

Guideline for the Construction of Low Flow Bypass Devices

Technical Fact Sheet for Off-Stream Diversion with 50:50 Flow Split

What is a low flow bypass?

A low flow by-pass is a device used to prevent a water storage, dam or other form of diversion from harvesting low flows (sometimes called environmental flows). These low flows are critical in maintaining our sensitive water dependant ecosystems.

Threshold flow rate

This is the rate of water flow which must be exceeded before water can be harvested or collected. It is normally measured in litres per second (l/s) and the required rate will be specified in your Water Affecting Activities Permit.

When does this fact sheet apply?

Watercourses and dams or diversions have many forms. Three fact sheets have been prepared to cover most situations.

These are:

1. On-stream dams (1 to 70 l/s)
2. Off-stream dams (10 to 520 l/s)
3. Off-stream dams with 50:50 flow split (5 to 2000 l/s)

It is not anticipated that the design in this fact sheet will be appropriate for all dams. Some dams will require a special design to suit the local conditions.

This fact sheet applies to off-stream dams or diversions built on catchments where the watercourse has a defined channel with bed and banks.

The device also requires a flat area on which a dam, pumping pool or other form of diversion can be formed. This fact sheet is appropriate for diversions with a threshold flow rate of 5 l/s and greater. You should also use this fact sheet if your permit specifies that you can harvest no more than 50% of the flow at any one time. If the conditions detailed on this fact sheet cannot be met for your site, this design is not appropriate and you should either use other fact sheets or consult a qualified engineer to help you develop a special design.

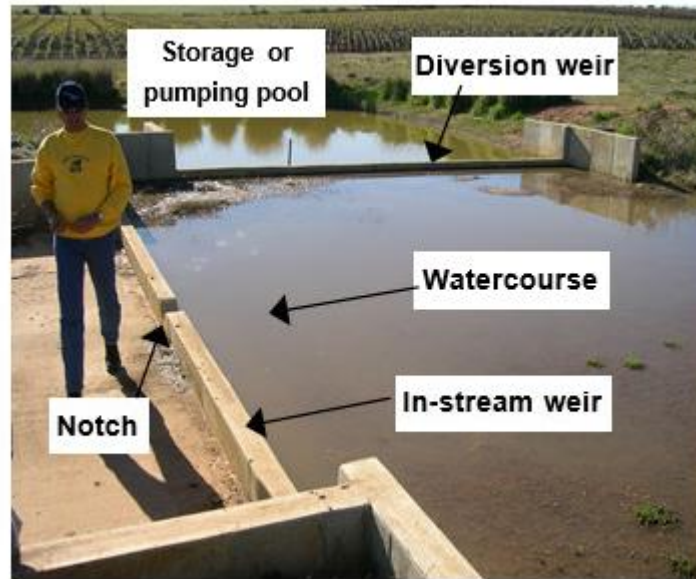


Figure 1: Example of a structure

How does the device work?

Water is diverted from the watercourse using weirs. Two weirs are used to control flow; an in-stream weir and a diversion weir. The size, shape and difference in crest level of the weirs and notches govern the threshold at which water is diverted and also the proportion of water diverted. During low flows water passes over a notch in the in-stream weir but not over the diversion weir. As flow rates increase the water level behind the in-stream weir increases. At flows above the threshold flow rate the water level rises above the crest level of the diversion weir and water is diverted.

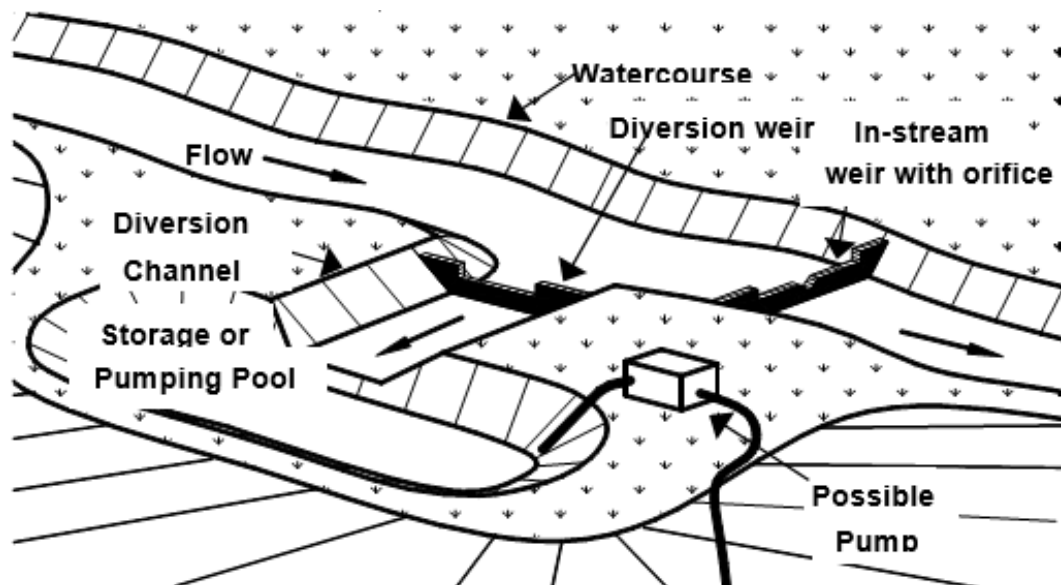


Figure 2: Layout of a typical structure

Design and construction

The weirs can be constructed from reinforced concrete or durable hardwood timber. Timber structures may be built by skilled handy-people whilst concrete structures must be built by an experienced builder or civil works contractor.

Functional Details: Threshold Flow Rates Between 5 and 120 L/S

Introduction

For these flow rates a V notch is constructed in the in- stream weir. The V notch is designed to carry the required threshold flow rate (the low flows). The crest of the in- stream weir (above the V notch) is set to the same level as the diversion weir and, excluding the V notch in the in- stream weir, the weirs have the same dimensions. At flow rates greater than the threshold flow the capacity of the V notch is exceeded and the water level rises. The water then overtops the in-stream and diversion weirs simultaneously. The diversion weir is a rectangular weir with no V notch. The functional design of the structures is shown in Figures 3 and 4. Structural design information is provided later in this fact sheet.

V Notch

The V notch height is selected from Figure 7 to provide the required threshold flow rate. The angle of the V notch is 90 degrees.

The V notch plate should be made from steel plate (approx 5 - 10 mm) and fixed to the upstream side of the weir using galvanised nuts and bolts. Sealant may be required to provide a water tight bond to the weir.

Crest Width

The sidewalls are used to concentrate flows in the centre of the creek and direct flows away from the banks, reducing bank erosion. This crest width should be slightly larger than the bed width of the watercourse and no more than 2/3 of the top of bank width of the watercourse.

Side Wall Height

The side wall height should be between 10 and 30 cm. For timber structures it can be the width of one timber sleeper.

Notch and Crest Level

The crest level of both the in-stream and diversion weirs must be the same. To achieve this it will be necessary to use a survey (dumpy) level to set the levels correctly. Determining the right notch level requires some thought and observation of your watercourse. It is important to understand how much the water level changes in response to changes in flow rate. If the level is set too high, fish and other aquatic animals will be unable to swim over the structure in high flows. If it is set too low the weir will overtop too often and not work as intended. It is intended that the in- stream weir is submerged regularly, and on a number of occasions during an average or wet year. To determine

the right level observe your watercourse during periods of low flow and place marking pegs on the banks to monitor how the water level changes. The bottom of the V notch should be set to match the water level during periods of relatively low flow. The water level that you experience in winter when water levels have receded completely from any heavy rainfall should be appropriate.

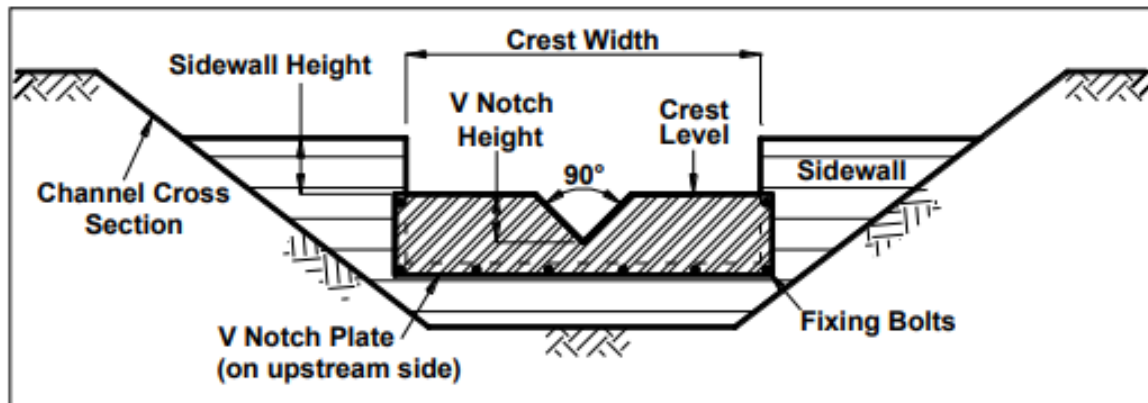


Figure 3: In-stream Weir Details

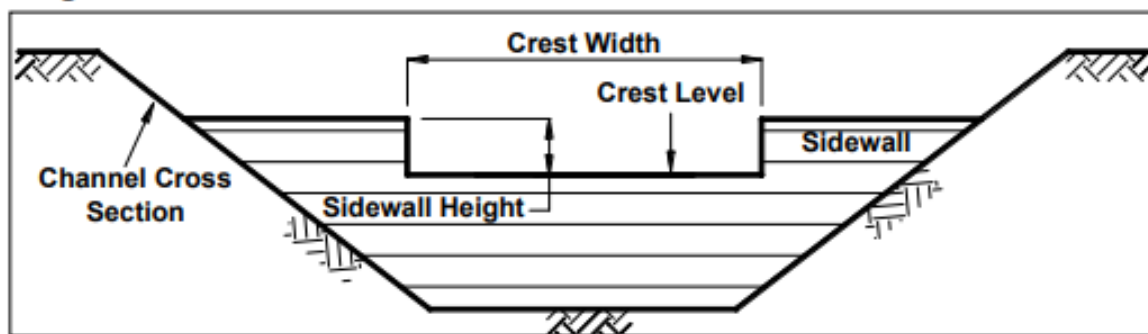


Figure 4: Diversion Weir Details

Functional Details: Threshold Flow Rates above 120 L/S

Introduction

For these higher flow rates the V notch in the in-stream weir is replaced with a rectangular notch. The rectangular notch is designed to carry the required threshold flow rate (the low flows). At flow rates greater than the threshold flow the capacity of the notch is exceeded and the water level rises. The water then overtops the in-stream and diversion weirs simultaneously. The diversion weir is a rectangular weir with no notch. The crest of the in-stream weir (above the notch) is set to the same level as the diversion weir and, excluding the notch in the in-stream weir, the weirs have the same dimensions. The functional design of the structures is shown in Figures 5 and 6. Structural design information is provided later in this fact sheet.

Notch Width and Height

The rectangular notch width and height is selected from Figures 8 and 9 to provide the required threshold flow rate. Different combinations of notch width and height can be selected to achieve the same flow rate. The width should generally be about the same as the bed width of the watercourse.

Ideally the notch width should be selected to provide a notch height of between 20 and 30 cm to meet the threshold flow rate. As opposed to the V notch weir where the notch is constructed using steel plate, the rectangular notch is an integral part of the weir structure and is formed in the timber or concrete of the weir.

Crest Width

The sidewalls are used to concentrate flows in the centre of the creek and direct flows away from the banks, reducing bank erosion. This crest width should be slightly larger than the bed width of the watercourse and no more than 2/3 of the top of bank width of the watercourse.

Side Wall Height

The side wall height should be between 10 and 30 cm. For timber structures it can be the width of one timber sleeper.

Notch and Crest Level

The crest level of both the in-stream and diversion weirs must be the same. To achieve this it will be necessary to use a survey (dumpy) level to set the levels correctly. Determining the notch level requires some thought and observation of your watercourse. It is important to understand how much the water level changes in response to changes in flow rate. If the level is set too high fish and other aquatic animals will be unable to swim over the structure. If it is set too low the weir will overtop too often and not work as intended. It is intended that the in-stream weir is submerged regularly in wet times, and on a number of occasions during an average or wet year. To determine the right level observe your watercourse during periods of low flow and place marking pegs on the banks to monitor how the water level changes. The bottom of the rectangular notch should be set to match the water level during periods of relatively low flow. The water level that you experience in winter when water levels have receded completely from any heavy rainfall should be appropriate.

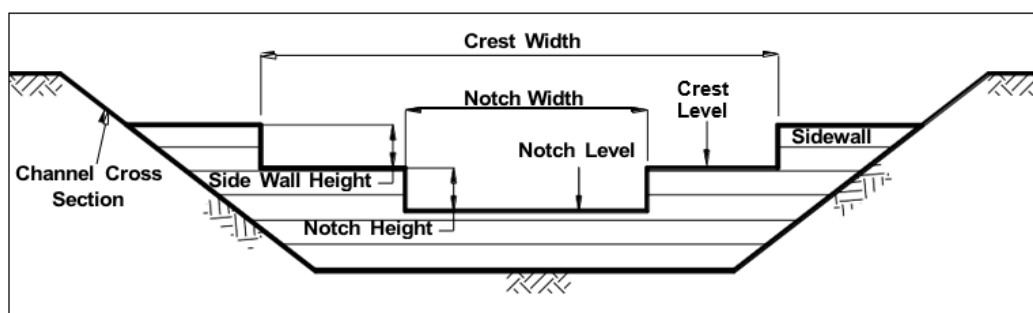


Figure 5: In-stream weir details

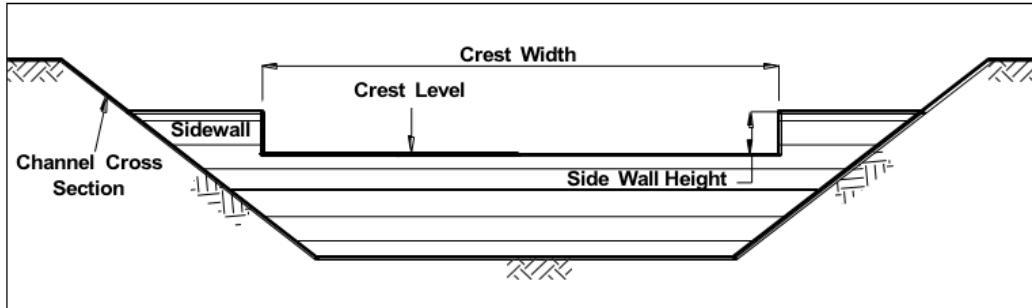
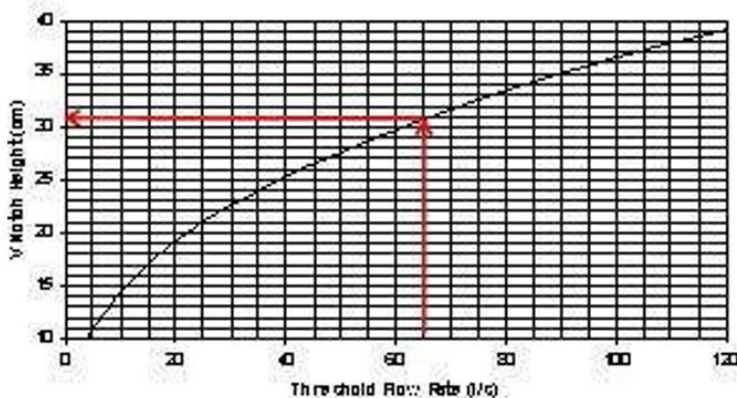


Figure 6: Diversion weir details

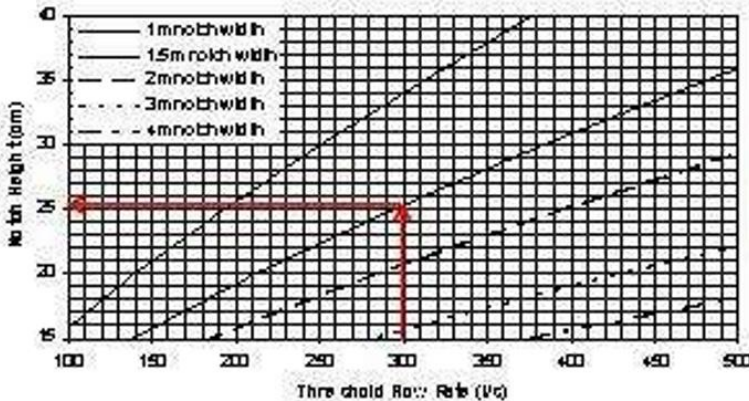
DESIGN DIMENSION FIGURES

Figure 7: V Notch Height versus Threshold Flow Rate (5 – 120 l/s)



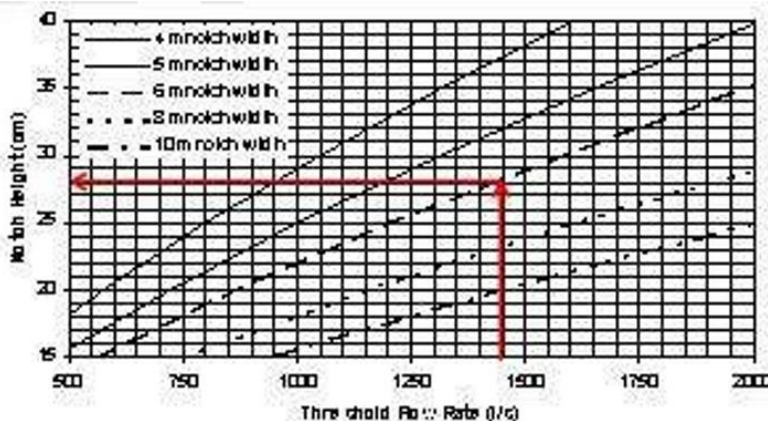
Example:
For a threshold flow rate of 65 l/s, the V notch height is 31 cm.

Figure 8: Rectangular Notch Height versus Threshold Flow Rate (120 – 500 l/s)



Example:
For a threshold flow rate of 300 l/s, and a 1.5 m notch width, the notch height is 25 cm. Other notch widths will give different notch heights for the same flow rate.

Figure 9: Rectangular Notch Height versus Threshold Flow Rate (500 – 2000 l/s)



Example:
For a threshold flow rate of 1450 l/s, and a 6 m notch width, the notch height is 28 cm. Other notch widths will give different notch heights for the same flow rate.

Structural Design and Construction - Timber Weirs

Introduction

Timber weirs may be used for small structures (less than 1 m crest height and 5 m width). The weirs are formed with hardwood timber sleepers. Horizontal timbers form the weir with vertical timbers providing support. Rock is used to prevent erosion from water cascading over the weir. Geotextile is used to prevent water leakage through any gaps in the timbers and also to prevent soil loss from beneath the rock.

Construction materials

A single weir 3 m wide with a 50 cm drop will require the following: approx 16 hardwood sleepers, approx 8 cubic metres of rock, approx 25 square metres of geotextile. The design and quantities will need adjustment for different sized weirs.

Timber Sleepers: Sleepers come in a range of sizes, such as 2400 x 200 x 100 mm. Durability Class 1 or 2 (e.g. red gum) timber will provide a long life.

Rock: Rock should be large, hard, angular and have a range of sizes from 100 to 600 mm with an average size of at least 300 mm.

Geotextile: Medium weight, non woven, needle punched (e.g. Bidim A44). It is sold at many building materials supply stores.

Other Materials: Galvanised nuts and bolts will be required to assemble the weir and steel plate (5-10 mm thick, galvanised preferred) will be required for the notch plate. Concrete is used to backfill around the vertical timbers, to provide a sound support for the weir.

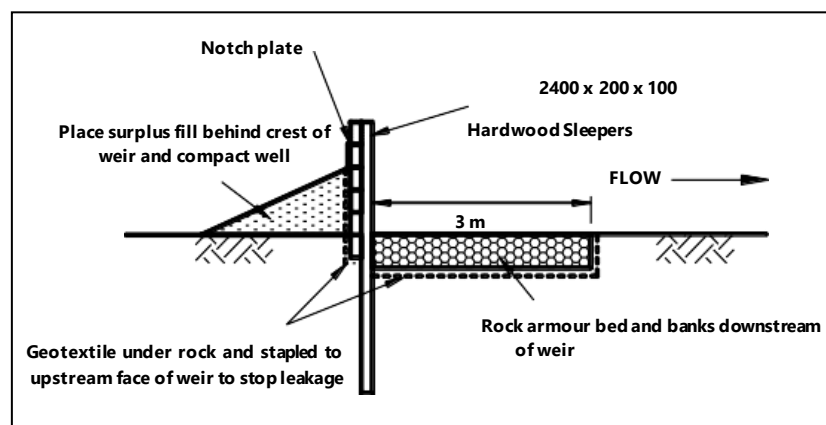


Figure 11: Timber weir, typical profile view

Construction notes

The sidewalls are used to concentrate flows in the centre of the creek and direct flows away from the banks, reducing bank erosion. This crest width should be slightly larger than the bed width of the watercourse and no more than 2/3 of the top of bank width of the watercourse.

Step 1 – Set Out: Mark out the location and extent of the weir on the ground.

Step 2 – Excavation: Batter the watercourse banks, excavate the slot for the weir, bore the holes for vertical timbers and excavate the creek bed for rock placement.

Step 3 – Vertical Timbers: Install the vertical timbers in the bore holes and set in place with concrete.

Step 4 – Horizontal Timbers: Fix the horizontal timbers to the vertical timbers. The first timber should be set below creek bed level and timbers should extend at least 1 m into each bank.

Step 5 – Notch Plate (where required): Cut the notch plate and bolt to upstream face of the in-stream weir. Sealant may be required to make it water tight.

Step 6 – Geotextile: Staple geotextile across the upstream face of the weir and lay geotextile in the area excavated for rock. Any joins should overlap minimum 50 cm.

Step 7 – Rock Placement: Place rock in the creek bed downstream of the weir for a distance of 3 m. Rock should be a minimum 600 mm thick and be set entirely into the bed rather than placed upon it. Rock must extend up the banks to the top of the side wall

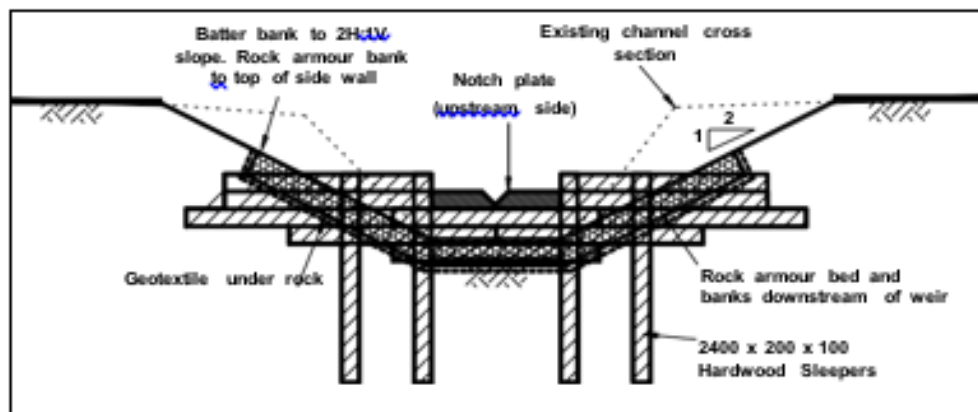


Figure 12: Timber weir, typical cross section view

Structural Design and Construction – Concrete Weirs

Introduction

Concrete weirs may be used for structures up to 1 m crest height, 30 cm side wall height (above crest) and 10 m crest width. The concept may be used for larger weirs however the structural details will need reassessment by a qualified engineer. For reasons of safety (ie potential formwork collapse) and functional requirements (ie prevention of formwork deformation) construction must be undertaken by an experienced builder or civil works contractor.

Construction Materials

Concrete: Concrete must be N32 (32 MPa) with a maximum aggregate size of 20 mm and slump of 80 mm.

Steel Reinforcement: Two types of steel reinforcement are required. SL82 reinforcing mesh must be centrally placed in all heel, toe, crest, sidewall, cut-off and abutment walls and slabs. N12 deformed bars are required in the form of 'L-bars' to connect all junctions in the structure (i.e. at all wall/slab, wall/abutment and slab/cut-off wall junctions). These 'L-bars' shall have 400 mm legs and be placed at 400 mm centres along the junctions.

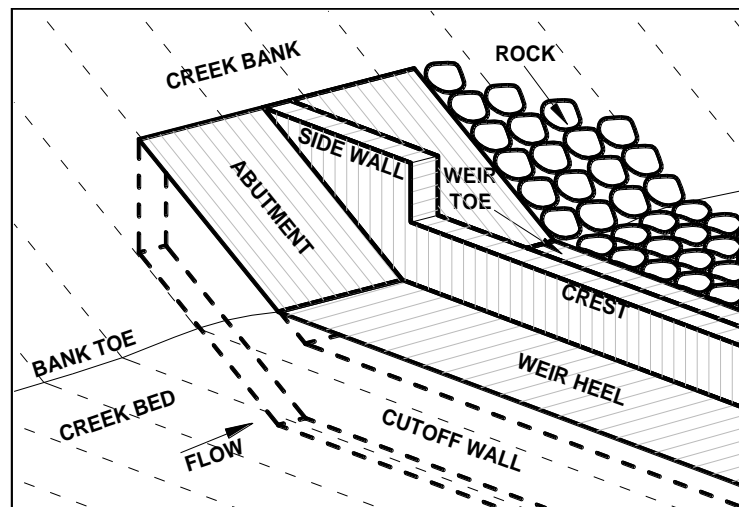


Figure 13: Concrete weir, perspective view (half weir)

Construction notes

Step 1 – Set Out: Mark out the location and extent of the weir on the ground. Use a survey (dumpy) level to ensure that the levels of the in-stream and diversion weirs are the same, as discussed earlier.

Step 2 – Excavation: Batter the watercourse banks and excavate the bed and banks for the weir slab (heel and toe) and abutments. Excavate a trench for the cut-off wall, down to solid impermeable material. The cut-off wall and trench should be a minimum 50 cm deep. Where solid, impermeable material is at considerable depth, alternatives such as steel sheet piling may be used for the cut-off wall. Consult a qualified engineer.

Step 3 – Formwork: For safety as well as functional reasons formwork should be designed and installed by an experienced builder or civil works contractor. Formwork must be rigid, watertight and constructed to AS3610, S.A.A. Formwork Code.

Step 4 – Reinforcement: Cut and install steel reinforcement mesh, and 'L-bars' in accordance with the drawings. All reinforcement must be firmly held in its required position and adequately supported by 'chairs' at approximately 750 mm centres. Reinforcement is to be placed centrally within the walls, slabs and abutments. Splices in reinforcing mesh, if required, shall be equivalent to the cross-wire spacing plus 25 mm.

Step 5 - Concrete Placement: Pour concrete to the design levels and compact using a mechanical vibrator to remove all entrained air and completely fill the formwork.

Step 6 - Concrete Curing: Curing must be undertaken in accordance with AS3600, S.A.A. Concrete Structures Code. All exposed surfaces of the concrete must be kept moist by application of either a curing compound or by covering with polyethylene sheeting for at least 7 days.

Step 7 – Notch Plate (where required): Cut the notch plate, drill holes in the concrete weir and fix the plate to the upstream face of the in-stream weir. Sealant may be required to make the joint water tight.

STRUCTURAL DESIGN AND CONSTRUCTION – CONCRETE WEIRS

Figure 14: Concrete Weir, Profile View

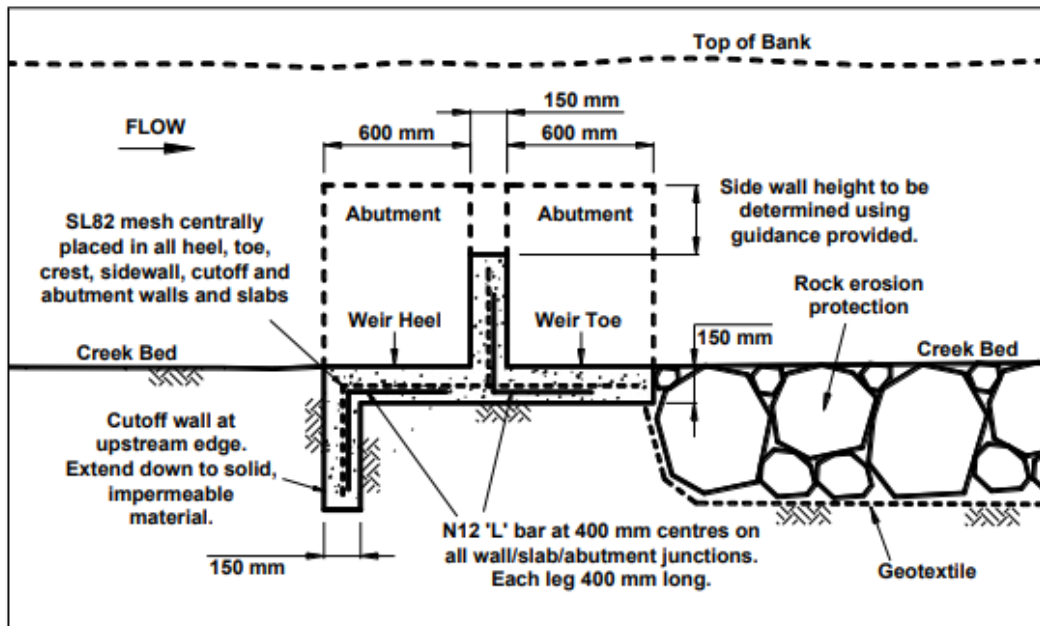
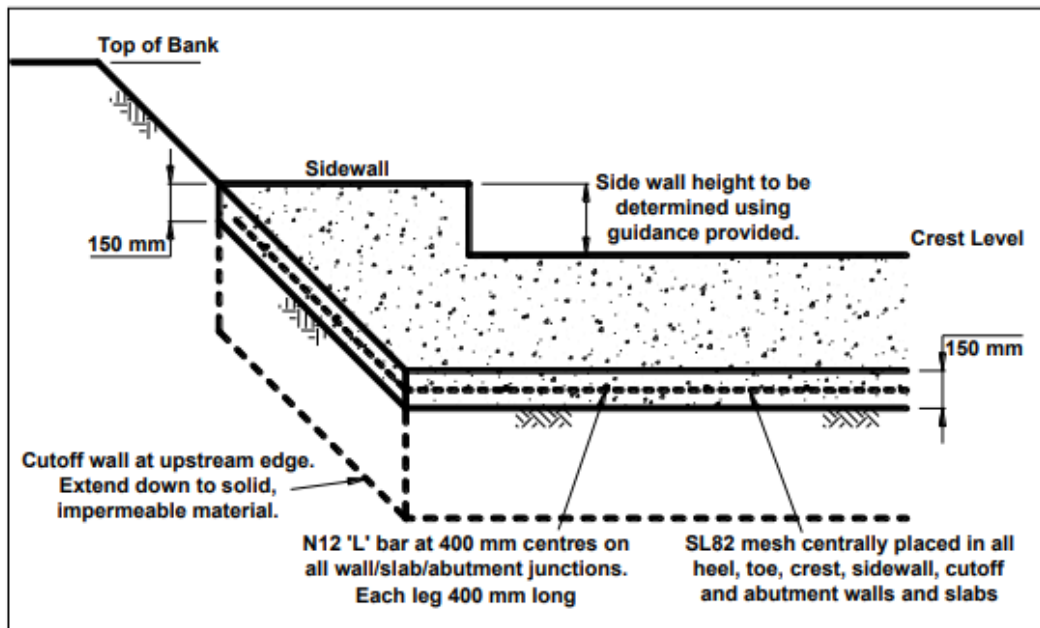


Figure 15: Concrete Weir, Cross Section (half weir)



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More information

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www.landscape.sa.gov.au/mr/water/managing-water-resources/water-affecting-activities