LANDSCAPE SOUTH AUSTRALIA HILLS AND FLEURIEU

Ford crossings in watercourses

Best practice guidelines for design and construction

All ford crossings can cause significant environmental harm and impact adjoining properties. Impacts include but not limited to a barrier to fish passage, alternation to flow characteristics, increased flooding, erosion and habitat destruction.

Purpose

This guideline has been developed to provide landholders with information and guidance on best practice design and construction techniques that minimise environmental and adjoining property impact and reduce ongoing maintenance costs when constructing, repairing or removing a ford crossing in a watercourse. We want a good outcome for you and the environment.

The information in this guideline is provided for general information only and does not constitute site specific professional engineering advice.

Note: in this guideline, the term 'watercourse' includes waterway, creeks, rivers, lakes, springs, wetlands, on-stream dams, estuaries and other natural watercourses, whether modified or not. The guideline also applies to the floodplains of these watercourses.

Approvals

Section 104(4) of the *Landscape South Australia Act 2019 (the Act)* requires a water affecting activity (WAA) permit for a range of activities that could impact water resources. Constructing, repairing or removing a ford crossing in a watercourse is a water affecting activity and requires a permit application to be lodge to the board for assessment and permitting. Permit applications are assessed against the relevant water allocation plan or the Hills and Fleurieu Landscape Board WAA Control Policy.

Note: If the watercourse flows year-round and you need to undertake excavation work while standing or flowing water is present, you should contact the Environment Protection Authority (EPA) to determine whether a dredging license is required before applying for a WAA permit. Even if an EPA license is granted, there may still be aspects of the ford crossing works that require a WAA permit.

What is a ford crossing?

A ford is a shallow part of a natural or artificial stream channel, where people, vehicles or animals can cross with relative ease. Ford crossings are the most environmentally friendly and least disruptive way to gain access across a watercourse. This is because these types of crossings are constructed as close to the natural watercourse level as possible, with the bed and banks armoured with rock and or concrete, to reduce the risk of erosion and possible failure of the ford. There are many advantages to building a ford crossing instead of a culvert or bridge, including:

- A ford crossing blends with the natural bed and bank profile so that the characteristics of the watercourse's flow are preserved.
- The more natural bed and bank profile means that fish passage up the watercourse is easier to accommodate in the design.

- Reduced risk of watercourse blockage and flooding.
- Reduced maintenance following significant storm flows.
- Reduced risk of concentrating flows and therefore erosion downstream of the ford crossing.

Site selection

Ford crossings should be located on a stretch of watercourse that will result in the least construction cost, ongoing maintenance costs and environmental impact. Consideration should be given to:

- Being located on a straight stretch of the watercourse where flow is directed through the centre of the main channel.
- A naturally rocky section of the watercourse, which will provide a more stable foundation for all-weather access.
- Hydraulic effects of natural features (e.g. waterfalls) and artificial in-stream structures (e.g. weirs).
- Being located at naturally high points (not in deep water) to reduce the impact on the watercourse.
- The steepness of the banks and ability to maintain the watercourse's natural banks without having to cut into them.
- Fish passages and where to position the ford crossing to reduce any impact.
- Ensuring the ford crossing is not placed in an area known to be habitat for local native fauna or flora.
- Retaining existing trees and vegetation to minimise disturbance to the watercourse. This will also decrease the risk of generating new points of erosion.
- Ensuring the geology of the ford crossing point is stable, that it has limited existing points of erosion, and that there is a low risk of long-term erosion or watercourse meandering that could damage the ford crossing.

Design considerations

Ford crossing dimensions

Physical dimensions of ford crossings depend on its intended use. The width of a ford crossing that caters for livestock may be different to that intended for farm machinery or light and heavy vehicles. A minimum width of 3m is typically recommended. However, if the ford crossing is to be used when water is flowing over it, a minimum width of 4m is recommended to provide additional clearance for vehicles when the crossing is submerged.

Safety

Safety is an important design consideration. A ford crossing that is only used for stock and farm machinery may require lower-level safety considerations than a crossing that is used by light or heavy vehicles to access a property or one that is on a public road. A person unfamiliar with the ford crossing, and using it when water is flowing over it, may not have a sense of the depth of flow and could be at risk of being swept off the crossing. It is important to note that light vehicles become unstable in flood waters when the flow velocity is greater than 2.5m per second and flow depths are greater than 0.3m. If the ford crossing is going to be used by the public or people unfamiliar with it, consider installing a depth gauge adjacent to the lowest point and signage with warnings to help them evaluate the risks of crossing.

Flow depth and speed

Flow depth and speed are important design considerations. This information is not easily obtained for most rural watercourses and may need to be determined by an experienced engineer. In the absence of this data, you can use the following site observations to work out critical elements of the ford crossing:

- Identify the tops of the watercourse banks to work out the depth at full flow. This will help determine the extent of rock or concrete protection required.
- Identify the extent to which the approach road could be flooded during significant flows.
- Is there rock or soil in the base of the watercourse? If rock, what is the size of the largest rock that has not been dislodged and washed downstream? If there are no small rocks (less than 100mm in diameter) or gravel then the flow speed at the ford crossing is likely to be in excess of 2m per second. If soil, is there any noticeable erosion?


Figures 1 and 2: To the left is a failed ford crossing and to the right is a well-designed and constructed for crossing.

Note that a watercourse with a soil base and little signs of erosion typically indicates that flow speeds are low and there may be an issue with sediment being deposited at the ford crossing, not erosion. A watercourse with an eroded soil base may indicate that flow velocities are greater than 1m per second and erosion is likely to be an issue.

Construction materials and techniques

From an environmental perspective, natural materials, such as rock and gravels, are preferred for constructing ford crossings. Concrete will typically provide a longer life, however using concrete usually results in greater flow speed. Concrete structures can also be more expensive to construct and if not designed correctly, are prone to failure. If using concrete, it is recommended that the ford crossing is designed by an experienced engineer and includes measures to reduce the risk of undermining the concrete slab. Concrete ford crossings should include a rounded depression (5cm deep by 50cm wide) in the lowest point of the watercourse so that fish can swim across the ford during times of low flow. If using concrete, ensure the surface of the concrete is rough not smooth and keep the concrete works contained to the area to avoid residue washing into the watercourse. Concrete is alkaline and highly toxic to native fish.

If constructing a rock-lined ford crossing, the depth and size of rock to be used for moderate flow speeds is shown in table 1 below. If the expected flow speed is greater than that shown in table 1, consider finding an alternative ford crossing location. Small-sized rocks are used to lock larger rocks into position and reduce the risk of movement and loss of rock protection. 90% of rocks should be greater than 150mm. The thickness of the rock protection should be 500mm, which is typically adequate for flow speeds up to 2.6m per second. The rock should be hard, rough and angular. Rock that is laminated, fractured, porous, or otherwise physically weak should be avoided. A good guide to the ideal rock shape is that the breadth or thickness of a single rock should be not less than one third its length. Rocks may be placed by dumping and spread by hand (for smaller rocks) and/or an excavator.

A geofabric liner should be placed under all rocks to protect from erosion and reduce the risk of the underlying soil being eroded. A maximum gradient of the road, approaching the ford crossing, is recommended to be at 10%. Rock erosion control should extend 0.3m higher than the expected maximum water level and the ford crossing should not be raised greater than 100mm above the base of the existing watercourse. The transition back to natural watercourse levels, on the upstream and downstream sides of the ford crossing should extend a minimum of 1m up and downstream of the ford crossing to tie in with the existing watercourse level.

The width of the ford crossing will need to be excavated to suit the depth of rock protection and a geofabric liner installed at the base of the excavation. Regardless of whether rock or concrete is used in

the construction of a ford crossing, the points of weakness, with respect to erosion, are typically at the interface between the new and existing materials. It is important that significant level changes and holes at these interfaces are avoided. If a relatively smooth-running surface is required over the ford crossing, a finer gravel material or cement-stabilised pavement material can be laid on top of the rock protection. Depending on flow velocities, this finer material may be more susceptible to erosion and require more maintenance after significant flow events. To reduce ongoing maintenance, the finer material should be used to fill existing holes created by larger rocks and should not be constructed as a layer over the top of the rock protection.

Fish passage considerations

Watercourses within the Mount Lofty Ranges are home to numerous threatened native fish species. Structures built in watercourses that include appropriate fish passage design elements can have a positive effect on the connectivity of fish habitat. Ford crossings that extend up to 100mm above the watercourse bed must include a ramp down to natural bed level on both the upstream and downstream sides of the ford. Maintaining a rough "rocky" finish to the ford creates turbulent and lower velocity flow conditions that facilitate fish movement across the structure. Avoid an excessively smooth finish to the ford to assist with maintaining a healthy fish population in your watercourse.

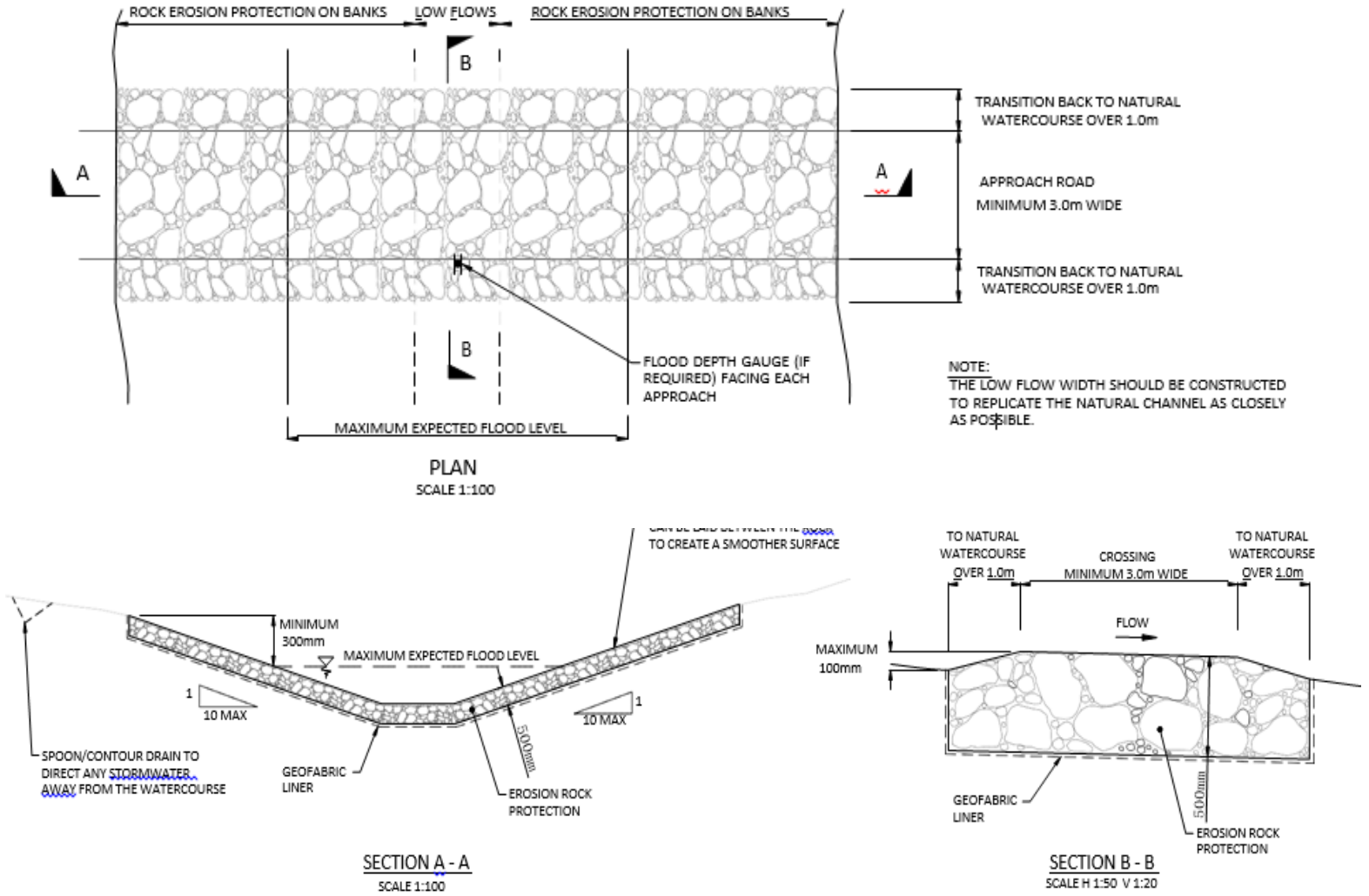
Table 1: Erosion protection using rocks, size and grading.

Moderate flow velocity (up to 2.6 m/s)	At 500mm depth rock protection		
	Rock size (mm)	**Rock mass (kg)**	**Minimum % of larger rock required (refer to rock size column)**
	400	**100**	**0**
	300	**35**	**50**
	150	**2.5**	**90**

Table 2: The preferred structures for different classes of fish habitat.

Classification	Stream characteristics	Preferred structure
Class 1 Major fish habitat	Major permanently or intermittently flowing waterway (e.g. river or major creek), habitat of a threatened fish species.	Bridge, arch structure or tunnel
Class 2 Moderate fish habitat	Named permanent or intermittent stream, creek or waterway with clearly defined bed and banks with semi-permanent to permanent waters in pools or in connected wetland areas. Marine or freshwater aquatic vegetation is present. Known fish habitat and / or fish observed inhabiting the area.	Bridge, arch structure, culvert or ford
Class 3 Minimal fish habitat	Named or unnamed waterway with intermittent flow and potential refuge, breeding or feeding areas for some aquatic fauna (e.g. fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or recognised aquatic habitats.	Culvert or ford
Class 4 Unlikely fish habitat	Named or unnamed waterway with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or freestanding water or pools after rain events (e.g. dry gullies or shallow floodplain depressions with no permanent aquatic flora present).	Culvert or ford

Figure 3: Aerial and cross-sectional drawings



Construction tips

1. Mark out the site, including the approach to the ford crossing and its alignment across the watercourse, and establish the finished level for the structure no more than 100mm above bed level.
2. Subject to having any necessary approvals in place, remove native/non-native vegetation within the footprint of the ford crossing and where possible preserve it so that it can be replanted adjacent to the ford crossing once construction is completed.
3. If necessary, excavate the footprint of the ford to a maximum depth of 500mm, ensuring that the finished rock surface will be no more that 100mm higher than the watercourse bed level.
4. Lay geotextile over the length of the ford foundation. The geotextile should be laid so that any overlapping seams run in the same direction as water flow (that is, should be perpendicular to the length of the ford). Any joins in geotextile should overlap a minimum of 500mm. Geotextile should be pinned to the soil foundations at 1m intervals.
5. Carefully place rock so that the voids between larger rocks are filled with smaller rocks and the ford forms a single interlocking mass of rock.
6. As necessary, distribute finer rock over the surface of the ford crossing to assist in the filling of the voids between the rocks to create a more trafficable surface.

Monitoring and maintenance

All ford crossings require maintenance over their lifetime, and you should incorporate this activity into your property management. Regular monitoring and maintenance of ford crossings will prolong their life and help with the early identification of potential problems. Tips on monitoring and maintaining your culvert are summarised below.

1. Inspections should occur during periods of low flow to ensure that fish passage across the structure is not blocked after significant flow events. Early intervention and repair of erosion will be much more effective and cost efficient in protecting the structure against more significant damage in the longer term.
2. Settlement of rock in the ford crossing may be expected over the short-term following completion.
3. The first high flow events across the ford may dislodge some large rocks and move some of the smaller rock downstream. Ensure that no significant holes or loose rocks develop in the ford. Adjust/move rock as required and place additional rock where necessary.
4. Be particularly mindful of the development of any erosion on the downstream edge of the ford crossing.
5. Monitor the edges of the ford crossing, including at either end of the approach to the ford for any sign of erosion.
6. Keep a stockpile of the rock used in construction, including any finer rock used on the surface to make sure you are able to respond quickly to maintenance requirements.

Penalties may apply

Undertaking a WAA without a permit is an offence under the *Landscape South Australia Act 2019*. If you are unsure whether the works you are proposing will require a permit, contact Landscapes Hills and Fleurieu for advice before conducting any works.

Help and further information

This is a free service and is aimed at ensuring the best outcome for you, your property and your watercourse. We are here to help!

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