Flow Diversion Banks: General

DRAINAGE CONTROL TECHNIQUE

Low Gradient	✓	Velocity Control		Short Term	✓
Steep Gradient		Channel Lining		Medium-Long Term	✓
Outlet Control		Soil Treatment		Permanent	[1]

[1] Flow diversion banks are not commonly used as permanent drainage structures.

Symbol → DB →

Photo 1 – Flow diversion bank down-slope of a future pipeline installation

Photo 2 – Flow diversion bank up-slope of a building site

Key Principles

1. Key design parameters are the effective flow capacity of the structure, and the scour resistance of the embankment material.
2. The critical operational issue is usually preventing structural damage to the embankment as a result of high velocity flows or construction traffic.
3. Flow diversion banks are often favoured over *Catch Drains* in areas containing dispersive subsoil because their construction does not require exposure of the subsoils.

Design Information

Dimensional requirements of flow diversion banks and berms vary with the type of embankment. The recommended values are outlined in Table 1.

Table 1 – Recommended dimensional requirements of flow diversion banks/berms

Parameter	Earth banks	Compost berms [1]	Sandbag berms
Height (min)	500mm	300mm (450mm)	N/A
Top width (min)	500mm [2]	100mm (100mm)	N/A
Base width (min)	2500mm [2]	600mm (900mm)	N/A
Side slope (max)	2:1 (H:V)	1:1 (H:V)	N/A
Hydraulic freeboard	150mm (300mm) [3]	100mm	50mm

[1] Values in brackets apply to berms placed across land slopes steeper than 4:1 (H:V).

[2] Top width may be reduced in non-critical situations in which overtopping will not cause excessive erosion and the banks are unlikely to experience damage from construction equipment.

[3] A minimum freeboard of 300mm applies to non-vegetated earth embankments.

Free standing earth embankments may be stabilised with rock, vegetation, or *Erosion Control Blankets*; however, unprotected topsoil embankments are also acceptable for short-term applications.

Maximum recommended spacing of flow diversion banks down long continuous slopes is provided in Table 2. The actual spacing specified for a given site may need to be less than that presented in Table 2 if the soils are highly susceptible to erosion, or if intense storm events are expected (i.e. northern parts of Australia during the wet season).

Table 2 – Maximum recommended spacing of flow diversion banks down slopes

Open Earth Slopes						Vegetated Slopes		
Slope	**Horiz.**	**Vert.**	**Slope**	**Horiz.**	**Vert.**	**Slope**	**Horiz.**	**Vert.**
1%	80m	0.9m	15%	19m	2.9m	< 10%	No maximum	
2%	60m	1.2m	20%	16m	3.2m	12%	100m	12m
4%	40m	1.6m	25%	14m	3.5m	15%	80m	12m
6%	32m	1.9m	30%	12m	3.5m	20%	55m	11m
8%	28m	2.2m	35%	10m	3.5m	25%	40m	10m
10%	25m	2.5m	40%	9m	3.5m	30%	30m	9m
12%	22m	2.6m	50%	6m	3.0m	> 36%	Case specific	

Photo 3 – Flow diversion berm used to minimise road runoff flowing down a steep, unstable section of the embankment

Photo 4 – Sandbag flow diversion berm used to minimise surface flow over a recently seeded embankment

Photo 5 – Earth flow diversion bank used to direct runoff towards the entrance of a *Slope Drain*

Photo 6 – Turf-lined flow diversion bank with grass-lined outlet chutes at regular intervals along the embankment

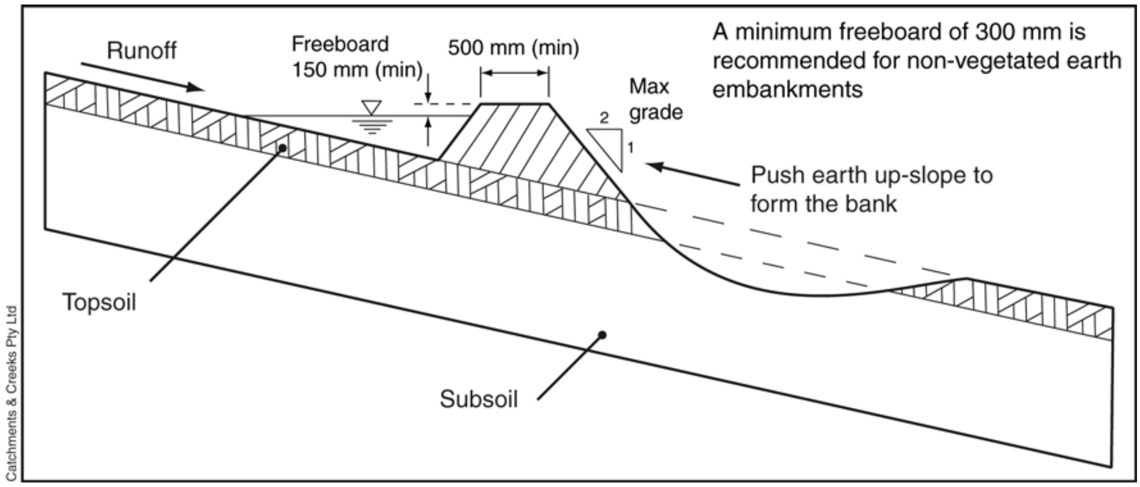
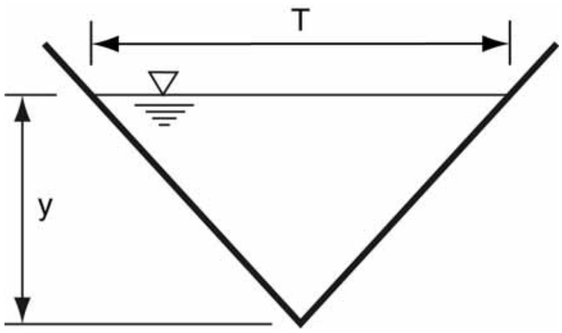
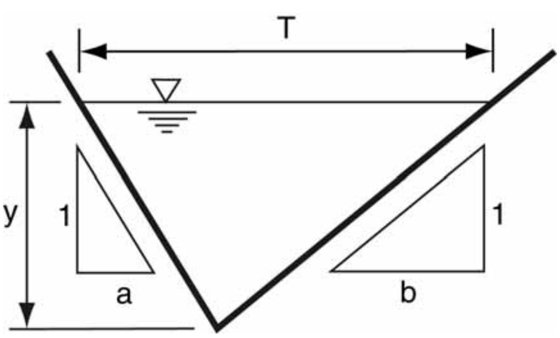


Figure 1 – Profile of “back-push” bank

The hydraulic capacity of a flow diversion bank normally needs to be assessed on a case-by-case basis; however, the associated fact sheets subtitled “On earth slope” and “On grassed slope” provide the hydraulic capacity for drains with a standard triangular profile established on earth and grassed slopes respectively.

The geometric properties of triangular drainage channels formed by the construction of a flow diversion bank are provided in Table 3.

Table 3 – Geometric properties of triangular drainage profiles

<table>
<tr><td rowspan="3">Symmetrical or asymmetric V-drain:

</td><td>Area (A):
$$A = 0.5\,T\,y$$</td></tr>
<tr><td>Wetted perimeter (P):
$$P = \sqrt{T^2 + 4y^2}$$</td></tr>
<tr><td>Hydraulics radius (R):
$$R = \frac{Ty}{2\sqrt{T^2 + 4y^2}}$$</td></tr>
<tr><td rowspan="3">Asymmetric V-drain:
where flow top width, T = y(a + b)

</td><td>Area (A):
$$A = \left(\frac{a+b}{2}\right)y^2$$</td></tr>
<tr><td>Wetted perimeter (P):
$$P = y\left[\sqrt{(1+a^2)} + \sqrt{(1+b^2)}\right]$$</td></tr>
<tr><td>Hydraulics radius (R):
$$R = \frac{0.5(a+b)y}{\sqrt{(1+a^2)} + \sqrt{(1+b^2)}}$$</td></tr>
</table>

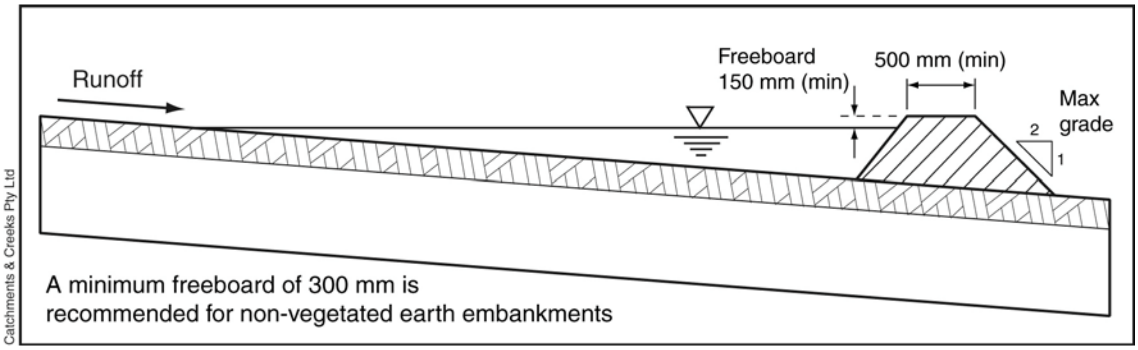


Figure 2 – Flow diversion bank formed from earth

Photo 7 – Flow diversion banks placed each side of drainage line passing through road construction site

Types of flow diversion banks:

The following provides a brief description of some of the flow diversion banks used within rural and construction land management.

Absorption bank	A level bank turned up at each end to promote water infiltration.
Back-push bank	A bank formed by moving in-situ earth up a slope.
Conventional bank	A bank formed by moving in-situ earth down thus forming an excavated drain up-slope of the bank. Also known as a "catch bank".
Diversion bank	A graded bank used to collect and divert water away from a soil disturbance, or to a dam, drainage channel, or sediment trap.
Graded bank	A bank constructed with a positive gradient to promote water movement.
Level bank	A bank constructed along a contour. Discharge usually occurs at each end of the bank.
Perimeter bank	A bank located along the upper or lower perimeter of a well-defined area, such as a building site, or along the top edge of a batter.
Trainer bank	A bank used to divert water away from unstable land.
Water-spreading bank	Banks used to collect and distribute surface runoff over an increased flow width. Typically used on low-gradient, marginal arable land.

Description

Flow diversion banks typically consist of a raised earth embankment normally placed along level or near level ground. Minor flow diversion berms can also be formed from tightly packed sandbags, or compost.

Short-term flow diversion banks can also be constructed from tightly packed straw bales. Such banks are often constructed prior to an impending storm.

The term *perimeter bank* is often used to describe an embankment constructed around the "perimeter" of a work site. These are used to either prevent clean water entering the site, or to prevent the uncontrolled release of dirty water from a site.

The term *back-push bank* is used to describe an embankment formed by pushing in-situ soils up a slope to from an earth embankment.

Purpose

Flow diversion banks and berms are used as temporary drainage systems to:

- collect sheet runoff (clean or dirty) from slopes and transport it across the slope to a stable outlet (Photo 1);
- divert up-slope runoff around a stockpile or soil disturbance (Photo 2);
- divert stormwater away from an unstable slope (Photos 3 & 4);
- direct water to the inlet of a *Chute* or *Slope Drain* (Photos 5 & 6);
- control the depth of ponding around a sediment trap such as a stormwater drop (field) inlet.

Flow diversion banks can also act as a form of topsoil stockpile. Topsoil can be stripped from a site and used to form flow diversion banks either up-slope and/or down-slope of the soil disturbance (Photo 1). Such a practice can be very space effective when conducting "strip" construction such as roadways and pipeline installation.

Limitations

Catchment area is limited by the allowable flow capacity of the diversion bank and the allowable flow velocity of the surface material.

Not used on slopes steeper than 10% (10:1).

Advantages

Quick to establish or re-establish if disturbed.

Generally inexpensive to construct and remove.

Allows for the management of stormwater flow without the need to excavate a drainage channel. This can be a significant advantage in areas that have highly erosive or dispersive subsoils.

Disadvantages

Can cause sediment problems and flow concentration if overtopped during a severe storm.

Can restrict the movement of equipment around the site.

Can be highly susceptible to damage by construction equipment.

Common Problems

Damaged by construction traffic.

Scour along the base of the embankment caused by excessive flow velocity or an unstable outlet.

Overtopping flows caused by the deposition of sediment up-slope of the bank.

Special Requirements

All flow diversion banks must have a stable outlet.

Flow diversion banks should be seeded and mulched if their working life is expected to exceed 30 days, or as required by the erosion control standard.

Banks should <u>not</u> be constructed of unstable, non-cohesive, or dispersive soil.

Location

When flow diversion banks are required and their locations are not shown on the approved plans, their location on the ground should be determined after taking into consideration the following:

- the bank must discharge to a stabilised outlet;
- the bank should drain to a sediment trap if the diverted water is expected to be contaminated with sediment;
- stormwater must not be unnaturally diverted or concentrated onto an adjacent property.

Site Inspection

Check for slumps, wheel track damage, or loss of freeboard.

Check for excessive sediment deposition.

Check for erosion along the bank.

Installation

1. Refer to approved plans for location, extent, and construction details. If there are questions or problems with the location, extent, or method of installation, contact the engineer or responsible on-site officer for assistance.
2. Clear the location for the bank, clearing only the area that is needed to provide access for personnel and equipment.
3. Remove roots, stumps, and other debris and dispose of them properly. Do not use debris to build the bank.
4. Form the bank from the material, and to the dimension specified in the approved plans.
5. If earth is used, then ensure the sides of the bank are no steeper than a 2:1 (H:V) slope, and the completed bank must be at least 500mm high.
6. If formed from sandbags, then ensure the bags are tightly packed such that water leakage through the bags is minimised.
7. Check the bank alignment to ensure positive drainage in the desired direction.
8. The bank should be vegetated (turfed, seeded and mulched), or otherwise stabilised immediately, unless it will operate for less than 30 days or if significant rainfall is not expected during the life of the bank.
9. Ensure the embankment drains to a stable outlet, and does not discharge to an unstable fill slope.

Maintenance

1. Inspect flow diversion banks at least weekly and after runoff-producing rainfall.
2. Inspect the bank for any slumps, wheel track damage or loss of freeboard. Make repairs as necessary.
3. Check that fill material or sediment has not partially blocked the drainage path up-slope of the embankment. Where necessary, remove any deposited material to allow free drainage.
4. Dispose of any collected sediment or fill in a manner that will not create an erosion or pollution hazard.
5. Repair any places in the bank that are weakened or in risk of failure.

Removal

1. When the soil disturbance above the bank is finished and the area is stabilised, the flow diversion bank should be removed, unless it is to remain as a permanent drainage feature.
2. Dispose of any sediment or earth in a manner that will not create an erosion or pollution hazard.
3. Grade the area and smooth it out in preparation for stabilisation.
4. Stabilise the area by grassing or as specified in the approved plan.