

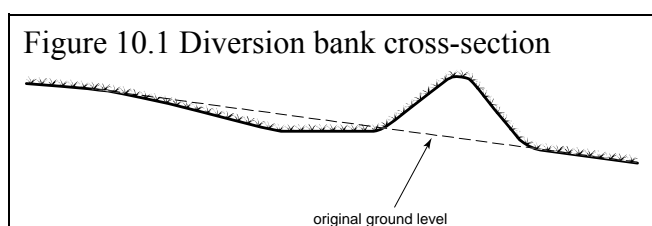
Chapter 10

Diversion banks

Diversion banks (Figure 10.1) 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 1 metre. Diversion banks are similar in many respects to perched waterways (refer to Chapter 11, *Waterways*). Where the failure of a diversion bank would have serious consequences, its design should be based on an increased ARI eg. 20 to 50 years.

Typical uses for diversion banks are as follows:

- above contour bank systems to intercept runoff from areas above cropping land
- 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.



10.1 Cross-sections

Diversion banks usually have a trapezoidal shape as shown in Figure 10.1. On slopes of above 2%, runoff will usually be contained entirely within the excavation. The excavated batter slope will increase as land slope increases and will be at risk from erosion until it is stabilised with vegetation.

However, on slopes of less than 2%, diversion bank cross-sections may approximate to 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.

10.2 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 is grassed, gradients higher 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.

10.3 Stabilisation

It is desirable that the diversion bank channel and batters should be stabilised with vegetation as soon as possible after construction. Species used for stabilising waterways or 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.

Annual species such as millet (summer) or oats (winter) are suitable for providing rapid, temporary protection from erosion until perennial species become established.

10.4 Freeboard and settlement

Refer to the section on freeboard and settlement in Chapter 8 for information about this topic.

10.5 Design approach

As in the design of contour banks and waterways the following formula needs to be considered:

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

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. |

In estimating the design discharge, consideration should be given to the consequences of the diversion bank failing. It may be appropriate to design a diversion bank for an ARI as high as 50 years or even higher if the circumstances permit (refer to Chapter 4, *Designing for risk*).

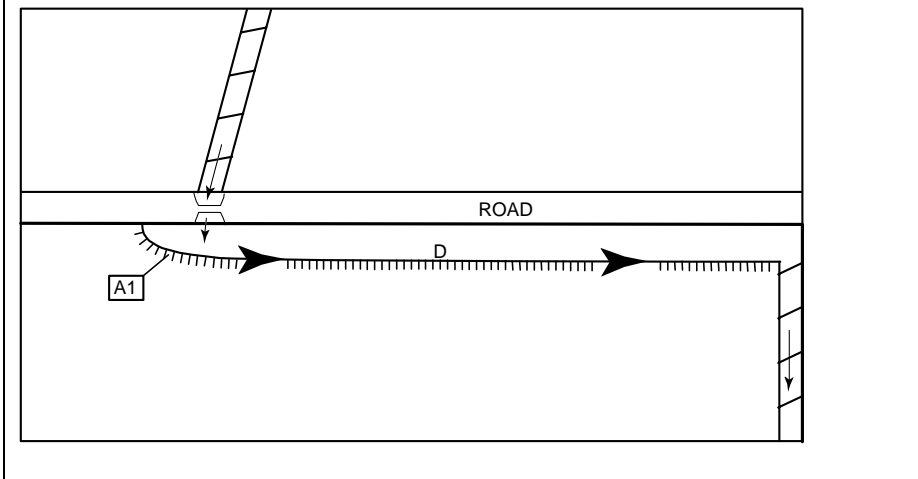
If the channel is grassed, then it is appropriate to apply the n-VR relationship rather than using a fixed n value (refer to Chapter 8, *Channel design principles*).

The approach to designing a diversion bank will vary with the following situations:

- slopes exceeding 2% (grassed channel)
- slopes less than 1% (grassed channel)
- cultivated 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 receipt (Design point A1 in Figure 10.2). An additional bank height of 0.3 metres is provided as a general guide in such situations.

Figure 10.2 Diversion bank receiving runoff below a road culvert



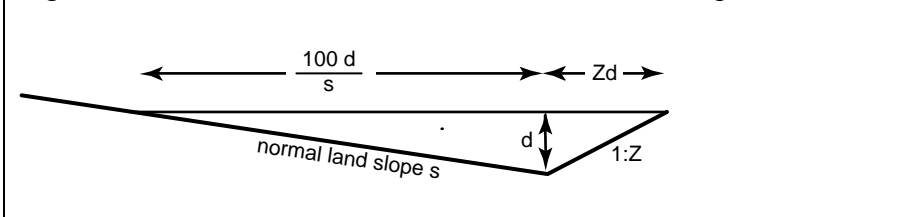
10.51 Slopes exceeding 2%

Where 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 and Chapter 11 should be referred to. As the batter slopes on the bank and on the excavated slope are likely to differ, an average slope can be chosen and used in the design exercise.

10.52 Slopes less than 2%

Where slopes are less than 2%, diversion bank cross-sections may approximate to a triangular shape where the upstream batter conforms to normal land slope (Figure 10.3).

Figure 10.3 Diversion bank cross-section on a land slope below 2%



The formula used for the cross-section of such a channel is as follows:

$$A = \frac{d^2(100/s + z)}{2} \dots\dots\dots \text{Equation 10.1}$$

The following formula is used to obtain an adequate approximation of the wetted perimeter:

$$P = d(100/s + z) \dots\dots\dots \text{Equation 10.2}$$

Where

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

To assist with design, a spreadsheet can be prepared in a similar manner to the approach used in contour bank design. Table 10.1 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 gradient of 0.5%.

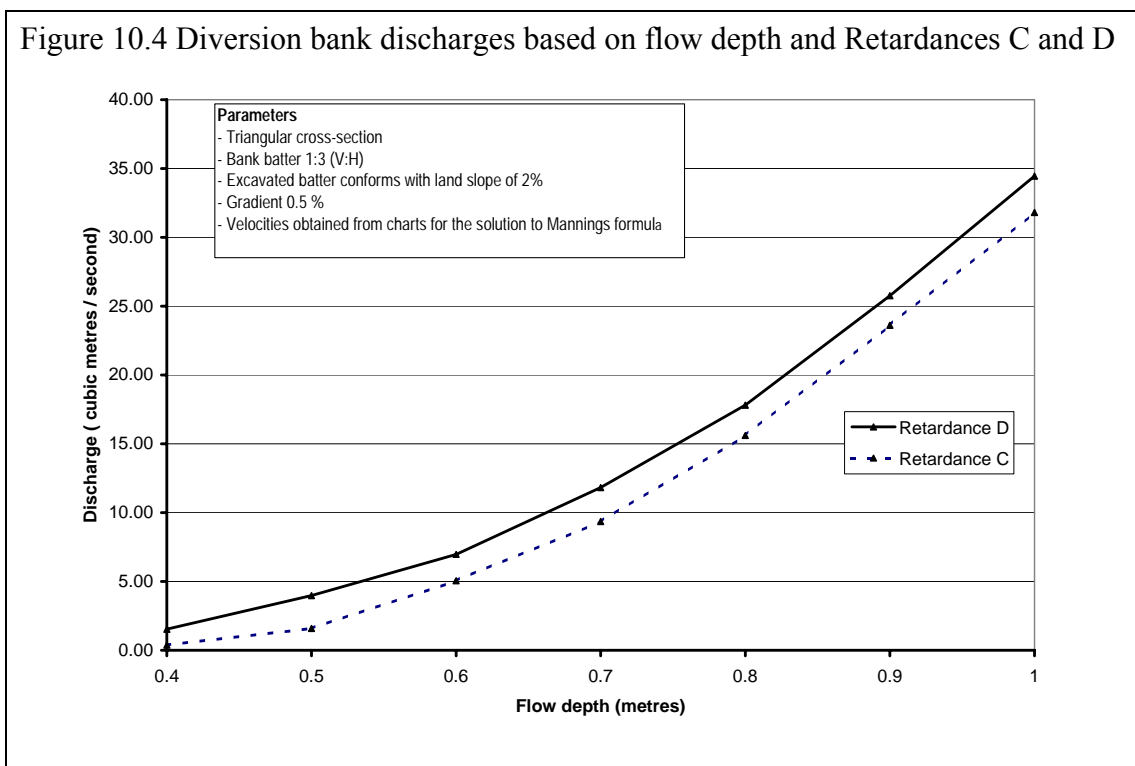
| Depth of flow (m) | Cross sectional area (m ²) | Wetted perimeter (m) | Hydraulic radius (m) | Retardance C | | Retardance D | |
|-------------------|--|----------------------|----------------------|--------------|------------------------|--------------|------------------------|
| | | | | Velocity m/s | Flow m ³ /s | Velocity m/s | Flow m ³ /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 (eg. Figure 8.4)

The results obtained in Table 10.1 are shown graphically in Figure 10.4



10.53 Diversion banks with cultivated channels

If a diversion bank within a cultivated area was to have a channel that was cultivated as part of the cropping cycle, then it is virtually a large contour bank. In such situations, Chapter 9, *Contour banks* should be referred to in relation to their design. ■