2 Key design assumptions

In preparing this guideline, a number of decisions and assumptions had to be made. These decisions influence the design standard of the measures included in sections 6-10 and are summarised below. These assumptions are included in more detail in Appendix A, with the aim of ensuring technical transparency and promoting robust critique and, if necessary, assisting the future revision of the guideline.

2.1 Best practicable option (BPO) approach

This guideline takes a best practicable option (BPO) approach to the management of erosion and sediment control. In relation to a discharge of a contaminant (among other things), BPO means the best way of preventing or minimising the adverse effects on the environment having regard, among other things, to:

- the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects;
- the financial implications, and the effects on the environment of that option when compared with other options; and
- the current state of technical knowledge and the likelihood that the option can be successfully applied.

The use of a BPO approach does not remove the responsibility of those carrying out activities to comply with the relevant policies and rules set out in regional and/or district plans and, where applicable, resource consents. Rather, it is critical that compliance with the discharge and water quality standards set out in the Regional Plans should be the foremost consideration in the BPO approach to erosion and sediment control.

2.2 Design storms

To maximise the effectiveness of the BPO approach, a robust design storm is needed. The most widely used design storms for erosion and sediment control in New Zealand are the 20 percent and 5 percent annual exceedance probability (AEP) (or 5 and 20-year return period) storms. Disproportionately more sediment is generated by the larger storms, and this is why the larger but more infrequent storm event is often used.

While much of Canterbury has lower rainfalls than other regions, some Canterbury soils, especially loess soils on steep slopes, are highly vulnerable to erosion. This makes it prudent to use the 20-year storm for runoff control practices and the 50-year storm for secondary overflow design.

Rainfall information from the 2003 Christchurch City Council Waterways Manual (CCC, 2003) has been used in the preparation of this guideline because it contains the best available representative rainfall data for some of the main areas currently undergoing rapid development in Canterbury.

Beyond Christchurch City, users of this guideline are encouraged to recalculate the design storms using more detailed local rainfall information, if available, in consultation with Environment Canterbury staff. Such local rainfall data may be available from:

- Environment Canterbury;
- the relevant city or district council; and/or
- the report on the frequency of high intensity rainfall events in Christchurch (Pearson, 1992).

If local data is not available, the following sources are recommended:

- for Christchurch, the Port Hills and Banks Peninsula apply as a minimum the rainfall intensities and methods specified in the Christchurch City Council (CCC) Waterways, Wetlands Drainage Guide (CCC 2003) based on the Pearson study (1992);
- for Christchurch's surrounding environments south of the Waimakariri River, those parts of the Selwyn District Council out to and including Rolleston, Lincoln and Taitapu as a minimum use the Pearson study (1992), as rainfall data in these areas were included in the study;
- for the Timaru District, apply the local study carried out by Opus (1999) for the Timaru District Council;
- for areas of Canterbury outside that specified above, where local studies have not been undertaken or no appropriate information is available, e.g. local rainfall data, the latest version of HIRDS can be used.

Runoff flow rates

The 20-year (5 percent AEP) rainfall event is used in the design of the run-on control and drainage diversion and conveyance structures described in section 6.3 (Water management – concentrated water flows). This is a conservative approach to environmental protection.

Secondary overflow

The 50-year, 10-minute rainfall event has been used to design sediment retention pond spillways, as a precautionary approach to managing health and safety.

Storage

A smaller design storm has been used for sediment control measures that retain water for treatment, such as ponds and decanting earth bunds. This is in order to achieve a realistic balance between minimising the risk to the environment and the size and expense of control measures. A comparative analysis was undertaken with the pond sizing criteria used in Auckland, because there is information available on pond effectiveness in that region. On the basis of this and local experience, the 10-hour twenty percent AEP (five-year) storm has been selected by Canterbury earthworks industry representatives and Environment Canterbury as the basis on which to size sediment retention ponds. While still being a conservative approach, the result is that smaller ponds than those used in Auckland are possible in most places around Canterbury.

Appendix A2 has more information about the design storm selected for sizing sediment retention ponds.

Site-specific assessment

The design storms used above may not be appropriate for all areas and may not ensure mitigation of all adverse effects at all sites. A site-specific assessment of environmental effects must be carried out for every site and it may sometimes be appropriate to recalculate design storms on a case-by-case basis, especially where accurate long-term local rainfall information is available.

2.3 Focus on a core of robust erosion and sediment control practices

This guideline aims to be a user-friendly resource for those designing erosion and sediment control plans and those using the practices on the ground. It is not a definitive compendium of all possible practices, but a toolbox of tried and tested practices that will work well for earthworks in the Canterbury region. The practices included in sections 6–10 give practitioners a lot of choices from which to select a series that will meet the particular characteristics of a wide range of sites.

The guideline includes some newer techniques not commonly used elsewhere in New Zealand, such as bonded fibre matrices (BFMs) and erosion and sediment control blankets, that may have particular application to Canterbury.

This guideline does not include:

- chemical treatment systems, pending demonstration of a requirement for their use in the context of Canterbury's soils and effects on receiving environments; and
- a number of commercially available proprietary products, because their inclusion could quickly outdate the guideline as new products are developed, and the efficiency of some products is yet to be verified.

This should not deter people from using products and measures that are deemed reliable in performing to a standard acceptable to Environment Canterbury and the relevant territorial authority.

This document is a guideline – not a rule book. Each site is different and section 5 aims to help practitioners mix and match a range of practices to suit individual site needs. This guideline encourages practitioners to recognise the different range of land types in Canterbury and understand the design capabilities of different erosion and sediment control measures, while also encouraging them to develop flexible and innovative solutions to their development.

2.4 Defining slope in percent, ratios and degrees

This guideline targets engineers who are designing and contractors who are building the erosion and sediment control practices described in Part B. Amongst engineers involved in the earthworks industry, the convention for defining slope is that:

- the general slope of landforms is expressed in percent;
- the angle of contour drains and other water-conveying structures is expressed in percent;
- constructed slopes such as cut or fill slopes are expressed as ratios h:v, such that a 4:1 slope means that for every 4 units of horizontal distance there is 1 unit of vertical change either up or down.

This guideline follows that convention. Table 2.1 shows how the conventions relate to each other.

Table 2.1 Conversion between different slope measures

Source: Forest Industries Training, 2000

%	Grade (h:1v)	Degrees		%	Grade (h:1v)	Degrees
2	50:1	1		49	2.0:1	26
3	33	2		51	2.0	27
5	20	3		53	1.9	28
7	14	4		55	1.8	29
9	11.1	5		58	1.7	30
11	9.1	6		60	1.7	31
12	8.3	7		62	1.6	32
14	7.1	8		65	1.5	33
16	6.3	9		67	1.5	34
18	5.6	10		70	1.4	35
19	5.3	11		73	1.4	36
21	4.8	12		75	1.3	37
23	4.3	13		78	1.3	38
25	4.0	14		81	1.2	39
27	3.7	15		84	1.2	40
29	3.4	16		87	1.1	41
31	3.2	17		90	1.1	42
32	3.1	18		93	1.1	43
34	2.9	19		97	1.0	44
36	2.8	20		100	1.0	45
38	2.6	21		104	1.0	46
40	2.5	22		107	0.9	47
42	2.4	23		111	0.9	48
45	2.2	24		115	0.9	49
47	2.1	25		119	0.9	50

2.5 Effectiveness of erosion and sediment control practices

If correctly deployed as indicated in Parts B and C, the BPO practices in this guideline will make a significant contribution towards the goal of reducing the adverse environmental effects of earthworks. The practices themselves have been selected on the basis of their ability to provide solutions on sites with a range of constraints (for example, for small as well as large catchment areas) and their relevance to Canterbury, as well as cost-effectiveness.

The actual effectiveness of practices on a given site will depend on how appropriately they are initially selected, how well they are put together in the context of an integrated erosion and sediment control plan, and how well they are built and maintained. If all of these aspects are done well, all the measures in this guideline will achieve a moderate to high effectiveness. If any of these aspects are poorly done, then their effectiveness will be low, and in extreme cases they could cause erosion and land instability if they concentrate flows without managing them well.

In specific terms, the effectiveness of sediment control practices can only be evaluated by field trials. Environment Canterbury will be verifying the effectiveness of selected measures for Canterbury as part of its erosion and sediment control programme. Table 2.2 sets out known information for some key practices, but it should be noted that results are highly dependent on soil types, slope gradient, slope length and rainfall patterns, and may not be directly transferable to the Canterbury region.

In general terms, the prevention of erosion is the most cost-effective environmental control, so the effectiveness of well planned, constructed and maintained erosion control practices is likely to be very high for events within the design limitations specified.

Table 2.2 Effectiveness of erosion and sediment control practices

Practice	Effectiveness	Source and comments
Dust control (section 6.1.2)		Institution of Engineers, Australia, 1996): Covering 30% of the soil surface with non-erodible material will reduce soil losses by 80%.
Surface protection (section 6.2)	65-99%	Centre for Watershed Protection (1997) USA data (Portland, Oregon and Washington). Lists the results of a number of trials on gravels to clay for straw, fibre mulch, wood fibre, jute, synthetic geotextiles and debris/leaf compost.
Vegetative filter strip (section 7.1.1)	56–95%	Leeds et al (no date, assumed to be 1994). USA data studies of reducing sediment and nutrients in sheet flow runoff from cropland (not earthworks sites). The results indicate that filter strips are somewhat to very effective in removing sediment from runoff, depending on soil characteristics, slope, rainfall and runoff conditions, and filter width. One study using a filter width greater than eight feet (2.44m) showed very little increase in effectiveness, at least for those study conditions. Another indicated no improvement in filter effectiveness beyond a thirty-foot (9.15m) filter width. The effectiveness of vegetative buffer strips will be dependent upon the species of grasses being used and their consequent growth habit, their height (e.g. mowing) and the percentage ground cover.
Sediment fence (section 7.1.3)	36 [a?]–86 [b] % 75%[c]	Centre for Watershed Protection (1997) USA data (Portland, Oregon and Washington). Lists the results of a number of trials: [a] 34% slopes [b] gravelly sandy loam [c] theoretical maximum for silty soils based on settling rates. Note that the efficiency of sediment fences will also depend upon the brand of proprietary material being used. No two products are the same and pore size/decant rate will vary considerably. See section 7.1.3.

Sediment retention pond (section 7.2.1)	75%	Winter (1999). Auckland data. Silt loam soil type. Higher efficiencies (>75%) occurred in small storms, whereas efficiencies dropped during larger storms.
Decanting earth bund (section 7.2.2)	Up to 75%	Auckland Regional Council. Trials currently under way as at 2006. Auckland data. Clay and silt loam soil types. Big range in interim results – not finalised.