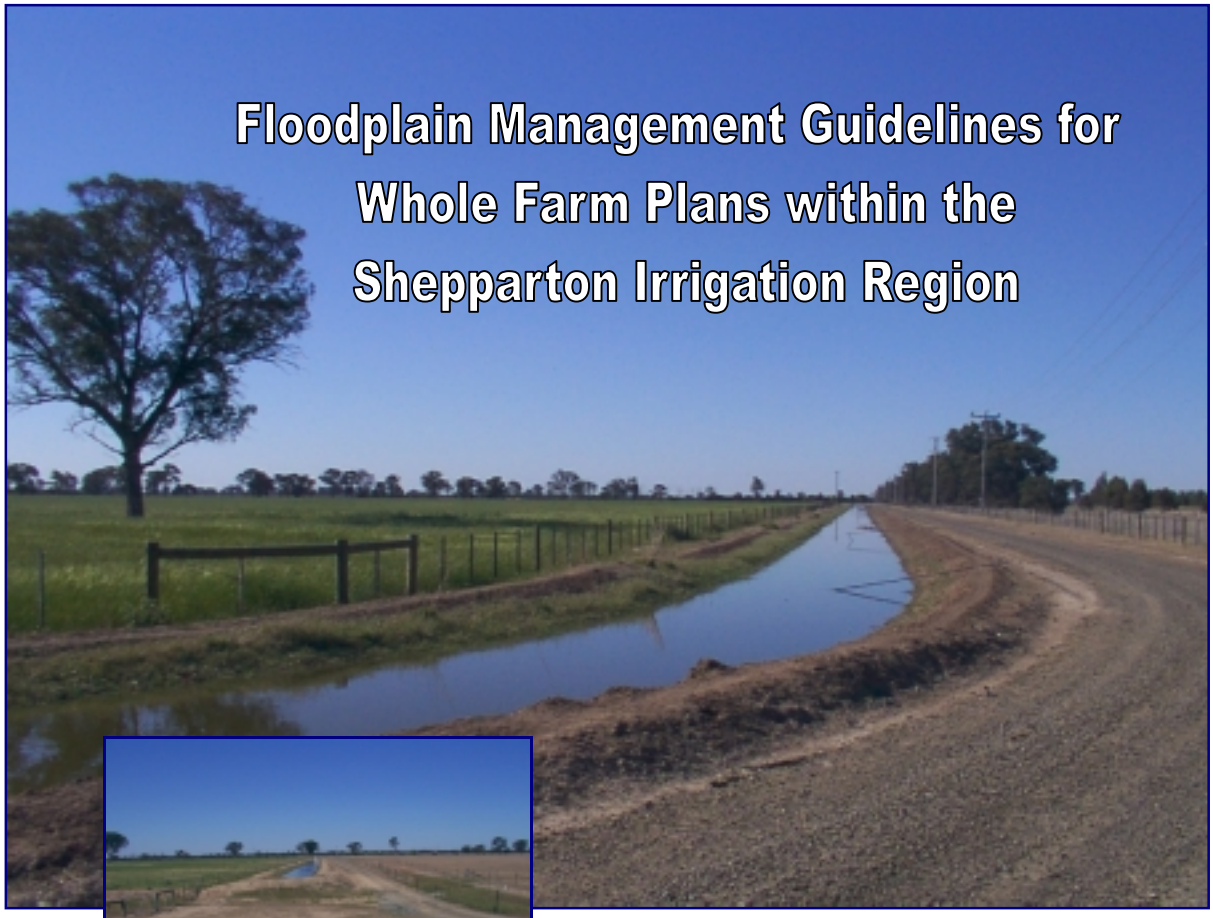
Floodplain Management Guidelines for Whole Farm Plans within the Shepparton Irrigation Region



Floodplain Management Whole Farm Plans Steering Committee

January 2003

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

North Central Catchment Management Authority

GOULBURN-MURRAY WATER

State Government Victoria Department of Natural Resources and Environment

SINCLAIR KNIGHT MERZ

FLOODPLAIN MANAGEMENT GUIDELINES FOR

WHOLE FARM PLANS WITHIN THE

SHEPPARTON IRRIGATION REGION

January 2003

Prepared by Sinclair Knight Merz for the Floodplain Management Whole Farm Plans Steering Committee on behalf of the Goulburn Broken Catchment Management Authority and the North Central Catchment Management Authority

Contents

Abbreviations

AAD	Average annual damage
AHD	Australian Height Datum
ARI	Average Recurrence Interval
CMA	Catchment Management Authority
DOI	Department of Planning and Infrastructure
FO	Floodway Overlay
GBCMA	Goulburn Broken Catchment Management Authority
G-MW	Goulburn-Murray Water
LSIO	Land Subject to Inundation Overlay
NCCMA	North Central Catchment Management Authority
NRE	Department of Natural Resources and Environment (now Department of Sustainability and Environment)
VPPs	Victoria Planning Provisions

1. Introduction

These guidelines have been prepared to assist the design of earthworks and structures associated with whole farm plans, so that resultant works do not aggravate flooding or cause damage to other property. They apply specifically to farm works in flood affected land within the Shepparton Irrigation Region, shown in **Figure 1-1,** which lies within the catchments of the Goulburn Broken Catchment Management Authority (GBCMA) and the North Central Catchment Management Authority (NCCMA).

Within the Shepparton Irrigation Region ad-hoc earthworks are discouraged. Instead works are to be designed in an integrated fashion on a whole farm basis, ie as part of a whole farm planning process which attracts financial incentives. A whole farm plan is an integrated plan that considers the most appropriate form of development, having regard for long term financial, agronomic and environmental planning, when developing irrigation and drainage layouts.

Farm works associated with land forming, irrigation and drainage, are generally undertaken to improve the overall productivity of the land, by improving the efficiency of applying and removing irrigation water and excess runoff. For works that affect the movement of water over the land surface, there is a need to ensure that there are no adverse impacts.

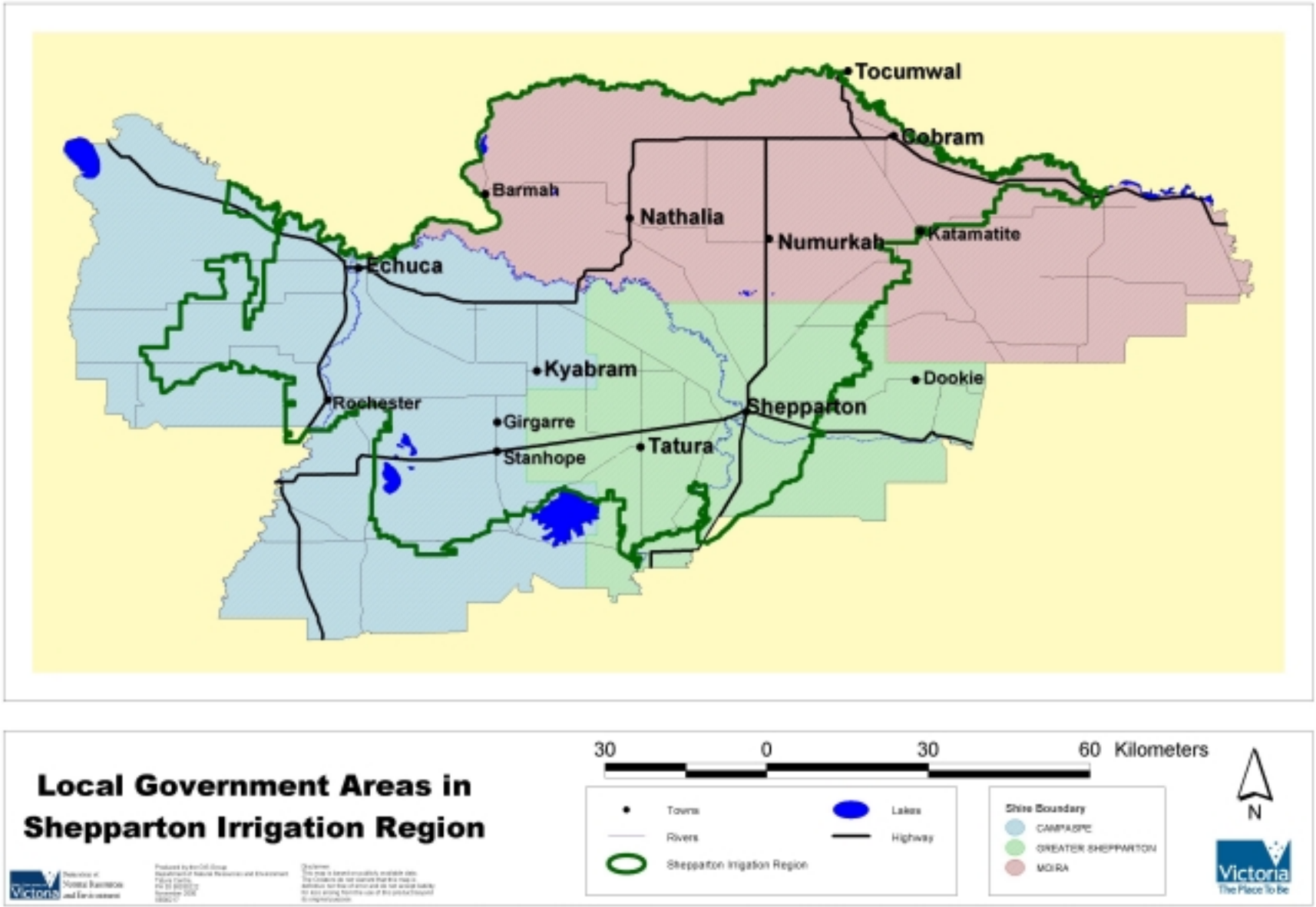
These guidelines incorporate current best practice principles and considerations that underpin responsible decision-making. They have been prepared to assist those involved in the assessment process, as well as those responsible for the design and implementation of whole farm plans.

Proposed works may also need to comply with the relevant sections of the *Water Act, 1989*. In particular, proposed works must not:

- cause or interfere with a reasonable flow (*s 16 & 20*);
- affect flood behaviour in areas declared as liable to flooding, or for which flood levels, flood fringe areas or building lines have been declared (*s 203 - 210*); or
- obstruct or interfere with flows in Declared Drainage Schemes (*s 218*).

While the guidelines will not take the place of assessment by the appropriate authorities under the relevant sections of the Water Act or the relevant municipal planning scheme, they will make the assessment process more efficient, effective, transparent, consistent and straightforward.

■ **Figure 1-1 Shepparton Irrigation Region**



1.1 Structure of the Guidelines

This document has seven distinct Sections, illustrated in **Figure 1-2**. Sections 1 to 4 provide explanations and details necessary to understand the background and context for the guidelines outlined in Section 5. Sections 6 and 7 contain useful references.

1.2 Objectives

The objectives of these guidelines are:

- *to ensure best practice floodplain management guidelines are utilised when developing and assessing whole farm plans;*
- *to improve the quality of planning permit applications; and*
- *to make the planning process more efficient and consistent.*

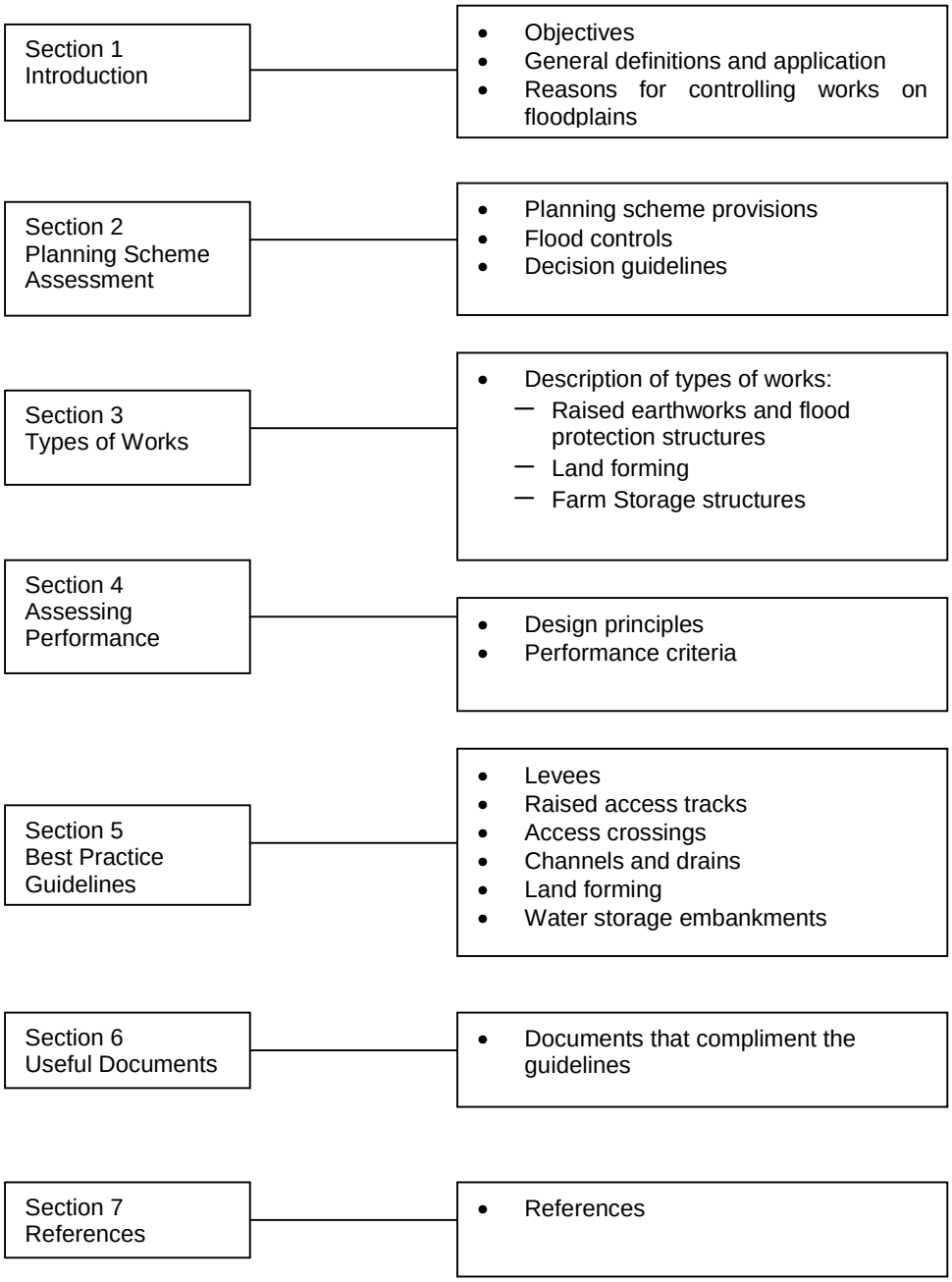
1.3 Integrated Whole Farm Plans

These guidelines apply to all aspects of the physical layout of a farm, including channels, drains, paddocks, reuse dams and other features. Such forms of development require the preparation of a suitable plan showing the proposed works and designers will need to ensure that any incremental or cumulative flood effects, are within acceptable limits and have no significant impacts on adjacent properties.

Landholders can simplify the approval process for planning permit applications for a number of works on the same property by presenting a whole farm plan. The effective preparation of whole farm plans involves:

- Making long term decisions on property management, such as the type of enterprise, how it will be managed in both the short and long term, and what level of investment is required (eg. stock, fencing, horticultural development, etc).
- Ensuring the plan shows channel and drain sizes, sizes of bay outlets and channel/drain structures, pumping requirements, sprinkler/dripper details, quantities of earth to be moved, storages and reuse dams, and the movement of machinery and vehicles. Engineering expertise is required to ensure that water can be applied efficiently to the property and drainage water can be controlled to prevent waterlogging of crops.
- Considering environmental aspects, eg how the proposed development will fit in with local conditions, how it will affect drainage lines and wetlands, how vegetation can be effectively managed in terms of retention of existing vegetation and/or additional planting.
- Agronomic planning, eg, the type of crops/pasture/trees to be grown, soil types, bay sizes, slopes, provision for topsoiling.
- Financial planning – how the work will be staged, detailed costing of works and payment structure.

■ **Figure 1-2 Report Structure**



Whole farm plans encourage strategic planning, which is likely to be more cost effective and lead to better farm management than a piecemeal approach. Furthermore, through the Whole Farm Plan Incentive Scheme, whole farm plans can attract financial incentives (refer NRE for eligibility criteria - *NRE, 2002).*

The preparation and implementation of whole farm plans by landholders is encouraged in order to:

- ensure money invested on restructuring an irrigation layout is well spent;
- ensure that individual property reconstructions are compatible with regional and district drainage systems; and to
- integrate appropriate salinity, nutrient control and management of native vegetation with land use and water management practices.

1.3.1 Certification of Whole Farm Plans

In the rural zone, a planning permit is required for earthworks which change the point of flow or the rate of flow of water across a property boundary, or which increase the discharge of saline groundwater. However works which are part of a Whole Farm Plan, can be exempt from the requirement for a planning permit if they have been certified in accordance with the document: "Planning Controls for Earthworks in the Goulburn Broken Catchment" (November 1997).

The certification process will usually require the Whole Farm Plan to be submitted to the relevant municipal council, who will generally refer it Goulburn-Murray Water (G-MW), the Department of Sustainability and Environment (NRE), and either the GBCMA or NCCMA as appropriate. Council may also refer the Plan to other agencies such as VicRoads if the proposed works could affect their assets.

1.4 Application

While the preparation of whole farm plans and the certification processes are to be encouraged within the Shepparton Irrigation Region, the principles contained in these guidelines apply to the full spectrum of farm planning, in other irrigated and dryland areas. A farm plan might comprise a single form of development (such as a dam) or an integrated farm plan, or anything in between.

1.5 Works on Floodplains

Some reasons why it is important to plan and control works on floodplains are:

- land forming can cause significant change to flooding patterns;
- poorly planned works can increase the frequency and magnitude of flooding on adjacent properties by:
  - obstructing flood flows, which can increase the level, duration and extent of upstream flooding, and in some cases can affect the distribution of floodwaters;
  - diverting flows, flooding lands not otherwise at risk; and
  - removing flood storage, in which case flows may increase and cause increased flooding downstream;
- poorly planned earthworks can lead to landholder disputes and social, economic and environmental problems;
- while the effects of individual inappropriate works may not appear to be significant they can have major long term cumulative effects on the floodplain, its waterways and rural drainage.

Inappropriate works associated with whole farm plans in active floodway areas or passive flood storage areas can be a significant obstacle to effective floodplain management, and the assessment of the flood impacts often requires specialist skills.

Where proposed works are located in areas subject to flood overlays, referral to the relevant Catchment Management Authority (GBCMA or NCCMA) is mandatory. This can be via the certification process described in **Section 1.3.1**.

Applicants should be encouraged to consult with the relevant municipality and the relevant CMA, in the planning stage, to ascertain requirements, in order to avoid unnecessary wastage of effort.

1.6 Acknowledgments

The opportunity is taken to acknowledge the Department of Sustainability and Environment for providing funds for this initiative.

The committee gratefully acknowledges the contributions of Mike Edwards of Sinclair Knight Merz in preparing this document.

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In preparing these guidelines we would also like to acknowledge the use of a number of reference documents listed in **Section 7**.

2. Planning Scheme Assessment Process

2.1 Planning Scheme Provisions

Any proposed modification to farm works will need to be consistent with the provisions of the relevant municipal planning scheme. For land subject to a "floodway overlay" (FO) or "land subject to inundation overlay" (LSIO), a planning permit is required to construct a building or carry out works, including a fence and roadworks (DOI, 1997)[1].

An applicant proposing new works will need to contact the relevant council planning office to explain what is intended. The applicant will be asked to apply for a planning permit and to pay the prescribed fees (which will vary according to the estimated cost of the proposal and will change from time to time).

If the proposed works are subject to flooding, the council planning office will refer the application to the relevant CMA, and other agencies where appropriate, for assessment. Persons likely to be affected by the proposed works may need to be notified, either directly in writing or, in the case of larger projects with less immediate impact, by public notice advertisement in the local press. This lets potentially affected persons know of their right to lodge a submission regarding the application.

"Works" are defined in the *Planning and Environment Act, 1987* as:

> *"Any change to the natural or existing condition or topography of land including the removal, destruction or lopping of trees and removal of vegetation or topsoil."*

2.2 VPP Planning Practice Notes

Planning Practice Notes (*DOI et al. 2000*) have been prepared to assist applicants, municipalities and referral authorities understand and apply the flood provisions in municipal planning schemes. Assessment criteria will vary for each whole farm plan, and will generally be determined by the location of the proposed works.

The principal types of development relevant to whole farm plans are earthworks, or other changes in topography, that can impede or divert drainage or floodwaters, or lead to increased runoff. In some cases, the construction of buildings may also be a consideration.

2.3 Flood Controls in the VPPs

Municipal planning schemes provide a means of introducing planning controls for buildings or works located in floodway areas (ie identified by a "Floodway Overlay") or areas subject to inundation (LSIO).

Floodways
Floodways are those areas of the floodplain where significant discharge or storage of water occurs during major floods (*NRE, 1998*). They are often aligned with naturally

[1] As indicated in Section 1.3.1, the certification process provides an alternative to applying for a planning permit.

defined depressions and include areas that, if filled or even partially blocked, would cause a significant flood hazard by the redistribution of flood flows and/or by increases in flood levels.

Floodways are frequently associated with:

- areas of significant depth and/or having high velocities;
- drain and creek corridors that are strategically important in maintaining flow paths;
- flood storage areas generally greater than 0.5 m depth, including lakes and billabongs
- areas which flood more frequently than 10 years on average; and
- areas where the duration of flooding is generally greater than 7 days.

The depth and velocity of floodwaters may be such as to cause structural damage to any farm works or buildings located in floodway areas. Therefore, inappropriate development may cause social disruption and significant financial loss. In extreme cases, there may be danger to personal safety.

The impacts of inappropriate developments on the floodplain can also be significant. For a given flood, significant obstructions can lead to increased flow velocities and flood levels, and in some cases a significant increase in the area affected by flooding.

A reduction in flood storage can lead to a loss of flood attenuation (with a consequent increase in the peak flow rate, higher flow velocities and increased flood levels). It can also lead to a reduction in the environmental health of the floodplain, caused by isolating the watercourse from the floodplain, or modifying the natural flooding regime.

Design considerations for these areas include:

- ensuring that any proposed works do not obstruct flows, or lead to the redistribution of flows across the floodplain;
- ensuring that the proposed development considers the risk to life, health and safety of the properties and adjacent properties;
- preserving the passage of floodwaters without accelerating flood flows;
- ensuring significant flood storage areas are maintained;
- ensuring water quality is not affected; and
- preserving significant wetland areas.

General principles to follow in respect of whole farm plans are as follows:

- design the layout to minimise obstructions (eg avoid embankments that run across the direction of flow where possible);
- keep significant buildings out of floodway areas;
- avoid locating farm storages on floodway land if possible;
- ensure flow conveyance and flood storage requirements are met by having adequate culverts and/or openings in embankments; and
- ensure that people and livestock can be safely evacuated.

Land Subject to Inundation

Land Subject to Inundation (LSI) is based on the flood extent from a 100-year "average recurrence interval" (ARI) flood or, where this cannot be determined, the largest flood for which flood data is available. A flood with a discharge as large or greater than the 100-year ARI flood will occur on average every 100 years.

For rural areas where whole farm plans are most likely to be implemented, there are two main categories of land subject to inundation.

Category 1 - Where Floodway Areas have not been Delineated Separately
This applies to rural land where there has been insufficient information to identify floodway areas and only the extent of land subject to inundation is known. In such cases, the delineated flood extent may be considered an interim measure.

Ground level contours and other additional information provided in the whole farm plan will often enable areas of high flood risk to be identified. These areas are likely to be delineated as "floodway" at some future stage, and therefore works in these areas will generally be assessed accordingly.

Where ground level contours and other additional information indicates that the flood risk is not severe enough to warrant delineation as "floodway at some future stage, works will generally be assessed according to the principles for Category 2 LSI.

Category 2 Land Subject to Inundation
This applies to all land subject to flooding, excluding floodway areas or high risk Category 1 LSI. Flood depths are generally lower compared to floodway areas or Category 1 LSI, as are flow velocities. Consequently design considerations are reduced, and where they are the same as for floodway land, they are applied with less severity.

Design considerations for these areas include:

- ensuring that any proposed works do not obstruct flows, or contribute to the redistribution of flows across the floodplain;
- preserving the passage of floodwaters without accelerating flood flows;
- ensuring significant flood storage areas are maintained; and
- ensuring water quality is not affected.

General principles to follow in respect of whole farm plans are as follows:

- design the layout to minimise obstructions (eg avoid embankments that run across the direction of flow where possible);
- locate significant buildings on higher sections of land where possible;
- ensure flow conveyance and flood storage requirements are met by having adequate culverts and/or openings in embankments; and
- ensure that people and livestock can be safely evacuated.

2.3.1 Decision Guidelines

Under Clause 65-01 of the VPPs, in deciding on farm plan applications, the responsible authority must give consideration to, as appropriate:

- the matters set out in Section 60 of the *Planning and Environment Act, 1987*;
- the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies;
- the purpose of the zone, overlay or other provision;
- any matter required to be considered in the zone, overlay or other provision;
- the orderly planning of the area;
- the effect on the amenity of the area;
- the proximity of the land to any public land;

- factors likely to cause or contribute to land degradation, salinity or reduce water quality;
- whether the proposed development is designed to maintain or improve the quality of stormwater within and exiting the site;
- the extent and character of native vegetation and the likelihood of its destruction;
- whether native vegetation is to be or can be protected, planted or allowed to regenerate;
- the degree of flood, erosion or fire hazard associated with the location of the land; and
- the use, development or management of the land so as to minimise any such hazard.

Additional decision guidelines are listed in Clauses 37-03, 44-03 and 44-04 (covering Urban Floodway Zone, Floodway Overlay and Land Subject to Inundation Overlay respectively). These require the responsible authority to consider (in addition to the above):

- the local floodplain development plan (if one has been developed) or flood risk report;
- any comments of the relevant floodplain management authority.

If a local floodplain development plan has not been developed, and if the land is subject to FO, an application must be accompanied by a flood risk report, which must consider:

i) The existing use and development of the land.
ii) Whether the proposed use or development could be located on flood-free land or land with a lesser flood hazard.
iii) The susceptibility of the development to flooding and flood damage.
iv) The potential flood risk to life, health and safety associated with the development. Flood risk factors to consider include:
   - the frequency, duration, extent, depth and velocity of flooding of the site and accessway;
   - the flood warning time available; and
   - the danger to the occupants of the development, other floodplain residents and emergency personnel if the site or accessway is flooded.
v) The effect of the development on redirecting or obstructing floodwater, stormwater or drainage water and the effect of the development on reducing flood storage and increasing flood levels and flow velocities.
vi) The effects of the development on environmental values such as natural habitat, stream stability, erosion, water quality and sites of scientific significance.

If a local floodplain development plan has not been developed, and if the land is subject to LSIO, there is no need for an application to be accompanied by a flood risk report. However, in deciding an application, the responsible authority must still consider (i) to (vi) above.

2.3.2 Native Vegetation

It should be noted that a separate planning permit is required for the removal of native vegetation.

2.4 Areas Not Currently Delineated as FO or LSIO

Not all areas that are subject to flooding are covered by flood overlays in municipal planning schemes. For example, Goulburn-Murray Water has prepared maps showing active flow paths and passive storage areas (*G-MW, 1998)*. Some of these areas have not been included in the overlays.

The G-MW maps specifically apply to irrigated areas and show active flowpaths and passive storage areas. They do not include all known drainage lines, watercourses or flood storage areas.

Active flowpaths comprise significant drainage lines and minor watercourses that convey drainage and other flows. They discharge the runoff from the catchment at rates of flow dictated by their natural cross sections, longitudinal grades and vegetation characteristics. They may comprise deeply incised continuous depressions, a series of low basins and shallow overflow paths, or a combination of both.

Passive storage areas are characterised by low basins, backwaters, depression loops and similar features, into which water will spill during a flood. They provide flood detention storage capacity that moderates flow through the system. Their removal is likely to accelerate flood flows and exacerbate flood and/or drainage problems downstream (*SKM, 1996*).

If properties include active flowpaths or passive storage areas, designers will need to ensure that the intended layout does not unduly affect flood behaviour. This is irrespective of whether such features have been identified as flood overlays and/or as active flowpaths or passive storage areas on G-MW plans.

Areas containing significant drainage lines, watercourses, wetlands or areas known to be subject to flood depths greater than 0.5 m, should be treated as if they are floodway land, and other areas known to flood should be treated as land subject to inundation.

2.5 Exemptions From Requirement for a Planning Permit

An applicant may not need to obtain a planning permit if the proposed works:

- are carried out according to an approved drainage scheme or approved drainage outfall associated with:
  - a G-MW drain;
  - a registered community surface drainage scheme;
  - a private or municipal drain in which the applicant is an authorised participant and contributor and for which appropriate drainage outfall has been formally approved; or
  - a natural drainage course to a river or stream that has been authorised by the appropriate authority (eg NRE);
- are carried out according to an approved soil conservation strategy developed with NRE and/or local LandCare group (eg contour levees to prevent hill-side erosion);
- comprise flood mitigation works carried out by the relevant municipal council or CMA.

In such cases planning approval will generally be required for the overall works, but not for individual components.

Planning approval will not be required for works that have been certified as detailed in **Section 1.3.1**.

If there is uncertainty over whether a planning permit is required, the relevant municipality should be contacted for advice.

2.6 Incremental and Cumulative Impacts

While it can often be successfully demonstrated that individual works will have no significant impacts, the compounding effects of similar proposals can be considerable.

For example, a reduction in flood storage through farm works could lead to a significant reduction in flood attenuation if a large number of similar proposals are approved, and result in higher peak flows and increased flood levels downstream. If the area is flat, then only a small increase in flood flows and levels could result in a significant increase in the area flooded.

These guidelines have therefore been developed to have regard for the cumulative effect of developments on the floodplain, as well as incremental effects.

2.7 Consultation

In addition to formal referral arrangements through municipal planning schemes, or the certification process, applicants are encouraged to consult relevant organisations during the preliminary design phase, for technical and expert advice. A list of helpful contacts is provided in **Appendix A**.

Catchment Management Authorities provide advice on a number of catchment issues, including:

- considerations and likely requirements when proposed works are in the vicinity of waterways;
- whether proposals have implications for strategic catchment wide land and water management issues;
- technical aspects relating to floodplain management.

The Goulburn Broken CMA and the North Central CMA are the two relevant CMAs within the Shepparton Irrigation Region.

Goulburn-Murray Water can provide advice relating to the impact of proposed works on its assets, as well as design considerations such as full supply level at the proposed offtake, confirmation or calculation of available drainage outfall and recommendations on appropriate outfall structures. It also can provide advice on strategic plans for community or other drains, has plans of major drainage lines and passive storage areas within its irrigation area, and can assist with technical issues associated with water supply, drainage, salinity, groundwater or associated matters.

The **Department of Sustainability and Environment** can provide advice on a range of land protection issues, particularly in dryland areas, such as salinity, soil conservation, vegetation management and land capability. They can also assist with alerting landholders to incentives schemes or assistance in environmental enhancement opportunities. . The Department of Sustainability and Environment can also assist with technical issues associated with water supply, drainage, salinity, groundwater or associated matters.

Through its "Aboriginal Affairs' branch, the Department also provides advice on cultural heritage sites. Under the *Archaeological and Aboriginal Relics Preservation Act, 1972* and the *Commonwealth Aboriginal and Torres Strait Islander Heritage Protection Act, 1984*, all sites and relics are protected when any major earthworks are contemplated in the vicinity of river courses, lakes and wetlands.

In addition to seeking advice from Aboriginal Affairs, notification of any major earthworks in the vicinity of rivers and watercourses needs to be communicated to the appropriate local aboriginal community organisation as designated under Part 2A of the *Commonwealth Aboriginal and Torres Strait Islander Heritage Protection Act, 1984*. Initial notification would be to the relevant Cultural Heritage Region Coordinator who would then advise of a contact for the relevant local aboriginal community organisation.

3. Types of Works

The guidelines apply to some or all of the following types of works and associated structures:

- raised earthworks or structures associated with levees, contour banks, access tracks or roads, channels, drains, and embankments[2];
- land forming; and
- water storages.

Unless these works are appropriately designed, constructed and maintained, they can significantly interfere with the natural flow and flooding regime.

3.1 Dams, Raised Earthworks and Flood Protection Structures

These comprise structures that are elevated above the surrounding topography. They include:

- levees or flood protection walls, designed to protect property or dwellings from the effects of floods (see **Figure 3-1**);
- raised access tracks, roads or embankments (see **Figure 3-2**);
- raised channels or drains designed to convey water to or from crops or stock (see **Figure 3-3**); and
- dams (see **Section 5.3**).

Where located in floodplains, these structures need to be sufficiently robust to withstand the impacts of a flood without failure. They also need to safely handle the effects of overtopping for large floods.

Of equal importance, they must be designed to ensure that they do not adversely affect others, in particular they need to ensure there is no significant loss of flood storage or redistribution of flood flows. For this reason levees are generally discouraged, and structures that could act as levees must usually allow for the passage of flood water[3].

Design considerations for raised earthworks include the types of material to be used, foundation design, drainage and, (in the case of earthworks) compaction and moisture content. Associated structures such as flood gates, syphons, bridges, inlets and flow control devices need to be capable of performing their intended function under flood conditions. Competent and appropriately qualified experts should therefore undertake design and construction.

The performance of these structures must not be at the expense of causing adverse impacts, particularly to adjacent properties. Poorly designed raised earthworks can intercept, concentrate and redirect overland flows, flooding areas that would otherwise not flood or causing nearby properties to flood to greater depths.

A dam and any associated embankment, located on a floodplain, can reduce flood storage, as it is unlikely to be empty when a flood occurs. It can also restrict downstream flows from the drainage lines it harvests.

[2] Refer to Glossary for definitions

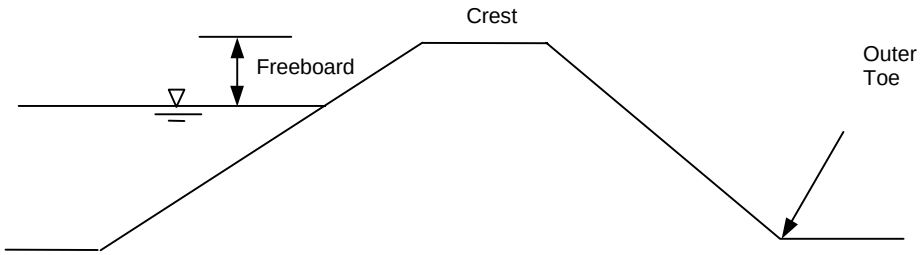
[3] Levees that protect dwellings are not considered in these guidelines.

Under Section 16 of the *Water Act, 1989*, persons causing an unreasonable flow of water from their land, or interfering with a reasonable flow of water onto any land, that results in damage or loss to other persons, may be liable to pay damages, and be ordered to modify or remove works.

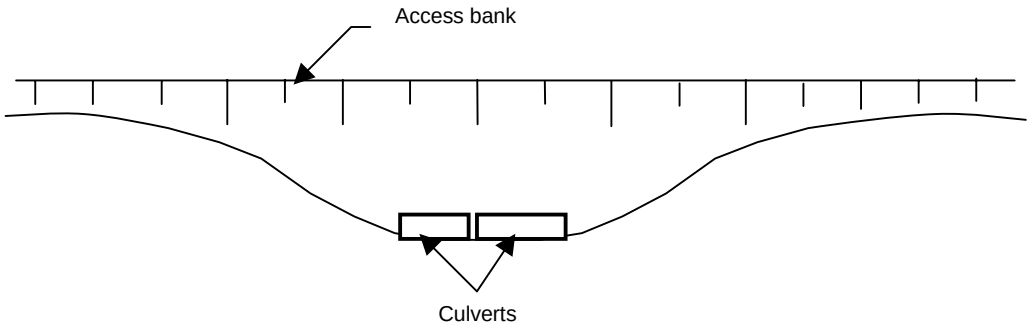
The fundamental issue in the design and location of these structures is that they are sufficient to prevent "unreasonable flows" downstream and that they do not significantly reduce flood storage.

Where the lower portion of land proposed for development coincides with billabongs, loop depressions or other water features, careful consideration should be given to environmental values. Re-use dams and other forms of water storage and earthworks should be kept separate from natural water features or active flowpaths, particularly if they contain wetland vegetation or serve an important ecological function by connecting a watercourse with its floodplain.

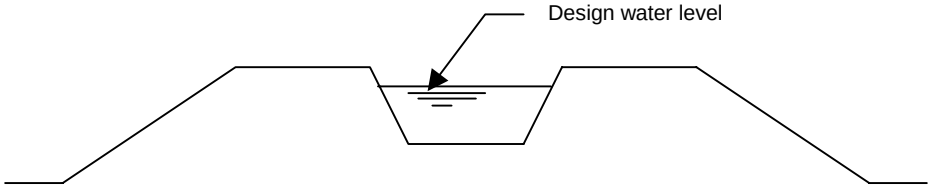
- **Figure 3-1 Levee**



- **Figure 3-2 Raised Access Crossing and Track**



- **Figure 3-3 Raised Channel or Drain**



Those responsible for designing these structures need to ensure that:

- upstream or downstream flood levels do not increase appreciably;
- flood velocities do not increase significantly;
- there is no significant redistribution of flood flows; and
- there is no significant loss in flood storage.

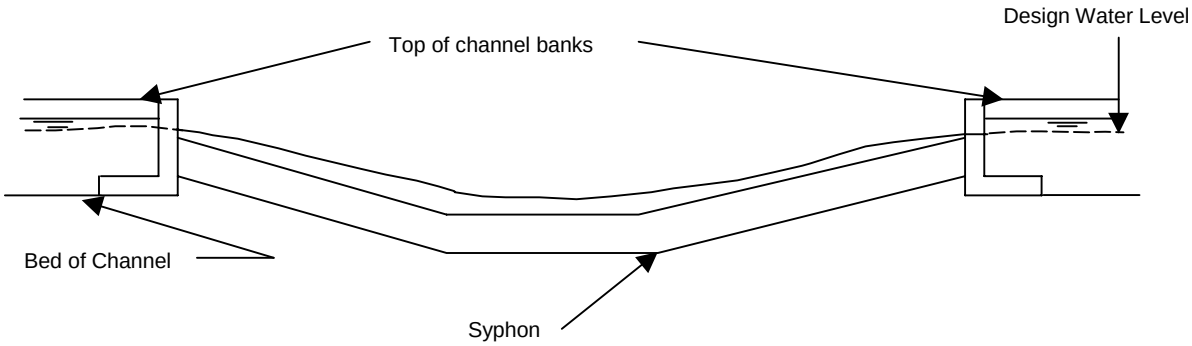
Generally this requires:

i) Ensuring raised roads, access tracks or embankments do not significantly hinder the passage of floodwaters. Generally they should not be raised significantly above the floodplain. If track raising is unavoidable, flood impacts would need to be minimised, by locating the track in a non-active part of the floodplain, and by incorporating culverts and bridges.

ii) Providing sufficient openings in irrigation channels, so that flood flows are not obstructed. This may require irrigation channels to terminate a reasonable distance from a watercourse or drainage path. Alternatively, syphons could be installed (see **Figure 3-4**) with provision made for energy losses through the culvert. Another option, which also has advantages for land management and for access, is to totally pipe the channel system underground.

iii) Providing regular openings in spoil banks associated with drainage works, particularly where they run perpendicular to the direction of flood flow, or in some instances, locating surplus spoil outside the floodplain.

■ **Figure 3-4 Channel Crossing – Syphon**

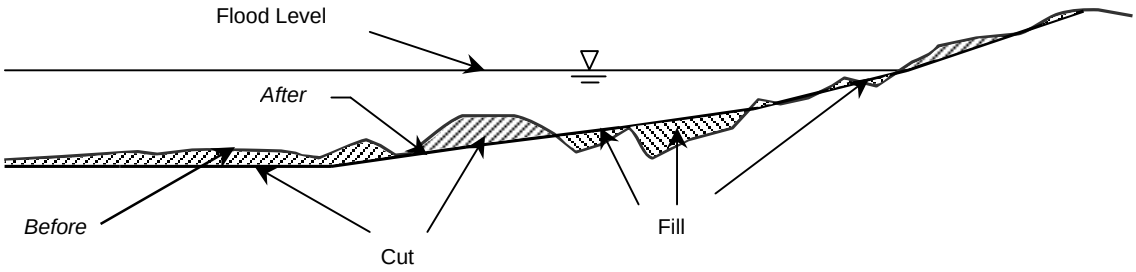


3.2 Land Forming

Land forming involves reshaping of the site to help improve watering efficiency and farm management practices, thereby achieving savings in the quantity of water used, and higher returns through increased yields and better crops. It can also help reduce salinisation by reducing accessions to groundwater.

Generally land forming involves achieving a balance between cut and fill using laser grading or some other technique (refer **Figure 3-5).**

■ **Figure 3-5 Landforming**



When land forming in areas affected by flooding, any reduction in flood storage should be avoided. In other words, the volume of fill on land liable to flooding must be less than or equal to the volume of cut. The cumulative effects of a significant loss in flood storage are to reduce attenuation, thereby increasing the peak flow rate and flow velocities, depths and extent.

In addition, there may be instances where compensatory earthworks achieve no net loss in terms of flood storage, but will adversely restrict the passage of flood waters (ie, flow conveyance).

The introduction of fill onto the floodplain from areas not prone to flooding is not supported in principle. Where filling is contemplated, both flow conveyance and flood storage must not be compromised. Supporting documentation will need to be submitted to the floodplain management authority which demonstrates no adverse impacts of any introduced filling.

Not only is it necessary to ensure the volume of excavated material equals or exceeds the volume of fill material, it is also necessary to ensure that the flow conveyance does not change unreasonably. Excavation concentrated in a relatively small area, with substantial filling of adjacent areas, may be effective for small flows, but this may not necessarily be the case for larger floods. Hydraulic analysis may need to be undertaken in some instances to ensure that reshaping the topography of the floodplain does not change the flow pattern or flood behaviour.

By smoothing out the topographical variations in a site through landforming, the efficiency of surface runoff may increase, leading to higher peak flood flows, with increased velocities and depths and a greater flood extent further downstream. It is therefore usually desirable to include re-use dams to ensure the net runoff does not exceed natural limits.

It is policy within the Shepparton Irrigation Region that where a whole farm plan exceeds 10 hectares, a re-use dam is required or the works must be connected to an existing re-use dam.

Land forming can obliterate natural drainage lines, which can potentially affect natural wetlands. Consideration should be given to preserving drainage lines and/or linear wetlands that contain native flora and fauna. Furthermore, the irrigation layout should ensure there are no flow re-distributions, and that floodwaters accumulating on the subject property can be passed into drainage lines on adjoining land downstream, without unreasonably changing the “pre-development” flow rates, flow velocities or levels.

While vegetation clearance is not part of these guidelines, those preparing whole farm plans and those assessing whole farm plans should ensure the landholder is aware of any native Vegetation Retention Controls and the need to seek approval for vegetation clearance under the relevant provisions of the planning scheme.

4. Assessing Performance

The nature of flooding and its impacts is complex. It is appropriate to engage the services of appropriately experienced surveyors or engineers with expertise in hydrology and hydraulic analysis, as well as surveying, farm infrastructure design and financial planning.

In determining a suitable whole farm plan that satisfactorily meets the floodplain management performance criteria described in **Table 4-1**, designers will need to consider the flood storage aspects. In addition the following characteristics, described in the glossary (Appendix D), may also need to be considered:

- the frequency of flooding;
- peak flood flows, depths and flow distribution;
- flow velocities;
- environmental values of wetlands and other low-lying areas; and
- the effects of afflux.

4.1 Design Principles

The flooding characteristics listed above will vary from case to case, as no floodplain or flood behaves in the same way. However, general design principles can be formulated:

- Proposed works must not unreasonably block or restrict the natural carrying capacity of depressions or flood flow paths, including those that contain constructed drains.
- Proposed works must not unreasonably accelerate flows through these waterways or unreasonably change the distribution of flood flows. As far as practicable, any alterations to topography or new works should include measures that ensure the flow at the upstream and downstream ends of the property are maintained at the same magnitude and distribution as pre-development levels or natural levels.
- Proposed works should be consistent with long term plans to expand drainage works in the Shepparton Irrigation Region and shall be consistent with the Regional Drainage Strategy. There is a need to ensure that future drainage lines that are likely to provide a basis for extending the drainage system, are protected from inappropriate works[4]. It is also in the interests of landholders to know what drainage developments are likely in their areas, so that structures that are costly to install are not found to be in the wrong place, when drainage systems are implemented[5].
- Farm layouts should be consistent with any potential future developments that will help achieve water quality and salinity management objectives.
- Proposed works must not reduce floodplain storage.
- Significant wetland areas should be preserved or enhanced.

[4] One way of doing this is to set aside an easement to leave land aside for a drain.

[5] Best practice guidelines for drainage in dryland catchments (*SMEC, 2002*) provide the long term planning horizon for regional drainage. In addition, G-MW has plans showing major drainage lines for the area (*G-MW, 1998*).

■ Table 4-1 Performance Criteria

Performance Criteria	Design Considerations
PC1: The development does not result in unacceptable risks to life, health or safety, due to impacts on flooding behaviour at other locations.	• Ensure velocities, depths and extents on the property or on neighbouring properties are not affected. • New buildings should be preferably located on high ground. • Access tracks should not be raised above the level of irrigation bays and shall not significantly affect flow distributions, flood storage or flood depth. Landholders shall not rely on low-level access to dwellings that floods by more than 0.8 m in a 100-year ARI event.
PC2: There is no significant change in the direction of existing flows.	• Ensure design layout is sympathetic with the existing flood behaviour. • Have adequate openings in channels, drains, farm tracks or any other raised embankments. • Keep farm channels on the higher sections of land and align parallel to the prevailing direction of flow
PC3: There is no unreasonable change in flow rate or distribution	• Ensure natural inflow and outflow rates are retained and that points of entry and outfall across property boundaries are not unduly altered. • Seek to preserve drainage lines, but where this is impractical, limit the capacity of any downstream drainage line to the “pre-development” capacity upstream of the property. • Minimise flow obstructions which could (for a given flood) lead to a reduction in the flow across the property and therefore an increase in flows elsewhere.
PC4: There is no unreasonable change in the volume of flow across a property boundary	• Ensure that works do not reduce flood storage. • Balance cut and fill. • Avoid raised embankments for farm dams located on the deeper parts of the floodplain.
PC5 The function of flowpaths, drainage lines and significant wetlands is preserved.	• Preserve significant wetlands and natural depressions. • Assess environmental and water quality impacts of any proposed works. • Ensure there are no detrimental environmental impacts on neighbouring properties.
PC6: The design has regard for any future drainage developments and the capacity of existing drainage systems, where known.	• Consult G-MW for any planned drainage expansion (eg Surface Drainage Strategy plans) • Allow space adjacent to significant natural drainage lines for future drain (G-MW has maps showing significant drainage lines).

5. Best Practice Guidelines

The assessment of whole farm plans requires a holistic approach, with decision making covering not just floodplain management issues, but also other planning objectives affecting water quality, land management, irrigation, drainage, vegetation management and environmental values. While compromises may have to be made, it is possible to formulate specific guidelines that ensure the layout of proposed farm works minimises detrimental flood impacts. These are described in **Sections 5.1 to 5.3** and **Appendix B**.

5.1 Raised Earthworks and Flood Protection Structures

These comprise structures that are elevated above the surrounding topography. They include:

- raised access tracks, roads or embankments, and
- channels or drains designed to convey water to or from crops or stock.

The potential impacts of these raised earthworks should be assessed and mitigated in a similar manner. The applicant must demonstrate, to the satisfaction of the floodplain management authority, that that no adverse flood impacts are created to waterways or to adjoining properties. This will generally mean that the proposed works contain sufficient openings or culverts to ensure there is no loss of flood storage, that there are no major alterations to the flow distribution and there is no significant increase in flood levels.

5.1.1 Levees

Levees are raised embankments that protect dwellings and other property against flooding. Artificially constructed levees (or flood protection walls) have the potential to create adverse flood impacts by:

- obstructing flows;
- reducing flood storage; and
- reducing biological diversity by isolating a water course from sections of its floodplain by preventing essential biological processes from occurring and/or causing wetlands to dry up.

Because of their adverse effects, levees are not encouraged.

In some instances levees may be permitted to provide stock refuges. The Floodplain Management Authority may prescribe compensatory works to preserve flood storage, and require the applicant to demonstrate there is no detrimental impact on stream stability, local drainage or environmental values. In such cases, an appropriately experienced and qualified engineer should design the levees.

5.1.2 Raised Access Tracks or Roads and Embankments

A sensible farm layout will ensure that access is readily available to dwellings, and to irrigation and drainage infrastructure in times of flood. However this should not be at the expense of increasing flood impacts, particularly to adjacent landholders.

Embankments can be constructed for a variety of reasons. They might comprise contour banks to intercept flows (in dryland areas), or banks at property boundaries, or they might form access crossings or channel crossings where they pass across a depression.

The key requirement is that these structures do not unreasonably obstruct flows or reduce flood storage.

In order to minimise flood impacts:

- Access tracks should be preferably located on the higher parts of the land and, where possible, should be orientated parallel to the direction of flow.
- Where practicable the height of access tracks should be no more than the height of adjacent finished irrigation bay levels.
- As a general rule, access tracks to dwellings should only be located where the depth of flooding above the surrounding ground level in a 100-year ARI flood is less than 0.8 metres (see **Figure 5-1**). The impacts of raised access tracks would need to be carefully assessed to ensure they do not significantly obstruct flows.
- Where access tracks have the potential to obstruct flood flows, they should be constructed at the natural ground level across the flowpath or depression. This should be for a distance of at least 30 metres, or otherwise sufficient to pass the design flow without increasing upstream flood levels to the degree that they alter flood behaviour and affect adjacent properties. If this is not possible, the section of track crossing the flowpath or depression will need to be designed as an access crossing.
- Embankments should be located and aligned to minimise obstructions to flood flows.

Figure 5-2 illustrates a laneway constructed at the general natural surface elevation across a floodway.

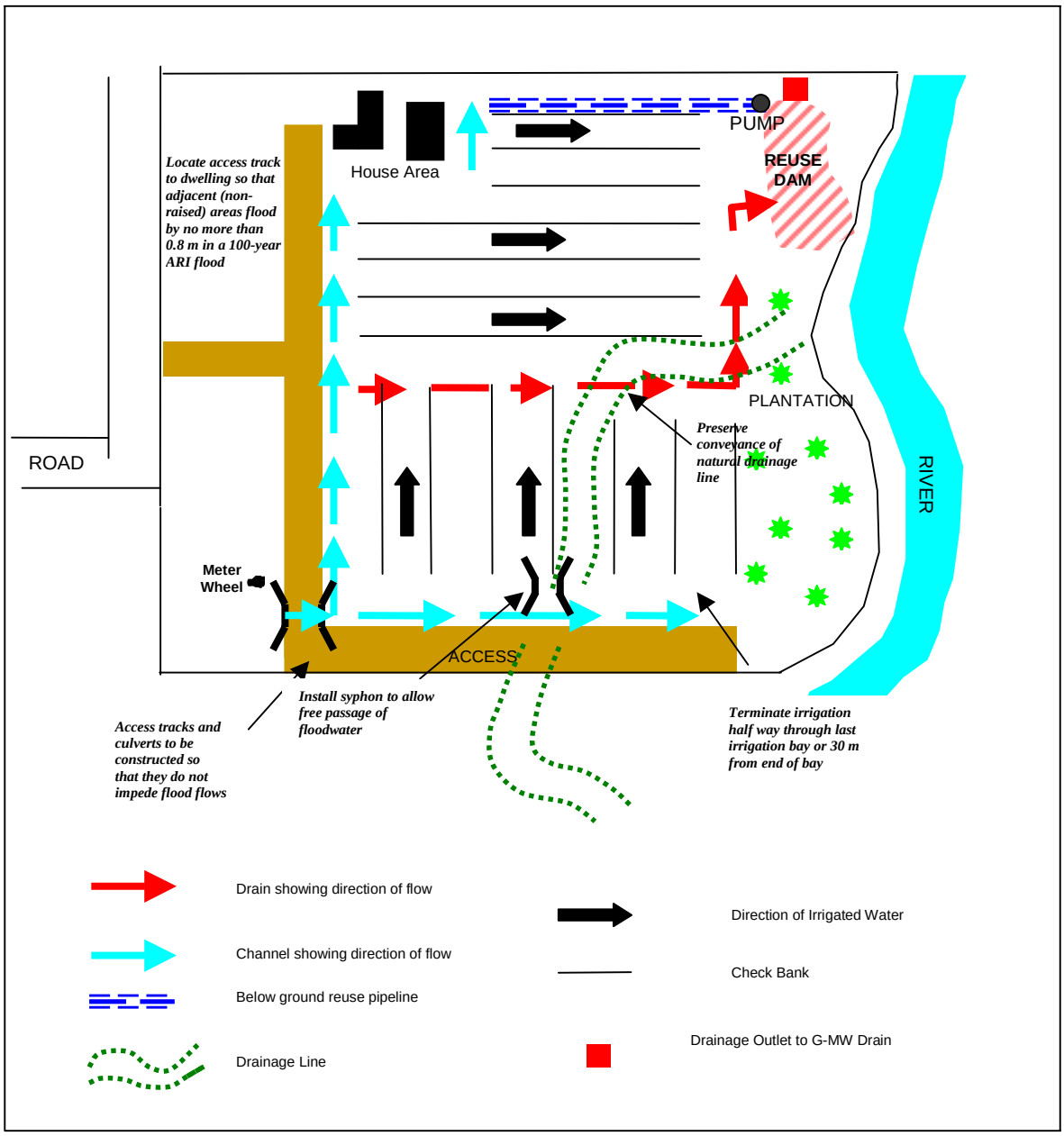
5.1.3 Access Crossings

Access crossings must not impede flows. However, some afflux may be permitted, provided flood impacts are minimal. Potential upstream impacts include increasing the extent of flooding, re-diverting flows, or increasing the depth of flooding.

It should be noted that the effects of afflux are more of an issue rather than the afflux itself. For instance, works that cause a significant increase in water level upstream of the structure may not be a problem if the effects of afflux are contained within a single farm property.

Works on flat floodplains may only generate a slight increase in flood level upstream of the relevant structure. However the flat terrain may mean that even a slight increase in flood level is sufficient to inundate adjacent properties.

■ **Figure 5-1 Simplified Farm Layout**



■ **Figure 5-2 Farm Track Across a Floodway**

As a general guide access crossings shall be designed to allow for the relatively unimpeded passage of flood flows. This will normally require a combination of culverts/bridges through the structure (which will accommodate low flows) plus provision for overtopping (to accommodate the higher flows). There will generally be a trade-off between the size of the culvert(s) or bridge opening and the amount of overtopping, which will be determined from economic and hydraulic considerations.

General design constraints (apart from afflux considerations) are as follows:

- Culverts (where used) are to be free draining.
- The velocities through culverts and bridge openings should generally be low enough to ensure there is no scouring at their entrance or exit points. If this is not practical, energy dissipating structures such as headwalls should be employed, together with rock beaching (see RWC, 1988 for further information).
- The average velocity over well grassed and compacted raised embankments should be no more than 1.0 m/s, and significantly less if they are not well grassed and compacted.[6]

Culvert Design:
Head losses though culverts occur at their entry and exit, at bends and fittings and from friction along the pipe.

As a general guide, pipes should be sized to limit the flow velocity through the pipe to less than 1.0 m/s. Minimum pipe size should be 450 mm. **Table 5-1** below shows the maximum flow that can be passed through pipes if the velocity is limited to 1.0 m/s.

[6] Refer RWC, 1998, pg. 174-175 for information on scour velocities.

- **Table 5-1 Pipe Diameter Vs Flow for Maximum Velocity of 1.0 m/s**

Pipe Diameter (mm)	Maximum Flow (ML/d)
450	15
600	25
750	40
900	55
1050	75
1200	100

In flood conditions, it may be appropriate to utilise the available head to increase the velocity through the culvert. If so, scour protection and/or headwalls will be required.

Various equations, charts and computer software are available for calculating friction loss, based on the Colebrook-White equation, the Manning equation, or some other equivalent equation (refer RWC, 1988 – pg. 217, or CPAA, 1983). These documents also provide technical guidelines on determining entrance and exit losses, and bend losses.

Bridge Design

The size of opening is determined by the need to keep afflux effects and velocities to acceptable limits. The head loss caused by the contraction in the waterway area at the bridge becomes the key consideration, as far as the hydraulic design is concerned. Guidance on design is provided in a number of documents (NAASRA, 1976; AustRoads, 1994, SKM, 2000).

Designing for Overtopping

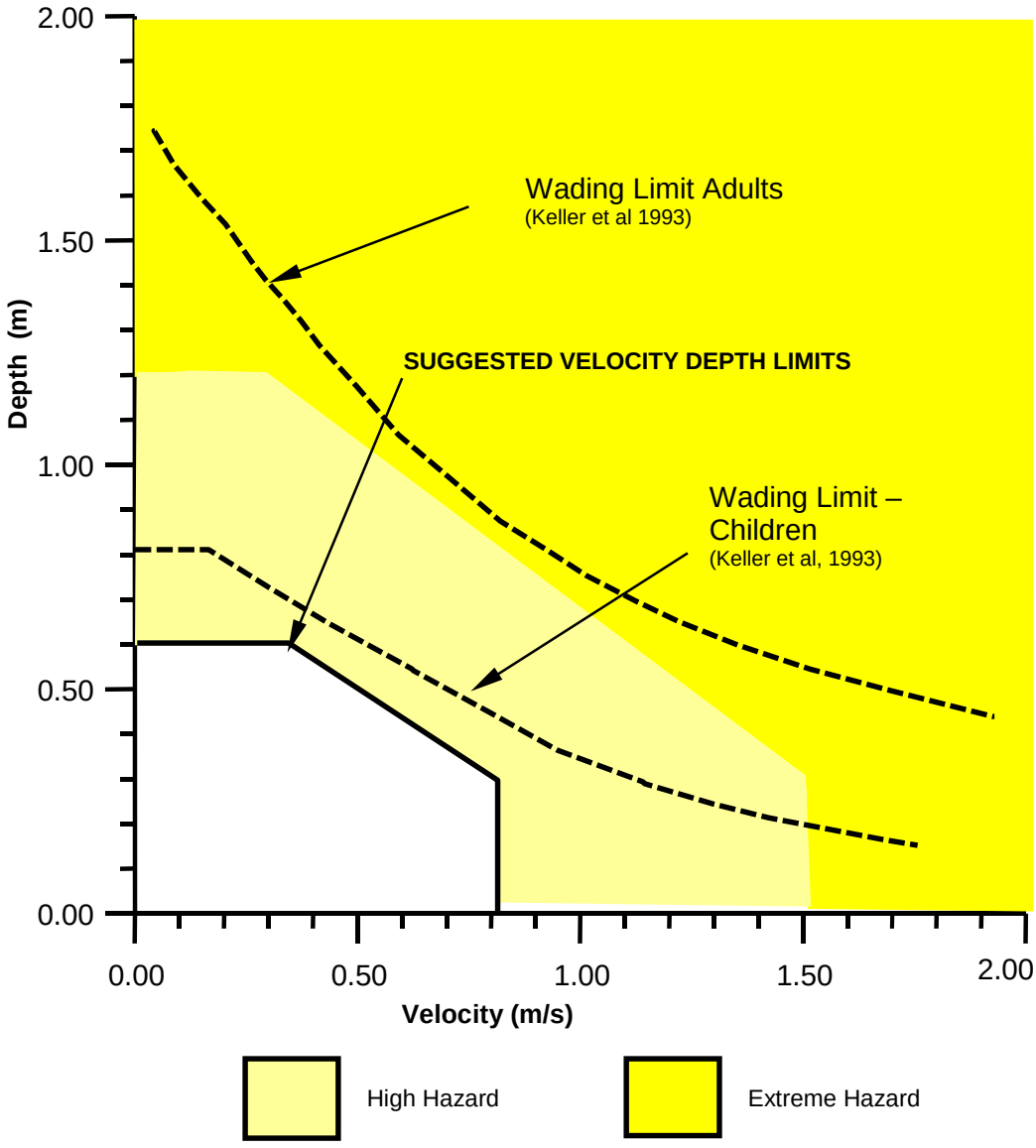
If the proposed culverts or bridge openings are not sufficient for passing 100-year ARI flows, the access crossing will need to be designed to overtop, with afflux, velocity and maximum depth considerations determining the permissible depth of flooding over the bridge and access track. The maximum depth of flooding will vary with the velocity of the floodwaters over the structure, as is illustrated in **Figure 5-3**.

Figure 5-4 shows an incorporated floodway taken from a low level pipe culvert crossing, which is designed to overtop during major floods. It is also worth noting rock protection has been included.

Flood Storage

Along with its capacity to convey flows with minimal increases in flood levels, each access crossing should be checked for its ability to meet flood storage requirements. As a general guide, the area downstream of an access crossing and/or any sections of raised channels, embankments or other structures that impede flows, should be capable of filling in a reasonable period of time. This will depend on the catchment conditions.

■ **Figure 5-3 Assessment of Flood Hazard Based On Depth and Velocity**



(Adapted from Edwards, 1998)

■ **Figure 5-4 Low Level Pipe Culvert with Rock Protection**

5.1.4 Channel and Drain Design

Along with levees, raised tracks and access crossings, channels and drains have the potential to create adverse flood impacts by obstructing flows and reducing flood storage. In the case of drains, they could also reduce biological diversity if they alter the natural drainage characteristics of wetlands. A sensible farm layout will ensure that irrigation and drainage infrastructure on floodplains has regard for these constraints.

Where possible, farm channels and drains should be aligned parallel to the flood flow and shall make adequate provision for maintaining flood storage.

As a general rule, any irrigation layout that cuts across a flood storage area or has the potential to isolate sections of the floodplain must contain openings to ensure available flood storage is utilised.

Approval from Goulburn-Murray Water will need to be sought for external channel supply works and/or drainage inlet works.

Farm Channels

Where farm channels have the potential to obstruct flowpaths they should be designed to terminate midway or 30 m from the end of the most downstream irrigation bay, whichever is the largest (see **Figure 5-1**).

Where farm channels have the potential to isolate sections of the floodplain, provision must be made to ensure flood storage is not adversely affected (see comments on flood storage in **Section 5.1.3**).

If farm channels cannot be curtailed where they cut across flowpaths or flood storage areas, a syphon or several syphons will need to be provided. This is illustrated in **Figure 5-5**

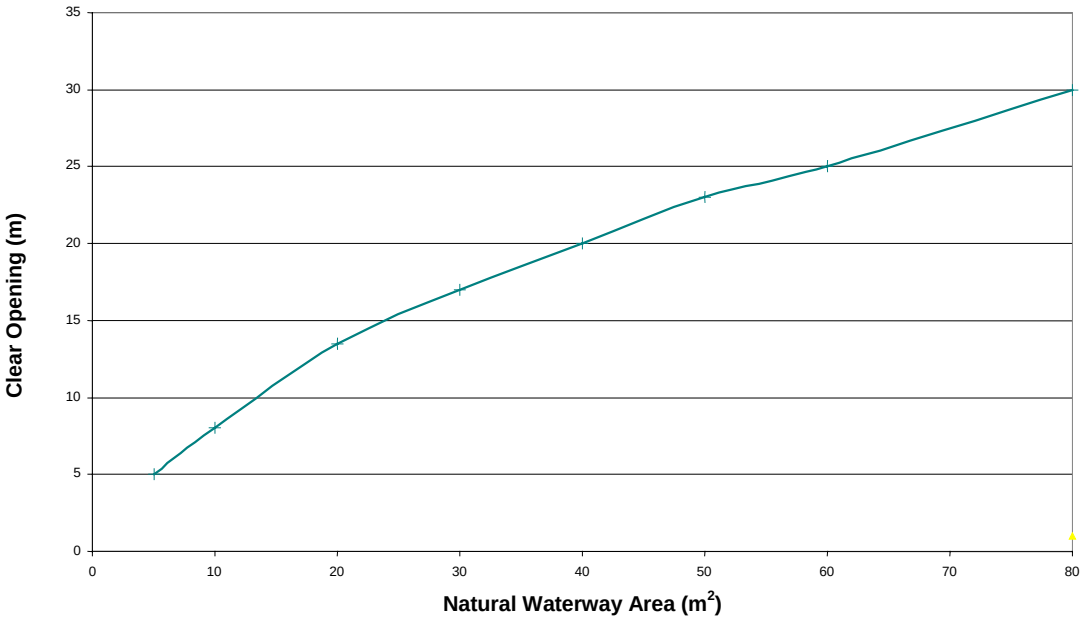
Figure 5-5 Syphon Installed in a Farm Channel to Create an Opening for Floodwaters

Obstructions Across Flowpaths

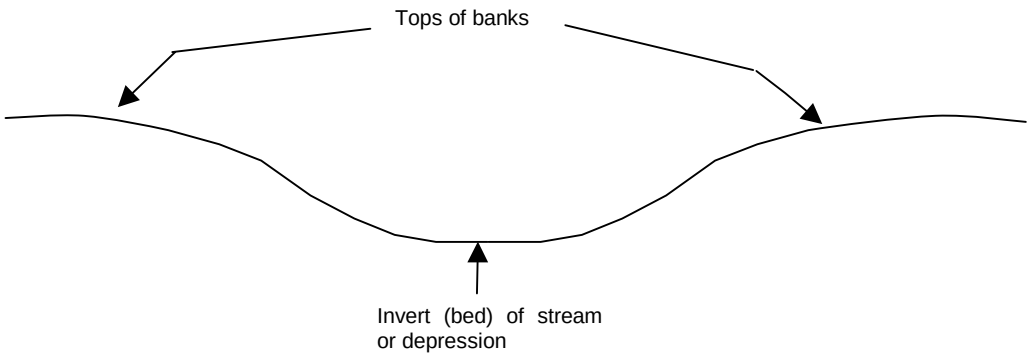
As a general rule, where channels run across streams or flowpaths (depressions), the minimum size of the openings shall be as shown in **Figure 5-6**. The derivation of this relationship is described in **Appendix C**.

Streams or flowpaths (depressions) are considered to be those areas that can be defined as having inverts and tops of banks as shown in **Figure 5-7**.

■ **Figure 5-6 Natural Waterway Area vs Clear Opening Width**



■ **Figure 5-7 Typical Profile of a Stream or Flowpath (Depression)**



If required, the applicant could undertake a more rigorous analysis, to demonstrate to the satisfaction of the CMA, that smaller openings can be achieved without creating significant afflux.

Designers should explore various farm channel arrangements to maximise floodplain functionality. **Figure 5-8** is an example where a farm channel was aligned 45^0 leaving the corner of the property free from obstructions.

■ Figure 5-8 Farm Channel Aligned to Maintain Floodway Across Property Corner

Overland Flooding

For overland flooding, a cumulative opening of 10% of the total length of floodplain obstructed will normally be sufficient, to allow for flood storage and conveyance. For example a 1,500 metre long farm channel would require at least a single or multiple openings totalling 150 metres. Farm channel openings should be positioned in low points where possible.

Height of Farm Channels

The height of farm channels would generally be determined by the need to command land for irrigation. In some isolated cases, there may be a need for the design level of a farm channel to be higher than the specified supply level in a G-MW's channel. Arrangements would need to be in place to ensure water cannot backflow from the farm into the authority's channel. However, in general, farm channels that are raised higher than what is considered to be sufficient to supply water by gravity will not be permitted.

In instances where a section of farm channel merely transfers water to be utilised elsewhere on the farm, consideration could be given to pumping water over the relevant low-lying area through an underground pipeline.

Farm Drains

The main requirement for farm drains in relation to these guidelines is to ensure the location of any spoil does not obstruct flows or reduce flood storage.

As a general guide, all spoil associated with drains crossing flow paths or flood storage areas[7], is to have a 20 metre gap for each 40 metres of drain length. In high hazard floodway areas, spoil may need to be totally removed.

Check Banks

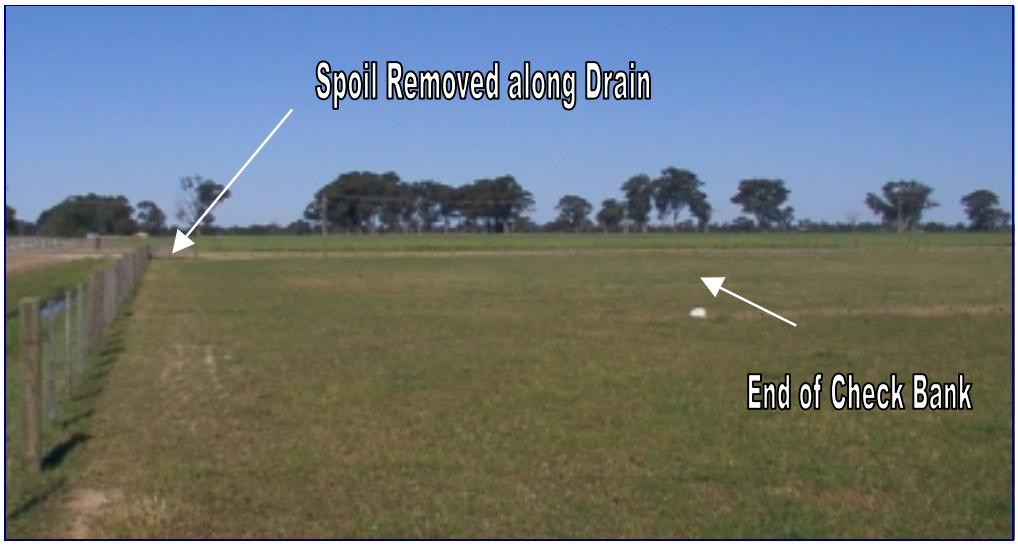
Check banks are typically 300 to 450 mm in height, and are designed to guide irrigation water down the irrigation bay, from the farm channel to the drain. In some instances the irrigation bays adjacent to the drain can interfere with important

[7] These areas will generally be identified as either land identified as FO or LSIO on planning scheme maps, or as land associated with active flowpaths or passive flood storage areas in maps held by G-MW (see Section 2.4). However, areas that are known to flood but not shown on these maps should be treated in a similar manner.

flowpath areas. Check banks within these areas should be curtailed at least 20 m short of drains.

Figure 5-9 provides an example where spoil material has been removed from the drain with check banks finishing short of the drain.

■ **Figure 5-9 Modifications to Allow for Passage of Floodwater**



5.2 Land Forming

An important principle in respect of land forming is that there should be no net loss of flood storage or flow capacity. Any compensatory measures to maintain an equivalent flood storage or flow capacity under existing conditions must not impact on stream stability, local drainage or environmental values (see Section 3.2). Furthermore, the natural points of entry and outfall across property boundaries must not be unduly altered.

The amount of cut and fill across the floodplain should be minimised with particular attention to prevent filling of any waterway, wetland or depression systems. The landholder will need to prove to the satisfaction of the floodplain management authority that the total volume of fill in the floodplain does not exceed the total volume of excavation. Furthermore, an allowance may need to be made for the loss of flood storage associated with water storages (see **Section 5.3**).

If the amount of reshaping is substantial, hydraulic calculations may be required to ensure flow conveyance for a range of flows is not affected.

5.3 Water Storage

The size of a re-use dam or other storage is determined by the amount of additional runoff attributed to the proposed works[8], plus any allowance for surplus flows from irrigation infrastructure.

[8] If a community drain or G-MW drain is already overloaded, excess runoff from a property may be deemed as the difference between the runoff generated by proposed improvements to irrigation and the “natural runoff, ie the farm in its unirrigated state.

Farm storages come in a variety of shapes and sizes. They are often located on low-lying land so that drainage flows can be harvested.

The Murray Darling Basin Commission has placed a cap on surface water diversions and recent changes now require all farm dams to be licensed or registered except re-use dams which meet Ministerial design criteria. Where new re-use storages exceed 1 ML/10 ha for irrigated land and 2.5 ML/10 ha for rice growing, that component will need to be licensed or registered. In addition to any design considerations listed/mentioned in these guidelines, Goulburn-Murray Water will need to provide approval and conditions for storages that exceed the allowable re-use component from the property or on any waterway.

The inclusion of water storage in whole farm plans is a best practice requirement for three reasons:

- they can help improve water quality and may assist with salinity management by encouraging re-use of irrigation water;
- they can counter any potential increase in surface runoff through land forming, by keeping outflows from a property the same as under natural conditions; and
- they help improve irrigation efficiency through drainage re-use.

If a farm storage is to be located on flood affected land, it is reasonable to expect any loss in flood storage to be compensated by additional excavated areas or some other measure. This principle also applies to the storage of pollutants, such as dairy waste, which need to be protected from flooding.

Farm storages cannot be utilised for flood storage unless they are empty, and in some instances the associated embankment may obstruct flood flows. Therefore compensatory flood storage may be required.

The location of farm storages should be carefully chosen to ensure the passage of flood flows is not adversely affected and that flowpaths are not blocked.

The location of storages should be carefully chosen to ensure the passage of flood flows is not adversely affected, that flowpaths are not blocked, and they do not displace natural water features such as billabongs, areas containing remnant vegetation or other areas of environmental sensitivity.

Sump style dams with the spoil material removed are preferred. Wherever possible, storage dams with embankments should be located outside floodway areas.

6. Other Useful Documents

While these guidelines apply to the consideration of farm works from the perspective of floodplain management, there are other equally important aspects that need to be considered, including:

- drainage outfalls into water courses;
- subsurface drains;
- salinity control works;
- groundwater control works
- water quality;
- works outside floodplains;
- regional drainage schemes;
- erosion control works; and
- native vegetation.

Guidance for these matters can be obtained from a number of documents and agencies, including the following:

- SKM (Jun 1999): *Planning Controls for Earthworks in the Shepparton Irrigation Region Campaspe Shire Council, City of Greater Shepparton, Moira Shire Council. Operation and Application Technical Guidelines.*
- North East Planning Referrals Committee (April, 2001): *Guidelines for the Protection of Water Quality.*
- Goulburn Broken Catchment Management Authority & Murray Dairy (May, 2002): *Dairy Cattle Feedpad Guidelines for the Goulburn Broken Catchment.*
- SMEC (2002): *Goulburn Broken Catchment Management Authority Best Practice Principles and Standards for Drainage in Dryland Catchments.*
- Goulburn-Murray Water: *Shepparton Irrigation Region Land and Water Salinity Management Plan.*
- SMEC (2002): Surface Water Management Strategy Review, Shepparton Irrigation Region
- SKM (2002): Sub Surface Drainage Program Review, Shepparton Irrigation Region Land and Water Salinity Management Plan

In addition, G-MW and NRE can provide pamphlets and information on farm design, flood irrigation, laser grading, irrigation layouts, drainage reuse, farm storages and financial incentives.

7. References

SKM, 2002 Goulburn Broken Catchment Management Authority *Regional Floodplain Management Strategy (2002)*.

AustRoads, 1994 AustRoads: *Waterway Design: A Guide to the Hydraulic Design of Bridges, Culverts and Floodways.* 1994.

Campaspe Shire et al, 1999 Campaspe Shire Council, City of Greater Shepparton and Moira Shire Council: *Planning Controls for Earthworks in the Shepparton Irrigation Region. Operation and Application Technical Guidelines* (June 1999).

DOI, 1997 Department of Infrastructure: *Victoria Planning Provisions* (1997)

DOI et al, 2000 Department of Infrastructure, Department of Natural Resources and Environment and Melbourne Water: *VPP Practice Notes – Applying for a Planning Permit under the Flood Provisions and Applying the Flood Provisions in Planning Schemes. 2 Volumes* (2000).

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SMEC, 2002 SMEC: *Best Practice Principles and Standards for Drainage in Dryland Catchments*, 2002

Smith, 2002 A Smith, Municipal Catchment Coordinator, Shepparton Irrigation Region: *Background Notes, Incorporating Draft Procedures for Whole Farm Plan Certification* (May 2002).

USACE, 1995 US Army Corps of Engineers. Hydrologic Engineering Centre: *HEC-RAS River Analysis System. Hydraulic Reference Manual*. (July 1995). Other versions available.

Appendix A Useful Contacts

Organisation	Address	Phone	Facsimile
Aboriginal Affairs Victoria	PO Box 515 (Level 10/8 Nicholson Street) EAST MELBOURNE VIC 3002	9637 8000	9637 8024
Cultural Heritage Program – North East Region	Yorta Yorta Clans Centre Cnr Maloney and Shiels Street BARMAH VIC 3639	5869 3353 or 5869 3380	5869 3352
Department of Sustainability and Environment (NRE)	PO Box 500 (8 Nicholson Street) EAST MELBOURNE VIC 3002	9637 8000	9637 8100
NRE North East Region	35 Sydney Road BENALLA VIC 3672	5761 1611	5761 1628
NRE Northern Irrigation Regional Office	Ferguson Road TATURA VIC 3616ra	5833 5222	5833 5299
Department of Infrastructure	Level 14, 80 Collins Street, (GPO Box 2797Y) MELBOURNE VIC 3000	(03) 9655 6666	(03) 9655 6752
Department of Infrastructure	North East Region, 50-52 Clarke Street BENALLA VIC 3672	57611857	5762 7870
Environment Protection Authority	Herald and Weekly Times Tower PO Box 4395Q (40 City Road) SOUTHBANK VIC 3006	9695 2700	9695 2780
Goulburn Broken Catchment Management Authority	PO Box 1752 (55 Welsford Street) SHEPPARTON VIC 3632	5822 2288	5831 6254
Goulburn-Murray Water	PO Box 165 (40 Casey Street) TATURA VIC 3616	5833 5500	5833 5501
VicRoads-Northern Region	57 Lansell Street (PO Box 204) BENDIGO VIC 3550	13 11 74	
VicRoads – North Eastern Region	50-52 Clarke Street (PO Box 135) BENALLA VIC 3672	13 11 74	

Appendix B Components of a Plan

B.1 Site Plan

Where applicable, the information below should be provided on plans, as a minimum. ***Existing and proposed arrangements must be shown on separate plans to facilitate assessment.***

Cadastral and Topography

- detailed ground contour information under existing conditions and following implementation of the proposed works if approved (30 m grid)[9];
- significant features, eg property boundaries, existing fences (where appropriate), property access and stock movement via internal and external road/track network, wetlands, saline areas, watercourses, G-MW channels and drains, community drains, any significant vegetation (existing or proposed);
- existing irrigation area (hectares);
- proposed irrigation area (hectares);
- areas of cut and fill.

Soil and Drainage Features

- dominant soil type(s);
- location of any significant drainage lines (these may have been previously identified in Goulburn-Murray Water maps showing drainage lines for the Shepparton Irrigation Region (see Section 2.4);
- details of any potential Primary or Community Surface Water Management system (consult Goulburn-Murray Water);
- drain details (existing and proposed):
  - drain capacity;
  - drain dimensions;
  - drain slope;
  - representative berm elevations in AHD at upstream and downstream ends of each section, and every 100-300 m (if elevated) and locations of openings;
  - spoil details (location, alignment, height, openings);
  - description and location of associated structures (relevant dimensions, eg width, length, depth, diameter, length, type);
  - drainage structure details – type (eg outfall point or drainage inlet) levels, dimensions, location, description of where the water goes (eg outfalls to formal drain (name the drain) or to drainage line).

Irrigation Features

- supply level in G-MW Channel, outlet location and details;
- existing and proposed irrigation bay dimensions, as a minimum:
  - top of bay elevation;
  - bottom of bay elevation;

[9] In some cases detailed topographic information may not be warranted. For example if there is only sufficient water right to irrigate part of a property, or if there are areas unsuitable for irrigation, then there is no need to survey and design the full area. Alternatively, if the proposed works are relatively minor, survey could be limited to key features to ensure the works will achieve their desired objectives.

  - width and length of bays;
- location of channels, drains and access tracks;
- channel details (existing and proposed):
  - channel capacity;
  - representative cross sections (bed and banks, showing width, depth and slopes to scale);
  - representative channel heights at upstream and downstream ends of each section, and every 100-300 m (bed and bank elevations);
  - description and location of associated structures such as syphons and crossings (relevant dimensions, eg width, length, depth, diameter, length, type.

Storages

- storages/re-use system (existing and proposed);
  - sump details (location, capacity, dimensions, bed elevations);
  - other storage details (location, type, capacity, dimensions, bed elevations, embankment details including top of bank);
  - details of any associated structures, eg pump and motor details;
  - water delivery system details;
- dairy effluent pond (if any) – location, size, dimensions, discharge point;
- farm crossings (existing and proposed).

Crossings

  - centreline elevations in AHD;
  - details of crossings (location, type, culvert size and capacity, dimensions, bed elevations, embankment details including top of crossing).

Vegetation

- vegetation details[10] (existing and proposed);
  - native vegetation (type, location, density);
  - non-native vegetation (type, location, density).

B.2 Other Information

Mandatory:

- estimated cost of the works;
- whether or not the land may be affected by a future Primary or Community Surface Water Management system;
- details of any restrictive covenents applying to the land;
- copy of the Certificate of Title or other plan sufficient to identify the location of the property.
- an assessment to demonstrate that the proposed works do not significantly increase flood risks for upstream, adjacent and downstream areas, unless approved by the floodplain management authority.

Where flood inundation maps are available, flooded areas should also be shown on the plan (light blue for land subject to inundation and medium-dark blue for floodway). Significant drainage lines should also be shown.

[10] If native vegetation is to be removed, separate advice should be sought from NRE to ascertain any conditions or requirements.

Desirable:

- aerial photography of the property and/or other information to establish existing directions of water flow;
- details on the flooding history of the property;
- any relevant information on how water levels, flow velocities, flow distribution, or discharge into and out of the property will be affected;
- an assessment to demonstrate that the proposed works do not significantly increase flood risks for upstream, adjacent and downstream areas.

B.3 Plan Layout

Guidelines on whole farm plan layouts are provided in RWC document entitled: "Design Guidelines for Whole Farm Plans for Irrigation" (Volume 2).

Appendix C Waterway Openings

Where channels cut across streams and flowpaths, openings shall be provided to allow for flow conveyance. A relationship was established in Section 5.1.4 to determine the minimum size of opening required. The analysis was based on the following methodology:

1) A design cross section having a bed width of 40 m, and side slopes of 1 vertical to 40 horizontal was assumed.

2) Depths of flooding were assumed to range from 0.2 m to 1.0 metres approximately.

3) Average bed slopes of 0.1 m /1000 m, 0.5 m/1000 m and 0.7 m / 1000 m were investigated (typical of those encountered in the Shepparton Irrigation Region).

4) Manning's formula was used to calculate the flow capacities for the range of slopes and depths of flooding considered. The formula is:

   $Q = AR^{2/3}S^{1/2}/n$, where:

   Q = the design flow (m^3/s)
   A = the waterway area (m^2);
   R = the hydraulic radius = the waterway area divided by the "wetted perimeter."
   S = the hydraulic slope, which was approximated to the bed slope
   n = Manning's roughness coefficient.

5) Manning's n values used in the analysis varied from 0.10 for a depth of 0.3 m, to 0.05 for depths greater than 0.6 m.

6) Opening sizes were determined using the formula:

   $\text{Afflux} = \alpha v^2/2g$, where:

   v = the velocity at the constricted opening
   g = gravitational acceleration = 9.81 m^2/s
   α = a variable.

7) Afflux limits varied according to the bed slope, and were generally that required to accommodate the increase in level over a distance of approximately 250 m.

8) A number of values for α were estimated from HECRAS hydraulic modelling, with remaining values interpolated. A number of runs were modelled for a range of flows, slopes and openings, with the afflux at the constriction being determined by subtracting the water level at the constriction from a run in which there was no constriction.

Appendix D Glossary

AAD
Average annual damage, the average damage per year that would occur in a particular area from flooding over a very long period of time. This provides a basis for comparing the economic effectiveness of different projects.

Access Crossing
Farm laneway or track that crosses a depression. It will generally comprise either a bridge or a raised formation across the depression, with a culvert or culverts to maintain low flows. For the latter case, in times of major floods, flows in excess of the culvert capacity will pass over the raised formation.

Active Flowpaths
Significant drainage lines, watercourses other features associated with the conveyance of floodwaters, either continuously or intermittently. They may have important implications for preservation of water quality and preservation of aquatic habitat. To preserve the passage of flood flows, main flow paths should be kept free from obstructions wherever possible.

AEP
Annual exceedance probability, the likelihood of occurrence of a flood of a given size or larger occurring in any one year. A 1% AEP event is effectively a 100-year ARI flood.

Afflux
The rise in the water level caused by works, as measured at a particular flow rate or flood frequency.

AHD
Australian Height Datum is the adopted national height datum that generally relates to height above mean sea level.

ARI
Average Recurrence Interval, the likelihood of occurrence of flooding, expressed in terms of the long-term average number of years between the occurrence of a flood as large as or greater than the flood being referred to. For example, a flood with a discharge as large or greater than the 100-year ARI flood will occur on average every 100 years.

Bridge
A clear span structure across a stream, roadway, carrying a road, path, pipe, railway, etc.

Catchment
The area draining to a particular site. It always relates to a specific location and includes the catchments of the main stream and its tributaries.

Channel/Farm Channel
Open channel or flume designed to convey water from an upstream water source to farms. **Main channels** primarily convey bulk water from headworks storage or river diversion points to the distribution system. **Distribution channels** primarily deliver water from the man channels to individual farms. **Farm channels** distribute water within individual properties. The bed and banks of channels are typically raised above the surrounding ground to permit gravity irrigation.

Contour Banks
Raised banks constructed along contour lines designed to control surface runoff. In many instances they will direct flows towards farm storages.

Channel or Delver Crossing
A section of channel/delver that crosses a depression. All flood flows along the depression will need to pass under the farm channel (drainage subway) or a section of channel will need to be piped beneath the depression (syphon).

Check Banks
Small banks along the sides and in some cases the bottom of irrigation bays, for assisting control the extent of watering.

Contour Bank
Small banks constructed along the natural contours of land to train overland flows and minimise soil erosion.

Depression Reshaping
A type of landforming, involving parallel banking and/or reshaping along a depression, with filling of depression fringe areas. Care must be taken to ensure wetlands are protected and there is no change in flood impacts on adjoining property.

Development
The erection of a building or the carrying out of works, or the use of land or of a building of works.

Drain
A conduit for removing the additional runoff resulting from irrigation of the catchment. One of the aims of drainage design is to add capacity to the natural drainage system sufficient only to offset the effects of irrigation. It is fundamental that the natural drainage capacity be maintained for the purpose of conveying natural runoff.

Drainage Runoff
Flow of surface water from a given area resulting from the effects of rainwater and/or applied irrigation water not taken up by crops or leached.

Drainage Subway
Conduit laid transversely under a supply channel to convey natural drainage flows across the channel.

Earthworks
Any change to the natural or existing topography that alters the direction or rate of flow of water across a property boundary, or changes the discharge point of water. It includes land forming, laser grading, levee construction, roads, tracks, aqueducts or channels, water storages, drains and any associated structures.

Effective Warning Time
The time available for residents in flood prone areas to defend their properties and/or evacuate themselves and their moveable possessions after having received a warning to do so. The longer the available warning time and the more flood aware the population, the more effective defence and evacuation procedures will be.

Embankment
Raised mound of earth for confining water or carrying road or other infrastructure.

Environmental Values (of Floodplains)
Those aspects associated with the natural functions of floodplains in replenishing wetlands, transporting food supplies, triggering the life cycles of many plants and animals and protecting streams from high sediments and nutrient loads.

Farm Plan
A plan for a proposed development associated with an agricultural use.

Farm Re-use Dam
On farm storage system that helps improve water quality and manage salinity problems through recycling surplus irrigation runoff.

Farm Track
Privately owned road that provides access to farm dwellings and/or infrastructure.

Floodplain Management
The planning and flood impact prevention/minimisation activities of flood management together with related environmental activities.

Floodplain Management Authority
Any Authority with direct or delegated functions for Floodplain Management under Part 10, Division 4 of the Water Act, 1989. The main floodplain management authorities are Melbourne Water, Catchment Management Authorities, and the Minister for Agriculture and Resources (for areas not covered by a delegated Authority).

Flood Depth
Linear measurement from the surface of floodwaters to the bottom. Along with velocity, flood depth is a critical factor in determining the flood hazard, particularly in terms of personal safety and the potential for major structural damage. Both are dependent on the size of the flood and the hydraulic characteristics of the floodplain.

Wading by able bodied adults becomes difficult and dangerous when velocities are relatively high even when depths are comparatively low. Conversely wading is also dangerous when depths are large and velocities are low. This risk increases when depressions, pot holes, fences and other structures and features are hidden.

The passage of small motor vehicles through floodwaters is considered a risk when water depths exceed 0.3 m. For larger vehicles the depth increases to about 0.5 m to 0.8 m provided the flow velocity doesn't exceed 0.5 m/s.

Flood Duration
The time taken for a flood to pass.

Flood Storage Areas

That part of the floodplain which temporarily store floodwater, to be later discharged as the flood recedes. Flood storage areas are important for the attenuation of a flood and consequent reduction in the flood levels and velocities during the passage of a flood.

Flood Storage Characteristics
Factors that influence a floodplain's capacity for flood storage. They include the slope of the land, the width of the floodplain and the duration of flooding. Flows through flood storage areas may be almost stationary (as with inflows into a swamp or lake) or slow moving (as occurs within wide floodplains adjacent to perched watercourses).

Flood storage is important for all floodplains. If water is prevented from occupying some part of the floodplain by obstructions (such as levees, channels, raised roads, etc.) the loss of flood storage causes higher flows downstream.

The effects of flood storage will be more critical for floodplains in rural areas with wide, slow moving floodwaters. Narrow floodplains and/or fast flowing water will result in the rate of recession of floodwaters in the floodplain being similar to that of the river/creek.

Flood Volume
The total volume of flood water for a given flood. This is a useful indicator of the severity of flooding and is related to both the duration of flooding and the change in flood flow rate over time.

Floodway (non-structural)
The channel, stream and that portion of land liable to flooding necessary to store and convey the main flow of floodwater. It usually comprises the high hazard portion of the floodplain where most development is to be avoided. Floodways are usually areas where a significant volume of water flows during floods and are areas, which even if only partially blocked, would cause a significant redistribution of flood flow or a significant increase in flood levels, which in turn may adversely affect other areas.

Floodway (Structural)
Constructed works to redirect a portion of floodwaters away from areas under threat from flooding, thereby reducing flood levels along the channel downstream of the diversion.

Floodway Overlay
An overlay in municipal planning schemes which shows urban and rural areas of active flood flows or significant flood storage.

Flow Distribution
The dispersal of flood flows across a floodplain. This is influenced by the number and relative capacities of flowpaths, the slope perpendicular and parallel with the direction of flow, soil type, vegetation, and obstructions on the floodplain.

Flow Velocities
The speed of the flood flow, which is not constant but will vary across the floodplain and will be influenced by geometry, obstructions to flow and the relative roughness of the floodplain.

Freeboard
Vertical distance between the design level and the top of a channel or embankment.

Freeboard takes into account uncertainties in design values and allowances for wave action and, settlement. Freeboard should not be relied upon to provide protection for events larger than the design value.

Frequency of Flooding
This refers to how often flooding occurs. This is usually expressed in terms of the "average recurrence interval" or annual exceedance probability.

Hydraulics
The study of water flow, in particular the evaluation of flow parameters such as water level and flow velocity in a river, stream or adjacent floodplain.

Hydraulic Slope/Friction Slope
The slope of the energy grade line (under uniform flow conditions), which is generally similar to the slope of the water surface level. For these guidelines this can be approximated to the average bed slope.

Hydrology
The study of the rainfall and runoff process as it relates to the derivation of flow in watercourses.

Landforming
The re-shaping of land, usually involving a combination of filling in low-lying areas and excavating higher areas in order to improve the distribution and management of irrigation water on a property. Care must be taken to ensure there is no net loss in flood storage.

Laser Grading
The use of laser beam controlled land forming equipment to grade irrigation farms to produce a very even slope. The technique enables farms having many small bays to be transformed into a layout comprising a small number of wide and long bays with little or no cross slope.

Land Fill
Material imported onto the floodplain. Generally land fill shall be restricted to a building pad for a dwelling, so that there is no loss of flood storage.

Land Subject to Inundation (LSI).
Land that will be inundated by a design flood. Unless stated otherwise, LSI is usually taken to mean land inundated by the 100-year ARI flood or the flood of record.

Land Subject to Inundation Overlay (LSIO)
An overlay that shows Land Subject to inundation, unless delineated as Floodway Overlay. LSIO can also be used as an interim measure to identify flood-affected areas where detailed information to define floodway is not available.

Levee
Natural or artificial embankment constructed to protect property from flooding.

Local Floodplain Development Plan
A set of requirements and guidelines for development in a particular area, prepared by the relevant municipal council in consultation with the floodplain management authority. If a local floodplain development plan exists for an area and has been incorporated into the council's planning scheme, an planning permit application must be consistent with the plan.

Local Planning Policies (LPPs)
Local planning policies adopted by municipalities in their planning schemes.

Municipal Planning Scheme
A combination of statewide and local land use and development objectives, strategies, land zones and overlays that set the direction for the use, development and protection of land within the relevant municipality.

Overland Flooding
Inundation by local runoff or overbank discharge associated with widespread, shallow flooding at low velocities.

Passive Storage Areas
Low basins, backwaters, depression loops and similar features into which water spills during a flood. They provide flood detention storage capacity that moderates flow through the system (see also "Flood Storage").

Peak Discharge
The maximum discharge occurring during a flood event.

Responsible Authority
The specified body or agency which administers and enforces a planning scheme.

Risk Management
The systematic application of management policies, procedures and practices to the tasks of identifying, analysing, assessing, treating and monitoring risk.

Runoff
The portion of rainfall which actually ends up as streamflow.

Stakeholder
A person, group, authority or organisation which has an interest or involvement in floodplain management.

Stormwater Flooding
Inundation by local runoff. This occurs when the capacity of stormwater drainage systems is exceeded. It can also occur when high flood levels at their point of discharge into rivers and streams prevents stormwater systems from functioning properly, leading to drain overflows.

Supply Point (or Farm Offtake)
The point of delivery from the supply system of an irrigation authority to an individual farm. This usually comprises a small gated regulator or pipe outlet, which may incorporate a measurement device such as a Dethridge meter outlet or an in-line flow meter.

Syphon
A structure or section of a pipeline that conveys channel flow under a natural depressions, river or drain.

Topography
Relating to the natural and proposed surface and features. A topographic map relates to the representation of the natural and artificial features of the relevant locality.

Whole Farm Plan
An integrated plan that considers the most appropriate form of development, having regard for long term financial, agronomic and environmental planning, when developing irrigation and drainage layouts.

Works
Any change to the natural or existing condition or topography of land including the removal, destruction or lopping of trees and removal of vegetation or topsoil.

Victoria Planning Provisions (VPPs)
Uniform statewide format for municipal planning schemes which contain a state planning policy framework, a local planning policy framework and a series of zones and overlays.