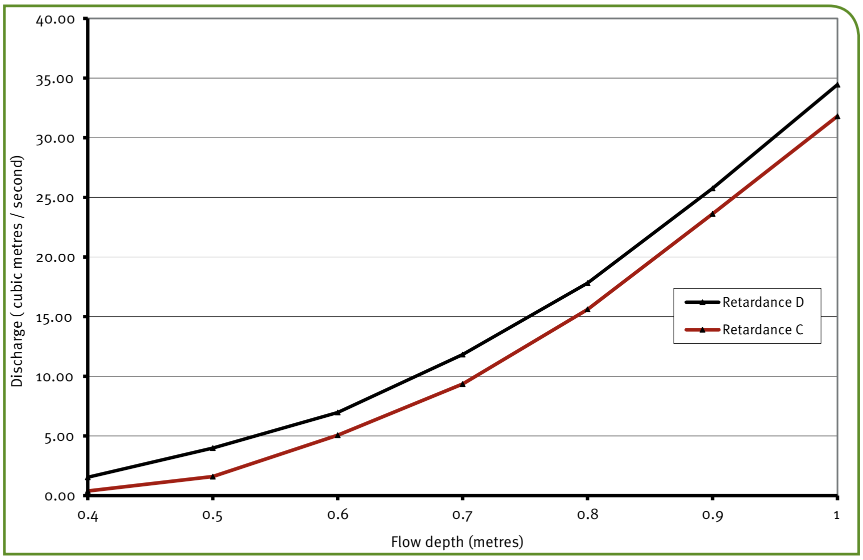
To assist in designing diversion banks, a spreadsheet can be prepared in a similar manner to the approach used in contour bank design (see Chapter 7). Table 8.1 is an example of such a table based on a triangular cross-section, a bank batter of 1:3, an up-slope batter that conforms to the land slope of 2%, and a channel gradient of 0.5%.

Table 8.1: Example of a spreadsheet prepared for diversion bank design

Depth of flow (m)	Cross-sectional area (m²)	Wetted perimeter (m)	Hydraulic radius (m)	Retardance C		Retardance D	
				Velocity m/s	Flow m³/s	Velocity m/s	Flow m³/s
0.3	2.4	15.9	0.15	na	na	0.18	0.43
0.4	4.2	21.2	0.20	0.09	0.38	0.36	1.53
0.5	6.6	26.5	0.25	0.24	1.59	0.63	4.17
0.6	9.5	31.8	0.30	0.53	5.06	0.73	6.96
0.7	13.0	37.1	0.35	0.72	9.35	0.94	12.21
0.8	17.0	42.4	0.40	0.90	15.26	1.00	16.96
0.9	21.5	47.7	0.45	1.10	23.61	1.20	25.76
1.0	26.5	53.0	0.50	1.20	31.80	1.30	34.45

Parameters:
Triangular cross-section
Bank batter 1:3
Land slope 2% (upper batter conforms with land slope)
Gradient 0.5%
Velocities obtained from charts for the solution to the Manning formula

Figure 8.4 is a graphical version of the relationship from which Table 8.1 is derived



8.6.3 Diversion banks with cultivated channels

If a diversion bank within a cultivated area is to have a channel that is cultivated as part of the cropping cycle, then it is virtually a large contour bank. In such situations, the information provided in Chapter 7 can be used for design guidance.

8.6.4 Diversion banks with bare, consolidated channels, not cultivated

In this situation, the approach would be to prepare a spreadsheet similar to Table 8.1 except that the value for Manning's n would be a constant value of 0.02.

8.7 Further information

Alt, S, Jenkins, A, and Lines-Kelly R (2009) *Saving soil—A landholder's guide to preventing and repairing soil erosion*, published by Northern Rivers Catchment Management Authority and Department of Primary Industries, State of New South Wales.

Queensland Department of Environment and Resource Management fact sheet: *Run-off control measures for erosion control in cropping land* (refer to the DERM fact sheets on the Queensland Government website ‹qld.gov.au/environment/land/soil/erosion/management›.