Managing large woody debris (LWD) in waterways

- Leave LWD undisturbed unless it can be demonstrated that it is causing serious flooding or erosion.
- If local flooding caused by LWD is shown to be detrimental, but full-scale removal cannot be justified on either economic or ecological grounds, re-positioning of LWD may be an option.
- Extensive loss of riparian and floodplain vegetation has removed the source of LWD found in many waterways. Re-introducing LWD can help improve stream water quality, erosion protection and habitat diversity.

Managing riparian vegetation

- Protecting existing riparian zones in good condition is easier than remediation of degraded sites.
- Managing stock access to waterways by fencing is a key step in maintaining healthy riparian vegetation.
- Removal of weeds must be done in a planned manner.
- Riparian zone width should reflect management objectives.

Community involvement in works

- Community groups should seek advice and support from council before undertaking works.
- While smaller works may just require a work plan, larger scale works require a proper Rivercare Plan.

Role of local government

Local government has the power under the *Land Use Planning and Approvals Act 1993* to regulate works on waterways and wetlands. Councils are taking an active role in their management for a variety of reasons:

- infrastructure protection
- flood mitigation
- community expectations
- maintaining river health
- bio-diversity issues
- preserving existing uses (e.g. drinking water), and
- providing options for future resource use.

Successfully achieving these outcomes requires a planning and works approach utilising environmental best practice combined with effective on-going management and maintenance arrangements.

Waterways & Wetlands Works Manual

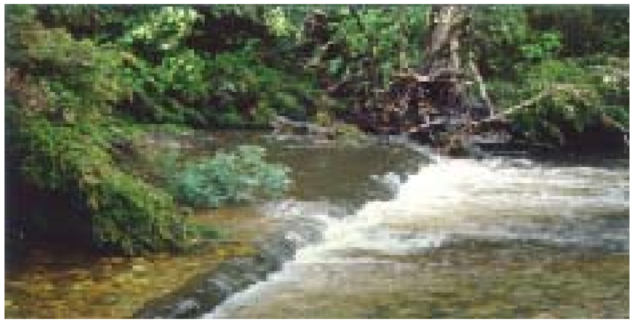
To support councils in the management of waterways and wetlands, DPIWE in partnership with the LGAT and supported by NHT funding has compiled the *Waterways & Wetlands Works Manual*.

The *Manual* is a set of eight documents (plus *Introduction* document) with information on environmental best practice requirements covering the following areas:

1. *Legislative and policy requirements for protecting waterways & wetlands when undertaking works*
2. *Environmental best practice guidelines: construction practices in waterways & wetlands*
3. *Environmental best practice guidelines: excavating in waterways.*
4. *Environmental best practice guidelines: minimising environmental harm from agricultural drainage channels*
5. *Environmental best practice guidelines: siting and design stream crossings.*
6. *Environmental best practice guidelines: managing large woody debris in waterways.*
7. *Environmental best practice guidelines: managing riparian vegetation*
8. *Environmental best practice guidelines: guiding community involvement in works on waterways & wetlands*

The *Manual* will be of use to anyone intending to undertake works in waterways and wetlands. It should always be used in conjunction with appropriate technical advice and, where necessary, utilising additional technical literature.

The Manual can be downloaded from the DPIWE website
http://www.dpiwe.tas.gov.au

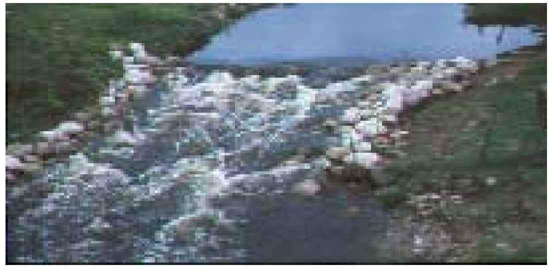


WATERWAYS & WETLANDS
~ WORKS MANUAL ~

Environmental Best Practice Guidelines when undertaking Works on Waterways & Wetlands in Tasmania

How to minimise the risk of environmental harm when undertaking works on waterways & wetlands.

Tasmania
DEPARTMENT *of* PRIMARY INDUSTRIES, WATER *and* ENVIRONMENT



LGAT
local government association of tasmania

Natural Heritage Trust

Protecting our waterways & wetlands

Healthy waterways and reliable supplies of good quality water are critical to Tasmania's future. Our state has extensive water resources with approximately 150,000 kilometres of waterways and over 8,000 wetlands.

***Waterways** are natural depressions, consisting of a defined channel with a bed and banks, that carry perennial or intermittent flows of surface water for all or part of the year. Any land that adjoins, directly influences or is influenced by a body of water (ie riparian land) should be regarded as part of the waterway.*

***Wetlands** are depressions in the landscape or areas of poor drainage that hold water derived from ground water and surface water run-off and support plants adapted to partial or full inundation. Wetlands are usually associated with standing water but they can be part of a waterway or an adjoining marsh or billabong. Wetlands are not always wet. Temporary wetlands may dry out on a seasonal or less regular basis.*

Works as a 'threatening process'

Works on waterways and wetlands in Tasmania are routinely undertaken by state and local government, industry, farmers, and community groups. These works include:

- modifying and diverting stream channels
- constructing weirs, levees and drainage lines on farms
- stream crossings for roads, pipelines and other utilities
- clearing large woody debris and riparian vegetation

These activities may have unintended consequences:

- severely degraded stream health
- threaten survival of native flora and fauna
- put at risk in-stream structures (bridges, culverts etc.)
- threaten essential service delivery or increase cost of supply (eg drinking water supplies)
- in extreme cases, cause danger to human life

Waterways and wetlands are complex and dynamic ecosystems. The impacts of works programs may extend over large distances upstream and downstream and persist over long timeframes. Badly conceived & implemented projects are expensive, fail to achieve outcomes, and can have serious environmental (and financial) consequences.

Environmental best practice

The risk of environmental harm from works can be minimised by complying with environmental best practice requirements outlined in the *Tasmanian Waterways & Wetlands Works Manual*. Key best practice requirements include:

Appropriate authorisation of works

- Works approval may be required at local, state or commonwealth government level. Advice should be sought from council or DPIWE before starting works.

Expert advice sought

- Expert input and a site briefing before starting works.

Works plan prepared

- A plan outlining works to be undertaken and measures to minimise environmental harm.

Low risk construction practices

- Contractors and plant operators are aware of, and adopt, best practice requirements.
- A sediment and erosion control plan in place.
- Contaminants are kept out of waterways.
- The works site is stabilised and rehabilitated.

"Works in waterways and wetlands can have unwanted consequences..."

Bed and bank excavation in waterways

- Avoid excavating at high risk sites. Assess whether it is a 'high risk' works site, eg likely to cause flooding, bank erosion, bed degradation or initiate headward erosion, where a bridge is close by, threatened species are present etc.
- Gain an understanding of the works site and river system of which it is a part through desktop & field surveys.
- Choose appropriate stream bed/bank control structures.
- Reapply natural stream geometry, materials and habitat.
- Preserve riparian vegetation for bank stability.
- Avoid developments on flood prone areas which will require the construction of levee banks.

Developing agricultural drainage channels

- Assess suitability of site for drainage - soil type, hydrological and hydraulic characteristics, etc..
- Design and construct drainage channels to reduce risk of erosion and minimise stormwater sediment loads.
- Install channel outlet structures to prevent drainage flows eroding stream bed/banks when entering waterways.
- Regularly inspect drains. Include stock, weed and erosion control in maintenance programs.

Siting and design of stream crossings: bridges, culverts, fords, causeways & stock-crossings

- Explore all alternatives to the construction of a new crossing. Use existing crossings wherever possible.
- When selecting structure type, use the following order of preference to minimise environmental impacts – bridge, arch culvert, open-bottom box culvert, closed bottom box culvert, pipe culvert.
- Maintain the natural flow regime by avoiding or minimising changes to channel form and flow volume.
- Avoid 'perched culverts' which have an outlet more than 10 cm above the level of downstream waters.
- Minimise disturbance to streambank soil and vegetation.
- Ensure adequate erosion control on approach roads.
- Regulate stock access to waterways.

Environmental Best Practice Guidelines 1. Legislative and Policy Requirements for Protecting Waterways and Wetlands when Undertaking Works

There is a raft of legislative and policy instruments which do have, or may have, some bearing upon the regulation of works undertaken within our wetlands and waterways. This document provides a brief outline of these regulatory requirements. Best professional judgement should be used by local government personnel in determining their applicability to individual cases. Where required, further advice on interpretation and implementation is available from the nominated agencies.

1. Legislation and policy

Tasmanian Resource Management and Planning System (RMPS)

Tasmania's RMPS is an integrated planning and environmental management framework to achieve sustainable outcomes from the use or development of the State's natural and physical resources. Sustainable development means

> *..managing the use, development and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic and cultural well-being and for their health and safety while -*
>
> *(a) sustaining the potential of natural and physical resources to meet the reasonably foreseeable needs of future generations; and*
>
> *(b) safeguarding the life-supporting capacity of air, water, soil and ecosystems; and*
>
> *(c) avoiding, remedying or mitigating any adverse effects of activities on the environment. (Clause 2, Schedule 1, Land Use Planning and Approvals Act 1993)*

Local government must ensure that planning and environmental decisions within its jurisdiction promote sustainable development of water resources.

Land Use Planning and Approvals Act 1993 (LUPAA 1993)

Local government regulates land use and development through planning schemes and a planning permit system. Planning schemes must seek to further the RMPS objectives and must be prepared in accordance with state policies (the State Policy on Water Quality Management 1997 being the key policy for wetlands & waterways). These requirements are achieved in some recent planning schemes through incorporation of a Wetlands & Waterway Schedule which specifies the objectives and standards for development in, or near, wetlands and waterways. Provisions in older planning schemes that predate, and are inconsistent with, a State Policy are void to the extent of any inconsistency.

Local government must observe, and enforce the observance of, the planning scheme in respect of all use or development undertaken within the area covered by the scheme.

"development" under LUPAA 1993 includes

> *... (c) the construction or carrying out of works; ...*

"works" includes

> *...any change to the natural or existing condition or topography of land including the removal, destruction or lopping of trees and the removal of vegetation or topsoil, but does not include forest practices, as defined in the Forest Practices Act 1985, carried out in State forests.*

where "land" includes

> *(a) buildings and other structures permanently fixed to land; and*
>
> *(b) land covered with water; and*
>
> *(c) water covering land; ...*

A planning permit is required before commencement of any use or development which, under the provisions of a planning scheme, requires planning approval. The approvals process must ensure that land-use and environmental effects arising from the use or development do not conflict with planning scheme requirements (including development standards such as those contained within the Wetlands & Waterway Schedule), state policies, or environmental regulations.

Examples of uses and developments that may require a planning permit include works in wetlands and waterways that involve:

- stormwater and erosion control
- clearing of debris and vegetation from streams and stream banks
- development of drainage and riverworks schemes (not routine maintenance)
- stream channel modifications
- roads and pipeline stream crossings
- structures such as pump stations on banks
- off-stream storages of less than 1ML
- works ancillary to dam construction such as access roads (not dams themselves).

Variations exist between individual planning schemes as to what activities are considered to be exempt from the requirement to obtain a planning permit. Some specified activities are exempt in all planning schemes - i.e. most dam construction and routine operational & maintenance works undertaken by water entities - due to the operation of other legislation.

Local Government Act 1993 (LGA 1993)

Works in wetlands and waterways may be subject to council requirements as detailed in council by-laws and/or abatement notices.

A council has a general power under Part 11 of the LGA 1993 to make by-laws in respect of any act, matter or thing for which a council has a legislated function or power. By-laws may include activities such as the execution of works in watercourses and riparian zones, requiring such works to be undertaken by an appropriately qualified person in the manner specified by council.

Abatement notices can also be issued by council where it is satisfied that a nuisance exists. These notices detail actions that need to be taken and the timeframes for implementation. Under section 199 of the Act, a nuisance includes anything that causes, or is likely to cause, danger or harm to the health, safety or welfare of any person; a risk to public health; or an activity that gives rise to unreasonable or excessive levels of pollution in waterways. Penalties exist for non-compliance with by-laws and abatement notices.

Environmental Management & Pollution Control Act 1994 & Regulations 1996

Local government authorities are responsible for any necessary environmental regulation of smaller scale activities and

> *...must use its best endeavours to prevent or control acts or omissions which cause or are capable of causing pollution (Section 20).*

An environmental protection notice can be served on the responsible person where the council officer is satisfied that in relation to an environmentally relevant activity

(a) environmental harm is being or is likely to be caused (where environmental harm is any adverse effect on the environment of whatever degree or duration and includes an environmental nuisance); or

(b) environmental harm has occurred and remediation of that harm is required; or

(c) it is necessary to do so in order to give effect to a State Policy or an environment protection policy; or

(d) it is desirable to vary the conditions of a permit; or

(e) it is necessary to secure compliance with the general environmental duty (Section 44)

The environmental protection notice can require specified measures to be taken (including best practice environmental management) to prevent, control, reduce or remediate environmental harm. In terms of compliance with the general environmental duty, section 23A requires that:

> *A person must take such steps as are practicable or reasonable to prevent or minimise environmental harm or environmental nuisance caused, or likely to be caused, by an activity conducted by that person.*
>
> *In determining whether a person has complied with the general environmental duty, regard must be had to all the circumstances of the conduct of the activity, including but not limited to*
>
> *(a) the nature of the harm or nuisance or potential harm or nuisance; and*
>
> *(b) the sensitivity of the environment into which a pollutant is discharged, emitted or deposited; and*
>
> *(c) the current state of technical knowledge for the activity; and*
>
> *(d) the likelihood and degree of success in preventing or minimising the harm or nuisance of each of the measures that might be taken; and*
>
> *(e) the financial implications of taking each of those measures.*

While this legislation provides mechanisms for the protection of wetlands and waterways from environmental harm, it is worth noting that environmental impacts may only become evident several years down the track and at locations remote from the original works. There may not always be clear and unambiguous links between the activity and the environmental consequences. In such cases, the issue of an environmental protection notice may not be appropriate. A preferred approach may be the provision of practical advice to those undertaking works and dissemination of best practice guidelines on how to minimise the environmental impacts. For further information contact the Environment Division of DPIWE.

Crown Lands Act 1976 (CLA 1976)

Crown Land Services (CLS) manages crown lands under licence, lease or being held for sale. CLS facilitates the assessment within the State Government of all applications for crown land use, including the private use of reserved lands under both the CLA 1976 and the National Parks and Wildlife Act 1970. This covers new developments such as weirs, channel modification, Telstra services, roads, pump stations or other structures on banks. Such developments are, however, still subject to LUPAA 1993 requirements. No works can commence until all approvals are received from CLS and, depending on the local planning scheme, the relevant council. In some cases riparian reserves may be leased back to local government to manage. Prior to undertaking any activities likely to disturb flora or fauna on crown land, authority is required from the local ranger.

National Parks and Wildlife Act 1970 (NP&WA 1970)

The Parks & Wildlife Service has responsibility for the on-ground management of all public reserves under both the CLA 1976 and the NP&WA 1970. Recent amendments to LUPAA 1993 (to be proclaimed) will require developments and certain activities conducted on lands reserved under the NP&WA 1970 to be subject to local government planning approval. As the local Parks District have the key role in enforcing regulations and in developing and implementing management plans, they are the appropriate first point of contact when planning to undertake works on wetlands or waterways likely to affect public reserves.

Water Management Act 1999 (WMA 1999)

The Assessment Committee for Dam Construction (ACDC) regulates the construction of all on-stream dam construction and all off-stream storages larger than 1 ML. As stated above, a permit granted by the ACDC under this Act negates any need for a permit for the same works under LUPAA 1993. For dam proposals a Regional Water Management Officer completes a dam assessment report based on guidelines for issues such as dam safety, environmental impact, geo-heritage, threatened species, aboriginal and cultural heritage and fish passage. A water licence is also required from DPIWE to store water behind this structure where water usage is not covered under stock or riparian rights. Water diversion works and activities are, in most cases, regulated under the Act.

The creation of water districts and the development of riverworks or drainage schemes for purposes such as channel modification, bank protection or removal of flow obstructions, requires Ministerial approval under the Act. The Minister is required to consult with the Director of Environmental Management. Subject to the requirements of the local planning scheme, development approval may also be required from council. A permit is not required, however, for works undertaken in the normal course of their operation.

> *A water entity administering a water management plan or a water district is not required to hold a permit for any activities which are -*
>
> *(a) necessary for the operation, maintenance, repair, minor modification, upgrading or replacement of existing works managed or owned by that water entity and will not cause environmental nuisance, material environmental harm, serious environmental harm or result in an increased risk to human life; or*
>
> *(b) required urgently to protect persons from injury or those works from damage so long as the activities will not cause serious environmental harm. (Section 185).*

Where these activities have resulted in material environmental harm or serious environmental harm, the Minister under this Act may serve notice on the water entity directing it to rectify the effects of the activity.

The point of contact for activities covered by the WMA 1999 will generally be the Regional Water Management Officer, Water Resources Division DPIWE.

State Policy on Water Quality Management 1997

Local councils are responsible under the RMPS for the prevention or control of pollution in surface water by activities within their jurisdiction which are not level 2 or level 3 activities. The Policy applies to surface waters and groundwaters and details a range of mechanisms for the control of point source and diffuse source pollutants.

The development and implementation of best practice environmental management strategies are seen as the key principle for control of diffuse source pollution. Regulatory authorities should take account of the application of such codes when considering enforcement action under legislation in areas such as agricultural and urban run-off, forestry, road construction and other forms of land disturbance. Section 39.2 of the Policy states

> *Regulatory authorities shall develop criteria for the approval of stream management works and require that any such works are designed and carried out in accordance with best practice environmental management and so as not to prejudice the achievement of water quality objectives.*

All works must comply with the requirements of the State Policy. Further information on implementing the Policy can be obtained from the Environment Division of DPIWE.

Inland Fisheries Act 1995

The focus of this Act is on maintaining fish passage & protection of fish habitat. Section 126 prohibits the flow into inland waters containing fish any “liquid, gaseous or solid matter” likely to harm fish or spawning grounds or food - this would include sediment. Section 139 states that a person must not place or use in any inland waters any equipment, instrument or device likely to hinder or obstruct the free passage of fish in those waters, without the written consent of the Director of Inland Fisheries. Sections 154 & 155 enable the creation of fauna reserves within inland waters and the placement of restrictions upon activities within such reserves. For further information contact the Inland Fisheries Service.

Forest Practices Act 1985 & Forest Practices Regulations 1997

The Forest Practices Act 1985 and Forest Practices Regulations 1997 cover the environmental regulation of forestry operations on public and private land and are administered by the Forest Practices Board. Forestry activities must comply with the requirements of the Forest Practices Code 2000 and may require a Forest Practices Plan. Streamside reserves, drainage lines and swamps are defined as ‘vulnerable land’ and generally forest clearing is prohibited, even where no commercial wood is produced. Circumstances in which harvesting or clearing is allowed are detailed in *Environmental Best Practice Guidelines 7: Managing Riparian Vegetation.*

Forestry activities within State forests and Private Timber Reserves do not require a permit from local government. However, non-forestry related activities affecting waterways remain subject to planning scheme requirements. The relevant point of contact for further information is the Forest Practices Board.

Threatened Species Protection Act 1995

Section 51 makes it an offence to knowingly take, destroy, injure, trade, keep or disturb listed flora or fauna without a permit. The Act allows the Minister to make an interim protection order to conserve the habitat, or part of the habitat, of a listed or nominated taxon of flora or fauna on either private or crown land. Interim protection orders prevail over planning schemes and can incorporate the prohibition or regulation of any activity likely to affect the habitat adversely.

Threatened species gain this status because their abundance, range or habitat has been reduced or threatening process are occurring likely to result in population reduction. In Tasmania there are 14 species of freshwater plants, over 30 riparian plant species and 76 species of freshwater fauna listed under the Act. The presence of threatened flora or fauna in the vicinity can be determined by contacting the Threatened Species Unit, Parks and Wildlife Service or by electronically accessing GT Spot (www.gisparks.tas.gov.au), which holds the threatened species data base.

Environment Protection and Biodiversity Conservation Act 1999

This commonwealth statute establishes powers over new projects or developments which may have a 'significant impact' on matters of 'national environmental significance' (i.e. listed threatened species and ecological communities; Ramsar wetlands; listed migratory species; and World Heritage properties).

For freshwater ecosystems the Act may encompass irrigation and other consumptive use developments; water infrastructure projects (such as weirs, channels, levee banks or dams); flow altering or pollution causing developments affecting native fish and wetlands; and land clearing activities.

Further details are provided at the Environment Australia website
http://www.ea.gov.au/epbc/assessapprov/referrals/significanceguide.html

Aboriginal Relics Act 1975

This Act covers the physical remains of Aboriginal occupation in Tasmania and makes it illegal to interfere, conceal, remove, damage or destroy an Aboriginal relic, such as middens, stone tools and rock shelters, regardless of land tenure (unless a permit has been granted by the Minister on the advice of the Director, National Parks and Wildlife).

River verges and wetlands are likely to have a long history of Aboriginal use. Surveys may be required where works are planned in areas likely to contain Aboriginal relics. Generally these surveys are done by private consultants. The Aboriginal Heritage Section, Tasmanian Heritage Office should be contacted for further information.

Historic Cultural Heritage Act 1995

Restrictions on works may apply where a waterway or a structure on a waterway is deemed to have historic cultural heritage significance to any group or community in relation to the archaeological, architectural, cultural, historical, scientific, social or technical value of the place. Specified works and specified primary production within a heritage area may have Ministerial exemption.

The planning authority (or Heritage Council where local government does not have that delegated power) may only approve a works application in respect of works which are likely to destroy or reduce the historic cultural heritage significance of a registered place or a place within a heritage area if it is satisfied that there is no prudent and feasible alternative to carrying out the works.

The Tasmanian Heritage Register is accessible at www.tasheritage.tas.gov.au or contact the Cultural Heritage Unit of the Tasmanian Heritage Office.

The Register of the National Estate which is maintained by the (Commonwealth) Australian Heritage Commission under the Australian Heritage Commission Act 1975 may also impact where works and activities require government approval.

Agricultural and Veterinary Chemicals (Control of Use) Act 1995

A person proposing to use chemicals to control pests (including weeds) in streams or along river banks must use non chemical means of control wherever practical. Where it can be demonstrated that chemical control poses less net environmental risk, chemicals must be used in accordance with this Act. An operator providing a commercial spraying service must hold a Commercial Operator Licence and a Certificate of Competency relevant to the type of work undertaken.

A Code of Practice for Ground Spraying has been developed for ground spraying which prescribes responsibilities and minimum standards. No spraying should take place on waterways or waterbodies or waterlogged areas unless the product is approved for such use. When spraying, chemical is not to move off-target to extent it may adversely affect waterways or waterbodies or waterlogged areas. The Code can be accessed via the internet - www.dpiwe.tas.gov.au. Contact the Chemical Management Unit, DPIWE for further details on legislative requirements.

Weed Management Act 1999

This is the principal legislation concerned with the management of declared weeds in Tasmania and is an important component in delivering the State Weed Management Strategy (WeedPlan). A plant considered a serious economic, environmental and/or social risk, is declared under the Act, allowing legally enforceable actions to be undertaken to control it. Examples of declared riparian weeds are willows and blackberries.

Weed Management Plans are developed for each weed species. These contain information relevant to the legally enforceable management of that weed and includes measures to control, eradicate or restrict the spread of the weed, and establishes the law in relation to its importation, distribution and sale.

Many councils have a gazetted weed management officer. This allows councils to strategically manage weeds in their municipality and help fulfil any obligations they have under the Act. For more information on weed control and the Act, contact a DPIWE Regional Weed Management Officer or access the DPIWE website.

Mineral Resources Development Act 1995

In rare cases, where there is a benefit to the waterway and surrounding environment, sand and gravel extraction from a waterway may be acceptable. Where more than 100 tonne per annum of any rock, stone, sand, gravel and clay is to be extracted, the Mineral Resources Development Act 1995 requires a mining lease to be issued by Mineral Resources Tasmania and compliance with the requirements of the 1999 Tasmanian Quarry Code of Practice. Quantities less than this extracted from crown land will require a licence from Crown Land Services. Operators of new extractive pits, with the exception of forestry quarries, will also be required to hold a permit issued by a planning authority under LUPAA 1993. Most permits will be discretionary and will require public advertisement of the application. Further information is available from Mineral Resources Tasmania.

Public Health Act 1997

Works on wetlands and waterways may impact upon water quality through re-suspension of sediments and erosion impacts. Increasing turbidity levels will generally increase the cost of drinking water disinfection.

Section 128 of the Act requires that any agency, public authority or person managing or in control of water must manage the water in a manner that does not pose a threat to public health; and on becoming aware that the quality of the water is, or is likely to become, a threat to public health, notify the Director of Public Health in accordance with any relevant guidelines.

> *If a council receives a report from an environmental health officer that the quality of water is, or is likely to become, a threat to public health, the council must take any necessary and practicable action in accordance with any relevant guidelines to prevent the threat by*
>
> *(a) restricting or preventing the use of the water; or*
>
> *(b) restricting or preventing the use of any food product in which the water has been used; or*
>
> *(c) rendering the water safe; or*
>
> *(d) giving warnings and information to the public about the safe use of the water or risk of using the water. (Section 128.3)*

Where further information is required contact the Director of Public Health.

2. Complementary resource management tools

A strategic approach to natural resource management is essential for positive environmental outcomes. The following publications and programs should be considered where appropriate. Access to funding support for on-ground activities may require compliance with the objectives or recommendations of one or more of the following programs.

Tasmanian Natural Resource Management (NRM) Framework

The Natural Resource Management Bill 2002 provides the statutory basis for the implementation of the Tasmanian NRM framework. Resource management priorities determined by state and regional committees will have implications for the management of wetlands and waterways in areas such as the protection of biodiversity, water quality and soil values.

Rivercare Plans

For works funded under the Natural Heritage Trust, development of Rivercare Plans incorporating professional advice is required before works are undertaken. Such plans provide an assessment of community and environmental values associated with these ecosystems and a plan for implementation and on-going maintenance of works. *Environmental Best Practice Guidelines 8: Guiding Community Involvement in Works on Waterways & Wetlands* describes the process for plan development.

Other resources

- State Wetlands Strategy (under development)
- Directory of Important Wetlands in Australia
- Tasmanian Nature Conservation Strategy (under development)
- Threatened Species Strategy
- Tasmanian Geo-conservation Database
- Integrated Catchment Management Plans
- Landcare/community based plans
- Planning by Water Authorities (e.g. Hobart Water, Esk Water)
- National Action Plan for Salinity and Water Quality
- National Local Government Biodiversity Strategy

3. CHECKLIST

Legislative and Policy Requirements for Protecting Waterways & Wetlands when Undertaking Works

Given the range of legislation and policy which may be triggered by works in wetlands and waterways, decisions on the application and interpretation of legislation and policy are not always clear-cut. Typically such decisions are aided by the collection of adequate information about the impacts, or potential impacts, of a development.

Outlined below are examples of the type of questions to be asked about proposed works when determining whether a specific piece of legislation or policy is applicable. These are examples only. Other information may also be required to allow a considered decision to be made.

When in doubt about the application or interpretation of legislation or policy, contact the relevant government agency for advice.

❑ Approval of landowner / land manager (Appendix 1)

Has the property title for the wetland or waterway been checked? Has permission been obtained from the landowner and/or land manager to undertake works?

❑ Tasmanian Resource Management and Planning System (Page 1)

Is the activity compatible with the sustainable development of water resources? Will the activity adversely affect the life-supporting capacity of aquatic ecosystems?

❑ Land Use Planning and Approvals Act 1993 (Page 1)

Does the planning scheme further the objectives of sustainable development? Is the planning scheme prepared in accordance with the State Policy on Water Quality Management 1997? Is a planning permit required for the proposed activity? Do land-use & environmental effects arising from use or development comply with planning scheme requirements?

❑ Local Government Act 1993 (Page 2)

Are there by-laws relating to the execution of works in wetlands and waterways? Is the activity likely to cause danger or harm to the health, safety or welfare of any person? Is the activity likely to cause a risk to public health? Does it give rise to unreasonable or excessive levels of pollution in waterways?

❑ Environmental Management & Pollution Control Act 1994 (Page 2)

Is environmental harm being or likely to be caused? Has environmental harm already occurred and remediation of that harm is required? Is the activity consistent with State Policy or an environment protection policy? Is there compliance with the general environmental duty?

❑ Crown Lands Act 1976 (Page 3)

Does the development involve the private use of crown lands? Are approvals required from Crown Land Services? Are development approvals required from council?

❑ National Parks and Wildlife Act 1970 (Page 3)

Is the activity on a riparian public reserve or within a national park? Does the development require approval from the Parks & Wildlife Service? Is development approval required from council?

❑ Water Management Act 1999 (Page 3)

Does the proposal involve dam construction? Does it require consideration by the Assessment Committee for Dam Construction (i.e. all on-stream dam construction and all off-stream storages larger than 1 ML)? Has a Regional Water Management Officer completed a dam assessment report? Has a water licence to store water been obtained from DPIWE? Are there works associated with the creation of water districts requiring a development approval from council?

❑ State Policy on Water Quality Management 1997 (Page 4)

Do all works comply with the requirements of the State Policy? Have best practice environmental management strategies been adopted? Are water quality objectives being protected?

❑ Inland Fisheries Act 1995 (Page 4)

Is fish passage being maintained? Is fish habitat protected?

❑ Forest Practices Act 1985 (Page 4)

Do forestry activities affecting waterways & wetlands require a permit from local government? Will works comply with riparian clearance restrictions enforced by the Forest Practices Board?

❑ Threatened Species Protection Act 1995 (Page 5)

Are threatened flora or fauna likely to be affected by the works? Has there been investigations into the presence of threatened flora or fauna in the vicinity?

❑ Environment Protection & Biodiversity Conservation Act 1999 (Page 5)

Does the project or development have a 'significant impact' on matters of 'national environmental significance' - e.g. Ramsar wetland site?

❑ Aboriginal Relics Act 1975 (Page 5)

Is there likely to be some evidence of Aboriginal occupation in the vicinity of works site? Will works interfere, conceal, remove, damage or destroy an Aboriginal relic?

❑ Historic Cultural Heritage Act 1995 (Page 5)

Will works affect a site on the Tasmanian Heritage Register or Register of National Estate? Has the planning authority or Heritage Council approved a works application?

❑ Agricultural & Veterinary Chemicals (Control of Use) Act 1995 (Page 6)

Is the herbicide to be used approved for use near waterways? Are the requirements within the Code of Practice for Ground Spraying being met?

❑ Weed Management Act 2000 (Page 6)

Is the weed targeted for removal declared under the Act? Has a Weed Management Plan been developed for the target weed?

❑ Mineral Resources Development Act 1995 (Page 6)

Is a planning permit held where extraction is taking place within a waterway? Does the amount extracted require a mining lease to be issued?

❑ Public Health Act 1997 (Page 6)

Will water quality impacts of the activity likely to be a threat to public health?

❑ Complementary Resource Management Tools (Page 7)

Are Rivercare Plans, Natural Resource Management Plans or other resource management tools available to enable a strategic approach to on-ground works?

Appendix 1: Determining ownership of riparian areas

Legislative changes over the years has meant that determining ownership of riparian areas is not always clear cut and may require some research. The Land Information System Tasmania (LIST) is available to local government for checking land titles (http://www.thelist.tas.gov.au/index.html). The most likely scenario is that a piece of land will either be private land or crown land.

Option 1: Private land (freehold title)

Private land is subject to riparian rights exercised by landowner. These are natural rights arising from ownership of the land. Adjoining landowners generally own to middle of the streambed unless the title says otherwise (i.e. may be a riverside reserve, see below). Many wetlands are also under private ownership.

Option 2: Crown land reserved under different Acts

Riparian land and wetlands may be 'public reserves' as declared by ministerial order under section 8 of the Crown Lands Act 1976 (CLA 1976). These are declared for a variety of public purposes as set out in schedule 5 (conservation, public recreation, cultural values etc.). The origins of some public reserves on major streams and rivers may predate the CLA 1976. A consequence of this is the possibility of different width buffer zones - 15 metre, 20.1m (one chain) or 30.5 metre (100 feet) - between the streambank and adjoining private land. The presence or absence of fences is not always a reliable method for determining tenure.

Riparian land and wetlands are also found within the more extensive areas covered by the National Parks and Wildlife Act 1970 (declared reserves: National Park, State Reserve etc.) and the Forestry Act 1920 (State Forest and Forest Reserves).

These guidelines should be used in conjunction with the appropriate technical advice and literature.

Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands

Undertaking works in waterways and wetlands without expert advice can cause environmental harm that may be difficult and expensive to remediate.

1. Potential environmental effects

Undertaking works and operating machinery in and near waterways and wetlands can cause environmental harm by

- eroding stream beds and banks
- filling in deep holes and pools
- destroying riparian and wetland vegetation
- smothering aquatic vegetation
- killing aquatic animals
- polluting water
- exacerbating flooding.

2. Environmental management principles

Before starting works in waterways and wetlands a works plan should be prepared. The plan should outline the works to be undertaken and the measures that will be used to minimise the risk of causing environmental harm. The measures outlined should include those described below. These measures should be required of all contractors and plant operators working in waterways and wetlands.

2.1 Prepare for works

- Expert advice should be sought before excavating in waterways and wetlands. Depending on the scale of the works, advice may needed from one or more experts, including a stream biologist, river engineer, fluvial geomorphologist or hydrologist.
- The risk of causing environmental harm should be minimised. Short-term disturbances may be unavoidable but steps should be taken to minimise their effects at the site as well as upstream and downstream of the site. The environmental harm that could result from the works should be assessed and measures developed to minimise the harm. For example, works should be avoided when aquatic species are migrating and birds are breeding.
- The proposed construction methods and procedures should be specified in the works plan.
- All downstream neighbours and river users, such as water authorities, should be notified of the works.
- All relevant authorisations for the works should be obtained. See *Environmental Best Practice Guidelines 1. Legislative and Policy Requirements for Protecting Waterways and Wetlands when Undertaking Works.*
- Everyone involved in the works should attend a site briefing before starting work.

2.2 Minimise sediment disturbance and control erosion

- The works should be scheduled appropriately. For example, works should be timed to coincide with periods of low flow and completed quickly, and works should be stopped if conditions are not suitable, such as during and after heavy rain.
- Damage to the ground cover should be minimised and confined to the works site. Blading and grubbing of the banks and the area adjacent to the works site should be avoided. The width of

any access tracks should be minimised. Vegetation on unstable and erodible banks should be cleared by hand. If possible, trees should be felled away from the waterway.

- In-stream structures (culverts, etc) should be installed according to the manufacturer's specifications.
- The type and size of any heavy machinery and attachments (eg crab-grab) should be appropriate for the site and the works being done.
- All machinery should be kept out of the waterway on dry and stable areas within the works site.
- Existing crossings should be used to move equipment across the waterway. If there is no crossing and the stream must be crossed, any disturbance should be minimised. If crossing once, the machinery should be carefully 'walked' across the stream. If crossing many times, a temporary crossing should be made by laying a pad of clean rock at a shallow point of the waterway. The rock should be removed when works have finished.

Keep machinery off wet and unstable areas

If excavating the channel isolate the works site

- When excavating the channel, the flow should be diverted and the works site isolated. Sometimes, if the environmental risk is small and the flow is low, it may be possible to do the works without a diversion structure. The stream should be diverted by constructing a cofferdam, berm or temporary channel. The cofferdam should be constructed using sandbags, clean rock, steel sheeting or other non-erodible material. Clean rock is rock of varying type and size, that contains no fines, soil, wastes and contaminants. Temporary diversion channels should be protected by lining them with non-erodible materials to the high water mark.
- Boulders, rock, shingle, gravels, soil and vegetation from the stream bed and banks should not be used or removed without authorisation. Any use or removal should be specified by a river engineer.
- Excavated material should be placed well away from the waterway to minimise erosion back into the stream. Fill should not be pushed into the waterway or stored in flood-prone areas.
- Surface and sub-surface flows at the site should be managed to minimise erosion and sedimentation of the waterway or wetland. Geo-textile sediment fences should be used to stop sediment entering the water. They should be installed along the bases of fills and cuts, on the downhill side of soil stockpiles, and along stream banks and around wetlands adjacent to cleared areas. They should be installed along a contour, and be entrenched and staked. They should extend the full width of the cleared area.

Sediment fences need maintenance to remain effective

- Any runoff from the works site should be diverted into a settling pond or sediment trap, or through a vegetated area to stop sediment entering the waterway or wetland. The settling basin or sediment trap should be designed so its capacity is large enough for the size of the area being drained and the volume of water being treated.
- The publications listed in 'Section 3. References' contain detailed information on managing soil and water at works sites.

2.3 Avoid contaminant spills

- All workers should be trained and equipped to contain equipment spills and leaks.
- If a spill occurs, immediate steps should be taken to stop it polluting the water, including the ground water. The spill should be reported to the appropriate authorities as soon as possible.
- Petroleum products and other hazardous substances should be kept out of the waterway. Refuelling, top-ups and oil checks should be done well away from the waterway. Fuel, and servicing and refuelling equipment should be stored so the fluids cannot enter the waterway.

Non-toxic hydraulic fluids, such as vegetable-based fluids, should be used if possible. All equipment should be inspected and repaired regularly to prevent oil and other fluids leaking into the waterway.

- If equipment is to be immersed in the waterway, it should be cleaned beforehand to remove any external grease, oil and other fluids. Wash-down water is not to enter the stream.
- Dirt and mud should be removed from all equipment before entering the works site and waterway to avoid transferring weeds and disease. Wash-down water is not to enter the stream.
- Fresh concrete should be kept out of the waterway. If practical, prefabricated structures and precast components should be transported to the site and assembled on site. Any cast-in-place concrete should be isolated from the waterway for at least 48 hours to allow the pH to neutralise.
- Paints should not be allowed to enter the waterway when constructing, repairing and maintaining in-stream structures.
- When using wood treated with preservatives, the chemicals should be given enough time to fix before immersing the wood in the water.

2.4 Stabilise and rehabilitate banks

- The site should be rehabilitated when the works have finished. If practical, native vegetation should be established on all exposed soil surfaces, including the headslopes of any bridges and culverts.
- Temporary erosion control measures, such as geo-textile silt fences, diversion ditches, sediment traps and temporary seeding with fast growing annuals, should be used to control erosion at the works site and in the table drains of any approach roads. These should remain in place until the long-term erosion control methods are established and functioning.
- Long-term measures should be used to control erosion at the works site. Suitable measures include slope stabilisation, revegetation, soil coverings, rip-rap and armouring, check dams, sediment traps, brush barriers and vegetation filters. The measures used should be inspected and maintained regularly to make sure they are effective.

3. References

Hobart Regional Councils. 1999. *Guidelines for Soil and Water Management.* Hobart Regional Councils, Hobart.

Hobart Regional Councils. 1999. *The Soil and Water Management Code of Practice for Hobart Regional Councils.* Hobart Regional Councils, Hobart.

Launceston City Council. 2000. *The Soil and Water Management Code of Practice for Launceston City Council.* Launceston City Council, Launceston.

These guidelines should be used in conjunction with the appropriate technical advice and literature.

Checklist

This checklist summarises the environmental management principles outlined in *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands.* The plan of works prepared should describe the proposed works and show that the measures listed below will be used to minimise the risk of causing environmental harm during and after the works.

- ❑ Works plan prepared

Prepare for works (Section 2.1)

- ❑ Expert advice sought
- ❑ Risk of causing environmental harm assessed
- ❑ Construction methods and procedures specified
- ❑ Downstream neighbours notified
- ❑ Water authorities notified if appropriate
- ❑ Appropriate authorisations obtained
- ❑ All site workers briefed

Minimise sediment disturbance and control erosion (Section 2.2)

- ❑ Works scheduled appropriately
- ❑ Ground cover disturbance minimised
- ❑ In-stream structures installed to manufacturer's specifications
- ❑ Heavy equipment appropriate for site and works
- ❑ Machinery restricted to dry and stable areas
- ❑ Crossing sites selected if appropriate
- ❑ Works site isolated from channel
- ❑ Any removal of boulders, rock, shingle, gravels, soil and vegetation authorised
- ❑ Excavated material placed away from waterway
- ❑ Sediment control devices selected and sited appropriately

Avoid contaminant spills (Section 2.3)

- ❑ Contingency plan prepared that outlines measures to minimise likelihood of spills on site and response if spills occur
- ❑ Workers trained and equipped to contain spills
- ❑ Refuelling and servicing equipment located away from waterway
- ❑ Arrangements made to clean vehicles and other equipment away from waterway
- ❑ Hazardous materials kept out of waterway

Stabilise and rehabilitate banks (Section 2.4)

- ❑ Site rehabilitated and stabilised
- ❑ Temporary erosion control measures installed
- ❑ Long-term erosion control measures installed and inspection and maintenance plan prepared

Environmental Best Practice Guidelines 3. Excavating in Waterways

Many works in waterways involve excavating stream beds and banks. Such works include stabilising stream beds, protecting and stabilising stream banks, diverting streams, creating channels to drain land and alleviate floods, deepening stream holes to increase the capacity of water off-takes, extracting sand and gravel, and works associated with developing infrastructure, such as bridges and pipelines.

Excavating can severely degrade or destroy ecosystems in waterways and wetlands so the precautionary principle should be followed. Excavating should not be allowed if it is likely to cause significant environmental harm. If the works will result in substantial benefits and minimal harm to the waterway and surrounding environment, excavating the bed and banks may be acceptable. However, the appropriate safeguards must be taken.

1. Potential environmental effects

1.1 Changes stream geomorphology

River systems will move towards a state of dynamic equilibrium after disturbance. A stream modified by removing alluvial material or channelising will attempt to revert to its 'natural' state. The resulting erosion, increased sediment transport, and reduced water quality may continue or even accelerate for many years after the works have been completed. Continual maintenance may be needed to control this process.

Removing alluvial material from the stream bed

Extracting material from the stream bed can trigger changes in the stream profile, along the stream and from bank to bank. Changes to the flow regime and disturbing the balance between the supply of sediment and the sediment carrying capacity of the flow can have the following effects.

Headcut eroding stream bed

Headcut erodes the stream bed: Excavating the channel deepens the stream bed. A nick point is created in the bed at the point where the flow velocities increase due to the steeper gradient. If the increased flow velocities erode the stream bed, the nick point migrates upstream in a process known as 'headcutting'. This continues until the gradient of the stream stabilises or the nick point meets an obstacle, such as a rock outcrop. Headcutting releases large amounts of sediment from the stream bed, which is transported and deposited downstream. The deposition fills in deep holes and pools, and changes the form of the channel.

Increased flow capacity affects sediment movement: Excavating the channel increases its cross-sectional area and hence its flow capacity. Larger floods ('1 in 2 year floods' and up) are more readily contained within the modified channel and are less likely to have their energy dissipated across the flood plain. This increases the stream energy during floods, which further erodes the channel, and increases sediment supply and transport from the stream reach.

Collapse of stream banks due to increased height: Deepening the stream bed can increase the height of the stream banks and make them more prone to erosion and collapse. If the banks collapse, the sediment load in the stream will increase. Widening of the stream due to extensive bank collapse increases flow capacity, and increases sediment supply and transport downstream.

Removal of gravel armouring the stream bed: Removing gravel that is protecting or 'armouring' the stream bed and stabilising the banks and bars may expose material that is more susceptible to erosion. If this occurs, excessive scouring of the bed and movement of sediment may result.

Loss of stream roughness: Removing objects that create roughness in the stream, such as large woody debris and boulders, when excavating can reduce the structural integrity of the stream and ecosystem health. These objects help control the morphology and hydraulics of the stream, and help regulate the storage of gravel and other sediments.

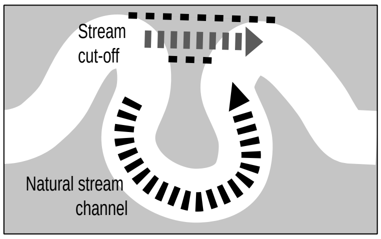
Channelising

In general, increasing the stream's flood carrying capacity by channelising the stream - that is, re-aligning the channel and smoothing the banks - decreases the stability of the stream. This can result in unforeseen and unintended erosion upstream and downstream of the channelled section.

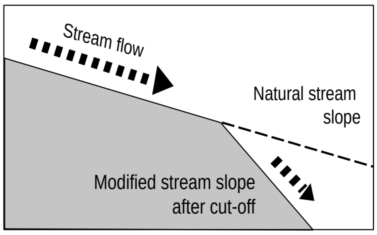
Increased slope increases flow velocities: Constructing meander cut-off channels and re-aligning the stream usually shortens the stream, which steepens its gradient. Abrupt changes in the slope of the channel cause can cause erosion and degradation of the channel upstream, and aggradation (increased silt, sand or gravel deposition) of the channel downstream (see Figure).

The significance of increased flow velocities depends on the composition of the bed and banks and the state of the riparian vegetation cover. Coarse, rough materials, such as cobbles and gravel, are more resistant to erosion from increased flow velocities than clay, fine sand and unconsolidated fill. A wide, healthy cover of native riparian vegetation helps resist erosion.

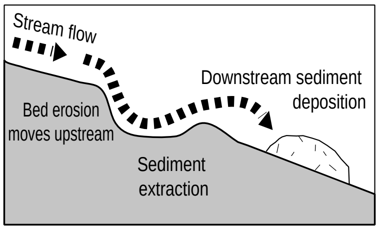
Increased flow downstream increases bank erosion: Larger volumes of flow being funnelled downstream can destabilise the banks due to the greater erosive forces of the flow and more frequent overtopping of the banks. The amount of water flowing in a waterway shapes the profile of the stream channel (along with sediment load) so increasing the flow may trigger further changes in the stream profile.



Channel diversion & loss of meander will shorten the channel, and...



...this will increase the slope of stream bed, which...



... increases flow velocity, causing 'headcut' erosion in the upstream direction and sediment deposition downstream.

Bed erosion due to channel diversion
(adapted from W.A. Water & Rivers Commission,
River Restoration Report No. RR10 - Stream Stabilisation.)

1.2 Effects on surface and ground water flows

In-stream works can change the local hydrology and lead to unpredictable changes in the surface and ground water flows.

Removing alluvial material

Excavating the stream bed and banks may lead to

- a lower water table
- reduced bank storage
- drainage of associated wetlands
- greater variations in stream flow
- more intermittent stream flows
- more uniform stream flow conditions.

Channelising

Straightening the stream and smoothing the banks will increase the flow capacity and flow velocities of the stream. This may have a number of consequences, including

- The higher average flow velocities may aggravate flooding downstream.
- The greater quantity of water flowing may trigger unintended changes in the course of the stream.
- Improved drainage of the land adjacent to the stream may increase the discharge of ground water, which may reduce the amount of water available for stream flows during dry periods.
- Stockpiles of soil and overburden left on the floodplain after excavating may change the hydraulics of the channel during floods.

1.3 Degrades aquatic and riparian habitat

The physical and biological changes arising from works in streams may reduce the abundance, composition and diversity of plant and animal species, especially sensitive species, and reduce the health of ecosystems. The effects may not be confined to the works site. They may also extend a long way upstream and downstream.

Excessive suspended sediment: Excavating changes the physical composition and stability of substrates in the stream and releases large amounts of sediment into the stream. Other activities at the works site, such as clearing, grading, stockpiling of materials and constructing an access track, can erode soil into the waterway and increase sediment loads (see *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands*). Clearing the riparian vegetation when excavating may increase the sediment load in the stream because less sediment is filtered from the overland flow. Operating heavy equipment in the channel bed can increase turbidity and suspended sediment downstream (see *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands*).

Increased sediment loads and increased deposition can create a unstable environment that is hostile to many fish and other aquatic animals by

- creating conditions favourable only to silt-tolerant plants and animals
- reducing the availability of benthic food due to smothering
- reducing light penetration and productivity of the waterway
- making it difficult for plants and animals to respire
- reducing the tolerance of fish to diseases and pollutants
- increasing physiological stress in fish by clogging and damaging their gills
- smothering fish eggs and reducing the success of spawning.

Removal of riparian vegetation: Trees and vegetation may have to be removed from the banks so workers and equipment can reach the excavation site. Collapse of the stream banks and lowering of the water table as a result of excavation can also destroy riparian vegetation. Less riparian vegetation may

- exacerbate fluctuations in water temperature and reduce the concentration of oxygen in the water by reducing shade
- reduce the amount of food, shelter, and spawning and breeding habitat available for aquatic and terrestrial animals.

Channelising the stream can destroy riparian habitat

Less diversity of aquatic habitat: Channelising the stream produces a straight, uniform channel with fewer features, such as pools, riffles, and undercut banks, that are important habitat for aquatic animals. Removing large woody debris, boulders, and so on during excavation works further simplifies the structure of the stream and reduces the range of habitats available. Operating heavy equipment in the channel bed may degrade or destroy habitat.

Habitat may also be lost if the works result in a shallower stream. Low water levels may expose riffles and cobble substrate in high gradient streams, and logs and snags in low gradient streams - all of which are important habitat for fish and other aquatic animals.

Restricts fish movement: Shallower surface flows caused by excavating in the stream may stop fish migrating upstream during low flows. The water may be too shallow for fish to remain submerged as they cross shallow sections. Previously submerged structures, such as logs and rock shelfs, may no longer be submerged and may a create a barrier that fish cannot get over.

1.4 Damages infrastructure

Erosion triggered by excavating the stream may damage public and private property far from the works site. Channel incision may undermine bridge piers and expose buried pipelines and utility lines. Exacerbating flooding downstream may increase the risk of damaging infrastructure and necessitate the construction of flood-protection structures, such as flood levees.

Excavating the stream may lead to infrastructure loss

Excavating streams does not always cause instability upstream and downstream. However, nearby landowners may attribute such problems to the excavation works and may take legal action to recoup their perceived costs.

1.5 Degrades water quality

Excavating streams can increase sediment loads and turbidity downstream, which may degrade the quality of domestic and stock water supplies. A new channel course may increase or decrease runoff and sediment input from the adjacent land. If the increased runoff is from agricultural land, more salts, nutrients and pesticides may be discharged into the stream. If town water supplies have to be treated, this will involve additional costs for the supplier.

1.6 Reduces recreational and aesthetic values

Recreational activities, such as fishing, swimming and bird-watching, need streams that are relatively free of sediment and visible pollutants. Excavating streams can reduce their recreational values if sediments and pollutants are mobilised. Preserving landforms and vegetation cover when excavating will preserve the stream’s aesthetic values.

2. Methods for controlling erosion

Before undertaking works to control erosion in streams it must be determined that the rate of erosion justifies the cost of the works, and that the works are likely to be successful and not create new problems. The methods used will depend on the scale of the erosion problem. Methods that stabilise and protect the banks are usually appropriate for managing localised bank instability, such as erosion of meander bends. If there is severe degradation of the stream bed, the bed may need to be stabilised before stabilising the banks. A variety of bed-control structures (also referred to as grade-control or full-width structures) can be used for this purpose. Extensive degradation of the river system may need a catchment-based approach that focuses on changing land use in the catchment.

The design requirements of structures to control and stabilise stream beds and banks can be found in the following publications

- The WES Stream Investigation and Streambank Stabilization Handbook (Biedenharn et al., 1997)
- Riparian Land Management Technical Guidelines Volume 2: On-ground Management Tools and Techniques (Lovett & Price, 2002)
- A Rehabilitation Manual for Australian Streams, Volume 2 (Rutherfurd et al., 2000)
- Guidelines for Stabilising Waterways (SCR&C, 1991)
- Stream Stabilisation. River Restoration Report No. 10 (WRC, 2001b).

2.1 Stabilising the banks

The two main approaches to controlling bank instability are re-aligning the flow and modifying the stream bank. At some sites both approaches will be needed.

Re-aligning the flow

The re-aligning approach uses structures that extend part-way into the channel to redirect the flow so the hydraulic forces along the bank are reduced and do not cause erosion, or the flow is directed away from the erodible bank. The partial-width structures most commonly used are groynes (extend from the eroding bend into the channel at an angle to the flow) and retards (a series of piles with cross members that provide a permeable barrier to flow). Large woody debris anchored to the bank can also be used (see *Environmental Best Practice Guidelines 6. Managing Large Woody Debris in Waterways*). If placed appropriately, a series of any of these structures will reduce flow velocities near the bank and increase sediment deposition along the bank, which will allow revegetation.

Seek expert advice if installing bank stabilisation structures such as pin groynes

Other structures that can be used are pin retards (unconnected pins), brush retards (pins connected by branches), jacks (tripods anchored by cables to each other and the bed), and low flow deflectors (low profile structures extending into the stream).

Modifying the banks

Stream flow is not the only cause of bank erosion. Inadequate vegetation cover, trampling by stock, and overland flow can also trigger bank erosion. It is important to determine the cause of the erosion so the most appropriate remedy can be used. The range of remedies is considerable. Revegetating the bank is probably the best remedy from an environmental and aesthetic perspective. However, revegetation must be combined with other approaches if the bank instability is too great. Battering or terracing the bank may be necessary to reduce the slope of the bank and allow plants to establish. Using organic geo-textile mats (natural fibre mats) will provide better conditions for growing plants if the area is not subject to high velocity flows. If the bank instability is due to undermining of the bank, the bank toe can be hardened by installing rock gabions (stone-filled wire cages) or rock rip-rap (loose rock). Dead trees and root wads can be used instead of rock in some situations.

2.2 Stabilising the bed

Bed-control structures stabilise the stream bed. They stop the active headcut moving upstream (including into tributaries) by creating a hard point in the bed that resists the erosive forces. Alternatively, they change the hydraulic conditions so the stream energy no longer scours the bed. Some bed-control structures do both.

Seek expert advice if installing bed control structures such as rock chutes

Bed-control structures usually span the width of the channel and allow some overflow. They also allow a temporary backwater pool to form upstream, and a permanent, stable scour pool to form downstream. Rock chutes are the most commonly used bed-control structures because rock is long lasting and copes with high flows. Grass chutes are sometimes used on seasonal waterways with low base flows. Reinforced-concrete drop structures and piped drops are less desirable because they may stop fish swimming upstream. Timber, can also be used, either a single log that spans the channel to form a low weir or angled logs that meet in the centre and concentrate low flows.

2.3 Changing land use in the catchment

Activities such as clearing vegetation, draining wetlands and damming streams will affect erosion in the catchment's waterways by changing the sediment loads and water yields. A catchment-based approach, such as a natural resource management framework, can be used to restore the sediment loads and water yields in the catchment to as close to their 'natural' levels as possible. For example, sediment going into the catchment's waterways may be reduced by establishing riparian buffer zones throughout the catchment and promoting better ways of managing stormwater.

3. Environmental management principles

Before excavating in waterways and wetlands a works plan should be prepared. The plan should outline the works to be undertaken and the measures that will be used to minimise the risk of causing environmental harm. The measures outlined should include those described below.

3.1 Get expert advice

- Undertaking works in streams without expert advice can cause environmental harm that may be difficult and expensive to remediate. Expert advice should be sought before excavating the bed and banks of waterways. Depending on the scale of the works, advice may be needed from one or more experts, including a stream biologist, river engineer, fluvial geomorphologist or hydrologist.

3.2 Avoid works on high risk sites

- The location and extent of any proposed excavation should be assessed on a case-by-case basis.
- The proposed works should meet the requirements of all relevant legislation, policies and regional strategies. Other ways of achieving the objectives of the works should be considered.
- Streams containing threatened plants and animals and having pristine ecosystem Protected Environmental Values should not be excavated.
- Significant geomorphological and cultural heritage sites should be protected.
- Avoid excavating upstream of nearby drinking water supplies and industrial water off-takes that need high quality water.
- The risk of damaging public and private infrastructure should be considered.
- The works should not damage recreational and aesthetic amenities.
- The likelihood that the sediments contain toxic materials, such as pesticides and metals, should be determined. If sediments upstream and downstream of the works site could be disturbed, these should also be assessed.
- Extracting sand and gravel from a waterway is only acceptable in rare situations where it benefits the waterway and surrounding environment. For example, where human activities outside the river reach have caused a build-up of sand and gravel (sediment slugs) that has eroded or changed the course of the stream, or destroyed habitat.

3.3 Understand site and system

- Waterways are complex systems and excavating them can cause unexpected consequences. Having accurate information about the stream channel and the discharge of water that shapes it, is critical to ensuring the works will be successful and harm minimised. Information about the geomorphology and land use in the catchment and sub-catchment should also be obtained. Stream Channel Analysis. River Restoration Report No. 9 (WRC, 2001a) (available on the internet) describes the information that should be collected before starting works. Groups and individuals excavating streams without this information risk causing environmental degradation, and having structures fail and costly maintenance problems afterwards.

Desk top survey to gather information about the stream area and catchment history	**Field work** to survey the stream and its catchment and gather information from locals	**Calculations** based on the information gathered that help plan the works
Catchment area and use	Longitudinal channel survey	Channel slope
Estimates of channel dimensions	Bank-full level	Average bank-full
Flow records	Stream cross-section	Wetted perimeter
Determine channel forming flow from flow records	Existing flow velocity	Channel roughness
Longitudinal survey of river channel	Assess bed material	Hydraulic radius
	Sketch map of channel	Median bed paving
	Assess foreshore and habitat	Flow velocity
		Discharge
		Stream power
		Critical flow

3.4 Adopt construction practices guidelines

- Contractors and plant operators undertaking works in streams should adopt the principles outlined in *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands* to minimise the risk of causing environmental harm. These guidelines focus on preparing for works, controlling sediment and erosion, avoiding contaminant spills, and stabilising and rehabilitating the stream.

3.5 Retain stream geometry, materials and habitat

- The stream should be restored to its 'natural' state after works have been completed. This will be easier if information about the waterway's environmental and aesthetic values was collected before the works started. Similar healthy, unmodified reaches in the catchment can be used as models if the site is degraded.
- Local, natural materials, such as rock and timber, should be used if possible. Artificial materials, such as concrete, old tyres and gabions, are less attractive. They also create a different flow regime to that of the original channel, need considerable maintenance, and do not provide good habitat for aquatic animals. The local materials should come from an appropriate source, such as an approved quarry.
- Creating large discontinuities in the water surface profile should be avoided. A vertical drop of more than 10 centimetres will stop native fish swimming upstream.
- A series of structures (eg a pool and riffle sequence or a series of large woody debris) should be used rather than a single structure if possible. More complex structures create a greater variety of habitats while still preventing erosion.
- Elements that create roughness in the stream, such as large woody debris, are critical for maintaining healthy aquatic ecosystems and should be restored.

3.6 Stabilise stream diversion (if required)

- If the channel is being re-aligned, the flow must be diverted into a properly designed and constructed channel that has been stabilised. It should not be diverted into an undefined channel.

3.7 Protect stream-entry points

- If extensive surface runoff may enter the receiving channel, the runoff should be directed through properly designed and constructed drainage ditches.
- It is best if drainage ditches and streams have small gradients as they approach and enter the receiving channel. If the gradient of the incoming drain or stream is steep, it may be necessary to line it with protective rock to prevent erosion of the receiving stream. If necessary, rip-rap may be used to line the bank of the receiving channel and prevent erosion and slumping of its banks.

3.8 Avoid constructing levee banks

- Levee banks are considered to be channel works even though they are not constructed in the stream channel. Levee banks deepen the flow channel during floods, which increases the likelihood of erosion along the stream bed and banks.
- Using large, long levees to prevent flooding of flood plains adversely affects the channel system and adjacent areas. Wetlands and riparian areas often rely on flooding to supply nutrients and trigger plant growth. Diverting flood waters away from these areas may make it difficult or impossible for plants to survive.
- If possible, development should be avoided on flood-prone areas. This removes the need to construct flood-protection structures.

3.9 Revegetate

- Deep-rooted plants, such as trees and shrubs, should be planted along the banks to stabilise the channel, provide shade to control water temperature, provide habitat and food for animals, and create an attractive and healthy waterway. Local, native riparian species should be used if possible.

- The works site should be monitored and maintained after revegetation to make sure the plants establish and weeds are controlled.

4. References

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These guidelines should be used in conjunction with the appropriate technical advice and literature.

Checklist

This checklist summarises the environmental management principles outlined in *Environmental Best Practice Guidelines 3. Excavating in Waterways*. The plan of works prepared for all works involving excavation in a waterway should describe the proposed works and show that the measures listed below will be used to minimise the risk of causing environmental harm during and after the works.

❑ Works plan prepared

Methods for controlling erosion (Section 2)

❑ Appropriate erosion-control method/s selected

Get expert advice (Section 3.1)

❑ Expert advice sought

Avoid works on high risk sites (Section 3.2)

❑ Environmental risk assessed

❑ Legislative and policy requirements met

❑ Sensitive ecosystems protected

❑ Geomorphological and cultural heritage sites protected

❑ Downstream water supplies and sensitive industrial off-takes not affected

❑ Public and private infrastructure not threatened

❑ Recreational and aesthetic effects minimal

❑ Public safety and use protected

❑ Contaminated sediments not present

Understand site and system (Section 3.3)

❑ Stream survey undertaken

Adopt construction practices guidelines (Section 3.4)

❑ Works conform to *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands*

Retain stream geometry, materials and habitat (Section 3.5)

❑ Natural geometry, materials and habitat maintained or restored

Stabilise stream diversion (Section 3.6)

❑ Diversion channels stabilised

Protect stream-entry points (Section 3.7)

❑ Stream entry points protected

Avoid constructing levee banks (Section 3.8)

❑ Flood protection used to minimise environmental effects

Revegetate (Section 3.9)

❑ Rehabilitation and revegetation program prepared

Environmental Best Practice Guidelines 4. Minimising Environmental Harm from Agricultural Drainage Channels

Agricultural lands are usually drained to improve crop production. Drainage removes excess water from the soil surface and the soil profile of crop land and pasture by gravity or artificial means. This helps create a well aerated soil, which enables better uptake of nutrients by plants. Draining wet soils allows early ploughing and planting, vigorous crop growth, and better productivity. Sub-surface drainage may also be used to prevent salinity in heavily irrigated soils.

Properly planning, designing and maintaining drainage channels will minimise the likelihood that they cause environmental harm and alleviate some of their adverse effects.

1. Potential environmental effects

Agricultural drainage improves crop production but it can also cause environmental harm.

Degrades waterways: Drainage works, such as straightening channels so water moves downstream faster, can alter the morphology and function of waterways. This can trigger erosion of the stream bed and banks, and degrade aquatic and riparian habitats.

Destroys wetlands: Wetlands perform important hydrological, biological, chemical and physical functions for the environment at the farm and catchment levels. They provide temporary water storages that reduce flooding during periods of high rainfall. They provide habitat for wetland plants and animals. They act as a filter or 'sink' for sediments and nutrients moving through the catchment. Draining wetlands destroys these functions.

Drainage works can have significant environmental impacts

Increases sediment loss during construction: Constructing drains can cause increased erosion and soil transport in the surface water. The effects may be only temporary as they may diminish when the exposed soil has been revegetated and stabilised. However, the increased movement of sediment may persist if the drainage leads to greater surface runoff.

Increases erosion due to increased water velocity: Drains on sloping land can increase water velocities. This can lead to erosion of the base and banks of the drains, greater transport of sediment, and siltation downstream. Serious erosion may occur even on very low gradient slopes (1:100 or less) if there is no vegetation cover.

Badly designed drainage works can trigger serious erosion

Exacerbates flooding downstream: Improved drainage can lead to flooding elsewhere if more water enters the waterway during times of high rainfall. If the receiving waterway is unable to accommodate the extra water, flooding, erosion and habitat disturbance downstream may result. 'Solving' the flooding problem at a site by building a drainage system may cause or increase the severity of flooding downstream. Drainage may move the problem rather than solve it.

Degrades water quality: Draining land may reduce the quality of water in the receiving stream by increasing the amount of sediment, fertiliser, herbicide, pesticide, organic waste and other pollutants washed into it. The pollutants may adversely affect aquatic plants and animals, and restrict water use downstream.

Increases drain outfall erosion: Headward erosion in the base of the outfall drain may result if there is no outlet structure and there is a substantial drop between the outlet of the agricultural drain and the normal low flow level of the stream. Extensive bank erosion may result if the drainage flow goes under or around the outfall pipe or upstream headwall. The erosion may also destroy the outfall structure.

2. Environmental design requirements

Before starting drainage works a works plan should be prepared. The plan should outline the works to be undertaken and the measures that will be used to minimise the risk of causing environmental harm. The measures outlined should include those described below.

Further information on farm drainage can be found in the Drainage Information Package produced by the Department of Primary Industries, Water and Environment (DPIWE, 2002).

2.1 Seek expert advice

- Undertaking drainage works without obtaining expert advice can cause environmental harm that may be difficult and expensive to remediate.
- Professional advice will usually be needed when designing a drainage system. In some cases only a preliminary assessment will be needed. However, for larger systems detailed soil analyses, and hydrological and hydraulic design engineering advice may be needed.
- Advice should be sought from one or more experts, such as a river engineer, soil manager or hydrologist, before excavating stream beds and banks.

2.2 Plan adequately

- All relevant legislative and policy requirements should be taken into account when planning a drainage system (eg Ramsar wetland sites, threatened species, possible water pollution). See *Environmental Best Practice Guidelines 1. Legislative and Policy Requirements for Protecting Waterways and Wetlands when Undertaking Works.*
- Drainage works may increase or decrease flows on neighbouring properties. Neighbours should be notified of the proposed works and their consent obtained. This will reduce the likelihood of legal action being taken to remedy flood damage or perceived changes in water availability.
- Existing elements of the drainage system, such as natural channels, wetlands and riparian vegetation, should be preserved. If possible, drains should be designed to follow the existing drainage lines in well defined depressions.
- The land capability should be determined. Will the slope of the land sustain the drainage proposed? Does the design need to be changed to minimise the risk of causing environmental harm?
- The soils should be analysed to make sure they can sustain the drainage proposed. Some soils are more prone to erosion than others. Specialised drainage systems may be needed for dispersive, saline or sodic soils and where acid-sulphate soils may occur.
- The drainage capacity must be adequate. The likelihood of floods and the extent of waterlogging should be assessed to determine whether the proposed drainage system can convey the volumes of water anticipated. Floodplain maps, if available, can help in this assessment.
- The drainage proposal must show how the drainage water will be disposed of. Disposing of good quality drainage water poses few problems. However, care must be taken to ensure that poor quality discharge water does not affect land and water supplies downstream. In these cases, the design must prevent any adverse effects. Sediment traps may be needed, or collecting and reusing the water on site may be a better alternative.

2.3 Drainage channel design and construction

- The drainage system should be constructed during the dry months to minimise muddying of the waterway downstream. The drain banks should be allowed to revegetate before water flows again.
- The drainage system should not be ‘over-designed’ so excessive earthworks and bank armouring are needed.
- Paddock drains should be constructed with the minimum effective gradient to avoid erosion. Flow velocities in the drain must be non-erosive: less than 0.6 metres/second in loams and silts, and less than 1.2 metres/second in clays and gravels.

- Steep drain banks (batters) should be avoided as they are more likely to erode than banks with gentle gradients.
- Open ditches should be flat bottomed rather than V-shaped to prevent scouring.
- The existing waterways should not be straightened because straightening will increase the steepness of the drainage system and increase erosion.
- Areas of bushland should be retained, particularly along drains, to slow runoff and filter stormwater pollutants.
- Grass or other ground cover should be planted in the drain to prevent erosion into the waterway. The vegetation will also hold the banks together.
- Access for drain maintenance should be provided.

2.4 Outlet design

- An outlet structure will usually be needed so the drainage entering the waterway does not erode the outfall drain and the stream bed and banks.
- The choice of outlet structure will be determined by the site characteristics. The outlet structure may be a natural depression, excavated earthen drain, pipe, rock chute, flume or drop structure. The hydraulic characteristics that should be taken into account include design flows, exit velocities, and tail-water levels in the receiving stream, and the effects of greater-than-expected flows.

Drainage line discharge should not flow unconfined across the landscape

- The smallest but most effective outlet should be installed at a number of points to reduce sediment and nutrient transport by reducing the amount of water discharged at any one point. This approach is often used in 'hump-and-hollow' drainage systems but it can also be used with more conventional open-ditch systems.
- The concrete cut-offs around the outlet structures should be large enough to prevent flows bypassing the outfall pipe and causing erosion around the structure.
- Advice on outlet structures should be sought from experts, particularly for larger drainage systems. Rivercare Engineers and DPIWE Regional Water Management Officers are good sources of initial advice and referral.

2.5 Maintenance

- Stock access to the drains should be controlled. Fencing off the drains stops stock damaging them and defecating into them. This reduces the need to de-silt the drains, which reduces maintenance costs. It also reduces nutrient levels, which restricts weed growth. The fences should be inspected regularly to make sure they have not been damaged.
- A carefully planned weed control program should be implemented annually. Using the wrong weed control methods could be expensive and make the drains ineffective. If using chemical sprays, select the right chemicals so that the weeds are controlled without killing animals, such as frogs and fish, that may live in the drain. Contact a DPIWE Regional Weed Management Officer for information on the most appropriate sprays to use. Further information is also available in the Rivercare Guidelines for Safe and Effective Herbicide Use near Water, which is available on the DPIWE website.
- Check regularly for erosion in the drains and receiving waterway. Remediate if necessary.

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These guidelines should be used in conjunction with the appropriate technical advice and literature.

Checklist

This checklist summarises the environmental design requirements outlined in *Environmental Best Practice Guidelines 4. Minimising Environmental Harm from Agricultural Drainage Channels.* The plan of works prepared should describe the proposed works and show that the measures listed below will be used to minimise the risk of causing environmental harm during and after the works.

- ❑ Works plan prepared

Seek expert advice (Section 2.1)

- ❑ Expert advice sought

Plan adequately (Section 2.2)

- ❑ Legislative and policy requirements taken into account
- ❑ Neighbours notified
- ❑ Natural channels, wetlands and riparian vegetation preserved
- ❑ Land capability assessment undertaken
- ❑ Soil assessment undertaken
- ❑ Drain capacity adequate
- ❑ Drainage water will not adversely affect water quality downstream

Drainage channel design and construction (Section 2.3)

- ❑ Construction scheduled for dry period
- ❑ Excessive earthworks and bank armouring avoided
- ❑ Drain gradient (longitudinal and bank) will not trigger erosion
- ❑ Drain flat-bottomed
- ❑ Areas of bushland along drain retained
- ❑ Grass cover in drain planted
- ❑ Access for drain maintenance provided

Outlet design (Section 2.4)

- ❑ Outlet structure appropriate
- ❑ Smallest, most effective drainage outlets chosen
- ❑ Concrete cut-offs large enough

Maintenance (Section 2.5)

- ❑ Drains fenced off to control stock access
- ❑ Weed control plan prepared
- ❑ Erosion inspection and maintenance program prepared

Environmental Best Practice Guidelines 5. Siting and Designing Stream Crossings

1. Background

These best practice guidelines discuss the siting and design principles that should be used to minimise environmental harm when constructing stream crossings. The principles should be considered by local councils when developing planning schemes and assessing planning permits for the construction of stream crossings.

Undertaking construction works in waterways and wetlands without expert advice can cause severe environmental harm that may be difficult and expensive to remediate. Depending on the scale of the works, advice may be needed from one or more experts, including a stream biologist, river engineer, fluvial geomorphologist or hydrologist.

2. Stream crossing types

The type of stream crossing selected will depend on the crossing's purpose and anticipated frequency of use, the site characteristics (bank height, bed stability, flow regime, depth, etc), and the budget.

If possible and appropriate, use the structure that is least likely to cause environmental harm. As a general rule of thumb, in descending order of preference, use bridges, arch culverts, open-bottom box culverts, closed-bottom box culverts, and pipe culverts.

Bridges are raised structures that carry a path or road over a waterway. They are used when frequent crossings are anticipated. Typically, bridges are used on waterways with clearly defined drainage channels, permanent and semi-permanent pools, and wetlands connected to rivers. Usually, they have little or no in-stream framework so they do not impede flows. As a result, they can be used during most floods.

Bridges are the most appropriate crossings for sites

- with actively eroding banks
- where the channel is too steep for a culvert
- with steep banks that would need considerable infilling if a culvert were used
- with threatened species, fish habitat or aquatic vegetation.

Culverts are arched, boxed or piped conduits that allow water to pass under a road or other structure. They are usually made of concrete or galvanised corrugated steel pipe. The location and size of the culvert will be determined by its flow capability requirements and the need for it to be safe during high flows. Like bridges, some large box and arch culverts do not significantly alter the form of the stream bed or the width of the channel.

Causeways are structures that raise the base of the stream bed. They allow water to go through a culvert underneath when flows are low but are inundated during floods. Typically, causeways are located on waterways with intermittent flows, poorly defined drainage channels, and semi-permanent pools that provide habitat for aquatic animals. They are suitable for wide shallow streams with gravel and soft substrate beds where it is too expensive to construct a bridge or culvert and intensive use is not anticipated.

Fords are vehicular crossings that are almost level with the river bed. Low flows pass over the structure rather than through a culvert below. They are used when infrequent use is anticipated (if more frequent use is anticipated, a permanent or temporary culvert may be needed to prevent disturbance to the channel). Fords are 'wet' crossings so they should be used only when flows are low or non-existent. Fords are suitable for intermittent waterways with little or no defined drainage channel, no lasting pools, and little or no vegetation.

Stock crossings are natural stream crossings that have had little or no modification. Stock crossings are 'wet' crossings so they should be used only when flows are low or non-existent. Stock are one of the major causes of environmental harm to waterways so stock access to waterways - and stock crossings - should be controlled and minimised.

3. Site selection

Crossings can cause severe environmental harm to waterways and are expensive to install so the number of crossings should be minimised. Existing crossings should be used if possible. If a new crossing is needed and there is a choice of sites, the site should be selected to comply with the following requirements

- the stream reach is straight, well defined and unobstructed
- a right-of-way exists
- to minimise need for training works the geology and soil conditions should be stable with minimal scouring, and minimal deposition and displacement of sediments (that is, little active erosion and meandering)
- select an area where the risk from environmental hazards such as floods and landslides is minimal
- the hydraulic effects of natural features (eg waterfalls) and artificial in-stream structures (eg weirs)
- avoid wetlands and floodplains
- avoid areas where the works could mobilise contaminated sediments
- avoid areas that have threatened species and pristine ecosystem Protected Environmental Values
- avoid areas with significant cultural heritage or geomorphological values
- select an area where disturbance to the riparian vegetation can be minimised
- select an area where public safety, use and enjoyment will not be compromised
- avoid areas of aesthetic value
- additional care will be needed if the crossing is upstream of domestic and town water supplies, aquaculture and other industrial off-takes, sensitive ecosystems, and recreational areas.

4. Bridges

Potential environmental effects

Reduces stream stability: Mobilising and removing alluvial material during construction, and scouring caused by the bridge's piers and footings can reduce the stability of the stream bed and banks.

Degrades water quality: Mobilising sediments during construction, and scouring caused by the bridge's piers and footings may increase the sediment load and turbidity of the waterway. Runoff from the bridge's decking and approach roads may also degrade water quality.

Destroys bank vegetation: The stream banks under bridges are usually permanently dry and shaded because light and moisture are blocked by the bridge. The resulting death of the vegetation cover can lead to instability of the banks, less filtering of overland flow, and a loss of food and shelter for animals.

Restricts movement of animals: The bridge footings and bank armouring may stop animals moving along the banks. This may force animals to use the nearby roads, which increases their chances of being killed on the road, particularly on busy roads.

Environmental design requirements

Before constructing a bridge a works plan should be prepared. The plan should outline the works to be undertaken and the measures that will be used to minimise the risk of causing environmental harm. The measures outlined should include those described below.

- Contractors and plant operators undertaking construction works in streams should adopt the principles outlined in *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands* to minimise the risk of causing environmental harm.
- The bridge should be designed and constructed to accommodate all flow conditions. Expert advice will be needed on a range of geographical, hydrological, hydraulic and geo-technical issues. If the bridge is to be used by the public and heavy vehicles, detailed design drawings should be submitted. The drawings should be certified by a qualified engineer and satisfy all the relevant Australian Standards.
- The bridge should be perpendicular to the waterway.
- The waterway's natural hydraulic regime should be preserved as much as possible. The piers and footings should be placed beyond the channel and above the high water mark to avoid constricting the channel and reducing the flow area.
- If the piers and footings must be placed in the channel, they should be parallel to the flow so the flow is not directed onto the banks. The minimum number of optimally shaped pylons should be used to minimise eddying and scouring of the waterway. Erosion protection should be included if scouring is likely to occur.

The number of piers and footings should be kept to a minimum in stream channels

- Rock beaching is usually used on the batters to protect against scouring of the abutment because it is unlikely the area will revegetate due to a lack of light and moisture under the bridge. Generally, the beaching should extend three metres upstream and downstream of the bridge. The batters should be excavated to the depth of the beaching to maintain the channel area. The batter slope should be 1:1-1:2 (vertical:height). Generally, the beaching should extend at least 600 mm below the toe of the banks to prevent undermining. Rock beaching may not be needed if the banks are stable.
- Using grated decking on a multi-lane bridge, so light and moisture can penetrate, may be considered if the risk of pollution from road spills is minimal.
- If possible, enough space should be provided under the bridge for animals to walk along the banks.
- Steep approaches to the bridge should be avoided.
- Cross-fall drains should be used to drain water from the access road into a sediment trap or the roadside vegetation. The drains should be at least 20 metres away from the crossing.

5. Culverts

Potential environmental effects

Degrades stream bed and associated habitats: If a culvert replaces a section of the stream, the stream bed and its associated aquatic and riparian habitats will be lost.

Initiates erosion of channel: If a culvert is installed too high - so the downstream end lies above the stream bed (perched culvert) - a waterfall will result. This can lead to bed scouring, bank erosion, and undercutting and structural damage of the culvert. If the culvert slope is too great, the increased water velocity can cause erosion downstream.

Initiates erosion around culvert: Confining the stream flow to a culvert may alter the flow regime and trigger erosion, deposition at the inlet, and scouring at the outlet.

Causes flooding: Blockage of culverts by waterborne debris can cause flooding during high flows. Bridges are better able to accommodate high flows.

Restricts fish movement: Tasmanian freshwater fish migrate downstream to estuaries to spawn and the juveniles migrate upstream. Fish have always had to overcome natural barriers, such as waterfalls and log-jams, when migrating. However, the expansion of forestry and urbanisation has greatly increased the number of barriers they face. A complete barrier can lead to extinction of migratory species upstream and possibly downstream. Tasmanian native freshwater fish cannot jump so a perched culvert with a drop of more than 10 centimetres will usually be a barrier to migration upstream. A survey of culverts in southern Tasmanian forestry catchments found that 50 percent of those surveyed did not allow fish to enter because of perching. A survey of culverts on Tasmanian roads would probably produce similar results.

Perched culverts are a barrier to fish passage

Culvert inlets constrict stream flow, which increases the flow velocity at the inlet. The increased velocity may make it difficult for fish to swim upstream out of the culvert.

When culvert gradients are more than 2 percent (1:50), the resultant high water velocities can make it difficult for native fish to swim through. The problem is more severe during high flows and in culverts with smooth walls, particularly if there are no resting places (eg behind baffles) in the culvert. A survey of culverts in southern Tasmanian forestry catchments found that 70 percent of those surveyed impeded the movement of fish because the culvert slope was greater than 2 percent (1:50). High water velocities can also impede the movement of other aquatic species, such as platypuses and water rats.

If several small pipes are used rather than one large barrel, the culverts may be too small for fish to swim through. The fish may also be reluctant to enter the culverts because they are too dark. Anecdotal information suggests that some platypuses and giant freshwater lobsters (Astacopsis gouldi) are killed on roads when avoiding such culverts.

Fish cannot swim large distances without resting. A lack of pools and rest areas immediately upstream and downstream of the culvert may make the culvert impassable if the distance they have to swim without a rest is too far.

Debris and sediment may block small diameter culverts particularly if trash screens or stock barriers have been installed. While total blockages are unlikely, the accumulated debris may stop migratory species passing through by creating a physical barrier or increasing flow velocity.

Reduces recreational use: Culverts may reduce recreational use of the river, particularly for fishing and canoeing.

Environmental design requirements

Before constructing a culvert/s a works plan should be prepared. The plan should outline the works to be undertaken and the measures that will be used to minimise the risk of causing environmental harm. The measures outlined should include those described below.

Round culverts are the most commonly used and worst designed culverts in terms of environmental outcomes. However, all culverts can cause significant environmental harm.

The flow characteristics and road alignment may restrict the design of culverts. Nevertheless, they should be designed and installed according to the following requirements.

- Contractors and plant operators installing culverts should adopt the principles outlined in *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands* to minimise the risk of causing environmental harm.
- The culvert's capacity should be able to accommodate peak flow volumes.

Open-bottom culverts with the natural streambed running through them are the preferred culvert structures

- Open-bottom culverts should not create a break in the bed substrate, and should be large enough not to constrict flows or trap debris during normal flow conditions.

If an open-bottom culvert is not possible, the following requirements apply

- One large culvert spanning the width of the waterway is preferable to two or more small culverts because it is usually more efficient hydraulically.
- If multiple culverts are needed to span the stream bed, one or more should be slightly lower than the others to concentrate low flows and allow fish to swim through.
- The culvert should be perpendicular to the flow to minimise the length needed (less than 4 metres) and allow fish to swim through.
- The culvert gradient should be similar to that of the stream, which should be gently sloping. If fish may be passing through, avoid using culverts on a waterway that has a gradient of more than 2 percent (1:50). The gradient immediately downstream of the culvert should be less than 5 percent (1:20) so fish can approach the culvert outlet.
- The culvert should not create any significant discontinuities in the water profile. Its size and placement should not cause ponding upstream, unless ponding is typical of the river reach. Perched culverts should be less than 10 centimetres above the receiving waters.
- If fish may be moving through the culvert, the culvert invert should be buried so a minimum of 20 percent of the diameter (round culvert) or 20 percent of the height (box culvert) lies below the channel bed. Generally, the invert should be placed so the water in the culvert is at least 200-500 millimetres deep during low flows.
- If the culvert gradient is 0.5-3.5 percent (1:200-1:30) the culvert diameter should be at least 1.25 times the width of the channel and the downstream invert should be embedded at least 20 percent below the stream bed. Natural substrate should be placed in the culvert if possible. This guideline applies only if the product of channel slope and culvert length is less than 20 percent of the culvert diameter.
- If possible, the culvert should be designed so its hydraulics are similar to that of the stream and the weakest fish species can swim through. The water depth should allow the largest fish species to remain submerged.
- The culvert should have at least 600 millimetres of space above the typical base flows so it is light enough inside that fish are not discouraged from entering and swimming through.
- Water velocities in the culvert should be similar to those at the site before the culvert was constructed. There should also be no differences in the flow rates upstream, in and downstream of the culvert.
- Baffles or large angular rocks typical of the area can be cemented along the base of longer concrete culverts to reduce flow velocities and allow fish and invertebrates to pass through. Lining the base of the culvert with a rough concrete finish and/or natural substrate will increase turbulence and make it easier for fish to swim through. Velocities of less than 0.3 metres/second will allow most native fish to swim through a 5 metre culvert. Placing small rocks along the base may also help other species, such as platypuses and water rats, pass through the culvert.
- Water velocities may be decreased and water depths increased by using appropriately designed tail-water control devices. These devices can be incorporated into the outlet-basin design.
- Fish resting pools constructed upstream and downstream of the culvert should be at least two metres long along the direction of flow, be deep enough for fish to remain submerged, and contain rocks and vegetation to provide cover. Aquatic and riparian plants can provide shading.

- Inlet and outlet flow velocities of less than 0.9 metres/second will not transport silt.
- A rip-rap apron should be placed up to six culvert diameters beyond the end of the pipe to prevent erosion downstream of the culvert outlet, particularly if the slope of the stream bed is greater than 2 percent (1:50). The apron should have a V-shaped cross-section so fish can swim through when water levels are low.
- The capacity of the culvert should be large enough to accommodate some deposition of gravel in the culvert.
- The culvert should be large enough to accommodate the anticipated debris and sediment load. The greater the anticipated load the greater the cross-sectional area needed for the culvert. Regular maintenance will be needed to remove debris and sediment and check for erosion.
- The culvert should not reduce the cross-sectional area of the channel and infilling of the channel should be avoided.
- Fill placed below the high water mark must be free of fines, sediment, soil, pollutants, contaminants, toxic materials and other waste materials.
- Steep approaches to the crossing should be avoided.
- Cross-fall drains should be used to drain water from the approach road into a sediment trap or the roadside vegetation. The drains should be at least 20 metres away from the crossing.

6. Causeways

Potential environmental effects

Initiates erosion: Poorly sited causeways can lead to erosion of the stream bed and banks. Scour holes may develop downstream of the causeway, and may undermine and outflank the structure. Restricted sediment transport and increased flow velocities may increase bed erosion.

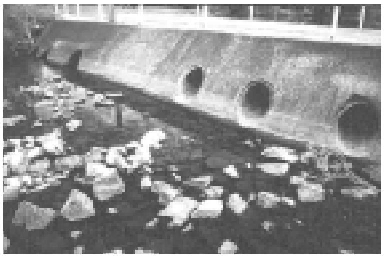
Deposits sediment into river: Poorly designed causeway approaches can erode and deposit large amounts of sediment into the waterway.

Causes flooding: Causeways can cause more frequent local flooding if they restrict flows.

Restricts fish movement: In steep gradient streams, a drop may be created on the downstream side of the causeway. This may make it difficult for fish and other aquatic animals to cross. Many freshwater species, particularly fish, need to swim freely in rivers to survive. Fish blocked by structures are more likely to be taken by birds.

Environmental design requirements

Before constructing a causeway a works plan should be prepared. The plan should outline the works to be undertaken and the measures that will be used to minimise the risk of causing environmental harm. The measures outlined should include those described below.



Multi level culverts may allow fish to pass through causeways during low flows

- Contractors and plant operators constructing causeways should adopt the principles outlined in *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands* to minimise the risk of causing environmental harm.
- If a culvert is used it should comply with the environmental design requirements for culverts (see 'Section 5. Culverts').
- The causeway should be sited on a straight stretch of the waterway that has a minimal gradient.
- The causeway should be perpendicular to the waterway.
- The river's normal hydraulic regime should be preserved as much as possible.
- The site should have a stable substrate and scour resistant material immediately downstream.
- The causeway should not be sited near a riffle or pool if possible because of the likelihood of causing erosion and degrading aquatic habitat.
- Both ends of the causeway should be 'keyed in' to the bank for 3-5 metres.
- The surface of the causeway should be constructed of erosion-proof material, such as interlocking angular rock or concrete.
- Deep box cuts should be avoided on the approaches to the causeway.
- Cross-fall drains should be used to drain water from the approach road into a sediment trap or the roadside vegetation. The drains should be at least 20 metres away from the crossing.

7. Fords

Potential environmental effects

Initiates erosion: Poorly designed and sited fords may trigger stream bed and bank erosion. Scour holes may develop below the ford if the invert is higher than the stream bed. This may eventually undermine and outflank the ford. Poorly designed approaches to fords may erode and deposit large amounts of sediment into the waterway.

Destabilises channel: Frequent use of unhardened fords may destabilise the channel and cause bed and bank erosion and siltation.

Restricts sediment transport: Fords may block sediment moving downstream by acting as a weir. Restricted sediment transport and increased flow velocities may increase bed erosion downstream of the ford.

Causes flooding: Fords may increase the frequency of local flooding by restricting flows.

Restricts movement of fish and aquatic animals: Fixed structures, such as concrete fords, cannot adjust their form as the height of the stream bed changes. If the stream bed deepens in a steep gradient stream, a vertical drop and waterfall may develop on the downstream side of the ford. This may prevent or make it difficult for fish and other aquatic animals to travel upstream across the ford.

If the ford is made of smooth concrete, the increased water velocities may make it difficult for fish and other aquatic animals to cross.

Flows are often spread across the width of fords during low flows. As a result, the water may be too shallow to allow fish and other aquatic animals to cross.

Environmental design requirements

Before constructing a ford a works plan should be prepared. The plan should outline the works to be undertaken and the measures that will be used to minimise the risk of causing environmental harm. The measures outlined should include those described below.

- A ford is appropriate only if infrequent use is anticipated.
- Contractors and plant operators constructing fords should adopt the principles outlined in *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands* to minimise the risk of causing environmental harm.
- The ford should be constructed and used during the driest times of the year.
- The site of the ford should have a stable, non-erodible rock or bedrock base to minimise siltation from traffic. Sandy, vegetated and silty sites are not appropriate.
- The ford should be perpendicular to the waterway.
- If rocks are used to construct the ford, they should be almost level with the stream bed and they should not affect flows significantly. Only clean material from another site should be used. Excavating rock from the stream is rarely acceptable.
- The surface of the ford should be constructed of an erosion-proof material, such as interlocking angular rock or concrete.
- Concrete fords should have a 'V'-shaped or rounded notch on the thalweg of the stream (lowest point of main channel) so fish can swim across the ford during times of low flow. The 'V' or notch should be least 5 centimetres deep and 30 centimetres wide.

Fords should be perpendicular to the waterway on non-erodible substrate

- Avoid deep box cuts on the approaches to the ford. The height of the banks adjacent to the ford should be less than 2 metres.
- Non-erodible material should be used on both banks to stabilise the approaches to the ford.
- The amount of vegetation removed adjacent to the ford should be minimised.

- Cross-fall drains should be used to drain water from the approach road into a sediment trap or the roadside vegetation. The drains should be at least 20 metres away from the crossing.
- Grease, oil and other fluids should be cleaned off all vehicles before entering the ford.
- A fence may be needed to stop stock entering the stream from the ford.

8. Stock crossings

Potential environmental effects

Degrades stream bed and banks: Stock in waterways degrade stream beds and banks by destroying the vegetation cover, eroding the bed and banks, compacting the soil and introducing weeds.

Degrades water quality: Stock in waterways degrade water quality by stirring up sediment. They also increase the number of bacteria and viruses in the water when they defecate into waterways. If access is uncontrolled, injured and dead stock can contaminate the stream and threaten public health.

Uncontrolled stock access can destabilise the stream bed and banks and degrade water quality

Environmental design requirements

Before constructing a stock crossing a works plan should be prepared. The plan should outline the works to be undertaken and the measures that will be used to minimise the risk of causing environmental harm. The measures outlined should include those described below.

- Contractors and plant operators constructing stock crossings should adopt the principles outlined in *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands* to minimise the risk of causing environmental harm.
- Stock crossings should not be used as watering points.
- If a naturally hardened substrate is not available, modification of the stream should be limited to hardening the stream bed.
- The approaches should be constructed of gravel or stone.
- Smooth approach ramps and walkways allow manure to be removed with a scraper.
- Electric fences should be placed on both sides of the walkway to stop stock moving along the stream bed and banks. Alternatively, plain-wire fences may be used because they are easily repaired and replaced after floods. Mesh-type fences (eg ringlock) should not be used because they catch debris and restrict flood flows.

If a temporary watering point is needed

- Allow stock to drink only at properly constructed and controlled access points. The watering point should be located on the downstream side of an inside bend that is not prone to erosion.
- Fencing off the riparian zone allows the timing, intensity and duration of stock access to the waterway to be controlled. Fences around the watering point should extend into the water.
- Providing water in troughs and dams away from the stream is better than creating a temporary watering point along the bank.

9. Ongoing maintenance

All stream crossings should be maintained regularly to minimise the risk of causing erosion and flooding, and obstructing the passage of fish and other animals. Regular inspections and maintenance should be carried out on new crossings, after periods of high flow, and before fish and other animals begin migrating. The inspection and maintenance should

- clear debris from the crossing's surface, entrance and exit
- remove excess silt from the entrance and exit of the culvert/s if more than a third of the entrance is blocked.
- make sure erosion is not being exacerbated.

10. Removing crossings

Stream crossings impede the movement of migratory fish and other animals. If a crossing is no longer being used, consider removing it and rehabilitating the site. Seek advice from the Inland Fisheries Service before removing any crossings.

11. References

Alberta Environment. 2001. *Guide to the Code of Practice for Watercourse Crossings, including Guidelines for Complying with the Code of Practice.* Alberta Environment, Edmonton. www.gov.ab.ca/env/water/Legislation/CoP/WatercourseGuide.pdf

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Fairfull, S. & Carter, S. 1999. (eds.) *Policy and Guidelines for Bridges, Roads, Causeways, Culverts and Similar Structures. NSW Fisheries, Sydney.*
www.fisheries.nsw.gov.au/conservation/policies/pdf/brochure.pdf

Inland Fisheries Service. 2001. *Culvert Use Guidelines for Aquatic Fauna Passage.* IFS, Hobart.

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NSW Fisheries & Catchments & Creeks. 2003. *Why Do Fish Need to Cross the Road?* National Guidelines on Fish Passage Requirements for Waterway Crossings. NSW Fisheries, Cronulla. (in press)

Walker, R. 1999. *Examination of the Barriers to Movement of Tasmanian Freshwater Fish Species.* Honours thesis. University of Tasmania, Hobart.

Witheridge, G. 2003. *Fish Passage Requirement for Waterway Crossings: Engineering Guidelines.* Institute of Public Works Engineering, Sydney. (in press)

These guidelines should be used in conjunction with the appropriate technical advice and literature.

Checklist

This checklist summarises the environmental design requirements outlined in E*nvironmental Best Practice Guidelines 5. Siting and Designing Stream Crossings*. The plan of works prepared should describe the proposed works and show that the measures listed below will be used to minimise the risk of causing environmental harm during and after the works.

❑ Works plan prepared

Stream crossing types (Section 2)

❑ Crossing type appropriate

Site selection (Section 3)

❑ Stream straight and well defined

❑ Right-of-way exists

❑ Geology and soil conditions appropriate

❑ No major environmental hazards

❑ Flow not affected by in-stream natural features or other structures

❑ Not wetland or floodplain

❑ Contaminated sediments not likely to be mobilised

❑ Threatened flora and fauna protected

❑ No pristine ecosystem Protected Environmental Values

❑ Sensitive ecosystems protected

❑ Cultural heritage and geomorphological values protected

❑ Vegetation disturbance minimised

❑ Public safety and use not compromised

❑ Minimal aesthetic effects

❑ Downstream town and domestic water supplies protected

❑ Sensitive downstream industrial off-takes protected

Bridges (Section 4)

❑ Works conform to *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands*

❑ Engineering advice sought

❑ Design drawings comply with Australian Standards

❑ Perpendicular to waterway

❑ Piers and footings designed and sited appropriately

❑ Appropriate rock beaching used

❑ Grated decking considered

❑ Terrestrial access along stream banks provided

❑ Approaches well designed

❑ Sediment control measures used

Culverts (Section 5)

- ❑ Works conform to *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands*
- ❑ Expert advice sought
- ❑ Retains natural stream bed
- ❑ Peak flow capacity adequate
- ❑ Low flows concentrated
- ❑ Perpendicular to flow
- ❑ Length does not restrict movement of aquatic animals
- ❑ Gradient approximates stream gradient
- ❑ No ponding upstream
- ❑ Drop less than 10 cm in perched culverts
- ❑ Pipe culvert embedded in stream bed
- ❑ Culvert size allows light entry
- ❑ Natural flow velocities retained
- ❑ Internal surface modified to reduce water velocities
- ❑ Tail-water control devices considered
- ❑ Shaded fish resting pools upstream and downstream of culvert
- ❑ Erosion control at outlet if necessary
- ❑ Anticipated sediment and debris load accommodated
- ❑ Fill material effects minimal
- ❑ Approaches well designed
- ❑ Sediment control measures used

Causeways (Section 6)

- ❑ Works conform to *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands*
- ❑ Expert advice sought
- ❑ Complies with culvert environmental design requirements
- ❑ Site appropriate
- ❑ Perpendicular to flow
- ❑ Stream substrate stable
- ❑ Not sited near riffle or pool
- ❑ Causeway 'keyed in' to banks
- ❑ Roughened erosion-proof surface used
- ❑ Approaches well designed
- ❑ Sediment control measures used

Fords (Section 7)

- ❑ Frequency of use appropriate
- ❑ Expert advice sought (depending on scale of works)
- ❑ Works conform to *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands*
- ❑ Site appropriate
- ❑ Minimal effects on flows
- ❑ Substrate stable
- ❑ Approaches well designed and stable
- ❑ Roughened erosion-proof surface used
- ❑ Fish able to cross during low flows
- ❑ Fenced off to control stock access
- ❑ Sediment control measures used

Stock crossings (Section 8)

- ❑ Expert advice sought (depending on scale of works)
- ❑ Works conform to *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands*
- ❑ Site and substrate appropriate
- ❑ Walkway at or near stream bed level
- ❑ Minimal effects on flow
- ❑ Fenced off to control stock access
- ❑ Off-stream watering points considered
- ❑ Access points hardened
- ❑ Sediment control measures used

Ongoing maintenance (Section 9)

- ❑ Maintenance program prepared

Environmental Best Practice Guidelines 6. Managing Large Woody Debris in Waterways

Branches, large limbs and trees that have fallen into rivers are commonly referred to as large woody debris (LWD) or snags. LWD is a vital component of Tasmanian waterways and its removal can severely degrade their health.

Woody debris is a vital component of healthy waterways

'De-snagging' and the removal of vegetation for forestry and agriculture has reduced the amount of LWD in our waterways. More willows and fewer native trees in riparian areas has also led to changes in the amount and type of LWD. All three processes have reduced the richness and density of macro-invertebrates in our waterways.

In recent years, a better understanding of the importance of LWD for aquatic ecosystems has led to changes in the way our rivers are managed. The focus of management has shifted from widespread 'de-snagging' of streams to maintaining and re-introducing LWD into streams.

When managing LWD in waterways, the challenge is to weigh up the ecological benefits of retaining the LWD against the possible adverse changes in river level the LWD may cause.

1. Importance of LWD

Stabilises river beds and banks: LWD decreases erosion of river beds and banks by resisting and deflecting flows.

Provides fish habitat: LWD provides shelter from high velocity flows, shade, feeding and spawning sites, nurseries for larvae and juvenile fish, territory markers for migratory fish, and refuges from predation. For example, river blackfish use hollow logs in the LWD for protection while spawning in spring and early summer.

Provides niche habitat: LWD creates a range of flow conditions from deep pools to chutes and aerated water, which provide a variety of habitats for aquatic plants and animals.

Improves water quality: LWD oxygenates the water flowing over it during low flows and reduces water stagnation. This increases the availability of oxygen for fish and reduces odours.

Provides space for colonisation: LWD provides a range of surfaces, including grooves, splits and hollows, on which invertebrates, microbes and algae can colonise. These tiny organisms lie at the bottom of the food chain and provide food - directly and indirectly - for all the animals living in the stream, including macro-invertebrates, fish, water rats and platypuses.

Provides food: The dissolved and particulate organic material (carbon) from LWD is an important source of food for aquatic invertebrates and fish. For example, the giant freshwater lobster (Astacopsis gouldi), which is listed in Commonwealth and Tasmanian threatened species legislation, relies on decaying wood for its diet.

Supports invertebrate life cycle: Many aquatic invertebrates have a terrestrial adult stage. These species need LWD that protrudes out the water so they can emerge from the larval to the adult stage of their life cycle.

Aids re-colonisation: Scour pools formed by LWD provide pockets of habitat for aquatic species in streams with little or no summer flows. The species living in these pools provide a reservoir of species that migrate and colonise the rest of the stream when flows increase.

Provides perches: Birds, reptiles and mammals use protruding LWD as resting, foraging and lookout sites.

Provides alternative food sources: LWD may be the main source of food for aquatic animals if streams in the catchment have been extensively dammed and stripped of their riparian vegetation.

2. Re-positioning LWD

Re-positioning LWD is an option if the debris is causing detrimental variations in flow and removing it cannot be justified on economic and ecological grounds. The objective of re-positioning is to minimise the negative effects on flow while still maintaining an ecologically desirable range of flow velocities and water depths in the channel.

Potential environmental effects

Initiates bank erosion: Re-positioning LWD may initiate bank erosion by diverting flows. The likelihood that LWD will initiate erosion depends on the alignment and size of the debris, the flow velocity and depth of the river, and the composition of the bed and banks. Generally, the likelihood of erosion decreases as river size increases.

Mobilises sediment: Re-positioning LWD may increase the maximum stream velocity in the centre of the river, which may mobilise bed sediment and deepen the stream. Sometimes, relocating LWD causes more problems than leaving it in place.

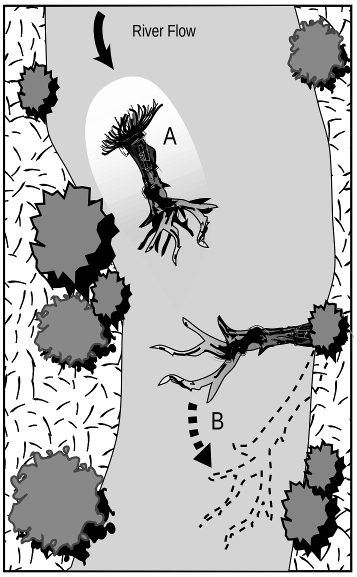
Degrades water quality: Short-term disturbance of sediment during re-alignment, and long-term erosion and mobilisation of sediment after re-alignment may degrade water quality.

Destroys habitat and food sources: Excessive re-alignment of logs closer to the bank may disturb or destroy existing aquatic habitats and food sources.

Environmental management principles

Before re-positioning LWD a works plan should be prepared. The plan should outline the works to be undertaken and the measures that will be used to minimise the risk of causing environmental harm. The measures outlined should include those described below.

- Undertaking works in waterways without expert advice can cause environmental harm that may be difficult and expensive to remediate. Depending on the scale of the works, advice may be needed from one or more experts, including a stream biologist, river engineer, fluvial geomorphologist or hydrologist.
- A proposal for re-positioning LWD should be treated like any other development needing council approval. A management proposal should be prepared that justifies the project and states its objectives (supported by hydraulic calculations that show the effects on velocity and flow), evaluates the environmental impact, and specifies the intended works. All relevant agencies and interested parties should be given the opportunity to comment on the proposed works.
- Works in or near streams should adopt the principles outlined in *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands* to minimise the risk of causing environmental harm.
- Logs lying perpendicular to the flow should be rotated so they lie closer to the bank at an angle of 0-40°. This should improve the capacity of the channel to carry peak flows while retaining a reasonable variety of habitats. Placing LWD this way creates lower water levels, maintains the surface area of the debris for aquatic plants and animals, and increases the availability of low velocity habitats.
- Placing all the logs along the edge of the stream bank will improve the flow capacity but reduce the availability of slow water habitats. While the LWD should be roughly aligned to the direction of flow, it should be placed in a variety of locations and alignments so it creates a variety of habitats. It should also be arranged so it is closely spaced.
- It may be necessary to anchor the re-positioned LWD so it is not carried away during high flows.
- The works should be inspected and maintained regularly to make sure they are effective.



LWD provides feeding and refuge areas for fish and other aquatic species. Hydraulic forces around LWD contribute structural diversity to the river bed - eg upstream scour pools (A). LWD should not be disturbed unless it is shown to be causing unacceptable flooding or erosion. If action is required, re-aligning LWD nearer to the bank is preferred to removal (B).

3. Removing LWD

In the past, river management agencies and landowner groups and individuals removed LWD from rivers - often because they were concerned it could cause flooding. However, there is little evidence to support the argument that removing LWD reduces the frequency of floods or improves the capacity of rivers to carry floods.

A river channel must be blocked substantially before the movement of flood waters is affected. Such blockages are generally obvious and would usually be described as a log-jam. LWD that lies perpendicular to the flow and covers more than 10 percent of the channel's cross-section may increase the likelihood of the stream flowing over its banks during floods. Smaller LWD has little effect on water levels.

Potential environmental effects

Initiates erosion and mobilises sediment: Removing LWD reduces the resistance to flow and may divert flows. This may trigger channel instability and further erosion without alleviating the flooding problem. Removing LWD may also increase the maximum stream velocity in the centre of the river, which may mobilise bed sediment and deepen the stream bed.

Degrades water quality: Short-term disturbance of sediment during removal, and long-term erosion and mobilisation of sediment after removal may degrade water quality.

Exacerbates flooding downstream: Complete removal of LWD and riparian vegetation in the middle to upper catchment may increase flow conveyance and exacerbate flooding problems for towns and properties downstream.

Destroys habitat and food sources: Removing LWD may disturb or destroy aquatic habitats and food sources.

Environmental management principles

Before removing LWD a works plan should be prepared. The plan should outline the works to be undertaken and the measures that will be used to minimise the risk of causing environmental harm. The measures outlined should include those described below.

- The preferred - and the most effective and cheapest - approach is to leave the LWD undisturbed, unless it is causing unacceptable flooding or severe erosion.
- If a log-jam is causing flooding it may be possible to re-position the tree trunks or lop the limbs. Re-positioning the fallen tree trunks so they are more closely aligned to the bank will reduce the effect they have on river levels while still maintaining their ecological benefits. Lopping the limbs to reduce the amount of debris they trap may reduce their effect on flow levels.
- Removing the LWD may be the only option if the debris is blocking a large proportion of the channel and it cannot be re-positioned, is hazardous to recreational users, or becomes trapped around a bridge and creates a safety hazard.
- Undertaking works in waterways without expert advice can cause environmental harm that may be difficult and expensive to remediate. Depending on the scale of the works, advice may be needed from one or more experts, including a stream biologist, river engineer, fluvial geomorphologist or hydrologist.
- A proposal for removing LWD should be treated like any other development needing council approval. A management proposal should be prepared that justifies the project and states its objectives (supported by hydraulic calculations that show the effects on velocity and flow), evaluates the environmental impact, and specifies the intended works. All relevant agencies and interested parties should be given the opportunity to comment on the proposed works.
- Works in or near streams should adopt the principles outlined in *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands* to minimise the risk of causing environmental harm.
- If long-lasting hardwoods are being removed, consider relocating the wood or storing it for future habitat restoration works.
- The works should be inspected and maintained regularly to make sure they are effective.

4. Re-introducing LWD

Extensive clearing of riparian and floodplain vegetation has removed the sources of LWD in many of our waterways. Even if successful stream bank revegetation has been undertaken, it may take hundreds of years to generate a new supply of LWD. Re-introducing LWD should be considered when restoring rivers to speed up their recovery. This will complement the effects of revegetating the banks and improve the river's ecological health.

Potential environmental effects

Re-introducing LWD will usually improve the river's health. However, it can cause detrimental environmental effects.

Degrades water quality: Short-term mobilisation of sediment when re-introducing LWD, and long-term erosion and mobilisation of sediment after re-introducing LWD may degrade water quality.

Destroys habitat: Re-introducing LWD can change the stream's hydraulic regime. This may lead to a loss of the plants and animals that were adapted to the previous conditions at the site.

Environmental management principles

Before re-introducing LWD a works plan should be prepared. The plan should outline the works to be undertaken and the measures that will be used to minimise the risk of causing environmental harm. The measures outlined should include those described below.

- Undertaking works in waterways without expert advice can cause environmental harm that may be difficult and expensive to remediate. Depending on the scale of the works, advice may be needed from one or more experts, including a stream biologist, river engineer, fluvial geomorphologist or hydrologist.
- A proposal for re-introducing LWD should be treated like any other development needing council approval. A management proposal should be prepared that justifies the project and states its objectives (supported by hydraulic calculations that show the effects on velocity and flow), evaluates the environmental impact, and specifies the intended works. All relevant agencies and interested parties should be given the opportunity to comment on the proposed works.
- Works in or near streams should adopt the principles outlined in *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands* to minimise the risk of causing environmental harm.
- LWD loads vary according to the type of river and river reach (ranging from zero upwards). Similar healthy, unmodified river reaches in the catchment should be used as models to determine the amount of LWD needed.

Re-introducing LWD can help improve stream health.

- The LWD should be placed on the downstream end of outside bends and have a range of alignments. When deciding where to place the LWD consider whether access to the bank by machinery may be needed in the future, whether single objects or more complex structures would be more appropriate, how much LWD should protrude above the water, and the reduction in flow velocities needed.
- A range of debris sizes should be used to promote habitat diversity. Native species should be used rather than introduced species (willows) and artificial materials (car bodies and concrete).
- The timber used should not come from the river's banks or floodplain. Logging waste may be a suitable alternative.
- Changed hydraulic conditions may cause erosion and scouring of the bed and banks around the LWD. This is not necessarily a problem as it may increase habitat diversity. Creating a wide enough riparian buffer zone will ensure the erosion cannot damage fences and other structures further away.
- It may be necessary to anchor the LWD so it is not carried away during high flows.
- The works should be inspected and maintained regularly to make sure they are effective. The ongoing maintenance may include lopping, re-alignment and selective removal.

5. References

Inland Fisheries Service. 2000. *Rivercare Management, Fish and Habitat Facts: Large Woody Debris. Rivercare Management Fact Sheet No. 4. IFS, Hobart.* http://www.ifs.tas.gov.au/Fact%20sheets%20for%20Rivercare/woody_debris.html

Land & Water Resources Research & Development Corporation. 2000. *Managing Snags and Large Woody Debris. Rip Rap Magazine, 16. LWRRDC, Canberra.* http://www.rivers.gov.au/acrobat/riprap16.pdf

Lovett, S. & Price, P. (eds). 2002. *Riparian Land Management Technical Guidelines Volume 1: Principles of Sound Management and Volume 2: On-ground Management Tools and Techniques.* Land & Water Australia, Canberra. http://www.rivers.gov.au/publicat/guidelines.htm

Rutherfurd, I., Marsh, N., Price, P. & Lovett, S. 2002. *Managing Woody Debris in Rivers. Fact Sheet 7.* Land & Water Australia, Canberra. http://www.rivers.gov.au/manage/index.htm

These guidelines should be used in conjunction with the appropriate technical advice and literature.

Checklist

This checklist summarises the environmental management principles outlined in *Environmental Best Practice Guidelines 6. Managing Large Woody Debris in Waterways.* The plan of works prepared should describe the proposed works and show that the measures listed below will be used to minimise the risk of causing environmental harm during and after the works.

- ❑ Works plan prepared

Re-positioning LWD (Section 2)

- ❑ Expert advice sought
- ❑ Management proposal prepared
- ❑ Works conform to *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands*
- ❑ Logs aligned at angle of 0-40° to stream bank
- ❑ Logs placed in variety of locations and alignments
- ❑ LWD anchored if necessary
- ❑ Inspection and maintenance program prepared

Removing LWD (Section 3)

- ❑ Leaving LWD undisturbed considered
- ❑ Re-positioning of trunks and lopping of limbs considered
- ❑ Expert advice sought
- ❑ Management proposal prepared
- ❑ Works conform to *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands*
- ❑ Extracted hardwoods relocated or stored for future use
- ❑ Inspection and maintenance program prepared

Re-introducing LWD (Section 4)

- ❑ Expert advice sought
- ❑ Management proposal prepared
- ❑ Works conform to *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands*
- ❑ LWD load modelled on similar healthy, unmodified reaches
- ❑ LWD placed on outside bends with range of alignments
- ❑ Native timber with range of debris sizes used
- ❑ Timber does not come from banks or floodplain
- ❑ Riparian buffer zone wide enough
- ❑ LWD anchored if necessary
- ❑ Inspection and maintenance program prepared

Environmental Best Practice Guidelines 7. Managing Riparian Vegetation

1. What is a riparian zone?

Riparian zones are areas of land that adjoin, influence or are influenced by a body of water. Typical examples are river banks, floodplains, lake foreshores and wetland fringes.

Riparian 'buffer' zones are fenced-off (usually) areas within riparian zones that are managed or reserved to protect the waterway or wetland, or provide a transition between the waterway or wetland and the adjacent land. The width and extent of a buffer zone depends on the management objectives. It may be only 20-30 metres wide if the objective is to protect bank stability. However, it may extend the entire width of a floodplain if the objective is to prevent damage from flooding. In some cases, the width of riparian reserves along larger waterways is set by statutory processes rather than management needs.

2. Importance of riparian vegetation

Healthy riparian zones are essential for maintaining healthy ecosystems and economic productivity along rivers. Some riparian zones in rural and urban landscapes are degraded and should be rehabilitated. The key to preserving the value of a riparian zone is to maintain a diverse vegetation cover.

A healthy riparian vegetation cover	A degraded riparian vegetation cover
Supports a diversity of aquatic habitats.	Has fewer aquatic habitats because there is less live and dead aquatic vegetation.
Shades the river, which reduces fluctuations in water temperature.	Allows more light to reach the river, which increases water temperature, which may trigger algal growth and reduce water quality.
Stabilises the stream banks.	Reduces the stability of the stream banks because there are fewer roots and less vegetation to hold the soil together.
Filters sediments and nutrients from the surface and sub-surface water, which reduces pollution of the river.	Allows sediments and pollutants in the surface and sub-surface water to enter the river, which may pollute the river.
Is a high productivity zone that provides food for aquatic animals.	Deposits less organic matter into the stream, which means there is less food for aquatic animals.
Adds agricultural value to the property by allowing selective timber harvesting, forage production and apiculture; providing a windbreak for adjoining paddocks; and providing emergency feed.	
Adds to the capital value of the land.	
	Deposits little woody debris into the river, which reduces stream 'roughness' and affects the flow regime.
	Can alter the depth of the water table and exacerbate the effects of salinity.

Healthy riparian vegetation cover

Severely degraded riparian vegetation cover

3. Threats to riparian zones

In many areas the only healthy riparian zones are patches of remnant vegetation. Many of these areas are threatened by human activities, including vegetation clearance, water regulation, fire, weeds, cattle grazing, and changes to ground-water conditions. Natural disturbances, such as floods, fire and extreme climatic conditions, can also threaten degraded or stressed riparian ecosystems.

4. Environmental management principles

If works in waterways and wetlands may affect the riparian zone, the works plan should describe the measures that will be used to minimise the risk of causing environmental harm to the riparian zone. The principles for managing riparian areas are described below.

Information on planning and managing activities in riparian zones can be found in the publications listed in 'Section 6. References'. Most of these publications are available on the internet. Information on plant communities and threatened species is available on the Department of Primary Industries, Water and Environment (DPIWE) website at www.gisparks.tas.gov.au.

Preserve remnant vegetation

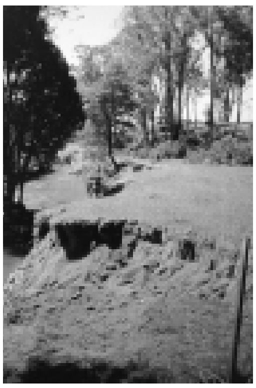
It is easier to protect riparian zones in reasonable to good condition than it is to remediate seriously degraded ones. The first priority for managing reasonably healthy riparian areas should be to preserve the remnant native vegetation by minimising human disturbances.

Seek expert advice

In some situations - very active bank erosion, foreshore improvement and so on - remediation and revegetation will be necessary. These projects are more likely to be successful if groups draw on the experiences of others when planning and implementing their works. This can be done by reviewing relevant publications, talking to individuals and groups that have done similar works, and seeking the advice of riparian ecologists and botanists.

Fence off riparian zone

Livestock are a major cause of damage to riparian vegetation on rural land. Excluding stock from riparian zones usually leads to a steady improvement in land condition, vegetation cover, stream health and water quality. Appropriate fencing makes it possible to exclude stock from riparian zones. It also allows access by stock when needed for emergency feed and weed control.



Uncontrolled stock access can cause serious bank erosion

Buffer width should reflect management objectives

The width of a riparian buffer zone will be determined by the management objectives for the area and the site characteristics. The zone should be wide enough to achieve the management objectives for the area. The site characteristics that should be considered include slope, soil texture and erodibility, drainage area, bank height, adjacent land use and existing vegetation. The large number of factors to be considered means that, although setting 'generic' widths for riparian zones at a regional or state level offers some protection for waterways, a detailed analysis is needed to determine the most appropriate width. For example, the publication Guidelines for Stabilising Streambanks with Riparian Vegetation (Abernethy & Rutherfurd, 1999) (see 'Section 6. References') describes a method for determining the width needed for a buffer zone designed to stabilise the banks.

Ideally, a riparian zone should be as large as possible. This will maximise the benefits of the riparian vegetation and minimise the effects of the adjacent land use on the waterway.

Stabilise channel

Stream beds should be stabilised before revegetation works begin. If a channel is actively deepening and widening, fencing off and revegetating the riparian zone will not stabilise the channel and its banks. In this situation, stream-bed control structures should be installed and the banks protected before revegetation begins.

Use native species

Native vegetation along degraded Tasmanian waterways may regenerate without replanting if stock are excluded and weeds controlled. If revegetation is necessary, advice should be sought on the most appropriate species for the site. Using inappropriate species, such as willows, may cause environmental harm that may be difficult and expensive to remediate. The species composition and community structure of the vegetation will vary with distance from the waterway or wetland as soil conditions become drier.

Remove weeds

Planning and ongoing maintenance are essential components of all weed removal programs. Removing weeds, such as gorse and willows, from waterways and riparian zones without timely revegetation can lead to erosion, bank instability, and loss of animal habitat and food.

If using chemical sprays, select the right chemicals so that the weeds are controlled without killing animals, such as frogs and fish, in the waterway. Contact a DPIWE Regional Weed Management Officer for information on the most appropriate sprays to use. Further information is also available in the Rivercare Guidelines for Safe and Effective Herbicide Use near Water (Noble, 2002), which is available on the DPIWE website.

Preserve small and large waterways

Riparian vegetation is critical for maintaining healthy ecosystems in small waterways and the upper reaches of large waterways. Leafy and woody debris from the riparian vegetation of small waterways is essential for local aquatic ecosystems. It is also an important source of carbon and nutrients for ecosystems downstream, where there is less shading and less leafy and woody debris entering the waterway.

If resources are scarce and the objective of management is protecting the riverine environment, preserving the riparian vegetation along small waterways should be given the same or greater priority as preserving the riparian vegetation along large waterways.

5. Riparian clearance controls

Forest Practices Board

The Forest Practices Act 1985 and the Forest Practices Regulations 1997 prohibit forest clearing on defined ‘vulnerable land’, such as stream-side reserves, drainage lines and swamps, even if no commercial wood is produced. The only exception to this is if the works are undertaken to protect public safety or maintain existing infrastructure, such as roads, fences and buildings. In such cases, the volume of timber cleared must be less than 5 tonnes or cover an area of less than 1 hectare (whichever is the lesser) per year on any property.

This clearance prohibition applies to all woody plants with a height or potential height of 5 metres or more, whether live, dead, standing or fallen. It includes all species native to Tasmania, including tree ferns, as well as introduced species used for processing or harvesting timber, such as pine and eucalypt plantings. It does not extend to removing non-native species, such as willows and fruit trees.

Selective harvesting on vulnerable land may be permitted in certain circumstances. Any harvesting must be approved under a Forest Practices Plan (FPP), certified by a Forest Practices Officer, and comply with the Forest Practices Code 2000. Exemptions from a FPP apply for small-scale operations where

- the owner of the land gives consent; and
- the harvesting of trees is necessary to protect public safety or maintain existing infrastructure, such as roads, fences and buildings; and
- the volume of timber harvested is less than 5 tonnes or the area of land cleared is less than 1 hectare (whichever is the lesser) on any property per year.

Exemptions also apply for harvesting timber and clearing trees for the development of easements for powerlines, gas pipelines and public roads.

Protecting vulnerable land is regarded as a duty of care. Substantial penalties can result from failure to comply with these requirements. Further information is available from the Forest Practices Board (http://www.fpb.tas.gov.au/fpb).

Local government

Planning schemes vary as to whether a permit is required to remove riparian vegetation on private and Crown land. In those municipalities where a permit is required, variations exist as to what land-use activities are considered exempt.

Some recent planning schemes incorporate a Wetlands and Waterways Schedule, which specifies the objectives and standards for development in or near waterways and wetlands. While the details of the Schedule vary between planning schemes, they typically cover general works, road construction, water quality protection, and riparian vegetation clearance (see generic example in box).

A key objective of the Schedule is to maintain riparian vegetation. This provides a natural filter for nutrients and soluble pollutants, prevents erosion and increased sediment flows, and provides habitat to preserve biological diversity. In implementing the Schedule, removing vegetation is generally prohibited within a set distance of the outer boundary of a stream bank of a waterway or a wetland. Removing vegetation within this distance may be approved if it can be demonstrated that the performance criteria have been met.

Issue: Riparian Vegetation

Objective

To maintain riparian vegetation as a natural filter for nutrients and soluble pollutants, and to prevent erosion and increased sediment flows.

Acceptable solution	Performance criteria
a) No vegetation is to be removed in or within 30 metres of i) a permanent wetland ii) a waterway iii) a shoreline or estuary.	a) If it is proposed to remove vegetation in or within 30 metres of the boundary of a waterway or wetland, applicants should demonstrate through a plan of management how i) the capacity of the remaining vegetation to act as a natural filter for nutrients and soluble pollutants will not be adversely affected ii) increased sediment flows will be prevented iii) biological diversity will be maintained iv) weeds will be removed in accordance with best practice environmental management principles.
b) No filling, draining or alteration of the water level of a naturally occurring waterway or wetland is allowed.	b) Any development or works affecting the water level of any naturally occurring waterway or wetland must not adversely affect natural flows and there is to be no increase in erosion or sedimentation as a result of the development or works.

Other controls

Clearing riparian vegetation can trigger a number of other legislative requirements

- Environmental Management and Pollution Control Act 1994
- Crown Lands Act 1976
- National Parks and Wildlife Act 1970
- Threatened Species Protection Act 1995
- Environment Protection and Biodiversity Conservation Act 1999
- Aboriginal Relics Act 1975
- Agricultural and Veterinary Chemicals (Control of Use) Act 1995.

These statutory requirements are outlined in *Environmental Best Practice Guidelines 1. Legislative and Policy Requirements for Protecting Waterways and Wetlands when Undertaking Works.* The relevant government agencies should be contacted for further advice.

6. References

Abernethy, B. & Rutherfurd, I. 1999. *Guidelines for Stabilising Streambanks with Riparian Vegetation.* Technical Report 99/10. Co-operative Research Centre for Catchment Hydrology, Melbourne. http://www.catchment.crc.org.au/pdfs/technical199910.pdf

Bryant, S. & Jackson, J. 1999. *Tasmania's Threatened Fauna Handbook.* Threatened Species Unit, Department of Primary Industries, Water & Environment, Hobart. http://www.dpiwe.tas.gov.au

Forest Practices Board. 2002. *Information Sheet: Land Clearing.* FPB, Hobart. http://www.fpb.tas.gov.au/fpb/

Kirkpatrick, J.B. & Gilfedder, L.A. 1999. *Tasmanian Bushcare Toolkit.* Department of Primary Industries, Water & Environment, Hobart. http://www.bushcare.tas.gov.au

Lovett, S. & Price, P. (eds). 2002. *Riparian Land Management Technical Guidelines Volume 1: Principles of Sound Management and Volume 2: On-ground Management Tools and Techniques.* Land & Water Australia, Canberra. http://www.rivers.gov.au/publicat/guidelines.htm

Munks, S. 1996. *A Guide to Riparian Vegetation and its Management.* Department of Primary Industries & Fisheries, Hobart.

Noble, M. 2002. *Rivercare Guidelines for Safe and Effective Herbicide Use near Water.* Department of Primary Industries, Water & Environment. http://www.dpiwe.tas.gov.au/inter.nsf/Attachments/JMUY-5CH7M2?open

Parker, G. & Bower, D. 1996. *Willow Management Guidelines.* Department of Primary Industries, Water & Environment, Hobart.

Price, P. & Lovett, S. 2002. *Managing Riparian Land. Fact Sheet 1.* Land & Water Australia, Canberra. http://www.rivers.gov.au/manage/index.htm

Price, P. & Lovett, S. 2002, *Riparian Habitat for Wildlife. Fact Sheet 5.* Land & Water Australia, Canberra. http://www.rivers.gov.au/manage/index.htm

Rutherfurd, I., Jerie, K. & Marsh, N. 2000. *A Rehabilitation Manual for Australian Streams, Volumes 1 and 2.* Land & Water Resources Research & Development Corporation, Canberra. http://www.rivers.gov.au/publicat.htm

Tasmanian Bushcare Reference Panel. 1999. *Vegetation Management Strategy for Tasmania.* Department of Primary Industries, Water & Environment, Hobart. http://www.nht.tas.gov.au/guides/vmst.pdf

Thorp, V. 1999. *Restoring Wetlands and Waterways: A Guide to Action.* Tasmanian Environment Centre, Hobart.

Wright, D. & Jacobson, T. 2000. *Managing Streamsides: Stock Control, Fencing and Watering Options.* Department of Primary Industries, Water & Environment, Tasmania.

These guidelines should be used in conjunction with the appropriate technical advice and literature.

Checklist

This checklist summarises the environmental management principles outlined in *Environmental Best Practice Guidelines 7. Managing Riparian Vegetation.* The works plan prepared for any works in waterways and wetlands that may affect the riparian zone should show that the measures listed below will be used to minimise the risk of causing environmental harm to the riparian zone during and after the works.

- ❑ Remnant vegetation preserved
- ❑ Expert advice sought
- ❑ Riparian zone fenced off
- ❑ Width of riparian zone reflects management objectives
- ❑ Channel stabilised
- ❑ Appropriate native species used for revegetation
- ❑ Weed removal program prepared
- ❑ Management plan prepared

Environmental Best Practice Guidelines 8. Guiding Community Involvement in Works on Waterways and Wetlands

Tasmania has a long history of community involvement in works on the State's waterways and wetlands. Traditionally, the community has been involved in irrigation and drainage schemes, 'river improvement' schemes, and farm dam construction. In recent years, Landcare, Rivercare and Waterwatch groups have protected, monitored, managed and rehabilitated waterways and wetlands around the State.

The Rivercare Program was established to ensure progress towards the sustainable management, rehabilitation and conservation of rivers. Many Rivercare projects in Tasmania are carried out by community groups so the State Government has developed a framework to help groups plan and implement their projects. Rivercare Plans are a key component of that framework, which are designed to

- achieve sustainable outcomes for works in and along rivers by ensuring that the works are appropriate, effective, and in accordance with other activities in the catchment
- foster community spirit and cohesion in managing rivers
- ensure appropriate work practices are adopted
- encourage groups to continue maintaining and improving rivers after their projects have finished.

Community groups are advised to seek advice and support from their local council before starting their project. When notified of a proposed project, council staff should find out if the group has a plan. If not, they should suggest that one be developed as part of the assessment process. The nature of the plan will depend on the scale of the project. All projects funded by government, including National Heritage Trust and local community grants, and most self-funded projects will need a Rivercare Plan. Smaller self-funded works may only need a works plan.

1. Developing a Rivercare Plan

Guidelines for Planning Rivercare Projects in Tasmania has been produced by the Tasmanian Rivercare Technical Assessment Panel (TRTAP) and the Department of Primary Industries, Water and Environment (DPIWE) (2000) to help community groups plan their Rivercare projects. Community groups should be encouraged to use the Guidelines when developing their project. The Guidelines can be downloaded from the DPIWE website at www.dpiwe.tas.gov.au.

The steps involved in developing a Rivercare Plan are

1. Vision for the river
2. Assess river condition
3. Management issues and objectives
4. Technical assessment and advice
5. Schedule of works
6. Links with other plans and processes
7. Monitoring the project
8. Provision for maintenance
9. Display and endorsement of the plan
10. Submit Rivercare Plan or works plan to council for assessment

Groups should be encouraged to see their Rivercare Plan as a 'living document' that states their community's long-term vision for the river and outlines the works they want to do, both in the immediate future and over the next 5-10 years.

1. Vision for the river

Groups should define their vision for the river and its catchment. The vision statement can be as short or as long as the group wants, provided it adequately describes their collective vision for the river. It may describe the river's look and 'feel', quality, riverine environment, riparian vegetation, birds and animals, agricultural production, recreational use and so on.

Public consultations should be held so the wider community and local government can contribute to the vision. Consulting the community will also allow groups to determine their community's awareness of the river and its condition, and discuss ways the vision might be achieved.

2. Assess river condition

Groups should survey their river to assess its condition and identify sites that are relatively healthy or degraded. Surveying the river will make it easier to determine what works need to be done and their priority, as well as the resources needed to do the works. The data collected will usually include information about remnant native vegetation, threatened species, weeds, stream conditions, erosion, bed and bank stability, stock management and fencing.

Guidelines for Planning Rivercare Projects in Tasmania (TRTAP & DPIWE, 2000) discusses the issues likely to be faced when surveying the river and outlines the data that should be collected. It also contains proformas that can be used to record the survey data.

3. Management issues and objectives

Groups should decide on the problems they will tackle and the objectives for resolving them. These decisions will be based on the analysis of the survey data. Each objective should show how the problem will be managed in order to achieve the group's vision for the river.

Relevant landowners and river users should be consulted to ensure no problems are missed and to make sure there is consensus on how the problems will be managed.

4. Technical assessment and advice

Groups should seek appropriate advice when developing their Rivercare Plans. The advice should cover a range of specialties, depending on the needs of the project. It may include

- An engineering survey to determine the suitability of the site and make sure the design of any structures, such as riffles and rip-rap, is appropriate before works begin.
- A geomorphic assessment to show how the river functions from a physical and hydraulic perspective (at a catchment, sub-catchment and reach scale), and how it will respond to the proposed works.
- Threatened Species Unit of DPIWE to find out if the works could affect any critical habitats and endangered species.

Possible sources of advice include State Government employees, extension staff and consultants. In addition, non-government organisations such as Birds Tasmania and the Tasmanian Field Naturalists can often provide useful information on bird and animal behaviour, and habitat needs and preferences.

Groups should be encouraged to seek advice in the early stages of developing their plans, although sometimes it will be needed in the latter stages as well. The advice should always be in writing, after a site visit. Any advice should be included in the plan as an attachment that can be referred to later.

Groups should also seek advice on public liability and any other insurance issues and liabilities that could arise during and after the project.

5. Schedule of works

The schedule of works should include

- A list of the planned works, along with their intended timelines and costings.
- A detailed description of the methods to be used for each of the works.
- A series of maps and aerial photographs that show the location and extent of all planned works. The maps are best done in 1.5-2.0 kilometre sections so they are clear and unambiguous.
- Detailed plans of all major river works, such as riffles and other structures.

General statements about the methods to be used can be given in the body of the plan. However, detailed descriptions of the proposed works should be included in the works schedule on a section-by-section basis. This is especially important if the works involve vegetation clearance (eg willows), in-stream works (eg riffles), stream bank works (eg rip-rap), or the use of machinery. Each of the descriptions should be linked to a map. An example of a works schedule can be found in Guidelines for Planning Rivercare Projects in Tasmania (TRTAP & DPIWE, 2000).

6. Links with other plans and processes

It is essential that groups obtain the support and agreement of the majority of landowners along the river when developing their Rivercare Plans. Council staff can advise community groups about the other interest groups and individuals that should be consulted. These people should be consulted to determine the likely effects of the plan on them and to obtain their consent.

It is also important to consider land use in the catchment and to link the plan to other management plans in the area. Such plans may include Rivercare Plans for other parts of the river, catchment management plans, whole farm plans, weed management strategies, and endangered species management plans.

Council planning schemes and management plans for national parks, state reserves and other Crown lands in the catchment should be considered to ensure the plan is co-ordinated with other planning processes.

If Rivercare Plans have or are being developed for other sections of the river they should be linked and integrated with each other. Groups should work out how they can co-ordinate their works with those of nearby groups. Groups working along the same river or in the same region should be encouraged to share resources and integrate their plans. The local DPIWE Water Management Officer and council planning officers may be able to facilitate this process if necessary.

7. Monitoring the project

Monitoring the river before, during and after the project will give an indication of the success of the project and the maintenance needed. However, groups do not have to do all the monitoring themselves. Members of the local community, schools and the local council may be able to help.

Several techniques can be used to monitor the success of a Rivercare Plan and its associated works. Groups can assess the condition of the river using the river survey proforma found in Guidelines for Planning Rivercare Projects in Tasmania (TRTAP & DPIWE, 2000). The proforma encourages groups to examine all components of the river, including the riparian vegetation, in-stream logs, erosion and sediments. Photo-points (photographs taken from fixed locations) can also be used to show the before and after condition of the river, and to monitor long-term changes after the project has been completed.

8. Provision for maintenance

The aim of the Rivercare program is to improve the long-term health of our rivers. Therefore, all groups must show how they will maintain the improvements they make to the river after the project has finished. Maintaining the improvements is particularly important in Tasmania where rivers can degrade quickly and the money spent improving them can be wasted if there are no follow-up works.

Long-term maintenance of the river can be funded by arrangements that share the costs equitably between the beneficiaries. The preferred arrangement is a riverworks district, which provides a framework for collecting the funds and administering and managing the maintenance. Generally, it is recommended that local councils establish riverworks districts and set up special council committees to administer them. However, incorporated trusts and Landcare groups can also establish and administer them. The local council or the DPIWE Rivercare Team can advise groups on the procedures for establishing such arrangements.

9. Display and endorsement of plan

The Rivercare Plan and its accompanying maps and aerial photographs should be displayed and made available to the public so all interested parties have the opportunity to comment on the planned works. Groups should seek endorsement from their general community, and individuals and groups likely to be affected by the plan. The local council may be able to use its normal planning processes to help groups seek public comment and endorsement.

10. Submit Rivercare Plan or works plan to council for assessment

The completed Rivercare Plan should be assessed by the local council before any works start. The level of assessment needed will depend on the scale of the works. The Department of Primary Industries, Water and Environment can be approached if the local council does not have the necessary technical and scientific expertise.

2. References

Tasmanian Rivercare Technical Assessment Panel & Department of Primary Industries, Water & Environment. 2000. *Guidelines for Planning Rivercare Projects in Tasmania.* DPIWE, Hobart. http://www.dpiwe.tas.gov.au

These guidelines should be used in conjunction with the appropriate technical advice and literature.